HISTORY OF THE SECOND WORLD WAR

UNITED KINGDOM MEDICAL SERIES

Editor-in-Chief :

SIR ARTHUR S. MACNALTY, K.C.B., M.A., M.D., F.R.C.P., F.R.C.S.

THE ARMY MEDICAL SERVICES

EDITED BY
F. A. E. CREW, F.R.S.

Administration

VOLUME II

LONDON
HER MAJESTY'S STATIONERY OFFICE
1955

First Published 1955

PUBLISHED BY HER MAJESTY'S STATIONERY OFFICE
To be purchased from
York House, Kingsway, LONDON, W.C.2 423 Oxford Street, LONDON, W.1
P.O. Box 569, LONDON, S.E.1
13a Castle Street, EDINBURGH, 2 109 St. Mary Street, CARDIFF
39 King Street, MANCHESTER, 2 Tower Lane, BRISTOL, 1
2 Edmund Street, BIRMINGHAM, 3 80 Chichester Street, BELFAST
or from any Bookseller
1955

Price £3 5s. od. net

Printed in Great Britain under the authority of Her Majesty's Stationery Office by John Wright & Sons Ltd., at the Stonebridge Press, Bristol.

PREFATORY NOTE

BY THE EDITOR-IN-CHIEF

THIS volume of the Official Medical History of the Second World War, edited by Professor F. A. E. Crew, D.Sc., M.D., F.R.S., is the second and last volume dealing with the administration of the Army Medical Services during the war. It is concerned with certain special aspects of medical administration.

Chapter I deals with the fine record in efficiency, self-sacrifice and devotion of the Army Nursing Service. Then comes the chronicle of the Army Hygiene Service. This Service, by safeguarding the health of the soldier, did much to prevent those deadly epidemics of infectious disease which, formerly, from the days of Sennacherib onwards, wreaked more havoc in armies than the enemy and brought campaigns like the ill-fated Walcheren expedition to an untimely close. Four chapters, including a chapter on certain diseases of military importance and the hygiene of prisoners-of-war, are devoted to this Service as it developed in extent and efficiency in all theatres of war. In Chapter 5 the creation of the Army Dental Service and its evolution during the war are considered. The remaining seven chapters treat of the Army Pathology Service, the Army Blood Transfusion Service, Medical Provision for the Auxiliary Territorial Service, the Army Psychiatric Service, the Directorate of Medical Research, of which Professor Crew was the first Director, the Army Ophthalmic Service, and the Army Radiological Service.

Certain of these special services were new departures; others were already in being, but were developed to serve the needs of warfare on a comprehensive scale. These historical accounts teach lessons from the past which, it is hoped, will be of value for the future.

This volume has been prepared under the direction of an Editorial Board appointed by H.M. Government, but the Editor alone is responsible for the presentation of the facts and the opinions expressed.

January, 1954. ARTHUR S. MACNALTY

EDITORIAL BOARD

Sir CYRIL FLOWER, C.B., F.S.A. (*Chairman*)

Sir WELDON DALRYMPLE-CHAMPNEYS, Bart., D.M., F.R.C.P. Sir FRANCIS R. FRASER, M.D., F.R.C.P.	*Ministry of Health*
Sir ANDREW DAVIDSON, M.D., F.R.C.P. Ed., F.R.C.S. Ed. A. K. BOWMAN, M.B., Ch.B., F.R.F.P.S.	*Department of Health for Scotland*
J. BOYD, M.D., F.R.C.P.I.	*Government of Northern Ireland*
Sir HAROLD HIMSWORTH, K.C.B., M.D., F.R.C.P., Q.H.P. JANET VAUGHAN, O.B.E., D.M., F.R.C.P.	*Medical Research Council*
Surgeon Vice Admiral Sir ALEXANDER INGLEBY MACKENZIE, K.B.E., C.B., B.M., B.Ch., Q.H.P.	*Admiralty*
Lt. General Sir FREDERICK HARRIS, K.B.E., C.B., M.C., M.B., Q.H.S. Major General A. SACHS, C.B.E., Q.H.P.	*War Office*
Air Marshal Sir JAMES M. KILPATRICK, K.B.E., C.B., M.B., B.Ch., D.P.H., Q.H.P.	*Air Ministry*
Brigadier H. B. LATHAM A. B. ACHESON, ESQ., C.M.G.	*Cabinet Office*

Editor-in-Chief: Sir ARTHUR S. MACNALTY, K.C.B., M.A., M.D., F.R.C.P., F.R.C.S.

Secretary: W. FRANKLIN MELLOR

The following persons served on the Editorial Board for varying periods:

The Rt. Hon. R. A. Butler, P.C., M.A., F.R.G.S., M.P. (*Chairman*); Brigadier General Sir James E. Edmonds, C.B., C.M.G., D.Litt. (*Committee of Imperial Defence*); Surgeon Vice Admiral Sir Sheldon F. Dudley, K.C.B., O.B.E., M.D., F.R.C.P., F.R.C.S.Ed., F.R.S.; Surgeon Vice Admiral Sir Henry St. Clair Colson, K.C.B., C.B.E., F.R.C.P.; Surgeon Vice Admiral Sir. Edward Greeson, K.B.E., C.B., M.D., Ch.B. (*Admiralty*); Lt. General Sir William P. MacArthur, K.C.B., D.S.O., O.B.E., M.D., B.Ch., D.Sc., F.R.C.P.; Lt. General Sir Alexander Hood, G.B.E., K.C.B., M.D., F.R.C.P., LL.D.; Lt. General Sir Neil Cantlie, K.C.B., K.B.E., M.C., M.B., F.R.C.S.; Major General H. M. J. Perry, C.B., O.B.E., F.R.C.P.; Major General L. T. POOLE, C.B., D.S.O., M.C., M.B., Ch.B.; Brigadier J. S. K. Boyd, O.B.E., M.D., F.R.S.; Brigadier H. T. FINDLAY, M.B., Ch.B. (*War Office*); Air Marshal Sir Harold E. Whittingham, K.C.B., K.B.E., M.B., Ch.B., F.R.C.P., F.R.C.S., LL.D.; Air Marshal Sir Andrew Grant, K.B.E., C.B., M.B., Ch.B., D.P.H.; Air Marshal Sir Philip C. Livingston, K.B.E., C.B., A.F.C., F.R.C.S. (*Air Ministry*); Sir Edward Mellanby, G.B.E., K.C.B., M.D., F.R.C.P., F.R.S. (*Medical Research Council*); Professor J. M. Mackintosh, M.A., M.D., F.R.C.P. (*Department of Health for Scotland*); Lt. Colonel J. S. Yule, O.B.E., Philip Allen, Esq., G. Godfrey Phillips, Esq., M. T. Flett, Esq., A. M. R. Topham, Esq., D. F. Hubback, Esq. (*Cabinet Office*).

EDITORIAL COMMITTEE

Sir ARTHUR S. MACNALTY, K.C.B., M.A., M.D., F.R.C.P., F.R.C.S. (*Chairman*)

Surgeon Commander J. L. S. COULTER, D.S.C., M.R.C.S., L.R.C.P. (Barrister-at-Law)	*Admiralty*
Professor F. A. E. CREW, D.Sc., M.D., F.R.C.P. Ed., F.R.S.	*War Office*
Squadron Leader S. C. REXFORD-WELCH, M.A., M.R.C.S., L.R.C.P.	*Air Ministry*
A. K. BOWMAN, M.B., Ch.B., F.R.F.P.S.	*Department of Health for Scotland*
J. BOYD, M.D., F.R.C.P.I.	*Government of Northern Ireland*
F. H. K. GREEN, C.B.E., M.D., F.R.C.P.	*Medical Research Council*
J. ALISON GLOVER, C.B.E., M.D., F.R.C.P.	*Ministry of Education*
A. SANDISON, O.B.E., M.D.	*Ministry of Pensions*
Lt. Colonel C. L. DUNN, C.I.E., I.M.S. (ret.) Sir ZACHARY COPE, B.A., M.D., M.S., F.R.C.S.	*Ministry of Health*

Secretary: W. FRANKLIN MELLOR

The following persons served on the Editorial Committee for varying periods:

Surgeon Commander J. J. Keevil, D.S.O., M.D., Surgeon Lieutenant L. D. de Launay, M.B., B.S., Surgeon Lieutenant Commander N. M. McArthur, M.D., Surgeon Commander A. D. Sinclair, M.B., Ch.B. (*Admiralty*); Colonel S. Lyle Cummins, C.B., C.M.G., LL.D., M.D. (*War Office*); Wing Commander R. Oddie, M.B., B.Ch., Wing Commander E. B. Davies, M.B., B.Ch., Squadron Leader R. Mortimer, M.B., B.S., Squadron Leader H. N. H. Genese, M.R.C.S., L.R.C.P. (*Air Ministry*); Charles E. Newman, M.D., F.R.C.P., N. G. Horner, M.D., F.R.C.P., F.R.C.S. (*Ministry of Health*).

CONTENTS

ILLUSTRATIONS

FIGURES

PLATES

THE ARMY HYGIENE SERVICE

THE ARMY DENTAL SERVICE

THE ARMY TRANSFUSION SERVICE

THE ARMY RADIOLOGICAL SERVICE

TABLES

THE ARMY NURSING SERVICE

THE ARMY HYGIENE SERVICE

THE ARMY DENTAL SERVICE

THE ARMY TRANSFUSION SERVICE

MEDICAL PROVISION FOR THE A.T.S.

THE ARMY PSYCHIATRIC SERVICE

THE ARMY RADIOLOGICAL SERVICE

ABBREVIATIONS

A.A.	Anti-Aircraft
A.A.C.	The Army Air Corps
A.A.G.	Assistant Adjutant-General
A.A.I	The Allied Armies in Italy
A.B.	Army Book
A.B.C.A.	The Army Bureau of Current Affairs
A.B.S.D.	The Army Blood Supply Depot (Home)
A.C.C.	The Army Catering Corps or Ambulance Car Company, R.A.S.C.
A.C.I.	An Army Council Instruction
A.D.A.P.	Assistant Director of Army Psychiatry
A.D.B.R.	Assistant Director of Biological Research
A.D.Corps.	The Army Dental Corps (now the Royal)
A.D.Centre	Army Dental Centre
A.D.D.S.	Assistant Director, Army Dental Service
A.D.G., A.M.S.	Assistant Director-General, Army Medical Services
A.D.G.B.	Air Defence of Great Britain
A.D.H.	Assistant Director of Hygiene
A.D.Lab.	Army Dental Laboratory (Home)
A.D.M.S.	Assistant Director of Medical Services
A.D.P.	Assistant Director of Pathology
A.D.S.	The Army Dental Service or an Advanced Dressing Station of a Field Ambulance
A.E.C.	The Army Education Corps
A.F.	Army Form
A.F.H.Q.	Allied Forces Headquarters (North Africa)
A.F.V.	Armoured Fighting Vehicle
A.G.	Adjutant-General
A/G	Anti-Gas
A.G.R.A.	Army Group Royal Artillery
A.I.F.	The Australian Imperial Force. (Middle East)
A.I.R.	Adviser in Radiology
A.K.S.	The Army Kinema Service
A.L.F.S.E.A.	The Allied Land Forces, South East Asia
A.L.	Anti-Louse or Air-landing
A.M.D.	The Army Medical Directorate
A.M.P.C.	The Auxiliary Military Pioneer Corps
A.M.S.	The Army Medical Services
A.O.	An Army Order issued by the Army Council
A.P.M.	Assistant Provost Marshal
A.P.T.C.	The Army Physical Training Corps
A.R.P.	Air Raid Precautions
A.S.C.	Army Selection Centre
A.S.D.	Army Spectacles Depot
A.S.H.	The Army School of Hygiene
A.S.T.U.	Army Selection Training Unit
A.T. A/T	Anti-Tank, or Anti-Typhus
A.T.S.	The Auxiliary Territorial Service
A.T.S.O.	Anti-Typhus Soluble Oil
A.Tr.S.	The Army Transfusion Service

A.V.	Anti-vesicant
A.W.M.O.	The Association of Wholesale and Manufacturing Opticians
A.W.O.L.	Absent without Leave
B.A.O.R.	The British Army of the Rhine
B.E.F.	The British Expeditionary Force, France 1939–40
B.G.H.	British General Hospital
B.L.A.	The British Liberation Army. Europe 1944
B.M.A.	The British Medical Association
B.M.J.	The British Medical Journal
B.N.A.F.	The British North African Force
B.O.R.	A British Other Rank
B.O.W.	Base Ophthalmic Wing
Br.	British
B.R.C.S.	The British Red Cross Society
B.T.	Benign Tertian Malaria
B.T.E.	British Troops in Egypt
B.T.S.R.Lab.	Blood Transfusion and Surgical Research Laboratory. France 1939–40
B.T.U.	Base Transfusion Unit
C.C.S.	Casualty Clearing Station
C.E.C.	The Central Emergency Committee of the British Medical Association or Corps Exhaustion Centre
C.G.H.	Combined General Hospital (British and Indian)
C. in C.	Commander-in-Chief
C.M.B.	Civilian Medical Board or Central Midwives Board
C.M.F.	The Central Mediterranean Force
C.M.P.	Civilian Medical Practitioner or The Corps of Military Police
C.M.T.C.	The Central Mediterranean Training Centre
C.M.W.C.	The Central Medical War Committee of the British Medical Association
C.O.	Commanding Officer
C.O.H.Q.	Combined Operations Headquarters
Compo Coy.	Composite Company
Cpl.	Corporal
C.P.L.	Central Pathology Laboratory
C.Q.M.S.	Company Quartermaster-Sergeant
C.R.E.	Commanding Royal Engineers
C.R.S.	Camp Reception Station
C.S.M.	Company Sergeant-Major
C.W.	Chemical Warfare
D.A.A.G.	Deputy Assistant Adjutant-General
D.Air	Director of Air (Parachute, Airborne Formations)
D.A.D.B.R.	Deputy Assistant Director of Biological Research
D.A.D.D.S.	Deputy Assistant Director, Army Dental Service

D.A.D.G.	Deputy Assistant Director-General, Army Medical Services
D.A.D.H.	Deputy Assistant Director of Hygiene
D.A.D.M.S.	Deputy Assistant Director of Medical Services
D.A.D.P.	Deputy Assistant Director of Pathology
D.A.D.S.	Director of the Army Dental Service
D.A.G.	Deputy Adjutant-General
D.A.P.	Director of Army Psychiatry
D.A. & Q.M.G.	Deputy Adjutant and Quartermaster-General
D.A.T.S.	Director of the Auxiliary Territorial Service
D.B.P.	Di-butyl phthalate
D.B.R.	Director of Biological Research
D.C.E.	Deputy Commander Engineers
D.C.I.G.S.	Deputy Chief of the Imperial General Staff
D.C.S.	Director of Controlled Stores
D.D.D.S.	Deputy Director, Army Dental Service
D.D.G.	Deputy Director-General, Army Medical Services
D.D.H.	Deputy Director of Hygiene
D.D.M.S.	Deputy Director, Army Medical Services
D.D.P.	Deputy Director of Pathology
D.D.S.P.	Deputy Director of Selection of Personnel
D.D.S.T.	Deputy Director, Supplies and Transport
D.D.T.	Dichloro-diphenyl-trichlorethane
D.E.C.	Divisional Exhaustion Centre
D.F.P.	Disinfector, Field Portable
D.G.A.M.S. or D.G.	The Director-General, Army Medical Services
D.G.A.R.	Director-General of Army Requirements
D.I.	Dangerously ill
D.L.I.	Durham Light Infantry
D.M.P.	Dimethyl phthalate
D.M.R.(D).	Diploma in Medical Radiology (Diagnosis)
D.M.R.	Director of Medical Research
D.M.S.	Director of Medical Services
D.M.(S).R.	Director of Medical (Statistical) Research
D.O.	Dental Officer
D. of H.	Director of Hygiene
D. of O.	Director of Organisation
D. of P.	Director of Pathology
D.P.H.	The Diploma in Public Health
D.R.	Despatch Rider or Director of Research. War Office or India
D.S.D.	Director of Staff Duties
D.S.P.	Director of Selection of Personnel
D.W.C.	The Dental War Committee
E.	Engineer Branches
E.C.T.	Electrical Convulsion Therapy
E.M.S.	The Emergency Medical Services of the Ministry of Health and the Department of Health for Scotland
E.M.O.	Embarkation Medical Officer
E.N.S.A.	Entertainments National Services Association

E.P.I.P.	European Privates, Indian Pattern, (tent)
E.T.	Early Treatment (Venereal Disease)
E.T.O.U.S.A.	European Theatre of Operations, United States Army
F.A.N.Y.	First Aid and Nursing Yeomanry
F.A.R.E.L.F.	Far East Land Forces
F.D.C.	Field Dental Centre
F.D.Lab.	Field Dental Laboratory
F.D.S.	Field Dressing Station.
F.F.I.	Free From Infection
Fd. Amb.	Field Ambulance
Fd. Hyg. Sec.	Field Hygiene Section
Fd. San. Sec.	Field Sanitary Section
F.S.R.	Field Service Ration
F.T.U.	Field Transfusion Unit
F.V.P.E.	Fighting Vehicle Proving Establishment
G.D.	General Duty
G.D.O.	General Duty Officer or Orderly
G.H.Q.	General Headquarters
G.O.C.	General Officer Commanding
G.P.I.	General Paralysis of the Insane
G.S.	General Service (Pattern)
G.S.C.	General Service Corps
H.A.A.	Heavy Anti-Aircraft
H.A.D.	Hot Air Disinfestor
H.M.S.O.	His Majesty's Stationery Office
H.M.T. or H.T.	His Majesty's Transport (Ship)
H.Q.	Headquarters
H.S.R.	Home Service Ration
I.A.T.	Inflammation of Areolar Tissue
I.C.I.	Imperial Chemical Industries
I.G.H.	Indian General Hospital
I.M.S.	The Indian Medical Service
I.R.C.C.	The International Red Cross Committee
I.T.C.	Infantry Training Centre
I.U.	International Unit (Vitamins)
I.W.T.	Inland Water Transport
J.C.A.	Junior Civil Assistant
L.C.C.	London County Council
L. of C.	Lines of Communication
'M' or Medical	The Medical Branch
M.B.U.	Mobile Bath Unit
M.C.C.	Malaria Control Company
M.C.U.	Malaria Control Unit

M.D.T.	Mobile Dental Team (Field Force)
M.D.U.	Mobile Dental Unit (Home).
M.D.S.	Main Dressing Station of a Field Ambulance
M.E.	The Middle East
M.E.T.C.	The Middle East Training Centre
M.E.C.	Middle East Command
M.E.F.	Middle East Force
M.E.S.H.	The Middle East School of Hygiene
M.F.H.	Military Families Hospital
M.I.	Military Intelligence or Medical Inspection (Room)
M.L.	Mobile Laundry
M.L.B.U.	Mobile Laundry and Bath Unit
M.M.R.	Mass Miniature Radiography
M.N.O.	Mental Nursing Orderly, R.A.M.C.
M.O..	Medical Officer
M.O.H.	Medical Officer of Health
Mob.	Mobilisation
Mob. Hyg. Lab.	Mobile Hygiene Laboratory
M.O.U.	Mobile Ophthalmic Unit
M.O.W.P.	Ministry of Works Pattern (Hutting).
M.P.R.C.	Military Personnel Research Committee of the Medical Research Council
M.R.C.	The Medical Research Council
M.T..	Mechanical Transport or Military Training or Malignant Tertian Malaria
M. & V.	Meat and Vegetables
M.W.F.	The Medical Women's Federation
N.A.	North Africa
N.A.A.F.I.	The Navy, Army and Air Force Institute
N.C.I.	Naphthalene-creosote-iodoform
N.C.O.	Non-commissioned Officer
N.O.	Nursing Orderly, R.A.M.C.
N.W.E.F.	The North Western Expeditionary Force (Norway)
N.Y.D.(N)	Not Yet Diagnosed (Nervous)
N.Z.	New Zealand
N.Z.E.F.	The New Zealand Expeditionary Force (Middle East)
N.Z.G.H.	New Zealand General Hospital
O.C.	Officer Commanding
O.C.T.U.	Officer Cadet Training Unit
O i/c.	Officer in charge of
O.R.	Other Rank
O.St.J.	The Venerable Order of St. John of Jerusalem
P	Primary Malaria (as contrasted with relapse)
P.A.	Personal Assistant
P.A.I.C.	Persia and Iraq Command
P.A.I. Force	Persia and Iraq Force
P.A.D.	Passive Air Defence
P.D.C.	Physical Development Centre

P/M	Principal Matron
P.o.W.	Prisoners-of-War
P.S.O.	Personnel Selection Officer
P.T.	Physical Training
P.T.C.	Primary Training Centre
Pte.	Private
P.T.I.	Physical Training Instructor
'Q'	Quartermaster General's Branch
Q.	Quartan Malaria
Q.A.A.N.B.	Queen Alexandra's Army Nursing Board
Q.A.I.M.N.S.	Queen Alexandra's Imperial Military Nursing Service
Q.A.I.M.N.S./R.	Queen Alexandra's Imperial Military Nursing Service Reserve
Q.A.M. Hospital	Queen Alexandra's Military Hospital
Q.A.M.F.H.N.S.	Queen Alexandra's Military Forces Hospital Nursing Service
Q.A.M.N.S.I.	Queen Alexandra's Military Nursing Service, India
Q.A.R.A.N.C.	Queen Alexandra's Royal Army Nursing Corps
Q.M.G.	The Quartermaster-General
R.A.	The Royal Regiment of Artillery
R.A.C.	The Royal Armoured Corps
R.A.Ch.D.	The Royal Army Chaplin's Department
R.A.F.	The Royal Air Force
R.A.M.C.	The Royal Army Medical Corps
R.A.M. College	The Royal Army Medical College
R.A.O.C.	The Royal Army Ordnance Corps
R.A.P.	Regimental Aid Post
R.A.P.C.	The Royal Army Pay Corps
R.A.R.	The Regular Army Reserve
R.A.R.O.	The Regular Army Reserve of Officers
R.A.S.C.	The Royal Army Service Corps
R.A.V.C.	The Royal Army Veterinary Corps
R.C.S.	The Royal Corps of Signals
R.C.O.G.	The Royal College of Obstetricians and Gynaecologists
R.E.	The Corps of Royal Engineers
Recce	Reconnaissance Units
R.E.M.E.	The Corps of Royal Electrical and Mechanical Engineers
R.H.A.	The Royal Horse Artillery
R.M.O.	Regimental Medical Officer
R.N.	The Royal Navy
R.T.U.	Returned to Unit
S.A.	South African
S.A.A.	Small Arms Ammunition
S.A./A.C.	Scientific Adviser to the Army Council
S.A.G.H.	South African General Hospital

S.A.S.	Special Air Service
S.D.O.	Senior Dental Officer
S.E.A.C.	South East Asia Command
S.G.	Selection Grade
S.H.A.E.F.	Supreme Headquarters Allied Expeditionary Force
S.M.O.	Senior Medical Officer
S.T.	Supply and Transport
S/Capt.	Staff Captain
Sergt. Sgt.	Sergeant
S/Sergt.	Staff Sergeant
S.R.	The Supplementary Reserve
S.W.G.	Starret Wire Gauge
T.A.	The Territorial Army
T.A.B.	Typhoid, Para-typhoid A and B
T.A.N.S.	The Territorial Army Nursing Service
T.A.R.O.	Territorial Army Reserve of Officers
T.B.	Tuberculosis
T.E.L.	Tetra-Ethyl Lead
T.E.T.M.O.S.	Tetra-ethyl Thiuram Monosulphide
T.F.N.S.	Territorial Force Nursing Service
T.O.	Training Officer
T.O.T.	The Treffry O. Thompson (Disinfector)
T.R.	Trade Recommendation
U.D.F.	The Union Defence Force (South Africa)
U.K.	The United Kingdom
U.S. or U.S.A.	The United States of America
U.S.M.C.	The United States Medical Corps
V.A.D.	Voluntary Aid Detachment of the British Red Cross Society and the Order of St. John
V.D.	Venereal Disease
Vit.	Vitamin
W.A.A.F.	The Womens' Auxiliary Air Force
W.A.C.	The West Africa Command
W.C.P.	Water Clarifying Powder
W.D.	War Department
W.E.	War Establishment
W.M.A.	Woman Medical Adviser
W.O..	The War Office or Warrant Officer
W.O.L.	War Office Letter
W.O.S.B.	War Office Selection Board
W.R.N.S.	The Women's Royal Naval Service
W.S.P.	Water Sterilising Powder
W.V.S.	The Women's Voluntary Services
Y.S.T.U.	Young Soldiers' Training Unit

PREFACE

THE activities of the Army Medical Directorate during the war years were compounded out of those of its component branches. The affairs of A.M.D.1, A.M.D.2, A.M.D.3, A.M.D.8, A.M.D.10 and A.M.D.12 were so interconnected that it would be exceedingly difficult to disentangle them. Moreover, together they constituted so large a part of the activities of the Directorate as a whole that, if this were done, nothing of importance would be added to the account already given in the first volume of this History.

But, in this respect, A.M.D.4 (The Army Nursing Service), A.M.D.5 (The Army Hygiene Service), A.M.D.6 (The Army Dental Service), A.M.D.7 (The Army Pathology Service), A.M.D.9 (Medical Provision for the Auxiliary Territorial Service), and A.M.D.11 (The Army Psychiatric Service) were different. Each of them was in charge, under the Director-General, of one of the services which in their combination comprised the Army Medical Services. For this reason alone they merit separate consideration in this History.

The Directorate of Medical Research was born of the special needs that arose out of the circumstances of the times. An account of its activities will therefore depict these needs and reveal the manner in which they were met.

Within the province of the Consulting Surgeon, concerned with the responsibility, under the Director-General, of ensuring that to the Army the very best of professional care should be made available, there were two fields, ophthalmology and radiology, wherein exceptional difficulty was encountered in providing the necessary equipment and apparatus. The administrative aspects of the Army Ophthalmic Service and of the Army Radiological Service therefore demand special treatment.

For reasons of convenience, the account of the classification of personnel by medical category, which administratively belonged to A.M.D.5, was included in the first volume.

The account given herein of the affairs of A.M.D.7 by no means covers them all. The practice of military medicine leans heavily upon the sciences of pathology and bacteriology. It follows therefore that much that refers to the Directorate of Pathology is to be found in the Clinical and in the Medical Research volumes of this History. It was in the field of pathology that an exceptional degree of integration between Service and civilian medical effort was achieved. In war, as also in peace, the world of the pathologist is the laboratory and his true uniform the laboratory coat. The overseas theatre to him is a unique opportunity for the encounter with rare pathogens and new problems.

Because of the contributions which the Army Transfusion Service made to the science and to the practice of transfusion generally, and because this Service was created and fashioned by the circumstances of war, a detailed account of its organisation and performance is offered.

This volume has been constructed out of accounts specially prepared either by the different directorates within the Army Medical Directorate or else by individuals who, during the war years, were personally involved in the affairs of some particular activity of this Directorate. To these much praise and much gratitude are due. Without the help they gave so abundantly and so willingly this volume could not have been written for its scope far exceeds the knowledge of any one person. That which they provided has, in many an instance, been modified and abbreviated. Such mutilation will be pardoned, for it will be agreed that within the finished volume there should be a certain harmony and balance.

Gratitude is also due to those who undertook the onerous task of scrutinising the manuscript and of correcting the many errors of various kinds that tarnished it, and particularly to Mr. W. Franklin Mellor and to Lieut. Colonel Dunn, of the staff of the Editor-in-Chief, who steered it on its tortuous course towards publication.

Edinburgh, 1952 F. A. E. C.

CHAPTER 1

THE ARMY NURSING SERVICE

INTRODUCTION*

PRIOR to the seventeenth century there existed no system of organised care for the sick and wounded of the British Army. Such inexpert, if kindly, attention as these received came from their fellows or, more commonly, from that motley collection of soldiers' wives and women—the camp followers. The first attempt on record to systematise such care would appear to be the recommendation included in the report of Donald Munro, M.D., Physician to His Majesty's Army, on the military hospitals in Germany, January 1761–March 1763. In this it is advocated that a female hospital staff, recruited from these followers, should be instituted. This advocacy was apparently successful, for in 1799, in the *Regulations to Regimental Surgeons for the better management of the Sick in Regimental Hospitals*, there are given instructions regarding the duties of those who were employed in the hospital, the rate of pay for such being one shilling per day. By the year 1800 there were matrons, head nurses and nurses serving in military hospitals, but these were in no sense trained nurses, being in the main the wives of the garrison.

So things remained until the Crimean War, when the deplorable conditions that existed in the military hospitals, becoming known, shocked the public conscience and evoked strenuous and immediate action. The parts played in this by Sidney Herbert and by Florence Nightingale respectively are too well known to demand further consideration in this narrative. It will suffice to record that in February 1856, Florence Nightingale was granted the title of General Superintendent of the Female Nursing Establishment of the Military Hospitals of the Army and that by the end of the Crimean War 125 nurses were employed within the Army.

On May 19, 1856, the foundation stone of the Royal Victoria Hospital was laid at Netley by Queen Victoria, and shortly afterwards, building of the Herbert Hospital (later the Royal Herbert) was begun. Each of these military hospitals had a nursing staff consisting of a lady superintendent and 6–10 nursing sisters.

In 1866, nurses were appointed to all military general hospitals. During the Zulu War of 1879–80 several nurses were sent overseas, but transport difficulties greatly restricted their usefulness. During the Egyptian Campaign of 1882, nurses were employed in the hospitals at

* The substance of this account was provided by the Directorate of Army Nursing.

Gibraltar and Malta. In 1883 it was ruled that all military hospitals having 100 beds or more should have a nursing staff. The nurses were to be 'responsible for the nursing of their patients, for giving them their medicines, food, etc., and also for the training of the orderlies in their wards'. In 1884 a *Code of Regulations for the Female Nursing Services of the Army* was published and it was then established that all Army nurses must have received previous training in a civil hospital. The day of the amateur was ended.

In 1899, at the outbreak of the Boer War, the Army Nursing Service consisted of:

1 Lady Superintendent (at Netley),
19 Superintendent Sisters,
68 Sisters and Nurses,

but by the end there were no less than 1,400 nurses employed in the twenty-two general hospitals, each of 520 beds, that had been established in South Africa. Reinforcements for the Regular Army Nursing Service were obtained from several sources. Princess Christian's Army Nursing Service Reserve, composed of civilian nurses with full or partial training, supplied most. The Princess of Wales (later Queen Alexandra) arranged for the despatch of a contingent from the London Hospital. Other contingents came from certain of the Dominions. The high quality of the work that was done made it inevitable that there should come into being a demand for an expanded Army Nursing Service. It had been amply demonstrated that the trained nurse and the organised nursing service were essential if the efficiency of the Army was to be maintained.

QUEEN ALEXANDRA'S IMPERIAL MILITARY NURSING SERVICE

In 1902 the final details of the new organisation were completed and there came into being Queen Alexandra's Imperial Military Nursing Service (Q.A.I.M.N.S.), the Queen graciously consenting to become its first President. To manage its affairs the Queen Alexandra's Army Nursing Board (Q.A.A.N.B.) was instituted. At its inaugural meeting its chairman, Surgeon-General W. Taylor, in explaining its functions and responsibilities, remarked that 'it has now been recognised that a further extension of the female nursing system in peace is necessary and the utility of female nurses in war is capable of an extension hitherto not contemplated'. The Board recommended that matrons, sisters and staff nurses should be regarded as officers of the hospital, taking a position immediately after the officers of the R.A.M.C., and that at all times they should receive the respect due to their position. Queen Alexandra signified her intention of giving a badge to all members, and as a result the much-treasured Q.A.I.M.N.S. badge was devised with the motto *Sub cruce candida* and a special ribbon. In 1905,

this badge was registered as the official insignia of the Q.A.I.M.N.S. The strength of the service was about 300, with a matron-in-chief at the War Office and two principal matrons, one at the War Office and one in South Africa. Plans were put into force for establishing means of rapid expansion to meet any emergency.

In 1907–8 schemes were completed for the formation of the two main sources of expansion—the Q.A.I.M.N.S. Reserve for absorption into the Q.A.I.M.N.S. as required, first consideration for enrolment being given to members of Princess Christian's Army Nursing Service Reserve which had already proved its worth during the South African War, and the Territorial Force Nursing Service (T.F.N.S.) which was to provide the nursing staff for the Territorial military hospitals. Each of these organisations had its own distinctive badge.

THE WAR OF 1914–18

On the outbreak of war the actual strength of the Q.A.I.M.N.S. was 272, composed as follows:

Matron-in-Chief	1
Principal Matrons	2
Matrons	24
Sisters	100
Staff Nurses	145

The rapidity of the expansion effected on mobilisation is shown by the fact that between August 12 (when the first general hospital landed in France) and the end of 1914, nursing staff was provided for no less than:

General Hospitals	13
Stationary and other Hospitals	10
Clearing Stations	9
Ambulance Trains	12
Hospital Ships	7

All these were for the British Expeditionary Force in France and an acting matron-in-chief was appointed for their administration.

Medical units with Q.A.I.M.N.S. personnel were later sent to Italy, Salonika, Egypt and Palestine, Mesopotamia and India, East Africa and Russia, the total number despatched overseas being 8,619 trained nurses and 2,812 female members of the Voluntary Aid Detachments of the British Red Cross Society and of the Order of St. John (V.A.Ds.). The total number enrolled in the Reserve throughout the war was 10,404 nurses and 8,495 V.A.Ds. These numbers do not include the T.F.N.S. The number of those who lost their lives, from various causes, was 195.

THE LULL BETWEEN THE WARS

The interval between 1919 and 1939 was again a period of overhaul and reorganisation for the Q.A.I.M.N.S. Improved conditions of pay and pensions were granted in 1920.

In 1920, it was agreed to re-form a permanent reserve composed (almost entirely) of members who had served during the war. In 1921, 705 members were enrolled, this figure rising to about 770 in 1922, but in 1923 concern was expressed regarding the wastage and lack of recruitment as the figures dropped to approximately 500.

Also in 1920, as a result of a letter in *The Times*, consideration was given to the granting of rank titles to members of the Q.A.I.M.N.S. for the first time, but the suggestion was rejected by the members of the Queen Alexandra's Army Nursing Board. It was not until 1926 that members of the Q.A.I.M.N.S. were granted even equivalent rank status with officers of the Army.

In 1921, a sister service was formed—Queen Alexandra's Military Families Nursing Service (Q.A.M.F.N.S.) to provide staff for military families' hospitals which had previously been staffed by civilians. This service had a very short life, for in 1927 it was absorbed in the Q.A.I.M.N.S.

In 1921 also began the lengthy deliberations which culminated in 1926 in the amalgamation of the Queen Alexandra's Military Nursing Service (India) with the Imperial Service, thus opening up a very much wider field for all members. This amalgamation also resulted in the formation of a new service in India for nursing Indian troops, known as the Indian Military Nursing Service.

In 1921, the Territorial Force became the Territorial Army and the T.F.N.S., the Territorial Army Nursing Service (T.A.N.S.).

By 1923 the strength of the nursing services was:

Q.A.I.M.N.S.	267
Q.A.M.F.N.S.	81
Q.A.I.M.N.S. (Reserve)	92 serving, 544 unembodied
T.A.N.S.	4 serving, 3,471 unembodied

REINFORCEMENT OF THE ARMY NURSING SERVICE DURING THE INTER-WAR YEARS

Following the armistice in November 1918 there came a period of demobilisation in the Army Nursing Service. By May 1919, 7,893 trained and 5,351 untrained nurses had been demobilised—a total of 13,244. By February 1920, a total of 6,001 members had been released from the Q.A.I.M.N.S/R.

In May 1920 the gradual rebuilding of the nursing service began. At a meeting of the Q.A.A.N. Board a discussion took place as to

the best means of procuring a reserve for the Q.A.I.M.N.S. It was decided that in view of the increased demands that would be made on the civil hospitals for the greatly augmented T.F.N.S. and the improbability of their being able to supply additional members for the Q.A.I.M.N.S./R., a scheme of enrolment with an annual retaining fee of £2 should be adopted and a reserve of 500 trained members ensured.

It is evident that in 1923 anxiety was beginning to be shown regarding the numbers of the Q.A.I.M.N.S. Permanent Reserve. The report of the Matron-in-Chief stated that the strength had fallen from 767 in 1922 to 544 in 1923, with a probability of a further decrease. After due consideration it was decided that to ensure an efficient and adequate reserve it would be necessary again to approach the civil hospitals for their co-operation on the same lines as in 1911—that is, that each hospital should be asked to state the number of nurses it would be able to supply in the event of war. During the following two years, however, enrolment still continued to be unsatisfactory, and in 1925 it was realised that some means of stimulating recruiting was necessary.

In December 1925 a special committee was brought into being to devise a scheme for a proposed reserve of nurses for the Fighting Services. This committee recommended that in the event of war the method of recruitment of a reserve of nurses adopted in the War of 1914–18 with eminently satisfactory results, each nurse being considered individually for the post she was required to fill, should be copied.

A scheme for promotion was introduced in May 1927, according to which senior sisters of the Q.A.I.M.N.S./R. with good administrative ability who had proved themselves capable of holding the higher appointment, might be promoted to matron; provision for the promotion of staff nurse to sister was also included.

During the following years a number of retired members of the Q.A.I.M.N.S. were re-employed and members of the Q.A.I.M.N.S./R. and T.A.N.S. employed with the Q.A.I.M.N.S.

In June 1929 there were thirty-eight members of the Q.A.I.M.N.S./R. and two T.A.N.S. in active employment, and this number steadily increased until mobilisation in 1939.

Table I on the following page shows the numbers employed from 1929 onwards.

In July 1938 the regulations for the admission to the Q.A.I.M.N.S./R. were revised and the ages for admission and retirement extended—upper age-limit for admission, 50; retiring age-limit, 60. The strength of the reserve continued to show a gradual increase until on November 1, 1939, the number on the roll was 1,357.

TABLE 1

Army Nursing Service. Numbers of Q.A.I.M.N.S. (ret.), Q.A.I.M.N.S./R. and T.A.N.S. employed 1929–39

Date	Q.A.I.M.N.S./R. Re-employed	Q.A.I.M.N.S./R.	T.A.N.S.	Totals
June 1, 1929 . .	—	38	2	40
June 1, 1930 . .	—	39	2	41
June 1, 1931 . .	6	43	3	52
June 1, 1932 . .	8	44	4	56
June 1, 1933 . .	4	44	3	51
June 1, 1934 . .	3	41	3	47
June 1, 1935 . .	3	39	2	44
June 1, 1936 . .	3	35	1	39
June 1, 1937 . .	3	44	2	49
June 1, 1938 . .	2	42	2	46
June 1, 1939 . .	2	80	2	84
November 27, 1939	10	994	183	1,187

The rate of expansion is shown below:

TABLE 2

Army Nursing Service. Rate of Expansion 1923–39

Date	Mobilisation requirements	Strength Permanent Reserve	Guaranteed from Civil hospitals	Total available for duty
December 1, 1923	968	621*	303	924
December 1, 1924	967	495	393	888
December 1, 1925	1,067	553	656	1,209
December 1, 1926	1,067	480	664	1,144
December 1, 1927	1,067	515	510	1,025
December 1, 1928	1,067	513	518	1,031
December 1, 1929	1,067	495	555	1,050
December 1, 1930	1,067	473	555	1,028
December 1, 1931	1,067	464	555	1,019
December 1, 1932	1,077	467	555	1,022
December 1, 1933	1,077	461	555	1,016
December 1, 1934	1,077	439	555	994
December 1, 1935	1,077	481	555	1,036
December 1, 1936	830 (Provisional)	482	269	751
December 1, 1937	1,103	493	375	868
December 1, 1938	1,109	531	400	931
December 1, 1939	1,109	1,303	205	1,508

* These numbers do not include members resident abroad. (Extracted from Q.A.A.N. Board Meeting Minutes.)

During the post-war years the T.F.N.S. was also undergoing demobilisation followed by reorganisation. At the end of 1920 the strength was 3,964. At a meeting held on January 30, 1920, between the Secretary of State for War and representatives of the Territorial Force Associations, the future position of the Territorial Army was discussed and reorganisation begun.

It was decided at a meeting of the T.F.N.S. Committee to ask the local committees of the county associations to resume their pre-war committee meetings. The twenty-four principal matrons were asked to attend these meetings, where questions concerning nursing arrangements were discussed. Among the duties of these P/Ms., most of whom held the position of matron in a civil hospital and none of whom were ever mobilised, were the receiving of applications of nurses wishing to join the T.F.N.S., the giving of advice to the associations administering general hospitals on nursing matters and the mobilisation of their units in the event of war. They received a grant of £25 a year to cover clerical expenses incurred by them in the performance of their duties. Several changes in the uniform were proposed and recommended and a scale of nursing staff for the various hospitals discussed. The old establishment of 80 nurses for 1,200 beds and 120 nurses for 2,400 beds was considered insufficient, and it was agreed that the trained nurses provided should be in the ratio of 1 to 10. It was stated that in the event of war the total number of nurses immediately required would be 4,444.

The system of recruiting was discussed and it was decided to retain the system then in force but to utilise various methods of stimulating it, such as notices in the press, social means, and by making arrangements for the T.F.N.S. to be represented at any public function at which the Army was represented.

During the next two years schemes for mobilisation were discussed and details decided upon; a new contract was drawn up and a clause added to the enrolment parchment stating willingness to undertake service overseas in a time of national danger.

In 1923, the seven days' training per annum in military hospitals for members of the T.A.N.S. was re-introduced. In 1925, the proposed expansion of the T.A.N.S. was discussed. It was suggested that the board be given authority to enrol 3,500 nurses additional to the existing establishment and on mobilisation to continue to enrol as required. The age limit was extended to forty years. In 1937, an increase in the number of T.A. general hospitals was proposed and the establishment of principal matrons increased from 23 to 32.

The strength of the T.A.N.S. continued to be maintained as is shown below:

TABLE 3

T.A.N.S. Strength 1921–38

1921	3,124	1927	4,289	1933	4,613
1922	3,460	1928	4,353	1934	4,578
1923	3,608	1929	4,354	1935	4,713
1924	3,725	1930	4,393	1936	4,642
1925	3,972	1931	4,471	1937	4,668
1926	4,171	1932	4,498	1938	4,764

On mobilisation in 1939 the position was as follows:

Number of T.A.N.S. members serving in T.A. units	388
Number of T.A.N.S. reinforcements to Q.A.I.M.N.S.	183
Total T.A.N.S. members mobilised	571

Strength on mobilisation was 4,167, the difference being due to the fact that many nurses could not be released from their civil posts.

The position of the Q.A.I.M.N.S. on mobilisation was as stated below:

Authorised Establishment:		
Home and Abroad	397	
India and Burma	227	
	624	
Reinforcements (Colonies)	58	
Field Force Units	1,069	
	1,127	
Grand Total		1,751

WAR-TIME DEVELOPMENTS

THE GROWTH OF A.M.D.4

At the outbreak of war in September 1939, the staff of A.M.D.4, which was then at Thames House, for the administration of the nursing service, was as follows:

Matrons-in-Chief	2	(1 for T.A.N.S.)
Principal Matron	1	
Clerical Officers	2	Civilians
Clerical Assistants	4	Civilians

In 1940, when A.M.D.4 moved to Hobart House, there was an addition of two matrons Q.A.I.M.N.S. and eleven clerical staff to cope with additional postings, movements and records consequent upon the strength increase. In November, A.M.D.4 moved to Cheltenham, where it remained until August 18, 1942. In 1941, with the absorption of the T.A.N.S., the appointment of a Matron-in-Chief, T.A.N.S. was considered unnecessary. Administration of the T.A.N.S. was vested in the Matron-in-Chief, Q.A.I.M.N.S., and an additional principal matron was appointed to A.M.D.4 to carry out the routine duties connected with the T.A.N.S. In 1942, a third principal matron was appointed to A.M.D.4 to carry out the duties of inspection of hospitals in the United Kingdom and so lighten the load of the Matron-in-Chief. Three more clerical officers were appointed (including a

supervising clerk). In 1943 the Q.A.I.M.N.S. staff remained unchanged but the clerical staff showed an addition of one clerical officer and one clerical assistant. Little change was seen in 1944, except that four military clerks were appointed in lieu of civilians to prepare the machinery for release.

The following year, 1945, showed marked changes. A chief principal matron was appointed to deputise for the Matron-in-Chief. As she also took over the inspection duties, there was a decrease of one in the appointments of principal matron. A senior sister was appointed to assist with postings. Six additional civilian clerks were appointed expressly to deal with the enormous amount of documentation occasioned by the inauguration of the release scheme. (*See* Table 4).

TABLE 4

A.M.D.4. Growth 1939–45

Military

Year	Matron-in-Chief	Chief Principal Matron	Principal Matron	Matron	Staff Sister	Clerks	Total Military
1939 .	2	–	1	–	–	–	3
1940 .	2	–	1	2	–	–	5
1941 .	1	–	2	2	–	–	5
1942 .	1	–	3	2	–	–	6
1943 .	1	–	3	2	–	–	6
1944 .	1	–	3	2	–	4	10
1945 .	1	1	2	2	1	6	13

Civilian

Year	Higher Executive Officer	Executive Officers	Clerical Officer	Clerical Assistant	Total Civilian
1939 .	—	—	2	4	6
1940 .	—	—	6	11	17
1941 .	—	—	6	11	17
1942 .	—	—	9	11	20
1943 .	—	—	10	12	22
1944 .	—	—	11	7½	18½
1945 .	—	—	11	13½	24½

Grand totals	1939 .	9
	1940 .	22
	1941 .	22
	1942 .	26
	1943 .	28
	1944 .	28½
	1945 .	37½

By this time the total strength of the nursing service was 10,419, and officers were serving in units in the United Kingdom, Europe, Middle East, including Palestine, Syria and Cyprus, Khartoum, Iraq, India, Ceylon, East and West Africa, Mauritius, Burma, Malaya, Singapore, Dutch East Indies and Hong Kong.

The whole of the administration of the Army Nursing Service was carried out by A.M.D.4, which also was its own personnel branch, dealing with the selection of intakes and consequent documentation, appointments, postings, movements, reliefs, reinforcements, release, retirements, relinquishments and records.

STAFF APPOINTMENTS

India. The first staff appointment of a member of the Q.A.I.M.N.S. in India was made at the time of the amalgamation of the Q.A.M.N.S.I. and the Q.A.I.M.N.S. in 1926. A matron of the Q.A.I.M.N.S. was attached to the staff for initiation into the administration of the military and military families' hospitals in India. At the same time the Lady Superintendent of the Q.A.M.N.S.I. was attached to the War Office to learn the administration of the Q.A.I.M.N.S.

In 1927 a Chief Principal Matron, India, and four principal matrons were appointed, one principal matron to each circle. These circles became commands shortly after the outbreak of war and the principal matrons were then known as command principal matrons.

A Command Principal Matron, Malaya, was appointed in 1939, and with the despatch of the B.E.F. to France in September of the same year a Principal Matron, B.E.F., was appointed.

In April 1942 the suggestion was made that nursing administrative officers of rank suitable to the establishment be appointed to every command at home and overseas. Such appointments might be covered by a single officer for more than one command according to the nursing commitment.

With the increasing amount of work at the War Office and the extra duties which had to be undertaken by the staff, it was considered necessary to appoint an acting principal matron inspector to the War Office. Among her duties was to be the inspection of the hospitals in the home commands.

Shortly afterwards the following staff appointments were made:

	Principal Matron Inspector .	War Office
	Chief Principal Matron . .	Middle East
	Principal Matron . . .	Egypt
	Principal Matron . . .	Palestine
	Principal Matron . . .	Iraq
followed by	Chief Principal Matron . .	A.L.F.S.E.A.
and	Principal Matron . . .	East Africa

In June 1942 four matrons were authorised for the home commands. They were stationed at Northern Command, Southern Command, Scottish Command and Eastern Command and London District. Their duty was to inspect all small units where women were stationed in order to give advice on nursing matters to the officer commanding and to assist the D.D.M.S. in any way possible with the administration of the Q.A.I.M.N.S. and the T.A.N.S. within the command. Their appointment was considered necessary as sisters and V.A.D. members had been approved for reception stations and, in addition, the steadily increasing numbers of A.T.S. complicated nursing problems. Their duties were extended to include A.A. reception stations on February 8, 1943.

With the upgrading of the matrons of 600-bedded hospitals to the rank of principal matron (A.O.33/44) difficulties arose with regard to the rank and status of the command matrons. The suggestion was made that they should be given the rank of principal matron. It was considered that the inspection of military medical units, combined with administrative work, interviewing of V.A.Ds. and general staff duties, fully justified the upgrading of these appointments (W.O.L. 79/Mob/5225(A.M.D.4), dated June 5, 1942). The request was granted and the new ranks were ordered to take effect from April 1, 1943. There were now five such appointments, Western Command having been included.

In 1943 a Command Principal Matron, North Africa Command, was appointed, and with the return of the B.E.F. to France a Chief Principal Matron, H.Q. 21 Army Group, and a Principal Matron, H.Q. L. of C. 21 Army Group, were appointed and embarked for France on July 14, 1944.

Establishment. Changes in the Q.A.I.M.N.S. establishment were as follows:

Pre-war establishment 1939—550 (Para. 65 of Army Estimates, 1939):

Matron-in-Chief	1
Principal Matrons	2
Matrons	21
Sisters and Staff Nurses	526
	550

Establishment 1941—624:

Matron-in-Chief	1
Chief Principal Matron	1
Principal Matrons	6
Matrons	36
Sisters	580
	624

Establishment applicable to September 1, 1945, (including Q.A.I.M.N.S./R. and T.A.N.S.)—11,024.

THE EXPANSION OF THE ARMY NURSING SERVICE

Even before the proclamation for general mobilisation, members of the Reserve and T.A.N.S. were reporting for duty in large numbers. For a few days the confusion was indescribable, but a certain degree of order was quickly established.

Units were despatched at very short notice (the first six members of the Q.A.I.M.N.S. landing at Cherbourg on September 10, 1939), so quickly, indeed, that many reserves had no time to get equipped with uniform and landed in France still in mufti.

The rate of expansion of the nursing service followed the same pattern as that of the Army as a whole. Figures extracted from the minutes of the meeting of the Q.A.A.N. Board show that during 1939 the permanent establishment increased to over 600, including 227 for India and Burma, and was composed as follows:

Matron-in-Chief	1
Chief Principal Matron (in India)	1
Principal Matrons	6
Matrons	36
Sisters and Staff Nurses	570 (approx.)

By November 1939 the figures were as follows:

	Enrolled	*Mobilised*
Q.A.I.M.N.S.	—	654
Q.A.I.M.N.S. Retired Re-employed	—	10
Q.A.I.M.N.S. Reserve	1,357	994
Civil Hospital Reserve (later absorbed into Q.A. Reserve)	205	205
T.A.N.S.	3,335	571
V.A.D. Trained Nurses	66	66
Total Mobilised		2,500

By May 1, 1940, this total had risen to 3,450 mobilised, but the evacuation from France in May and June 1940 produced a marked change. Approximately 1,300 were evacuated, fortunately without loss, though most of them, in common with the rest of the B.E.F., left most of their possessions behind. They were permitted to leave with only as much as they could carry, generally only a small suitcase. All heavy baggage, including camp kit, had to be jettisoned.

Owing to the conditions prevailing, employment in military hospitals could be found for only a very few other than Regulars. Many reserves and T.A.N.S. were therefore suspended indefinitely or sent to civilian hospitals to await recall for service again as units were formed for despatch overseas.

By November 1940 the numbers had risen again to 3,488 to cover many units sent to the Middle East and to West Africa, and for large reinforcements for India. Recruitment for the regular branch had now ceased.

During 1940 the decision was reached to absorb the Territorial Army into the general forces. This affected the T.A.N.S. in that there were no longer Territorial medical units as such and hospitals, etc., were staffed by whoever was available.

Thereafter the strength of the nursing service showed a steady rise:

May 1941	4,529
November 1941	4,835
May 1942	5,162
November 1942	6,754
May 1943	7,445
November 1943	8,957
May 1944	9,984
November 1944	10,177
May 1945	10,419

As from June 1943 all applications for appointment to the nursing service were dealt with by the appointments officers of the Ministry of Labour and National Service. All preliminaries, such as references and medical examination, were thus dealt with prior to the application reaching the War Office, where interviews were arranged and final selection made.

The winter of 1941–2 brought the disastrous news of the invasion of Hong Kong by Japanese forces in December 1941, and of the fall of Singapore in February 1942. At that time there were ten members of the nursing service in Hong Kong and sixty-five in Singapore. It was many long months before any details concerning them became known, but ultimately the news came that one had been killed on December 16 in Hong Kong and seven in Singapore during the attempt at evacuation. Gradually information filtered through and it was learnt that a number had escaped from Singapore and, after many hardships, had reached India, there to be employed again. The others, it subsequently became known, had been taken prisoner. Those who were prisoners-of-war in Hong Kong suffered from the great disadvantage of lacking badges of rank (which had not had time to reach so far East) and were therefore judged by the Japanese as having no military status. They were, however, after some time permitted to carry on their professional work. For the first eight months they were permitted to remain in the two military hospitals and continue their

nursing duties. Later they were moved to the large hospital in the women's camp at Stanley Bay where, in spite of untold hardships, they had a certain satisfaction in having a worthwhile occupation. Those in Malaya were, if possible, more unfortunate, for they had a vastly more uncomfortable climate to contend with and their Japanese guards apparently took great delight in ordering them to carry out the most humiliating duties.*

Disasters were frequent during the ensuing months. In December 1942 a ship carrying the personnel of a hospital to South Africa was sunk by enemy action with the loss of twenty-five Q.A.I.M.N.S. personnel. The loss of seven others by enemy action at sea was also reported. Later, in 1944, another ship bound for India from East Africa was sunk with the loss of forty-four members of the Q.A.I.M.N.S.

Throughout the duration of the war hospital ships and carriers were staffed by members of the Q.A.I.M.N.S., several sisters losing their lives in the sinking of ships by enemy action. Two members of the staff of the Hospital Carrier *Amsterdam* were posthumously commended for brave conduct during the attack upon, and sinking of, this ship.

During the war Q.A.I.M.N.S. personnel were to be found in all areas in which there were British troops. In addition they undertook the nursing organisation of several emergencies not necessarily connected with Army personnel, such as Belsen concentration camp, where they took charge until the arrival of a Red Cross unit; in repatriation camps and ships for displaced civilians and in Hong Kong, where they took over Queen Mary's Hospital and started it off again as a training school for Chinese nurses.

During these years the usual arguments arose for and against the employment of women in forward areas. Far from becoming a liability, however, it was proved that the actual presence of nurses was a source of the greatest encouragement to the wounded. This was so evident that an instruction was issued that, unless operationally impossible, Q.A.I.M.N.S. personnel were to wear their nursing uniform of grey and scarlet instead of the universal battledress. The latter, though much more suitable in many places, failed to provide the comfort and confidence to the wounded that was inspired by the sight of the well-known and well-loved scarlet cape. Even the Japanese appreciated the red cape, for in Hong Kong, when the prisoners-of-war were paraded, instructions were issued that the matron was to appear in it.

The roll of honour for the War of 1939–45 shows a list of 220 deaths, most of them by enemy action.

---

* *See Campaigns* Vol. 2. Hong Kong and Malaya.

Status. In May 1941 the decision was made to include the Q.A.I.M.N.S. as part of the Armed Forces of the Crown. This necessitated changes in several directions.

The first step was the abolition of the rank of staff nurse (A.O.37 of 1941) and at the same time the wearing of relative rank badges was authorised (A.O.101 of 1941). In September 1941 emergency commissions were granted to members of the nursing service and a request for permanent commissions for regulars was submitted. The first 700–1,000 reserves were gazetted in November of the same year, the commissioning of the regulars being temporarily held up in the hope of obtaining permanent commissions for them.

The following year saw the grant of emergency commissions to all women officers into the particular branch of the Services to which they belonged. The members of the Q.A.I.M.N.S., who had always been granted officer status, were the only women holding officer appointments in the Regular Army, but the possession of a Regular Commission required to be legalised when the Emergency Defence (Women's Forces) Regulations 1941 became ineffective. The gazetting of Q.A.I.M.N.S. personnel began in January 1943.

All ranks of the Q.A.I.M.N.S. were now readjusted. The Matron-in-Chief ranked as a brigadier, and senior sisters of ten years' service or assistant matrons and sisters-in-charge were granted the rank of captain. The following were the equivalent ranks, the authority for the adjustment of which was given in November 1942:

Matron-in-Chief	Brigadier
Chief Principal Matron (India and M.E.F.)	Colonel
Principal Matron	Lieut. Colonel
Matron	Major
*Sister-in-Charge	Captain
Assistant Matron	Captain
Sisters with ten years' service	Captain
Sister	Lieutenant

* At stations where charge pay was admissible.

At the same time the use of the collective term 'nursing officer' for the Q.A.I.M.N.S. and T.A.N.S. was introduced.

Pay. At a meeting of the Q.A.A.N. Board held on November 18, 1940, the situation as regards pay was discussed and it was pointed out that the pay of the Q.A.I.M.N.S., Q.A.I.M.N.S./R., and T.A.N.S. was considerably less than that of the Civil Nursing Reserve. Various suggestions were made and a table showing proposed increases of pay sent forward for approval. In May 1941 new rates of pay were issued for the three services:

	Initial Rate of Pay	*Increments*
Q.A.I.M.N.S.	£95 per annum	£5 annually up to a maximum of £125
Q.A.I.M.N.S./R. and T.A.N.S.	£105 per annum	£5 annually up to a maximum of £125
Seniors: +£5 for every three years of civil experience after the age of 25 in recognised hospitals, private nursing institutions or in an approved nursing service up to nine years (A.O.50+170/41)		
Senior Reserves and T.A.N.S.	£110–£120	

Great disappointment was felt that it had not been possible to obtain equal concessions for the regulars, but it was agreed that the case for these should be re-opened later.

Proposals for new rates of pay in line with the Rushcliffe Scale for civilian nurses were forwarded to the Treasury in May 1943. After much discussion a new scale was authorised in May 1944 and antedated to April 1, 1943 (A.O.33/44).

A.O.33/44 (Rise of Pay for All Ranks)

	Modified Rate from April 1, 1943	*New Rate from April 1, 1944*
Matron-in-Chief	£700	£730
Chief Principal Matron	500	610
Principal Matron:		
If serving as such on March 31, 1943	425	500
If appointed on or after April 1, 1943	400	

	Minimum	*Annual Increment*	*Maximum*
Matron	£275	£25	£400
Senior Sister	220	10	250
Sister:			
On appointment	105*		
After one year's service	130*	10	180
After ten years' service	—	—	200 (Not admissible before April 1, 1944)

* In special circumstances higher rates were admissible on appointment.

Increase of charge pay and further regulations concerning the issue of specialist pay were laid down.

A.O.87/45 (WAR SERVICE INCREMENTS (DAILY))

	On Completion of Three Years' Service reckoned from September 3, 1939	*In Each Subsequent Year of Service*
Matron and ranks above	2s.	8d.
Senior Sister and Sister	1s. 6d.	6d.

Uniform. In May 1939 the grey field force dress for use on active service was designed. It was of a coat-frock pattern of grey zephyr with a soft white collar, to be worn with a scarlet cape when not on duty and dispensing with aprons, belts and cuffs.

It was realised in 1941 that some modifications regarding uniform would be necessary as there was urgent need for economy. Two changes were made:

(1) The abolition of tropical dress of white tricoline with cape for outdoor wear;

(2) The wearing of the white overall with distinguishing epaulettes and rank badges for outdoor tropical wear.

In November of the same year pressure was again brought to bear on the Q.A.I.M.N.S. to reduce uniform. It was pointed out by the Matron-in-Chief that this demand was unreasonable because the Q.A.I.M.N.S. was being compared not with A.T.S. officers but with the nursing staffs of civil hospitals. No increase in the initial uniform allowance of £24 could be obtained, though A.T.S. officers received £40.

Owing to the introduction of the clothing rationing scheme in 1942 it became necessary to reduce the amount of material and cost of uniform. The tricoline dress and the beige bodice were given up entirely except for optional wear by matrons. The short-sleeved overalls were now made with detachable half-sleeves for wear in malarious regions. Slacks were permitted at night in the danger zones at sea and in forward areas.

An increase in the initial uniform allowance was granted in May 1942, the amount being increased to £28 and the tropical clothing allowance to £10. Grey blouses were introduced instead of white and all unnecessary trimmings on the uniform abolished. Grey service caps replaced the hat and storm cap.

In November 1942 it was found that increasing difficulties were being encountered in obtaining grey and scarlet material. The Board of Trade was reluctant to release the large supplies required and suggested the adoption of khaki. This idea was viewed with disfavour by the Q.A.A.N. Board, who informed the Board of Trade that 'they would view with great disquiet any alterations and would be prepared

to accept such change only as a most urgent war-time measure and in case of the materials becoming unavailable'.

A special meeting was called on December 30, 1942, to discuss changes in uniform which were being forced on the Service through difficulty in obtaining the various articles laid down in the existing scale. A staff officer representing the Principal Priority Officer was present who informed the board that it was becoming quite impossible to provide labour and material for the grey uniform and suggested the change to khaki. A letter was read from the President, Queen Mary, in which she expressed her dislike of the idea of members of the nursing service being dressed in khaki, except on urgent military and security grounds or inability to supply. It was agreed to protest to the Ministry of Labour and to the Board of Trade.

In April 1943, however, it was clearly evident that supplies of grey material were becoming exhausted and it was decided to adopt khaki, purely as a war-time measure, for outdoor uniform. At the same time an improved pattern of the field force indoor dress was displayed and approved. A.O.225 of 1943 authorised the change in the Q.A.I.M.N.S. uniform.

An increase of uniform allowance to £40 for grey and scarlet from April 1, 1943, and £45 on the introduction of khaki, was granted; proportional increases in the annual maintenance allowance were also back-dated to April 1, 1943.

Steps were taken to ensure that the grey and scarlet uniform would be retained for peace-time wear by the Q.A.I.M.N.S., each item of uniform being made a sealed pattern, and a clause suggested to be included in the A.O. authorising the new uniform to the effect that the wearing of khaki uniform was for the duration of the emergency only and that grey and scarlet would remain the peace-time Q.A.I.M.N.S. uniform.

In November 1944, regimental designations were authorised to be worn on battledress and bush shirts, and woven rank badges, as worn on battledress and tropical khaki, were mounted on a cherry background (A.C.I.117/45). A lanyard of grey and scarlet cords to maintain the traditional colours was designed to be worn by all ranks (A.C.I. 117/45).

SPECIALISATION WITHIN THE ARMY NURSING SERVICE

In 1927 one member of the Q.A.I.M.N.S. was granted a scholarship to represent Great Britain at an international course for nurse administrators at Bedford College; she was granted a year's leave without pay by the Army in order to take this course.

At a meeting of the Q.A.A.N. Board in the same year the desirability of Q.A.I.M.N.S. members being permitted to take post-graduate courses

was raised. The great importance of this work was emphasised and also the fact that many keen and valuable nurses were deterred from entering the Service because they felt that, if they joined, they would not have the same opportunities for keeping up to date in their professional knowledge as they had in civilian hospitals.

In 1928 sanction was obtained for one sister to attend a three weeks' post-graduate course at the Woolwich Hospital for Mothers and Babies, and soon afterwards financial approval was given for three members of the Q.A.I.M.N.S. to take post-graduate courses annually.

In 1931 financial approval was obtained for replacing paying pupils in military families' hospitals by an equal number of free pupils who would receive free board, lodging and laundry at public expense for a course of nine months. This meant that members of the Q.A.I.M.N.S. could take their midwifery training at the Louise Margaret Hospital, Aldershot, at public expense. On the outbreak of war this hospital had to be closed as a training school.

Courses for training in operating theatre duties were carried out in selected large hospitals. These courses lasted for three months.

In 1944 four members of Q.A.I.M.N.S. were sent to a staff course at the A.T.S. Wing at Bagshot. In 1945 the first Q.A.I.M.N.S. officers to take a psychiatric course commenced training. This course consisted of three months' training at the Military Wing of Banstead Hospital, three months at Northfield Hospital, Birmingham, and six months' practical experience at 'D' Block, Netley. Courses in hyperthermy were started in 1945. They were carried out at the Royal Victoria Hospital, Netley, and later at the Connaught Hospital, Hindhead, and covered a period of six months. In 1945 authority was obtained for four Q.A.I.M.N.S. officers to attend the sister tutors' course at London University. It was realised that, in order that the A.M.S. training might be kept abreast of the increasingly higher standards in the civil nursing world, sister tutors holding a recognised qualification were a necessity.

MARRIAGE AND ITS PROFESSIONAL CONSEQUENCES

Under the *Conditions of Service Q.A.I.M.N.S.* it was laid down that a candidate must be either single or a widow without dependent child; therefore resignation on marriage was compulsory.

In November 1941 the ban was raised for the duration of the war and the enrolment and re-enrolment of married members was authorised. Officers who married while serving were required to continue to serve, but in the event of pregnancy were relegated to the unemployed list (A.O. 159/41). It was agreed after some discussion that it was not in the interest of the Service to permit husband and wife to be members of the same unit, but with the approval of the G.O.C., husband and

wife might be permitted to remain in the same area. Further discussions took place regarding the question of married nursing officers being permitted to 'live out' with their husbands. After due consideration it was ruled that in view of the exacting nature of their work and the long hours, including night duty, it would be impossible to allow this concession.

THE INTER-RELATIONSHIP OF Q.A.I.M.N.S. AND V.A.D.

The first appearance of V.A.D. members in the wards of military hospitals was in the beginning of 1915. Their regulations stated that they were to work under fully trained nurses and to be under the direct control of the officer-in-charge and the matron of the hospital. They were to live in quarters provided for the nursing staff of the military hospitals under the control of the matron and they were required to adhere to the *Regulations and Standing Orders for Q.A.I.M.N.S.* as far as applicable.

During the War of 1914–18, there were 23,000 V.A.D. nursing members and 15,000 non-nursing members employed in Service hospitals at home and abroad. During 1916, the scope of the V.A.D. organisation, which had hitherto embraced nursing duties only, was, at the request of the Army Council, widened by the introduction of numerous classes of general service members. These included dispensers, masseuses, clerks, cooks, laundresses, telephonists, etc. (A.C.I.1060 of 1916).

Provision was made at the same time for the appointment of non-nursing members of officer status for administrative and welfare duties (commandants and assistant commandants). They relieved the hospital matrons of the responsibility for the welfare, administration and discipline of the V.A.D. members working under them.

In 1916 A.C.I.1244 was published, in which the duties of the nursing members were defined as follows:

> 'In consequence of the withdrawal of general duty and nursing orderlies from military hospitals, it has been decided that in future V.A.D. members employed as probationers in military hospitals will be required to perform the same duties as probationers in civil hospitals.'

These duties included: sweeping, dusting, polishing of brasses, cleaning of ward tables and patients' lockers, cleaning of baths, sinks and ward utensils, washing of patients' crockery, sorting of linen and, in addition any duties allotted to them by the matron of the hospital in which they were working and under whose control they would be at all times.

In March 1918 provision was made (A.C.I.214/18) for the promotion of V.A.D. nursing members, after not less than two years'

continuous hospital service and on recommendation, to the grade of V.A.D. assistant nurse. During the three years immediately following the war a certain number of V.A.Ds. were retained for service in military hospitals to meet the deficiency of R.A.M.C. personnel, but eventually all were demobilised. Each nursing member was required to attend a military hospital once in three years for a week for training in ward work.

During the first year of the Second World War there were complaints regarding V.A.Ds.' conditions. As a result, A.C.I.249 was published in March 1940, limiting the duties which V.A.Ds. were to perform. It was decided that the nursing members, grade I, should be given pay corresponding to that of a R.A.M.C. nursing orderly, class I, and in addition should receive certain 'officer' privileges such as first-class travel, in uniform, board and washing allowance and accommodation scale as for the Q.A.I.M.N.S. and rank 'next and after the Q.A.I.M.N.S.' (A.C.I.1300 of 1940). An anomalous position was thus created whereby V.A.D. nursing members enjoyed officer privileges while fulfilling 'other rank' functions.

Discussions were carried on tentatively during 1941 between the newly appointed chairman of the V.A.D. Council and the War Office, and eventually in May 1942 the Army Council proposed to the Order of St. John, the British Red Cross Society and the Order of St. Andrew that the existing organisation should be merged into the A.T.S. Great opposition to the scheme was forthcoming from the B.R.C.S. and the O.St.J., who felt that the existing V.A.D. organisation, with certain modifications, provided the best method of carrying out the services required by the Army medical authorities. They called a special meeting to consider the matter and recommended that 'assimilation be not proceeded with and that the V.A.Ds. retain their separate identity under their existing name'.

As an outcome of the deliberations of the Elliot Committee* in 1943, A.C.I.1773 was published and the following recommendations were made:

(*a*) The status and range of duties of V.A.D. nursing members will be the same as those applicable to the trade of nursing orderly A.T.S.

(*b*) V.A.D. members should not be assimilated with the A.T.S. but should retain their separate identity under their existing name.

(*c*) A standing committee representing the voluntary bodies concerned, including the Council of County Territorial Associations, should be substituted for the V.A.D. Council.

---

* *See* Volume 1, Chapter 9.

The A.C.I. also stated that nursing officers would act as officers to V.A.D. members and would be responsible for their welfare, instruction and technical supervision.

The implementation of this A.C.I. necessitated changes in the existing conditions of service of V.A.D. members, namely:

(*a*) V.A.D. members would, on enrolment for employment under the Army Council, become members of the Armed Forces of the Crown and would be subject to military law like auxiliaries of the A.T.S.

(*b*) Direct command over V.A.D. members so enrolled would be exercised by the C. in C., G.O.C. in C., or G.O.C. and by all corps, divisional and district commanders.

(*c*) V.A.D. members would continue to replace R.A.M.C. other ranks in military medical establishments and while doing so their employment, training, classification and promotion would follow the general rules applicable to other ranks of the R.A.M.C.

In September 1944 the first V.A.Ds. to be sent abroad embarked for B.A.O.R. and were attached to 21 Army Group. Shortly afterwards another detachment sailed for North Africa for service in the military hospitals in that area. During the following years further detachments were sent to N.W. Europe, C.M.F., M.E.F. (including Cairo and Palestine), Ceylon, Malta and Italy. Each draft was conducted by an officer of the Q.A.I.M.N.S.

At the end of the war demobilisation started, though it was at first found necessary to retain some of the V.A.Ds. to carry out ward duties owing to the shortage of R.A.M.C. orderlies. The last V.A.D. to be demobilised left from the Connaught Hospital, Hindhead, in July 1951.

WELFARE OFFICERS

During the war the majority of military hospitals had attached to them one or more welfare officers provided by the Service Hospitals Welfare Committee of the Order of St. John of Jerusalem and the British Red Cross Society. These officers proved a very useful addition to the staff of the hospitals and their appointment was continued in the post-war years. Their duties included:

(*a*) The carrying out of welfare functions for the patients in hospitals and the maintenance of a St. John and Red Cross office in the hospital for this purpose.

(*b*) The charge and supervision of the St. John and Red Cross hospital library.

(*c*) The supervision of diversional handicrafts.

(*d*) The supervision of the patients' library and reading.

(*e*) The care of visitors under the Dilfor scheme and the assisting, in every possible way, of the relatives of patients who visited the hospital.

(*f*) In conjunction with the hospital authorities, the provision of progress reports to relatives of patients (other than D.I. cases) and the supplying of news to patients of their families at home.

(*g*) The writing of letters for patients; shopping for patients.

(*h*) The arrangement of outings and entertainment for patients.

(*i*) The charge of all comforts and welfare funds provided by the St. John and Red Cross.

These welfare officers came directly under the officer commanding the hospital for discipline and for the receiving of orders regarding the general conduct of their work in the hospitals. They were honorary members of Q.A.I.M.N.S. officers' messes in which they were accommodated but were not eligible to vote at mess meetings or to become members of committees.

RELEASE AND DEFERMENT

In June 1945 release from the age and service groups* began. A.C.I.394/45 provided for the release of married officers. The release of the remaining nursing officers was carried on until December 31, 1948, the date of general demobilisation (W.O.U.M. 19/Demob/553 (Demob 1)).

Releases were of three types:

1. Class A Release—Release on the date specified by the officer's age and service group.
2. Class B Release—Release on grounds of national importance. (Employers were required to approach the government department directly concerned with the work on which their firm was engaged, stating that the release of the officer was required for work of vital importance. The government department then submitted a recommendation through the Ministry of Labour for consideration by the War Office.)
3. Class C Release—Release on compassionate grounds.

Deferment of release was permitted for periods of one year, two years, or until general demobilisation, and in the case of age and service groups 63–76 a further period of deferment of three months was allowed.

---

* *See* Volume 1, Chapter 9.

QUEEN ALEXANDRA'S ROYAL ARMY NURSING CORPS

Discussions on the reorganisation and post-war development of Q.A.I.M.N.S. were started in December 1945 and the following were among the proposals put forward:

1. The Matron-in-Chief should become Director of the Army Nursing Service with status and rank equal to that of the Director of the Army Dental Service and not below that accorded to the Director of the Auxiliary Territorial Service.
2. Post-war establishment should be increased to allow a straight eight-hour period of duty for all nursing personnel and to permit of adequate staffing of ward units according to modern standards.
3. Q.A.I.M.N.S. should form the one nursing service within the Army and should include all other rank personnel within the meaning of the Nurses Act 1943.
4. Training should be arranged within the Army or at civil centres to cover administration, specialist nursing, educational courses and basic military training.
5. Promotions should bear relation to time served combined with efficiency.
6. A permanent reserve of officers and O.Rs. should be maintained within the Q.A.I.M.N.S.

Endeavours were also made to obtain a more balanced rank structure. Working parties were appointed and many discussions took place during the following years until in February 1949 the formation of Queen Alexandra's Royal Army Nursing Corps (Q.A.R.A.N.C.) was announced (A.O.5/1949). This change of title and acceptance of complete military status necessitated a change in the function of the Q.A.A.N. Board, which now became an advisory board convened only when necessary to discuss important problems relating to the Army Nursing Service. Decisions on selections and promotions, which had been one of the functions of the Q.A.A.N. Board, now fell to a military selection board.

Her Majesty Queen Mary had been kept informed of the prospective changes and had approved the new title and graciously agreed to become Commandant-in-Chief (later, on introduction of Army rank titles, Colonel-in-Chief) of the new Corps.

Relinquishment of the commissions previously held by officers of the Q.A.I.M.N.S. under the Women's Forces (Officers' Commissions) Order 1941 and acceptance of regular commissions in the Q.A.R.A.N.C. involved a change in their legal status. They now became subject to the full provisions of the Army Act in common with all other officers of the Army.

Officers were appointed to commissions in the Q.A.R.A.N.C. in the undermentioned ranks and ranked with male officers of the Army as stated:

Senior Controller	Brigadier
Controller	Colonel
Chief Commander	Lieut. Colonel
Senior Commander	Major
Junior Commander	Captain
Subaltern	Lieutenant.

Officers transferred to the Q.A.R.A.N.C. were appointed in substantive rank based on the substantive nursing rank held in the Q.A.I.M.N.S. according to the following table:

Matron-in-Chief	Senior Controller
Chief Principal Matron	Controller
Principal Matron	Chief Commander
Matron	Senior Commander
Sister with 10 years' service	Junior Commander
Sister with less than 10 years' service	Subaltern

(A.C.I.193/49)

In August 1949 new appointment titles were adopted:

Matron-in-Chief	Matron-in-Chief and Director of Army Nursing Services	D.A.N.S.
Chief Principal Matron	Deputy Director of Army Nursing Services	D.D.A.N.S.
Principal Matron at W.O. or H.Q. Command	Assistant Director of Army Nursing Services	A.D.A.N.S.
Staff Matron at W.O. or H.Q. Command	Deputy Assistant Director of Army Nursing Services	D.A.D.A.N.S.

(A.C.I.713/49)

The rank titles were again changed in March 1950 and became the same as those for male officers in the Army:

Senior Controller	Brigadier
Controller	Colonel
Chief Commander	Lieut. Colonel
Senior Commander	Major
Junior Commander	Captain
Subaltern	Lieutenant

(A.O.33/50)

CHAPTER 2

THE ARMY HYGIENE SERVICE

The Directorate of Hygiene (A.M.D.5)*

At the outbreak of war the staff of this directorate consisted of the director and an assistant director of hygiene (A.D.H.). Soon there were added an adviser in venereology with the status of A.D.H.(B) and a deputy assistant director of hygiene (D.A.D.H.) to assist the original A.D.H.(A). Later, an adviser in dermatology A.D.H.(C) and a second D.A.D.H.(B) were appointed. Early in 1943 a D.A.D.H.(C), with a special knowledge of nutrition, was added, and in 1943 a specialist in physical medicine became A.D.H.(D). In addition to these, a medical intelligence officer (staff captain) was appointed to the staff and established a profitable liaison with the Directorate of Military Intelligence.

STAFF AND DISTRIBUTION OF DUTIES WITHIN THE BRANCH

THE DIRECTORATE AS A WHOLE

Supervision in general of the environment of the soldier from the point of view of the preservation and enhancement of his health and fitness.

Supervision in particular of water and food supplies, including ration scales; the medical aspects of accommodation, including selection of camp and barrack sites and layout and design of buildings; hygiene aspects of bathing, ablution and laundry facilities; disposal of waste matters of all kinds; disinfection and disinfestation; industrial hygiene; work, training including physical training; physical development centres and their medical aspects; recruiting, medical standards and categorisation.

Supervision in the training and teaching of military hygiene in all its aspects and the encouragement of research. The Army School of Hygiene —policy, instructional staff, equipment and courses. Research carried out in the Hygiene Department, Royal Army Medical College.

Routine and special inspections and reports as necessary.

Liaison with the Ministry of Health and the Department of Health for Scotland and with other civil organisations of importance and also with the other Services concerning public health matters.

Supervision and advice in regard to the practice of preventive medicine in general in the Army and especially to the prevention of the infectious diseases, more particularly those of special military importance such as malaria, venereal disease and dysentery.

* The substance of this account was provided by the Directorate of Army Health (formerly Hygiene) of the Army Medical Directorate.

Keeping a watch on the trends of disease.
Arrangements for hygiene propaganda of all kinds.

A.D.H.(A)
Co-ordination of all work within A.M.D.5.

A.D.H.(B)
All questions connected with the prevention and treatment of the venereal diseases, including documentation. Liaison with the Ministry of Health.

A.D.H.(C).
All questions concerned with the prevention and improved methods of treatment of skin diseases in the Army.

A.D.H.(D).
(i) Medical categorisation:
  (*a*) All questions related to the definition, use and modifications of category.
  (*b*) Medical aspects of the medical categories pamphlet for other ranks.
  (*c*) Pulhems system of medical classification.
  (*d*) All questions regarding medical categories in relation to personnel selection procedure.
  (*e*) All questions concerning the placement of personnel on account of medical disabilities.
  (*f*) Reported cases of errors of grading on the part of the Ministry of Labour and National Service.
(ii) Physical development centres.
(iii) Conditioning courses.
(iv) Questions of progression in training, including medical down-gradings as a result of training. Also questions of modification in relation to lower category personnel.
(v) Army selection centres. Advice on medical aspects.
(vi) Applications for re-enlistment.
(vii) Laying down medical standards for special troops and special accommodation, e.g. (*a*) parachute volunteers, (*b*) divers and (*c*) mountain warfare at high altitudes.
(viii) Liaison with Army physical training authorities on physical efficiency tests, remedial training and conditioning.
(ix) Adviser to the Army Cadet Corps on medical standards.
(x) Administrative duties in relation to liaison with the Consultant in Physical Medicine.
(xi) Secretary of Inter-Services Committee on post-war Medical Classification.

D.A.D.H.(A).
(i) Hygiene and sanitation:
General questions of preventive medicine and environmental hygiene.

(ii) Hygiene organisation—The organisation of hygiene services at home and overseas. Selection and training of potential hygiene officers. Personnel and equipment of hygiene units.

(iii) Technical questions concerning hygiene training. The Army School of Hygiene—questions of policy, instructional staff and equipment. Organisation of hygiene courses and arrangement of special courses at the school.

(iv) Water supplies—medical questions affecting water supplies. Sources of supply—methods of purification—medical questions affecting items of water purification equipment—water chemicals —individual water sterilising outfits. Training of regimental water duty orderlies. The detection of poisons in water. Medical questions affecting water storage. Water containers. Water requirements.

(v) Prevention of disease. Medical questions concerning occupational hazards encountered in the Army. Notifications from the Ministry of Labour of cases on the tuberculosis register before enlistment.

(vi) Medical aspects of leave.

(vii) Hygiene arrangements of overseas forces. Technical questions affecting the hygiene organisation of overseas forces including personnel and equipment.

(viii) Hygiene research. Questions concerning research into hygiene problems carried out in the Hygiene Department, Royal Army Medical College and at the Army School of Hygiene.

D.A.D.H.(B)

(i) Accommodation:

(*a*) Recommendations regarding scales of accommodation to be provided in barracks, etc.

(*b*) Medical aspects of heating, lighting and ventilation of buildings.

(ii) Clothing and Equipment:

(*a*) Medical aspects of material used for and design of clothing in different theatres of operations. Advice on hazards arising in connexion with dyeing and proofing of materials.

(*b*) Development in co-operation with supply branches, of supplies used in preventive medicine.

(*c*) Development in connexion with hygiene and ordnance branches of technical equipment used in the prevention of disease.

(*d*) Liaison between research workers and supply branches.

(*e*) Preparation of technical instructions on the use of new equipment, etc.

(*f*) Policy in connexion with disinfestation.

(iii) Sea transport—Consideration of health implications of voyage reports in conjunction with A.M.D.12.

(iv) Liaison with civil ministries—co-operation with civil health authorities in control of infectious diseases both arising at home and imported from abroad by sea and air.

D.A.D.H.(C).

(i) Scrutiny of all ration scales prepared by the War Office, S.T.6, or submitted by commands overseas with respect to their nutritive value. Recommendations to S.T.6 for amendment of any scale the nutritive value of which was considered to require improvement.

(ii) Co-operation in devising special ration packs—advice to S.T.6 regarding the required nutritive value of different compact ration packs and concerning the composition of the contents best suited to meet particular requirements.

(iii) Introduction of vitamin supplements, fortified foods, etc.—advice regarding vitamin preparations etc., required by the Army to supplement rations on occasion.

(iv) Nutritional surveys. Supervision of nutritional status of troops by visits of inspection to certain units and centres and by the organisation and administration of nutritional field investigations when necessary.

(v) Hygiene and nutrition of British and Imperial prisoners-of-war —Maintenance of information from incoming reports, etc. regarding hygiene conditions (and especially nutrition and rations) among British and Imperial prisoners-of-war.

(vi) Liaison with outside bodies. Maintenance of liaison with the Ministry of Food, Ministry of Health and other bodies in matters relating to the nutrition of army personnel.

(vii) Membership of committees, viz. War Office Ration Scales (Overseas Theatres) Committee; Inter-services Ration Scales Committee and Pacific Rations Committee.

(viii) Liaison with the Joint War Organisation of the British Red Cross Society and The Order of St. John.

(*a*) Nutritional adviser to prisoner-of-war invalid comforts and food parcels sections.

(*b*) Co-ordination of professional advice of the Army Medical Directorate regarding medical supplies to prisoners-of-war in enemy hands.

During 1943 the Adviser in Venereology was upgraded to the status of consultant, with the rank of brigadier, and some time later the Adviser in Dermatology was similarly upgraded.

Efforts to have the appointment of D.A.D.H.(C) upgraded to that of adviser in nutrition to the Director of Hygiene with the rank of lieut. colonel were made on several occasions, in view of the value and responsibility of his duties, but they did not succeed.

HYGIENE ORGANISATION. ARMY, CORPS, DIVISIONS, L. OF C., AND BASE AREAS

In the overseas organisation by which the health of the Army was ensured, the Director-General, Army Medical Services, exercised overall responsibility and was advised by the Director of Hygiene (D. of H.). The designations of the headquarters of forces overseas varied with the size and constitution of the force employed, e.g. General Headquarters (G.H.Q.), Headquarters British Troops (British Troops in Egypt) and where allied forces were employed joint headquarters were created, e.g. Allied Forces Headquarters (North Africa) (A.F.H.Q.) and Supreme Headquarters Allied Expeditionary Forces (North-West Europe) (S.H.A.E.F.).

The Director of Hygiene was represented at the headquarters as follows: at force headquarters there was a director or deputy director of hygiene, at army headquarters an A.D.H., at corps headquarters an A.D.H., and at most of the district or area headquarters a D.A.D.H. In a division the officer commanding a field hygiene section advised the A.D.M.S. on hygiene matters. These officers were the advisers of their medical superiors in all matters relating to the health and well-being of the troops.

Within the hygiene organisation in the field there were a number of the medical units, e.g. field hygiene sections, field sanitary sections, and mobile hygiene laboratories, which had demonstrated their great value in the War of 1914–18, together with some new units which had not previously been employed in war, e.g. malaria field laboratories, malaria control units, and entomological field units.

FIELD HYGIENE SECTIONS

These units do not exist in peace-time but are mobilised on the outbreak of war on a scale of one per division, corps and certain lines of communications and base areas. In 1939 there was one mobilised field hygiene section in Egypt and at home there were four field hygiene companies of the Territorial Army located in London, Southampton, Leeds and Glasgow. Most of the earlier field hygiene sections were formed by these companies which were reinforced for the purpose. When the School of Hygiene became established at Mytchett it was decided that all field hygiene sections to be formed should be raised and trained at the school before joining their formations. A number of officers in the field hygiene companies T.A. were non-medical—some, for example, being chemists. On the outbreak of war these were withdrawn to the Army School of Hygiene, where they were employed as instructors, and the chemists were eventually absorbed into mobile hygiene laboratories. Not all the medical officers in the Territorial hygiene companies were in possession of a D.P.H. and those who

were not were posted to general duty in view of the decision that all hygiene specialists, including officers commanding field hygiene sections, must have this special qualification. The personnel of these units included tradesmen such as sanitary inspectors, bricklayers, carpenters, tinsmiths, etc. Light field hygiene sections were employed with armoured formations. The functions of field hygiene sections were (i) inspectorial duties, (ii) skilled supervision of labour employed in the disposal of waste products and in the construction of sanitary appliances, (iii) supervision of water supplies, including their purification and distribution, (iv) disinfection of billets, clothing, etc. when communicable diseases occurred, (v) supervision of bathing, disinfection and disinfestation centres, (vi) the holding of classes of instruction for officers and other ranks within the formation, (vii) the carrying out of those sanitary measures requiring special knowledge not possessed by the troops, (viii) the preparation of special maps, graphs and statistics of infectious diseases in the area under their supervision, (ix) supervision of anti-mosquito, anti-fly and anti-louse measures as necessary.

FIELD SANITARY SECTIONS

In 1942, owing to the medical man-power position, it was decided that non-medical officers either trained in hygiene in the Army and qualified as sanitary assistants class I, or civil qualified sanitary inspectors could be employed to command newly formed field sanitary sections. These units took over the work of field hygiene sections in corps and L. of C. areas which already had hygiene specialists at their headquarters to advise the D.D.M.S. and A.D.M.S. respectively on health matters. Otherwise these units had functions similar to those of a field hygiene section, i.e. instruction, sanitary inspection of units and assistance in the building and maintenance of sanitary structures.

MOBILE HYGIENE LABORATORIES

These mobile laboratories, designed at the R.A.M. College, were equipped to carry out analyses of water and to perform analytical work in connexion with general hygiene such as the examination of foods, the detection of poisons and the investigation of occupational hazards. The officers in charge were chemists, and the most successful were those who had had previous experience of public health chemistry. These laboratories were mobilised on a scale of one per army, and were normally employed at a base.

ANTI-MALARIAL ORGANISATION IN THE FIELD

The necessity for an organisation within the establishment of a force operating in a malarious country to ensure that anti-malarial measures were carried out under expert guidance, was appreciated very early in

the war. For this work two new types of unit were evolved, viz. the malaria field laboratory and the malaria control unit.

Malaria Field Laboratories. The personnel of a malaria field laboratory consisted of three malariologists and one entomologist, together with a small number of other ranks specially selected from those having a scientific background. These were specially trained in anti-malarial work. The functions of this unit were to carry out malaria surveys, collate information, prepare malaria maps, advise on the specific anti-malarial measures to be carried out and to organise courses of instruction for medical and non-medical malaria officers. The officers acted as advisers to the senior administrative medical officer of the formation to which they were attached. Where necessary detached parties were sent to work in the forward areas there to undertake malaria surveys rapidly as the troops advanced and to advise on anti-malarial measures. These units were mobilised on a scale of one or two per army, depending on the size and nature of the area.

Malaria Control Units. These units were provided on a scale of one per division and up to two per base and L. of C. area, depending on the length of the latter. The establishment included one officer (non-medical), one N.C.O. and five O.Rs., and the unit controlled the work of a number of sections, the number depending on the area to be covered, but six was generally considered to be the maximum. The sections usually consisted of a locally enlisted civilian supervisor and a gang of twenty-three labourers. Their equipment included spades, bill-hooks, various types of sprayers for 'Malariol', and blowers and a mixer for Paris green. They carried out anti-larval work and the spraying of local houses. Malaria control units were attached to field hygiene sections, which gave invaluable assistance in helping to supervise anti-mosquito measures, particularly in areas which could not be covered by malaria control units.

In addition, every unit had a squad of trained personnel to carry out anti-mosquito measures within unit lines under the supervision of the medical officer. A small amount of equipment was authorised for unit squads, such as a ladle for collecting larvae, a spade, a sprayer, and a supply of anti-mosquito spray. Larvicides could be drawn on indent.

Reorganisation of Malaria Control. In November 1943 the Consulting Malariologist, Middle East, and the Adviser in Malariology, A.F.H.Q. (North West Africa) were called to a conference with the Consulting Malariologist at the War Office on the reorganisation of the scheme for malaria control found to be necessary in the light of experience gained in the Middle East and North Africa. A scheme was drawn up and implemented in due course. The new malaria organisation consisted of:

Unit . .	Anti-malaria officer (trained unit officer), one N.C.O. and three men for an infantry battalion with appropriate numbers for other units.
Division .	A staff officer (combatant) with the title D.A.A.G. (Health Discipline) to enforce maintenance of unit anti-malarial measures. Field hygiene sections were reinforced with specially trained personnel allotted as necessary from malaria control companies.
G.H.Q. .	The former malaria field laboratory was modified and replaced by a base and a mobile type laboratory.

The creation of the post of health discipline officer, to be filled by a representative of the Adjutant-General's branch and the overt assumption of responsibility by unit commanders for the regular taking of suppressive mepacrine by the troops under their command, were significant developments. Underlying them were a number of important concepts: (i) that the individual knew what health and disease were, valued health and wished to avoid disease and was prepared to take considerable trouble to safeguard his health and to protect himself against the hazards of disease; (ii) that the unit commander regarded the conservation of the health of his troops as part of his responsibility towards the army and towards them; (iii) that the unit commander needed the reinforcement of a specialist officer to help him discharge these duties; (iv) that the proper rôle of the medical services in this connexion was that of providing expert advice derived from scientific knowledge concerning the nature and causes of disease and of making recommendations concerning the best ways in which such advice might be transmuted into policy and action directed towards health promotion and disease prevention.

The Base Malaria Field Laboratory was intended to be located at base or L. of C. on a scale of one per force. The function of this unit was to collate information, institute propaganda and carry out experimental and investigatory work. It was to include a malaria instructional wing unless one already existed in a school of hygiene in the theatre.

The Mobile Malaria Field Laboratory was to be attached to each army, one or more, according to the malaria situation and the size of the theatre. These laboratories were provided with additional personnel and transport so as to make them independent and capable of working well up in the forward areas and able to move with formations to which they were attached. They could be broken up into independent sections. Their functions were to undertake malarial survey work rapidly as the troops advanced, to advise on preventive measures and to initiate them, and to prepare malaria maps, etc. The officers were to

act as malaria advisers to the senior administrative medical officers of the formations to which they were attached.

Malaria Control Companies, R.A.M.C. These companies replaced the non-medical malaria control units which were divisional and therefore moved with their divisions with resultant loss of continuity in anti-malarial work in a given area. The new malaria control company was a self-contained R.A.M.C. unit with R.A.S.C. personnel attached and provided with its own transport. Each company consisted of a headquarters and two or three sections, according to the needs of the theatre. One or more companies were allotted to an army and sections attached to corps, divisions, etc. as required. Sections or detachments of varying strengths were posted to brigades, areas, etc. as considered necessary. The function of these units was to undertake anti-mosquito measures outside unit lines, carry out local surveys, make maps, and control and direct the work of anti-mosquito gangs of locally enlisted civilian labour, or, where the latter was not available, labour from pioneer battalions. The use of the companies did not relieve field hygiene sections of their responsibilities. In some areas detachments of the malaria control companies were detached to them to assist in anti-malarial work. Under this new scheme men from malaria control companies could be concentrated where they were most needed.

Finally, where large-scale works beyond the capabilities of the manual labour of the malaria control companies were required, engineer units, provided with heavy earth-shifting and drainage equipment, were called upon to deal with malarious base areas in the shortest possible time.

ENTOMOLOGICAL FIELD UNITS

A great deal of laboratory work was carried out during the war in the United Kingdom in the development of insecticides. It was soon realised that however conclusive this work might be from a laboratory point of view the results could not be translated into practice in the majority of instances without field trials. A call for the provision of facilities for carrying out field trials on anti-malarial and anti-typhus insecticides was made by the Insecticide Development Panel of the Ministry of Production.

The first unit formed for this purpose was an entomological sub-section which was given a war establishment of one entomologist (major, R.A.M.C.—hygiene specialist), one laboratory assistant (sgt., R.A.M.C.) and one general-duty orderly (pte., R.A.M.C.). It was to be attached to a field hygiene section in a base or L. of C. area in an overseas theatre. It was provided with special laboratory equipment but had no transport. This entomological sub-section was despatched to North Africa early in 1943 with the special object of investigating possible substitutes for derris, one of the constituents of A.L.63,

supplies of which were no longer available. Other investigations carried out by this sub-section were on field methods for the impregnation of clothing with dichloro-diphenyl-trichloroethane (D.D.T.), and on the value of methyl bromide for disinfestation. The latter was used by the U.S. Army but was found to have certain serious disadvantages.

In view of the success of this unit and of the necessity for carrying out further extensive field trials it was considered that units with a larger war establishment than the sub-section should be formed to work in a similar but wider manner with the designation entomological field unit. Authority was given in due course for the formation of these units, which had a war establishment as follows:

> Two officers (entomologists), two laboratory assistants, and two general-duty orderlies, with one jeep and two motor-cycles for transport.

Eventually in 1944 three such units were formed. One was despatched to India to investigate the problem of scrub typhus and to carry out experiments in the impregnation of clothing with dimethyl phthalate (D.M.P.) and dibutyl phthalate (D.B.P.) as a protection against mites and mosquitoes. Another was formed on the entomological sub-section in North Africa. The third went to the Army School of Hygiene.

THE ARMY SCHOOL OF HYGIENE*

This school is a permanent instructional establishment under War Office control. It moved into the new Keogh Barracks, Mytchett, on November 13, 1939. During the war the hygiene department of the R.A.M. College was housed in the training block of these barracks and the peace-time accommodation of the school (51 officers and 650 other ranks) was greatly expanded by the construction of hutting.

COURSES OF INSTRUCTION

No less than fourteen different courses of instruction were offered. Some 583 British officers and 2,947 officers and other ranks from Dominion and Allied Forces attended certain of these. During the peak year, September 1942 to September 1943, 6,594 officers and 20,854 other ranks received training at the school. Table 5 shows the total number of officers and Table 6 the total number of other ranks who attended the school between September 1939 and September 1946.

The courses of instruction were arranged by the War Office (A.M.D.5) and notified in Army Council Instructions (A.C.Is.) from time to time. Vacancies on courses were allocated through staff channels to commands and districts and thence to units. Very comprehensive joining instructions were promulgated in A.C.Is. for the information of officers commanding units sending personnel to the school. Compliance with

* *See* Volume 1, Chapter 3.

TABLE 5

Number of Officers attending the Army School of Hygiene, September 1939–46

Period	Hygiene specialists	Medical officers	Fd. Hyg. secs. Fd. San. secs.	Regular officers	A.T.S. officers	Naval officers	Belgian officers	Dutch officers	Polish officers	Norwegian officers	Czecho-Slovakian officers	Indian officers	U.S. Army officers	Free French officers	Newfoundland officers	New Zealand officers	Canadian officers	Brazilian officers	Australian officers	Totals
September 1939 to September 1940	—	1,000	—	900	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1,900
September 1940 to September 1941	—	4,800	—	1,400	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6,200
September 1941 to September 1942	—	2,100	—	1,900	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4,000
September 1942 to September 1943	—	2,100	—	4,079	—	—	1	6	96	20	13	18	42	4	1	3	208	1	2	6,594
September 1943 to September 1944	—	1,500	—	3,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4,500
September 1944 to September 1945	—	900	—	3,800	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4,700
September 1945 to September 1946	57	612	17	250	20	2	2	77	6	3	—	—	—	—	—	—	—	—	—	1,046
Totals . .	57	13,012	17	15,329	20	2	3	83	102	23	13	18	42	4	1	3	208	1	2	28,940

TABLE 6

Number of Other Ranks attending the Army School of Hygiene, September 1939–46

Period	Anti-malaria	Regimental sanitary duties	Regimental water duties	A.T.S. O.Rs.	Sanitary assistants, Class III	Sanitary assistants, Class III Dutch	Upgrading	Regimental sanitary duties course for Dutch forces	Sen. N.C.Os.	Anti-rodent	W/E. course	Leeds University	W.V.S.	29th Training Battalion	Scots Guards	F.A.N.Y.	R.H.A.	R.E. civilian	British relief workers	U.S. Army O.Rs.	Canadian O.Rs.	Belgian O.Rs.	Polish O.Rs.	Norwegian O.Rs.	Totals
September 1939 to September 1940	–	4,250	4,050	–	2,000	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10,300
September 1940 to September 1941	–	5,100	4,600	–	700	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	-	–	–	–	10,400
September 1941 to September 1942	–	7,800	6,700	–	500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15,000
September 1942 to September 1943	–	9,000	8,000	–	1,100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	355	2,285	38	51	25	20,854
September 1943 to September 1944	–	9,800	7,000	–	2,100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18,900
September 1944 to September 1945	–	13,200	4,400	–	300	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	17,900
September 1945 to September 1946	76	1,691	1,076	16	196	18	49	175	74	41	201	9	452	904	210	94	27	33	115	355	2,285	38	51	25	5,457
Totals . .	76	50,841	35,826	16	6,896	18	49	175	74	41	201	9	452	904	210	94	27	33	115	355	2,285	38	51	25	98,811

these instructions simplified administration both for the units sending students and for the school.

The following courses were arranged for officers:

(*a*) *Medical Officers.* Newly joined medical officers were taught man management and the care of the soldier, together with the principles concerned in the maintenance and improvement of the health of the troops under the varying conditions encountered on active service. This included special measures to guard against disease and the methods of ensuring supplies of suitable food and pure water at all times and places. Women medical officers also attended this course. Duration of course—seven days. Number in class—130.

(*b*) *Specialist Course.* R.A.M.C. officers under training as hygiene specialists at the R.A.M. College attended the school for one week's practical instruction in water purification and sanitation in the field with special reference to tropical conditions. Number in class—10.

(*c*) *Regimental Officers.* This course was on similar lines to that for medical officers but less technical, and was designed for regimental officers of all arms (except R.A.M.C.). Every encouragement was given to commanding officers, seconds-in-command and company commanders to attend this course. This not only enabled them to appreciate the value of advice on health matters by their medical officers and to use their own initiative if medical advice was not available but, in giving them an appreciation of the scope of the subject, it usually resulted in their taking steps afterwards to ensure that their units only selected better educated men to attend courses at the school.

The following courses for other ranks were arranged:

(*a*) *R.A.M.C.*

(i) Sanitary assistants' course of two months' duration (number in class—75). Selected R.A.M.C. personnel were trained as sanitary assistants at the school. These men were used to staff field hygiene sections, field sanitary sections, and for sanitary duties in command pools, where they assisted hygiene officers in their areas much as sanitary inspectors do M.Os.H. in civil life.

(ii) Sanitary assistants' advanced course. Duration—fourteen days. Number in class—50. This advanced course was for qualified civilian sanitary inspectors graded as sanitary assistants class I and for R.A.M.C. sanitary assistants class II for upgrading to class I.

(iii) Sanitary assistants' refresher courses. These were four-day courses in the method of working special apparatus such as:

*Mobile Water Purifier . .	Number in class—20
A.S.H. Destructor . .	Number in class—10
Field Portable Disinfector .	Number in class—20

* A similar course was held for R.E. personnel of field park companies and field companies.

(*b*) *Regimental Personnel.* All arms—ten-day course. Number in class up to 1,000. There were two types of course, one in water purification in the field and the other in field sanitation. These courses were designed for the training of water duty and sanitary duty orderlies for employment as such with their units. It was necessary for all field units to have the numbers allowed them for water and sanitary duties in war establishments, plus 100 per cent. reserve, trained in these duties. In the case of training units, 2 in every 150 recruits were trained in either water or sanitary duties.

Special Demonstrations. Practical demonstrations of hygiene measures in the field were arranged for parties of officers and other ranks visiting the school. Cadets from the R.A.C., O.C.T.U., Sandhurst attended for instruction every Saturday.

A.T.S. Officers attended the military hygiene course for regimental officers. Other ranks were trained as regimental water duty orderlies or sanitary orderlies to fit them for duty with A.A. units and in camp.

Training. Training at the school was carried out by lectures, lecture demonstrations, cinema shows, and field work. Visual aids and practical work were used to the fullest extent and all equipment and material necessary for this purpose was available. The practical application of military hygiene to field conditions was the primary aim in all training, and the need for improvisation was stressed from every aspect. The instructors and assistant instructors at the school were carefully selected and the standard of instruction was high. In addition to hygiene specialists the staff included an entomologist and a sanitary inspector well known in public health circles.

(*a*) *Sanitation*

Full size models of all field sanitary appliances were available in the outdoor model ground and small scale models were set out in the model rooms. In the workshops men were instructed how to make these appliances in standard and improvised forms.

(*b*) *Entomology*

In the entomological laboratory insect pests and vectors of disease were studied together with the methods used for their eradication.

(*c*) *Water Purification*

For training in this subject every type of water purification and filtration appliance used in the field was operated at the water point at Mytchett Lake.

(*d*) *Films*

Instructional and informative hygiene films (with commentaries) were shown to students to supplement lectures on the subject. This proved to be a popular and effective method of instruction. An extensive library of films and cartoons was maintained at the school and included the following which were made at the school:

(i) *Water Purification in the Field* which dealt with the filtration, sterilisation and distribution of water in the field and the training of water duty personnel.
(ii) *Mosquitoes and Malaria.* Anti-mosquito and anti-malarial measures.
(iii) *The Louse.* Disinfestation and louse-borne diseases.
(iv) *The Housefly.* Fly-borne diseases and their prevention.
(v) *The Care of the Soldier.* How the medical officer could promote the soldier's fitness and welfare by co-operation.
(vi) *Sanitation in the Field.* Practical sanitation on the march, in camp and in billets.

FORMATION OF FIELD MEDICAL UNITS

Another important function of the school during the war was that of supervising the formation of newly raised hygiene units and of training them and if necessary mobilising them. The following types of unit were formed and trained at the school:

Field hygiene sections and field sanitary sections,
Mobile hygiene laboratories,
Malaria field laboratories.

Mobile Bath Units. Officers and men of mobile bath units attended the school for training in the theory and practice of cleansing and disinfestation.

EXPERIMENTAL WORK

This formed another important part of the activities of the school. Experimental models of appliances used in connexion with water purification and sanitation were designed, tested and improved upon in the light of practical experience. Much work was done in perfecting modern methods of water purification in the field and, in connexion with sanitation, methods of improvisation were devised and the utilisation of waste oil, in the oil and water flash fire for incinerators, was fully exploited. The efficacy of new insecticides and spraying equipment was investigated and the mosquito-proof properties of various fabrics for tropical clothing were also tested.

ANTI-MALARIAL TRAINING

During 1943, at a meeting between the Directors of Military Training, Ordnance and Hygiene, it was agreed that in order to make the troops aware of the nature and importance of malaria, more particularly with regard to measures of personal protection, immediate action should be taken to commence anti-malarial instruction in units. In this training emphasis was to be laid on the following points:

(*a*) Suppressive treatment by drugs.
(*b*) Use of mosquito nets, veils and gauntlets.
(*c*) Mosquito-proofed tents.
(*d*) Use of insect repellents.

It was agreed that attention should be called, in instructions sent out through staff channels, to the importance of unit discipline in the enforcement of individual action and in the maintenance of individual responsibility.

The basis on which this training was planned was that anti-malarial training was to be recognised as a form of weapon-training in which personal protection against malaria was a unit responsibility and therefore the training must be by the unit and not by the medical officers. In order, however, that the training should be started on the right lines, it was arranged for the medical services to instruct certain key personnel of the units, i.e. the commanding officer or second-in-command, a senior N.C.O., and the unit medical officer. This instruction was carried out by field hygiene sections and was on the lines of the pamphlet *Malaria* 1943. Hygiene officers arranged a lecture to their H.Q. staffs in which the operational aspect of malaria was stressed and experience and incidence in both world wars referred to, and the film *Mosquitoes and Malaria* was shown. After this preliminary instruction the unit personnel arranged to carry out the malaria training of their units. Apart from giving a lecture to the whole unit, in which the malaria film was shown, the medical officer took no further part in the training except as an adviser and umpire. A scale of equipment and stores for instructional purposes was drawn up and issued to reserve divisions, formations and units mobilising for overseas service (long sea voyage) and home commands. The various items were arranged in sets each consisting of:

TABLE 7

Scale of Equipment and Stores for Anti-malarial Training

R.A.O.C. Supply

Nets, mosquito, G.S.	2
Nets, bush	2
Tents, bivouac, mosquito-proofed	1
Veils, mosquito	2
Gauntlets	2 prs.
Sprayers, hand (Flit gun)	1

R.A.S.C. Supply

Anti-mosquito cream, 2-oz. containers, filled	6
Anti-mosquito cream, 7-lb. tin*	1

* For field hygiene sections only to replenish small containers.

These sets were issued on a scale of 40 sets per reserve division with a pool of 40 sets to each command for the instruction of mobilising units.

When it was represented that this scale of training equipment was insufficient to enable the necessary training to be given, the number of sets issued to commands was doubled and the scale of the 40 sets issued to reserve divisions was increased.

Late in 1944 and early in 1945, when planning for operations in the Far East was the main consideration, a further impetus was given to anti-malarial training.

Experience gained in malarious areas had shown that it was essential that commanding officers should have whole-time anti-malarial squads to assist them in training their men in the means of personal protection and in enforcing anti-malarial discipline. These squads were also necessary to carry out mosquito destruction inside the area for which the unit was responsible.

Although it was not possible to increase the man-power allowance for all units in order to permit the inclusion of such squads additional to the existing war establishment, nevertheless, commanding officers were required to ensure that men were available for these whole-time duties in malarious countries in addition to other unit sanitary personnel.

All war establishments for the Far East included in Volume XV contained the following note:

> 'Not less than (—) men will be trained in anti-malarial duties and of these (—) will be employed whole-time on these duties in a malarious area.'
>
> 'The numbers involved per company or equivalent unit will be eight men trained and four whole-time employed.'

It was also decided that the proportion to be trained in anti-malarial duties in training units should be on the same basis as that laid down for the training of sanitary and water duty personnel, viz. 1 in 150 recruits, and that in reserve divisions the proportion should be 4 in 100.

In order that the necessary numbers might be trained it was arranged for the Army School of Hygiene to hold a series of special three-day courses for unit anti-malarial personnel with 200 vacancies on each course, which were allocated to commands in the usual manner.

In view of the importance of hygiene and malaria in the Far East it was decided also to include instruction in the methods of preservation of health in the Tropics as well as measures for personal protection against malaria in the general training programme at corps training centres. Two periods in the corps training programme were allotted—one for anti-malarial instruction and the other for instruction in the prevention of dysentery.

The anti-malarial training at the school was supplemented by a further drive in unit training under local arrangements for which the scale of equipment authorised was augmented and brought up to date.

TABLE 8

Anti-malarial Equipment for Unit Training

	A Per Set	*B* Per Set
R.A.O.C. Supplies		
Tents bivouac, mosquito-proof	1	36
Nets, mosquito, bush	2	72
Curtains, mosquito, Mark II	2	72
Sprayers, Flit	2	6
Sprayers, anti-malarial Maney hand	1	1
Sprayers, anti-malarial knapsack pneumatic Mysto 7	1	1
Sprayers, stirrup pump	1	1
R.A.S.C. Supplies		
Insect repellent individual containers, 2 oz.	6	72
Individual insecticide sprayers	6	12
Insecticide dispenser (Aerosol Bomb)	1	2
Medical Supplies		
Tabs. mepacrine hydrochloride 0·1 g., strip packed (in strips of 7 tabs) Tabs.	14	84
Containers F.M.E. tin empty, personal for mepacrine tablets	6	12
Scale of Issue		
Set A		
Northern Command		100 sets
Other Commands		80 sets
C.O.H.Q.		10 sets
O.C.T.Us.		1 set
Set B		
Reserve Divisions (Each Echelon and equivalent unit. Other units in proportion to strength.)		1 set
Royal Marines		5 sets

SCHOOL OF HYGIENE, NORTH AFRICA

Later Central Mediterranean Training Centre (C.M.T.C.), C.M.F.

The proposal to form a school of hygiene in North Africa was put forward by H.Q. 15 Army Group in July 1943, together with suggestions regarding its scope, war establishment and individual key appointments. The war establishment was based on that for the Middle East School of Hygiene and included an attached malaria wing.

A selected officer was posted to A.F.H.Q. Algiers from C.M.F. on November 6, 1943, and was given instructions to form and open a school of hygiene. Unfortunately, through an oversight on the part of the staff, he was not, as officer commanding elect, given an opportunity

of stating a case before the war establishment committee before the ratification of the war establishment and found that it did not entirely meet his requirements.

From the experience he gained during the formation of this unit the commandant noted some practical points for future guidance:

(i) The commandant of such a school should have had previous experience of teaching organisation in addition to field experience in theatres of war to enable him to draw up a satisfactory G.1098, I.1248,* teaching layout and detailed programme of courses.

(ii) He should attend W.E. committee, as he alone can explain why certain personnel, equipment and vehicles are essential. A clear cut policy, moreover, is required as to what courses are to be arranged and the amount of instructors' time which is to be diverted to the instruction of extra-mural students.

(iii) He should be given access to R.A.M.C. Records to arrange the posting of key personnel such as warrant officer, clerk, N.C.O. instructors and workshop foreman.

(iv) Transport.—A public utility or 15 cwt. truck to be available for liaison and drawing smaller I.1248, G.1098 and L.1398† items of equipment. This is essential from the moment of arrival of the commandant. Occasionally, also, one 3 ton lorry is required for the transport of bulky ordnance and R.E. stores.

(v) Water point to be laid out first, so that instruction in water duties can be commenced while sanitation model grounds are in course of construction and the museum is being equipped.

The school was formed under the aegis of 8 Convalescent Depot, which relieved it of much unit administration and left the personnel free for the work of forming the school.

THE WORK OF THE SCHOOL

The first course—a water duty orderlies refresher course—was held between December 5 and 11, 1943. This was the only course held by the school in its original location, as it then received orders to pack up and stand by in readiness to move to join the Combined Military Training Centre, C.M.F., which was to become the parent centre of several schools.

The commandant and an advance party of four O.Rs. arrived at C.M.T.C. on January 20, 1944. Accommodation was allocated and the

---

* G.1098, the ordnance mobilisation equipment scale.
I.1248, the medical mobilisation equipment scale.
† L.1398, Stationery mobilisation equipment scale.

unit area defined. The main body arrived on February 5, and the interval had been occupied in planning the layout of the area, clearing space for model grounds, and laying in stocks of salvage material for the construction of models, etc. No Royal Engineer assistance was available on the arrival of the main body; the workshops staff therefore laid out a three-tap water point. While working models of sanitary appliances were being constructed, a water duty orderlies refresher course commenced on February 21, 1944. Thereafter the number and variety of courses held increased steadily and progressively without further interruption.

With the gradual opening of other schools in the centre much additional instructional work was undertaken for students of the tactical school, school of administration, physical training school, as well as of other visiting parties which were arranged from time to time.

It was decided to organise the programme of instruction in cycles of four weeks at a stretch with a week's interval between to rest instructors and allow time for reorganisation and reconstruction. Appropriate courses were offered regularly in each cycle.

In general the syllabi of the various courses were based on those adopted by the Army School of Hygiene in the United Kingdom, being modified only to fit in with practical experience in the Mediterranean theatre. In all classes, instruction was mainly practical and visual and lectures without aids were discouraged except where absolutely necessary. Working and demonstration models and the blackboard constituted the basic method of all instruction.

Training was not confined to officers and other ranks of the British Army; Allied and Dominion troops and co-belligerents were also trained. Some of these were non-English-speaking and produced their own problems. A special water duties class for Cypriots was arranged and the men selected for the course were of a suitable educational standard. As they could not speak English an interpreter was provided. From time to time, French-speaking Canadians, some with a very limited knowledge of the English language, attended courses in sanitation and water duties. Since they derived little benefit from set lectures, it was arranged for them to have a certain amount of individual practical instruction, and examination in French on the conclusion of the courses showed their knowledge to be up to the average standard.

A number of courses was held for the benefit of Italian medical personnel of six combat groups which were being formed. The majority of the students proved to be keen and hard-working but were found to be unable to retain a sufficient knowledge of the subject to be capable of giving instruction within their own formations. This was due to the educational standard of the men selected being too low, the majority being agricultural labourers. As the officer commanding observed in

this connexion: 'It is rarely possible in six days to turn an untrained B.O.R. into an efficient sanitary duty orderly. How impossible, therefore, to produce an instructor in such a subject out of a half-educated Italian!'

It was represented that, to ensure the selection of men of an adequate educational standard for these courses, a nucleus of Italian medical and regimental officers should be given a course of instruction at the school so that the scope of field sanitation might be more fully appreciated by those concerned in the selection of future students. The Italian medical officers who attended were found to be consistently keen, intelligent and painstaking and were of great assistance in the training of the other ranks.

One of the assistant instructors (a staff sergeant) on the school staff acquired some degree of fluency in Italian and was able to give most of his instruction in that language. This was fortunate as only two efficient interpreters were provided on each occasion. It would have been preferable to have had one interpreter permanently appointed for such classes in order to provide continuity and increase efficiency, by allowing sub-division of the class for practical instruction.

WAR ESTABLISHMENT

The war establishment originally sanctioned would have made it virtually impossible for the school to have functioned on the basis intended, and this was strongly represented. This W.E. had been drawn up by the C.M.T.C. and the Director of Military Training without consultation with the officer commanding the school. In the event, however, a compromise was reached and the school was able to function mainly because it was permitted to retain provisionally all teaching, G.D. and workshops personnel on its North African establishment and there were practically no deficiencies on that establishment when the school opened at C.M.T.C. in February. Also the instructional staff, who were handpicked, responded well to the extra work they were called upon to perform. Later, a more adequate establishment was authorised.

It was found that the attachment of a malaria wing to the school proved to be of considerable value to malaria teaching, as such a wing could never be self-supporting and there were facilities in the school such as workshops, general duty orderlies, and clerical staff without which it could not have functioned efficiently. The malaria wing, moreover, being short of two of the four technical experts held on W.E., could not, without outside assistance, have carried out all the teaching required of it. The assistance rendered to the malaria wing, during its attachment to the school, of course, resulted in the school having to remain rather understaffed.

One mobile hygiene laboratory was located at the school from April to November 1944, and this proved to be helpful, as the officer commanding assisted with the instruction of medical officer and sanitary inspector students and with experimental and research work of various kinds carried out at the school.

One M.C.U. was also attached to the school for several months during 1944, and the services of an artist were available when required for the production of posters and charts.

DIFFICULTIES IN ADMINISTRATION

A knowledge of the scope and function of a school of hygiene, and of the various R.A.M.C. trades is essential for the efficient administration of such a school. It was perhaps inevitable that difficulties arose when the school came under a purely non-medical administration in C.M.T.C. These difficulties were, however, overcome in time, more particularly when the revised war establishment was authorised.

At first difficulties were experienced on the 'Q' side of the school administration which was undertaken by the administrative H.Q. of the centre. It was found that material on indent was frequently so technical that indents were not always understood, nor, sometimes, the urgency of the requirement. It was found necessary to maintain ledgers and keep copies of all indents and to arrange with the quartermaster of administrative H.Q. to notify the reason for failure of supply, i.e. whether 'not available' or 'to follow'.

The officer commanding the school stressed the importance of his assistant instructors being smartly turned out and considered that they should be provided with a well-fitted suit of battledress which should be in good condition. Exception was taken to the issue of part-worn battledress to instructors. It was represented that facilities should be provided for a more frequent exchange than normal, or, better still, for the provision of a second suit in the case of assistant instructors.

During the formation of an instructional centre such as the C.M.T.C., particularly in the early stages, the main effort is directed towards getting all the schools to function as early as possible and the provision of amenities for the staff is given a low place in the priorities of R.E. work. During this period the school established an instructors' common room which catered for instructors' rest periods and provided accommodation for reading and writing and opportunities for debates, games and entertainments. The officer commanding considered that such an arrangement was essential in order to maintain the team spirit, so essential to the efficiency of the school and, in this way, preserving its individuality without prejudicing its loyalty to the parent centre.

NUMBERS OF STUDENTS TRAINED

During the period from February 19, 1944, when the school opened until mid-December 1944, the following numbers attended the school for training:

	School students	Extra-mural students	Italian	Totals
Officers . . .	365	1,719	6	2,090
O.Rs. . . .	1,362	1,960	84	3,406
Grand totals . .	1,727	3,679	90	5,496

Note.– These figures refer only to the first ten months of the school's existence.

MIDDLE EAST SCHOOL OF HYGIENE

In 1940, with the influx of new troops from the United Kingdom and the Dominions, the necessity for providing facilities for instruction in hygiene was fully appreciated by the staff of G.H.Q., M.E. In view of the extensive area covered by M.E. Command, however, the first question to be decided was whether or not this instruction should be offered at one central school. Because it was bound to be very expensive to move personnel from all parts of the command for short courses to one centre, it was agreed that the instruction should be provided by selected field hygiene sections in (*a*) Egypt and (*b*) Palestine.

2/1 Fd. Hyg. Sec. was chosen to carry out this instruction in Egypt and 2/3 Fd. Hyg. Sec. in Palestine. The latter unit had been located at Sarafand since 1939 and had already organised a school which had been very successful, mainly for the reason that instruction had been its main function. In Egypt the attempt to provide instruction in this way had failed. On two occasions the field hygiene sections nominated for this duty were moved elsewhere at short notice so that the courses of instruction were ended abruptly. It was concluded that the system of relying on field hygiene sections to function as instructional units in addition to carrying out their normal duties had not proved to be a success.

In consequence of this experience the D.M.S. early in 1941 pressed for the formation of a school of hygiene to be located preferably in Egypt. This was agreed in principle and a provisional war establishment was drawn up and submitted to the establishments committee of M.E., H.Q. for approval both by them and by the War Office.

Various locations were proposed for the school, including Moascar, Abbassia, Helmieh and Geneifa. It was the intention, if possible, to

avoid overhead expenses by arranging for both instructional staff and students to be attached to neighbouring units for accommodation and messing. The numbers involved were estimated to be 22 officers and 69 other ranks. All these proposed locations were examined in turn but were found to be unsuitable for various reasons, such as overcrowding of existing accommodation or the previous allocation of spare accommodation for other incoming units.

Eventually, in March 1941, the staff suggested that the Palestine Command Hygiene School in Sarafand, which was then being administered by 5 Fd. Hyg. Sec., should be taken over by H.Q., M.E.F., as the Middle East School of Hygiene. This proposal appeared to have many advantages which included:

(*a*) Taking over a going concern.

(*b*) Providing ample accommodation for housing and feeding school staff and students, and for lecture rooms, etc. in an existing leave and transit camp.

(*c*) The school would be located in a healthy climate.

The D.M.S. agreed to the proposed location for the school but opposed the suggestion that 5 Fd. Hyg. Sec. should run it. There was a shortage of field hygiene sections, and he was therefore anxious to free this unit for its legitimate duties. Consequently he continued to press for the draft war establishment for a M.E. school of hygiene, which he had already submitted, to be authorised. War Office approval for the war establishment was obtained in August 1941, but it was stipulated that the personnel were to be provided locally instead of being provided from the United Kingdom as requested.

The school was eventually mobilised on August 18, 1941, and took over the premises and demonstration ground used by 5 Fd. Hyg. Sec. The officer commanding the latter unit was appointed commandant of the school and remained with it for the rest of the war. Pending receipt of its own equipment the newly formed school was able to use that of 5 Fd. Hyg. Sec. for instructional purposes.

COURSES

The original establishment of the school was based on an output of 90 students a month and the following courses were arranged:

Course 'A'

Instruction of regimental personnel (pioneers) in the construction of permanent and semi-permanent sanitary appliances.

Duration of course . .	10 days
Number of students . .	15
Instructors . . .	1 sergeant

Course 'B'

Instruction of unit sanitary personnel. This consisted of lectures in the elements of hygiene, demonstrations and practical instruction in the temporary sanitary measures required in the field.

Duration of course	14 days
Number of students	30
Instructors	3 sergeants

Course 'C'

Instruction of water duty personnel. This consisted of lectures and practical demonstrations to ensure that men were conversant with the methods of water sterilisation employed in the field.

Duration of course	10 days
Number of students	24
Instructors	2 sergeants

Officers' Course

Classes for officers were substituted for Course 'B' when required.

Number of students	21 officers
Duration of course	10 days

The monthly student output from these courses was approximately as follows:

Course 'A'	15
Courses 'B' and 'C'	54
Regimental Officers	21
Total	90

In addition there was a course for twenty-one medical officers every three months and also a three months' course of instruction for ten R.A.M.C. sanitary assistants which was always in progress.

In January 1942 the possibility of increasing the turnover of the school was examined, as it was considered that an output of ninety a month was not sufficient in view of the size of the force and the great importance attached to the dissemination of knowledge in the practice of military hygiene in the Middle East. A proposal was submitted for a small increase in the establishment to allow the monthly output to be increased as follows:

Course 'A'	15	
Courses 'B' and 'C'	108	
Regimental Officers	24	—The intake for this course was later altered to 12 officers and 12 W.Os. or Senior N.C.Os.
Medical Officers	20	
Total	167	

The three months' course of instruction for ten R.A.M.C. sanitary assistants was to be continued in addition.

The increase as eventually authorised had the effect of upgrading the commandant to lieut. colonel and adding one major (specialist in hygiene), a staff sergeant and two privates to the establishment and deleting two sergeants.

There was a progressive increase in the teaching commitments of the school during 1942 and 1943. Instructors were called upon to lecture at outside instructional establishments, e.g. the staff college, the junior staff school and the M.E.T.C. Extra classes were necessary for A.T.S., Polish A.T.S., Naval and Royal Air Force officers, for hygiene units and for hygiene officers of the British, Dominion and Allied forces. Civilian medical practitioners in training and numerous other groups visited the school for lectures and demonstrations. Occasionally classes were held to deal with special subjects, e.g. rodent control.

In 1943 it was found that the personnel instructed in this manner, over and above the students who attended the official courses, were as follows:

Month	*Officers*	*Other Ranks*
April	179	111
May	88	255
June	291	95
July	231	71

Students were drawn from units and formations in Egypt, Palestine, Western Desert, Cyrenaica, Sudan, Paiforce and Cyprus, and Dominion forces were well represented.

Joining instructions were drawn up and circulated to facilitate administration. Vacancies for the official courses were allotted by G.H.Q., M.E.F. M.T.2 dealt with vacancies for all arms (except R.A.M.C.) through 'G' staffs of formations, and D.M.S. allotted vacancies on courses for medical personnel. Later it was agreed that all vacancies should be dealt with by 'G' staff.

On the conclusion of courses examinations were held and students were graded by two symbols according to their knowledge and instructional ability as prescribed in A.C.I. 1716/43:

Knowledge		*Instructional ability*
A	above average	X
B	average	Y
C	below average	Z

Before the introduction of this A.C.I., students had been graded as distinguished, passed, or failed. Results of examinations were circulated to all headquarters concerned.

On one day (June 16, 1943) the school had through its hands 119 officers and 40 warrant officers composed of British, Indian, South African, Polish and Belgian groups.

At this time the war establishment of the school was designed to deal with a maximum of 180 students a month, but with this remarkable increase in unofficial teaching commitments the staff became over-extended and, although augmented by an additional staff sergeant held surplus to establishment, was still insufficient to permit it to compete adequately with its increased responsibilities.

In July 1943 it was decided to centralise instruction in anti-malarial work in the Middle East at the M.E. School of Hygiene by adding a malaria wing to the school. In consequence a proposal was submitted for a revision of the war establishment. The following were the main effects of the proposal:

(*a*) The addition of a malariologist (major).

(*b*) The upgrading of the senior instructor from W.O.II to W.O.I.

(*c*) The upgrading of the workshop foreman from staff-sergeant to W.O.II.

(*d*) The addition of three instructors (sanitary assistants).

(*e*) Deletion of sergeant instructors (san. assts.) and replacement by staff-sergeants (san. assts.).

(*f*) The addition of 1 private (clerk).

(*g*) The addition of six civilian batmen and two civilians for regimental duties. The deletion of two privates (cook and batman) and one civilian (carpenter).

The instructors were thus increased to ten, which was considered to be the minimum, and were upgraded to staff-sergeants.

Instructors for the school were obtained from staff-sergeants in field hygiene sections; this rank in the war establishment of the school was necessary so that the school could obtain the best men without reduction in rank and consequent discontent.

The new establishment was approved and promulgated in September 1943 and raised the teaching capacity of the school and malaria wing to 230 students on official courses and including extra-mural students to some 500 a month. The opportunity was taken, when revising the war establishment, to increase the transport, which had hitherto consisted of a motor cycle and two instructional water-tank trucks, by the addition of a 15 cwt. truck. This was essential for the transport of students of the malaria wing for field work to various malarious areas and for other necessary duties of the unit for which vehicles had formerly to be requisitioned.

Courses at Malaria Wing M.E.S.H.

The following courses were held at regular intervals at the malaria wing:

Medical Officers' Malaria Course

To train medical officers in the principles and practice of malaria control.

Duration of course . .	10 days
Number of students . .	12 officers

Malaria Control Units' Officers Course

To train officers to command M.C.Us. and teach them practical measures for dealing with mosquito breeding areas.

Duration of course . .	10 days
Number of students . .	10 officers

Regimental Officers—Malaria Prevention

To train officers of all arms (except R.A.M.C. medical officers) in the practical measures of malaria prevention.

Duration of course . .	3 days
Number of students . .	15 officers

In June 1944 the D.M.S. proposed that there should be a reduction in the monthly intake of students at the school in view of the reduction in strength of the M.E.F. It was suggested that the monthly intake might be reduced to a total of 104 as follows:

Course 'A'. Pioneers	12
Course 'B'. Sanitary Orderlies . .	40
Course 'C'. Water Duties . . .	40
Officers and Warrant Officers . .	12
	104

This would have permitted a slight reduction to be effected in the war establishment of the school. The Military Training Branch, however, asked that the matter might be deferred for a period, as courses were being filled reasonably well and it appeared likely that this state of affairs would continue for some time. The situation was to be reviewed again at a later date.

In 1945 the work of the school was reviewed again and a revised war establishment was approved and promulgated in April 1945. It was based on a reduction of intake of students attending the M.E. School of Hygiene from 230 to 130 (30 officers and 100 O.Rs.). This permitted a reduction to be made in the instructional staff of three staff-sergeant instructors and two privates (clerk and bricklayer). The new establishment showed the malaria wing as a separate entity in

accordance with revised procedure and included two laboratory assistants and an additional officer (major—specialist in entomology). This officer had been employed in the malaria wing since its inception but was now allowed for in the W.E. The transport was increased to include a light utility car for the use of the entomologist to enable him to collect specimens, make malarial surveys and reconnoitre localities suitable for class demonstrations and practical field work.

It was found to be a great advantage to have the malaria wing at the school of hygiene as the personnel of the latter could be used to supplement that of the wing. There was a proposal late in 1945 to have a separate school of malariology independent of the School of Hygiene, M.E., but this was abandoned owing to shortage of malariologists and other related specialist personnel.

After the war the Middle East School of Hygiene was moved to Deir Suneid, approximately seven miles north-east of Gaza, where it was attached to the Middle East Training Course, M.E.F.

The school was closed when British forces left Palestine in 1947.

Administrative Difficulties. The following were some of the administrative difficulties experienced by the school during the early period of its existence:

(*a*) Partial filling of vacancies by formations and last-minute surrender making it impossible for the vacancies to be re-allotted and taken up by other formations.

(*b*) Late arrival of students for courses.

(*c*) Lack of discrimination in the selection of students for particular courses.

(i) Regimental officers were sent on courses in preventive medicine designed for medical officers and *vice versa*.

(ii) Too many O.R. students in sanitary and water duty courses held high N.C.O. rank. These courses were primarily intended to train men to fill the basic war establishments of units. Too high a proportion of the students for these courses came from medical units. It was found that this was due to 'G' branches of the staffs of lower formations and areas passing their allotments to 'M' branches for disposal to medical units.

(iii) Illiterates proved a difficulty as did students to whom English was a foreign language, such as Maoris, Afrikaans-speaking South Africans and French-speaking Seychellois. Such students as a rule did not fare well.

(iv) Some units sent unwilling students who were not interested in the subject. Such students were found to resist instruction.

(*c*) Poor attendance at officers' courses.

Most of these difficulties were overcome after they had been represented to the staff by the D.D.H.

Experimental Work. The school carried out a considerable amount of experimental work, some of which was directed by G.H.Q., M.E.F., and some was initiated locally. Trials were carried out of various types of latrines, latrine covers, portable disinfectors, fly safes, fly traps, and into the efficacy of various insecticides, etc. It was the only experimental establishment in the Middle East able to undertake this type of work. It also undertook the collection and co-ordination of technical information in connexion with hygiene.

HYGIENE PERSONNEL

HYGIENE SPECIALISTS*

The arrangements made before the war for the recruitment of specialists to the R.A.M.C., whereby the Central Medical War Committee of the British Medical Association undertook to nominate selected and suitably qualified individuals to meet the requirements of the War Office, did not apply to the recruitment of hygiene specialists.

Instead, the Hygiene Directorate made its own arrangements for selecting their specialists from among the newly commissioned medical officers who were considered to have suitable qualifications and experience of public health work at home or abroad. It had been decided that all hygiene specialists must be in possession of the D.P.H., and A.M.D.1 supplied A.M.D.5 with the names of newly commissioned R.A.M.C. officers with this qualification. Those who reported personally to the War Office were interviewed by A.M.D.5 and letters were sent to the others to ascertain their experience in public health work, if they were interested in military hygiene and desirous of being employed as hygiene specialists. In this way a list of potential specialists was constantly maintained at A.M.D.5.

During the early months of the war, officers were selected from this list in batches to attend a course in military hygiene and tropical medicine at the R.A.M. College, after which they were returned to general duty to await vacancies arising in the appointments of D.A.D.H., officers commanding field hygiene sections, or as instructors at the Army School of Hygiene. In the meantime it had been agreed with A.M.D.1 that these officers would be left where they were and at the disposal of A.M.D.5 until they were required for employment as specialists and this arrangement enabled A.M.D.5 to maintain a reserve of potential hygiene specialists to meet immediate requirements.

The appointments of D.A.D.H. and officer commanding a field hygiene section were not given specialist's status, i.e. the rank of major

* *See* Volume I, Chapter 9.

and specialist's pay, until some months after the commencement of the war.

It soon became apparent that many of these newly commissioned officers, who possessed special qualifications, had never had any practical experience of public health work in civil life. It was also evident that the increasing requirements for hygiene specialists could not be met from the relatively small numbers with the necessary experience then joining the R.A.M.C., more particularly as local authorities, in view of their increased commitments, were often unwilling to release their full-time public health officers. It was therefore decided that the Hygiene Directorate would have to arrange for the training of its own specialists. Certain qualifications and experience were laid down as essential for candidates accepted for this training. Candidates selected in the United Kingdom were required to qualify at a hygiene specialists' course at the R.A.M. College, after which they were given three months' practical instruction in the duties of a hygiene specialist by attachment for a period to a headquarters where there was a D.A.D.H. or an A.D.H., and for a period to a field hygiene section. It was necessary for a candidate to obtain a satisfactory report on the conclusion of this training before he was posted to fill a vacancy.

*Malariologists.** Malariologists were required as advisers or consultants in malarious theatres of war and to staff malaria field laboratories. In 1943 one was appointed to join the Army Medical Directorate staff of consultants as Consultant Malariologist to the War Office. Initially malariologists were selected from officers in the I.M.S. or the Colonial Medical Service who were experienced in this work and from those recommended by the deans of the London and Liverpool schools of tropical medicine.

As the war progressed and more malariologists were required, it became necessary to train those selected at the instructional wings or schools formed by malaria field laboratories in certain overseas theatres. The policy was to have an experienced malariologist in command of the malaria field laboratory and, with the exception of the entomologist, who should also be experienced, the remainder could be war-time trained. It was agreed that a young man trained in the Army would be more valuable than a civilian malariologist without experience of the Army. Malariologists were graded as specialists R.A.M.C. with the rank of major; advisers and officers commanding malaria field laboratories as lieut. colonels and consultants as brigadiers.

*Entomologists.** Entomologists were required for duty in malaria field laboratories and entomological field units or to carry out research and field trials on the efficacy of various insecticides. One was employed

* *See* Volume I, Chapter 9

as an instructor at the Army School of Hygiene, Aldershot. The total numbers employed, however, were relatively small and little difficulty was experienced in obtaining those needed. A number had made personal inquiries of the Army Medical Directorate as to whether there was any likelihood of their being employed and recommendations were obtained from the schools of tropical medicine and from the chairman of the Entomological Sub-committee of the Medical Personnel Research Committee of the Medical Research Council. These were interviewed and called up as required. They were graded as specialists R.A.M.C. with the rank of major.

*Chemists.** A comparatively few chemists were required as officers commanding mobile hygiene laboratories, and little difficulty was experienced in obtaining the numbers required. One or two were Territorial officers displaced from field hygiene companies when it was decided that hygiene officers must be medical men in possession of the D.P.H.

It was appreciated by experience that officers selected for duty with mobile hygiene laboratories should have had special experience in public health chemistry if the maximum advantage was to be obtained from these units.

Non-medical Hygiene Officers. To save medical man-power it was decided to employ a small number of non-medical officers as instructors at the Army School of Hygiene. They were selected from sanitary assistants, class I, and from those in possession of the certificate of the Royal Sanitary Institute, and commissioned as lieutenants, R.A.M.C. One exceptionally well-qualified sanitary inspector was commissioned directly from civil life as a major, R.A.M.C., in 1940, for duty as an instructor at the Army School of Hygiene.

When field sanitary sections were formed in 1943, officers to command them were also selected from among N.C.O. sanitary assistants either with a class I or civil qualification. These officers worked directly under the supervision of a D.A.D.H.

Sanitary Assistants.† Sanitary assistants were employed in staff field hygiene sections, field sanitary sections, the Army School of Hygiene and overseas schools of hygiene, and each command in the United Kingdom was allotted a pool of sanitary assistants to assist hygiene officers in supervising the sanitation of their areas. The numbers employed in these command pools were:

Sergeants	18
Corporals	80
Privates	33
	131

* *See* Volume I, Chapter 9.
† *See* Volume I, Chapter 10.

In addition one sanitary assistant was appointed to the staff of each sub-area quartering committee to advise on the hygiene aspects of accommodation taken over for occupation by the troops.

Candidates for training as sanitary assistants were mainly selected from R.A.M.C. personnel at the R.A.M.C. depot after completion of their primary training. Those selected were sent to the Army School of Hygiene, where they received a very comprehensive course of training lasting for two months. The numbers in these classes varied from 60 to 75. An examination was held at the conclusion of each course, and those who came up to the required standard were graded as sanitary assistants class III, and became available for posting as such.

After being employed for one year these men were eligible for upgrading to class II if recommended by a hygiene officer. Classes were held at schools of hygiene at home and overseas for sanitary assistants class II for upgrading to class I for which there was an examination.

Another source from which sanitary assistants was obtained was from civil sanitary inspectors who had been called up for military service or who had volunteered. In view of their civil qualifications—the certificate of the Royal Sanitary Institute—these men were given a fortnight's course at the Army School of Hygiene, after which they were graded as sanitary assistants class I.

In 1941 the further enlistment of sanitary inspectors was stopped, as there was a reported shortage of them for civil employment owing to the increased commitments of local authorities.

In the early years of the war the perennial question, 'Why cannot a sanitary assistant be promoted to command a field hygiene section?' was raised by the secretary of the Sanitary Inspectors' Association and by a member of Parliament. It was explained that the officer commanding a field hygiene section was in fact the adviser to the A.D.M.S. of a division on all matters pertaining to hygiene, including the prevention of disease, and that this responsibility could only be held by a medical officer with the D.P.H.

In 1944, with the introduction of field sanitary sections, it was possible to commission a number of N.C.O. sanitary assistants to command these units, since they were to be employed in L. of C. and base areas working directly under the supervision of the hygiene officer of the area.

In 1945 the grant of immediate commissions to selected N.C.O. sanitary assistants as non-medical officers (Hygiene and Sanitation) was authorised and a new war establishment for field hygiene sections (which included a non-medical officer as second in command) was submitted for approval.

Chiropodists (*R.A.M.C.*).* Before the war the necessity for chiropody in the Army was met by regimental chiropody orderlies borne on the strength of certain types of combatant units. These orderlies had been trained by R.A.M.C. officers on the lines laid down in the *Manual of Chiropody*, and received extra pay when employed. They carried out their duties on a part-time basis at medical inspection rooms under the supervision of the medical officer.

After the outbreak of war the prevalence of minor foot defects among recruits became a matter of concern as a cause of inefficiency and wastage. At the same time the various societies and associations of chiropodists throughout the country made representations in various ways suggesting that chiropody in the Army should be performed by qualified chiropodists rather than by regimental chiropody orderlies who had not had the same training and experience as the registered members of these associations.

Eventually the necessity for providing skilled chiropody as a medical service to newly joined recruits under training was recognised and accepted as a commitment. In 1940 the trade group of chiropodist was introduced and added to the schedule of R.A.M.C. trades (group D). Qualified chiropodists already in the service were transferred to the R.A.M.C. and the remainder were obtained by direct enlistment. They were enlisted in the rank of private but were granted the rank of corporal on being posted to units.

The A.T.S. created a demand for the services of chiropodists, as the auxiliaries experienced a good deal of foot trouble attributed to wearing ill-fitting shoes in their youth. The duties of many auxiliaries kept them on their feet a good deal during the day, and brought to light minor foot ailments. The A.T.S. endeavoured to enlist its own women chiropodists but found that they were not forthcoming in the numbers required, and this resulted in the A.T.S. having to depend on the services of R.A.M.C. chiropodists, when available, until it was able to train its own foot orderlies.

No general need for the provision of skilled chiropodial treatment in units other than those handling recruits was accepted and requirements for trained men were met mainly by the use of orderlies trained on a short-term basis until 1942, when there was a change of policy and a recommendation for the employment of chiropodists with field-force units was agreed to by the Hartgill Committee. In consequence the war establishments of certain field medical units (field ambulances) were amended to include a corporal chiropodist. This increased the demand for qualified chiropodists and made it necessary to withdraw some from command pools. It was considered that in this way a greater use could be made of their services.

* *See* Volume I, Chapter 10.

*Laboratory Assistants.** A comparatively small number of laboratory assistants was required for hygiene units such as malaria field laboratories and entomological laboratories. Initially they were selected from among men with a scientific background, such as entomologists, biologists, *et al.*, who had enlisted in some other branch of the Army and whose transfer to the R.A.M.C. was arranged, or from among men recommended for such employment by one of the schools of tropical medicine.

Subsequently they were selected from pathological laboratory assistants already in the R.A.M.C. and given a four weeks' course of training in entomology at the Army School of Hygiene. Where necessary, it was possible to arrange for them to be given a short follow-up course at the London School of Hygiene and Tropical Medicine. In this way it was possible to maintain a sufficient supply of trained laboratory assistants for hygiene units.

Supplies

FOOD AND MESSING RATION SCALES

HOME SCALE

Of the various ration scales in issue during the war, that of the Home Service Ration (H.S.R.) caused most concern for the reasons that it was subjected to a number of alterations and cuts, these being rendered necessary by general shortages of various essential items, and that for the greater period of the war it was the ration for the major proportion of the British Army.

When the war started the Army had a generous ration, perhaps too substantial in the light of later experience. It was generally badly cooked and there was a great deal of wastage. It had been drawn up with the following general considerations in mind:

(*a*) That it should have a sufficient energy value—a value of 4,000 Calories was generally accepted as the standard.
(*b*) That it should have the proximate principles in the ratio of proteins—1, fats—1, carbohydrates—4 to 5.
(*c*) That it should be complete with vitamins and salts.
(*d*) That it should conform to the normal dietetic habits of the social class from which recruits were drawn.

When war broke out the problem quickly became one of drawing up a ration from those foodstuffs which were available, but which were bound to become more restricted in quantity and variety. Certain key items, such as meat, cheese, margarine, sugar, etc., were in short supply and likely to become scarcer. It was intimated that potato and flour must be made the basis of the ration.

---

* *See* Volume I, Chapter 10.

During the war period the H.S.R. was revised on no less than nine occasions, viz. June 1940, October 1940, January 1941, March 1941, May 1941, May 1943, April 1945, November 1945 and June 1946 (Table 9).

By March 1941 meat had been progressively reduced from 12 to 6 oz., bacon from 2 to $1\frac{2}{7}$ oz., bread from 16 to 10 oz., cheese from 1 to $\frac{4}{7}$ oz., sugar $3\frac{1}{2}$ to 2 oz., and sausages, fish and fruit to negligible amounts, while butter, $1\frac{1}{2}$ oz., had become margarine $1\frac{1}{2}$ oz. A ration cash allowance of $1\frac{1}{2}$d. was introduced in December 1940 and was increased to $2\frac{1}{2}$d. in March 1941 to offset the reduction in the meat ration.

The gross value of the pre-war ration was 4,300 Calories. In March 1941 it was estimated to be 3,140, and the value of the cash allowance at the cost of living then obtaining at about 115 Calories. The proportions of the proximate principles became: proteins—1, fats—1·25 and carbohydrates—4, i.e. 105, 122 and 415 g. respectively. The vitamins were estimated to be as follows (the standard requirements in brackets)*:

A = 3,638 International Units (3,000),
B_1 = 518 International Units (300),†
C = 53 mg. (30).

The salts were estimated to be:

phosphorus 1,500 mg. (680),
calcium 760 mg. (680).

At this period the questions which caused most concern were:

(*a*) What should the calorie value of the ration be in view of the food situation?
(*b*) How should these calories be provided?
(*c*) Was a sufficiency of the vitamin factors being supplied in the ration?

Methods for increasing the calorie value of the ration received careful consideration. At the time the best methods were considered to be:

(*a*) An increase in the ration of potatoes, which were popular with the troops. This was 12 oz. in June 1940, giving 300 Calories, and was increased to 13 oz. in January 1941, and to 20 oz. in May 1943, providing 500 Calories, as well as being the main source of vitamin C.
(*b*) The incorporation of soya bean flour, rich in protein and fat, in the flour ration in the proportion of 1 to 10; $\frac{1}{2}$ oz. would provide an extra 60 Calories. The supply situation, however, did not make this feasible.

---

* The standard requirements recommended were taken from the Table of Daily Allowances Recommended by the Committee on Foods and Nutrition, National Research Council, U.S.A. (1943)—revised 1945.

† Vitamin B is expressed in some places as International Units and in others as milligrammes (marked +). (1 mg. = 333 i.u.)

TABLE 9

Home Service Ration Scale—Variations in Scale from September 1939 to October 1946

Item	September 1939	June 1940	October 1940	January 1941	March 1941	May 1941	May 1943	April 1945	November 1945	June 1946
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
1 Meat (bone in)	12	10	10	8	6	6	6	6	5	4½
5A Galantine	–	3/7	3/7	–	–	–	–	–	–	–
6 Bacon	2	1 5/7	1 5/7	1 3/7	1 3/7	1 3/7	1 3/7	1 3/7	1 3/7	1
8 Offal or sausage	–	1 5/7	2 3/7	1 5/7	1 5/7	1 5/7	1 5/7	1 5/7	1 5/7	1 1/2
10 Bread	16	12	10	10	10	10	10	10	10	9
12 Flour	–	2 1/2	2 1/2	2	2	2	1 3/4	1 3/4	2 3/4	2 1/2
13 Cake	–	4/7	4/7	–	4/7	4/7	4/7	4/7	4/7	1/2
13A Fruit or meat pie	–	1/7 pie	1/7 pie	–	–	–	–	–	–	–
15 Rice or macaroni or semolina	–	1/2	2/7	2/7	2/7	2/7	2/7	2/7	2/7	1/4
16 Oatmeal	–	4/7	2/7	6/7	6/7	6/7	6/7	6/7	6/7	2/4
23 Butter and margarine	1½	1½	1½	1½	1½	1½	1½	1½	1½	1 7/16
25 Cheese	1	4/7	4/7	4/7	4/7	4/7	2/7	2/7	2/7	3/4
29 Milk (tinned)	–	2	3	3	3	3	3	3	3	2 7/16
30 Milk dried (skim)	–	–	–	–	–	–	2/7	2/7	2/7	1/4
33 Jam	1	1½	1½	1½	1½	1	1	1½	1½	1
35 Sugar	1½	2½	2½	2½	2	2	2	2	1 9/16	1 9/16
38 Dried fruit	–	4/7	4/7	2/7	6/7	6/7	6/7	6/7	6/7	3/4
45 Potatoes	–	12	12	13	13	13	20	20	18	16
47 Fresh vegetables	–	5 5/7	5 5/7	5 5/7	5 5/7	5 5/7	5 5/7	5 5/7	5 5/7	5 1/2
48 Dried vegetables	–	4/7	4/7	4/7	4/7	4/7	4/7	4/7	2/7	2/4
52 Fresh fish	–	–	–	–	–	–	–	–	1	9/16
57 Tinned fish	–	3/7	3/7	2/7	2/7	2/7	3/7	3/7	3/7	2/7
58 Tea	2/8	1/2	2/8	2/8	2/7	2/7	2/7	2/7	2/7	2/7
59 Cocoa	–	–	2/16	2/16	2/16	2/16	2/8	2/8	2/8	2/8
63 Meat paste	–	1/7	1/7	–	–	–	–	–	–	–
64 Salt	1/4	1/4	2/8	2/8	2/8	2/8	2/8	2/8	2/8	2/8
69 Condiments	–	Various	Various	–	–	–	–	–	–	–
Ration cash allowance (other ranks)	–	–	–	1½d.	2½d.	2½d.	2½d.	2½d.	2½d.	2½d.

(*c*) A military agricultural scheme had been initiated about this time and units were encouraged to grow their own vegetables; subsidies were offered. Extra potatoes, turnips, carrots and greens were grown to supplement the ration, but not all units were so placed as to be able to have extensive market gardens.

(*d*) It was not possible to make use of fresh fish owing to the scarcity occasioned by the shortage of trawlers.

The adequacy of the vitamins in the ration was constantly under review.

(*a*) Greens in season, carrots and milk formed the main source of vitamin A. Care was necessary to ensure that carrots, which store well, were available when greens were not in season, so that the risk of the supply of A being low might be avoided.

(*b*) The issue to the troops of National bread containing 15 per cent. wholemeal removed all need for worry with regard to vitamin B_1. The army biscuit had been proved to be practically devoid of vitamin B_1 owing to the alkaline baking powder (sodium bicarbonate) used in its manufacture. Marmite was found to lose its potency after three months.

(*c*) Since the potato was the chief source of vitamin C, it was necessary to ensure that only the minimum was lost in the preparation, cooking and serving of this vegetable. Attention had been drawn to an article in *Der Deutsche Militakartz* of November 1938 in which it had been shown that:

(1) 750 g. of potatoes boiled in their jackets gave	29·6 mg. vitamin C.
(2) 750 g. of potatoes boiled without their jackets	20·6 mg. vitamin C.
(3) 750 g. of potatoes mashed gave	10·0 mg. vitamin C.

These findings were confirmed by experiments carried out at the R.A.M. College, which showed that:

(1) 100 g. of boiled potatoes (peeled) gave from	6·7 to 6·4 mg. vitamin C
(2) 100 g. of steamed potatoes (peeled) gave from	7·3 to 7·2 mg. vitamin C.
(3) 100 g. of mashed potatoes (peeled) gave from	4·7 to 3·0 mg. vitamin C.
left on man's plate	2·0 mg. vitamin C.
(4) 100 g. of whole boiled potatoes left on plate—for 20 minutes	6·8 to 6·4 mg. vitamin C.
for 30 minutes	6·5 mg. vitamin C.
for 40 minutes	6·4 mg. vitamin C.
(5) 100 g. broken up potatoes left for 30 minutes on plate	2·3 mg. vitamin C.

The accepted daily requirement of vitamin C was 50 mg., but the Directorate was satisfied if 25 to 30 mg. were supplied; 16 oz. of potatoes would have provided 29 mg., but until May 1943 the ration of potatoes did not exceed 13 oz., giving 23·5 mg. of vitamin C. It was therefore very necessary, for the preservation of vitamin C, for catering officers to ensure that potatoes were not mashed when served to the troops. Attempts were made to ascertain if it would be possible to introduce ascorbic acid into jam, but it was found that there were technical difficulties.

In March 1941 the Army Hygiene Advisory Committee agreed that a ration of 3,700 Calories should be sufficient for the soldier and that, if an increase in any one item was necessary, it should be in potatoes or oatmeal. They were also of the opinion that the vitamin content of the ration at that period was adequate, provided it was not spoilt in cooking and that, with vitamin concentrates, the ration needed no supplementation. They strongly recommended that the Army should adopt the National loaf for general issue. At that period it was an optional issue. They further recommended that the Army should obtain the services of a nutritional expert on the staff of the Medical Research Council to carry out a survey and report on the methods of cooking and the conditions in which the food was presented to the soldier. There had been several small outbreaks of acute ulcerative gingivitis among troops in the United Kingdom and the Director of the Dental Service was particularly anxious to learn if the ration contained vitamin C in adequate amounts or if ascorbic acid should be issued as a preventive. The Army Hygiene Advisory Committee did not consider that this was necessary, as there was a sufficiency of vitamin C in the diet. It was deemed advisable at the end of 1941 to test the vitamin C saturation of troops in the United Kingdom, as certain investigations had indicated that this was low and dropped lower with Army service. If this proved to be the case it would have indicated that cooking in Army messes was destructive of vitamin C, as the average civilian ration was definitely not richer in this vitamin. The Canadians had shown that 75 per cent. of their troops who had been in this country more than a year were below saturation point and that the degree increased with the time spent in this country. The saturation level varied with national habits, and the Canadians, who were accustomed to eat more fruit than the British, had a higher level. The relation between signs of deficiency disease and saturation level was not known. A scheme was drawn up and an investigation was carried out. One hundred soldiers in each command were selected for examination and divided into two groups, of which 50 per cent. were newly joined recruits and 50 per cent. soldiers with over one year's service. To avoid vitiation of the results by men recruited from or stationed in agricultural

areas, it was decided to divide the numbers in each of these two groups equally into men recruited from industrial areas and men recruited from agricultural areas and men stationed for six months in industrial areas and those stationed similarly in agricultural areas.

The test was carried out during the winter of 1941–2 on 600 soldiers in the different commands in the United Kingdom. It was found that the majority did not become saturated until the third day and, of those recruited from or stationed for six months or over in industrial areas, many required four or even five doses to become saturated. The saturation point was lower in soldiers of over six months' service than in newly joined recruits.

In the autumn of 1942 an investigation was undertaken of the vitamin C content of the soldiers' meals as actually received by the man on his plate. This showed the average daily intake to be 29–52 mg. These results, together with the relatively poor response to the saturation test, suggested that soldiers required more vitamin C than civilians to achieve saturation, possibly owing to their greater physical activity.

In due course the services of the nutritional expert of the Medical Research Council were obtained and arrangements were made for him to visit a representative selection of units in Southern, South-Eastern and Scottish Commands. He submitted a most valuable report of his survey of nutrition in the Army. In general, he was most unfavourably impressed by the lack of interest displayed by medical officers in the nutritional aspect of messing. Medical responsibility had been allowed to devolve on the Catering Corps, who were more concerned with the appearance and variety of meals than with the conservation of nutrients of which they had little expert knowledge. The report evaluated the Home Service and Field Service Ration scales as set out in the following tables. For purposes of comparison, values are also given of the civilian war-time dietary and the U.S. Army recommendations and for two U.S. standard rations (Tables 10, 11 and 12).

The main points appearing from these theoretical evaluations were:

(*a*) The calorie value was somewhat low compared with the U.S.A. Garrison Ration.

(*b*) The H.S.R. was probably too low in its vitamin B_1 content.

(*c*) The calcium level for both home and field service scales was too low.

An analysis was made to show the percentages of the total amount of nutrients obtained from different classes of foodstuffs.

Other observations of importance were:

(*a*) While supply and catering organisations might be for the most part satisfactory, there was need for the application of

nutritional knowledge both as regards the preparation of the food and the maintenance of optimal physical efficiency.

(*b*) From the theoretical evaluation the Army ration scale appeared to be adequate, but it was not sufficient for optimal nutrition and it would be quite inadequate if there was gross or subtle wastage.

TABLE 10

Evaluation of Ration Scales

	Home Service Ration	Field Service Ration	Civilian Dietary average per head	U.S.A. recommend:	U.S.A. Garrison Ration	U.S.A. Travel Ration	British Mess Tin Ration
Calories, total, non-fat	3,110	3,678	2,800	—	5,140	3,150	2,875
Protein . . gm.	97	118	80	100	149	107	97
Vitamin A . I.U.	1,686	2,030	1,330	—	—	—	—
Pro-vitamin A . I.U.	8,079*	11,167	6,480	—	—	—	—
Total Vitamin A I.U.	4,379	5,752	3,490	8,000	5,760	2,990	—
Vitamin B1† . mg.	1·78	2·15	1·30	1,500I.U.†	3·15	0·78	—
Riboflavin . mg.	2·0	2·5	1·4	3·0	2·3	1·3	—
Vitamin B6 . mg.	—	—	—	—	—	—	—
Nicotinic acid . mg.	21	28	14	25	—	—	—
Vitamin C . mg.	78	91	61	100	46	33	—
Vitamin D . —	—	—	—	—	—	—	—
Calcium . . mg.	645	613	680	750	740	380	1,093
Total iron . mg.	18	22	12	15	23	15	31

* 3 I.U. pro-vitamin A are equivalent to 1 I.U. vitamin A.
† Equivalent to 3·0 mg. thiamin hydrochloride.

Early in 1942 it was estimated that the energy expenditure of soldiers during training was about 3,500 Calories. The H.S.R. yielded only 2,790 Calories net (after deduction of 10 per cent. for table waste and non-absorption). The remaining 700 Calories were made up from purchases by the soldier which would probably have been continued even if the full requirements had been supplied in the ration. A review of the vitamin content of the ration showed this to be adequate with the possible exception of riboflavin, which was 0·9 mg. *per diem* against 1–3 mg. recommended as adequate, and it was decided that a large-scale test should be carried out for signs of any deficiency. It was considered that when the National loaf became a general issue in the Army the position regarding riboflavin would be improved. During the winter of 1942–3, 1,200 soldiers in the United Kingdom were examined for signs of riboflavin deficiency. Out of 106 who showed some evidence of corneal vascularisation, only 4 responded to riboflavin given in 5-mg. doses daily for three to ten days.

The calorie value of the H.S.R. was admitted to be too low and on this account caused much concern. During the winter of

1942–3 it was estimated that the edible portion of this ration scale had a gross value of 3,200 Calories. For hard training an

TABLE 11

The Nutritive Value of the Home Service Ration Scale in Amounts per Head per Day and Percentage Contributions of Various Types of Foodstuffs

	Total per head per day	Cereals	Potatoes	Milk	Other animal foodstuffs	Vegetables and fruit	Fats	Sugar
Calories	3,110	38	9	5	25	6	10	7
Protein	97 g.	34	6	7	49	4	trace	—
Calcium	645 mg.	14	3·5	40	30·5	12	trace	trace
Total iron	18 mg.	23	12	1	53	10	1	—
Vitamin A	1,686 I.U.	—	—	13	40	—	47	—
Pro-vitamin A (as B-carotene)	8,079 I.U.	—	—	—	—	100	—	—
Vitamin B1*	543 I.U.	18	18	6	45	13	—	—
Riboflavin	20 mg.	7	7	16	62	8	—	—
Nicotinic acid	21 mg.	10	21	3	64	2	—	—
Vitamin C	78 mg.	—	38	4	—	58	—	—

TABLE 12

The Nutritive Value of the Field Service Ration Scale in Amounts per Head per Day and Percentage Contributions of Various Types of Foodstuffs

	Total per head per day	Cereals	Potatoes	Milk	Other animal products	Vegetables and fruit	Fats	Sugar
Calories	3,678	35	7	2	33	4	9	10
Protein	118 g.	33	5	4	55	3	—	—
Calcium	613 mg.	18	4	27	36	15	trace	trace
Total iron	22 mg.	21·5	10	0·5	59·5	8	0·5	—
Vitamin A	2,030 mg.	—	—	4	57	—	39	—
Pro-vitamin A (as B-carotene)	1,167 mg.	—	—	—	—	100	—	—
Vitamin B1*	644 I.U.	15	15	1·5	59	9·5	—	—
Riboflavin	2·5 mg.	8	6	5	78	3	—	—
Nicotinic acid	28 mg.	8	16	1	74	1	—	—
Vitamin C	91 mg.	—	33	1	—	66	—	—

* Equivalent to 3·0 mg. thiamin hydrochloride.

extra 2 oz. of bread was already authorised and also 2 oz. of bread for haversack rations. The value of the ration with these additions was 3,500 Calories.

As the result of strong representations the Ministry of Food agreed to the following increases and additions, which were eventually made available in May 1943:

Addition: $\frac{2}{7}$ oz. of dried skimmed milk powder.
Increases: Potatoes from . . . 13 oz. to 20 oz.
Cheese from . . . $\frac{4}{7}$ oz. to $\frac{6}{7}$ oz.
Dried vegetables from . $\frac{4}{7}$ oz. to $\frac{6}{7}$ oz.
Decreases: Flour from . . . 2 oz. to $1\frac{3}{4}$ oz.

Supplement for hard work.
Addition: Slab cake $\frac{4}{7}$ oz.

These additions raised the value of the ration to 3,450 Calories. The extras for hard work, including the 4 oz. of bread previously mentioned, were equivalent to a further 350 Calories.

The inadequacy of the ration had been most evident at battle schools where the training was very strenuous. The following items, additional to the extra bread and slab-cake admissible for hard training, were authorised for issue to personnel attending these schools:

Bread . . 2 oz.
Margarine . $\frac{1}{4}$ oz.
Jam . . $\frac{1}{2}$ oz.

At the end of 1941 the H.S.R. of the A.T.S. yielded 2,800 Calories. Generally speaking it was considered to be a fair ration for women taking a moderate amount of exercise. It was reviewed in 1941 and certain recommendations were made for its improvement. It was low in vitamin A, only containing about half the lowest amount a woman should have. The replacement of pulses by half greens and half carrots was recommended to improve it. While the vitamin B content was satisfactory, substitution of white bread by wholemeal bread would improve it. The vitamin C content was also satisfactory but very liable to loss by the non-use of the water in which the vegetables were soaked or cooked, and exposure to air in mashing potatoes and keeping vegetables hot one to two hours.

Early in 1942 a difficulty arose in mixed operational units with communal feeding arrangements, where the troops and A.T.S. were on different ration scales. The effect of the smaller A.T.S. scale was to reduce the scale for the men in these units. A strong recommendation was made that the A.T.S. personnel in mixed operational units should be given the same ration as the men. This was eventually accepted.

FIELD SERVICE SCALES

When a force was sent overseas to a new theatre of war it was customary for Supplies to send out a standard ration based on the

guide scale in *Allowance Regulations*. After their arrival, a survey was made of the local resources and an assessment made of the items which could be obtained locally and those which must be sent out from home. The field service scales for British troops were more liberal than the home service scale, e.g. Middle East 3,700 Calories, C.M.F. 3,600, B.A.O.R. 4,000, Persia/Iraq 4,000, East Africa 3,500, West Africa 4,100, South East Asia 4,500.

One of the complexities in feeding troops in the field during the War of 1939–45 was the vast number of different ration scales required. Apart from operational ration packs no less than forty-nine different scales are fully described in the *Record of Ration Scales operative during the Period September* 1939–*October* 1946, together with brief references to a further 149 scales which had been used from time to time during the same period for specific purposes. Scales were necessary for British troops, Q.A.I.M.N.S. and A.T.S., Dominion and Allied forces serving with British troops, including Australian, South African, Polish, French and Greek troops in the various theatres of war, as well as for Indians, Africans (South, West and East), Palestinians, Cingalese, Cypriots, Malayans and Chinese; prisoners-of-war (German, Italian and Eritrean) and internees. Each individual scale had to be drawn up to suit local conditions and the dietetic habits of the consumers.

OPERATIONAL RATION PACKS

Emergency Ration. The standard emergency ration at the beginning of the war was 6 oz. of a solid mixture of the chocolate type with a value of 800 Calories.

It was packed in a small tin box and was issued to all men serving overseas. With the introduction of special ration packs it became redundant.

Early in the war there was an increased demand for the provision of special ration packs to meet the needs of special units such as the crews of armoured fighting vehicles (A.F.Vs.), commandos and para-troops. Light and non-bulky packs were essential.

The early attempts to meet this demand were not very successful; the constituents were merely picked from existing stocks with a few additions made on the suggestion of a member of a polar expedition, and they were badly packed. An example produced at a meeting of the Army Hygiene Advisory Committee in July 1941 received unqualified condemnation on account of the haphazard selection of items and the insecure packing.

A great deal of experimental work was carried out by the Rations Sub-committee of the M.P.R.C. of the Medical Research Council*

* *See* the Medical Research Volume of this History.

with the object of producing a compact ration which would be nutritive, satisfying, easily consumed and attractive to the consumer, and which would be light (requirements for one day weighing about 30 oz.). Perishable items, of course, could not be included.

In due course both the War Office and the M.R.C. devised independently a 48-hour mess tin ration, and these two experimental rations were given field trials. The M.R.C. ration yielded 3,015 Calories and the War Office mess tin ration 2,480 Calories. During the trials the former ration appeared to be preferred by the troops as being the more satisfying. Alterations to the contents of both rations were suggested to meet criticisms, and it was eventually decided to adopt a 24-hour ration pack which combined the best qualities of both the experimental types and which was designed to fit into the larger half of the mess tin.

This *24-hour Ration Pack*, which had a calorie value of 4,000 (approx.), consisted of the following items:

TABLE 13

The 24-hour Ration Pack

Item	Number of pieces	Ration (approximate)	Description of package
		oz.	
Biscuits	10	9	Waxed cardboard carton.
Oatmeal	2 blocks	3½	Measurement 6 in. × 4⅛ in. × 2⅜ in.
Tea, sugar and milk blocks	Several wrapped together	2	Gross weight 2 lb. 3 oz.
Meat block	1	4	
Raisin chocolate	2 slabs	4	
Chocolate (vit.)	1 slab	2	
Sweets boiled	—	4	
Chewing gum	2 packets	—	
Meat extract cubes	—	½	
Salt	1 packet	½	
Latrine paper	4	—	

This 24-hour ration was designed to provide the highest possible food value in the smallest possible space and weight. It achieved its high ratio of food value for weight largely by eliminating the use of tin-plate. The food items were packed in a waxed cardboard container which was both water- and gas-proof, and fitted into the large half of the mess tin. This pack was used primarily as a landing ration or as an assault ration, and in special circumstances as a sea-passage ration, but was restricted to theatres of operations in temperate climates. Although normally designed for subsistence during the first 48 hours of an operation, in practice it was found, owing to its high calorific value,

that one pack per day was adequate to sustain a man under strenuous conditions for a period up to ten days, if the occasion demanded. One solid fuel cooker, either of the hexamine fuel tablet type or solidified alcohol type, was issued separately with the ration for making tea.

Armoured Fighting Vehicle Ration Pack. It had been strongly represented from the Middle East that some improvement in the method of feeding personnel of armoured fighting vehicles was essential. Tinned foods in the normal size of container, once the tins were opened, quickly spoiled, as did loaves of bread. The A.F.V. pack was essentially a reserve ration to be carried in armoured fighting vehicles and certain ancillary vehicles. Special metal boxes were fitted on these vehicles to carry a three days' reserve for the crew.

The contents of the *2-men Pack (new type)* were as follows:

TABLE 14

The 2-Men Pack. New Type

Item	No. and size of tins in each pack	Ration per man	Description of package
	oz.	oz.	
Sausages tinned	1 × 16	8	Fibreboard case measuring $8\frac{1}{2}$ in. × $5\frac{1}{2}$ in. × 5 in. Gross weight 6 lb. 6 oz.
M. and V. Ration or meat luncheon	1 × 12	6	
Sardines	1 × $4\frac{1}{2}$	$2\frac{1}{2}$	
Grease	3 × $1\frac{1}{2}$	$2\frac{1}{2}$	
Bacon canned	1 × 16	8	
Tea, sugar and milk powder	2 × 5	5	
Jam	2 × 4	4	
Sweets boiled	1 × 5	$2\frac{1}{2}$	
Biscuits service	2 × 10	10	
Latrine paper	12 pieces	6 pieces	

Composite (14-men) Ration Pack. The Compo (14-men) Pack was produced for feeding troops for periods not exceeding six weeks during the initial stages of an operation and immediately following the consumption of the 24-hour ration. Each package weighed 65 lb. and was sufficient to feed 14 men for one day giving an average calorific value per man of 3,590. It was made up entirely of tinned commodities with variations to allow for a daily change of diet throughout the week.

There were two categories of these packs—one with biscuit and the other without biscuit for issue when fresh bread was available.

(i) The Compo (14-men) Pack with biscuit had varieties of menus identified by markings 'Type A' to 'Type G'.

(ii) The Compo (14-men) Pack without biscuit had three varieties identified by markings 'Type 1' to 'Type 3'.

They contained cooked meats, such as steak and kidney pudding, steak and kidney, Irish stew, stewed steak, haricot oxtail, M. and V., pork and vegetable, which only required to be heated. Since this ration might have to be used for a rather lengthy period its vitamin content received special consideration. Each man had a daily allowance of 2 oz. of vitaminised chocolate containing 1,500 i.u. vitamin A, 250 i.u. vitamin B_1 and 20 mg. ascorbic acid per ounce.

With one exception each of these packs contained one or other of the following varieties of sweet puddings—date, sultana, marmalade, treacle, rice—to provide approximately 5 oz. per man daily. In one pack mixed fruit (tinned) on a daily scale of 4 oz. was substituted. The puddings were excellent and were greatly appreciated.

The Pacific 24-hour Ration (British Troops). This ration was a further development of the 24-hour ration pack already described, adapting it specifically for use in tropical and jungle warfare. It provided a highly nutritive and varied ration at the minimum of space and weight and had a calorific value of 4,160. The special feature of this pack was that the day's meals were segregated in different containers and certain new food items were introduced. The pack comprised three hermetically sealed containers containing breakfast, a midday snack and supper respectively. The three containers were nested and strapped together to facilitate distribution, and each complete ration weighed 3 lb. The new food items introduced in this ration included chopped ham and egg, chopped ham and beef, meat biscuit and cheese blocks. The first two were solid meat packs packed in a small tin. The meat biscuit provided a palatable contrast to the tendency towards sweetness in the midday snack. The cheese block was dehydrated cheese which could be eaten either in the form in which it was packed or, when mixed with a little water, produced an excellent cream cheese to spread on biscuit. Each pack contained a mepacrine tablet to ensure regular distribution during the period when, through operational reasons, bulk supplies were not available. Cigarettes, matches and latrine paper were also included. Solid fuel cookers (tropical) were available for separate issue together with eight solid fuel tablets (sufficient for two days).

Pacific 24-hour Ration (Indian Troops). This ration was fundamentally the same as that of British troops with the meat items substituted by fish items or cheese to meet 'caste' prejudices.

The Pacific Compo (6-men) Ration Pack. This pack was produced for feeding troops actually engaged in operations in tropical and jungle conditions. It was designed for use during the post-assault period as a follow-up ration after the 24-hour ration. It was made up entirely of tinned commodities which provided seven varieties of menu designated P.1 to P.7. The nutritive value of the ration was 4,330 Calories. Vitamins

were supplemented by one compound vitamin tablet and 1 oz. vitaminised chocolate. A water-sterilising tablet, a mepacrine tablet and ½ oz. of salt were also included in each ration, together with a soap tablet, cigarettes and toilet paper. Type P.1 provided a separately packed 'midday snack' for use in cases where unit feeding was possible for morning and evening meals. It was contained in a waxed cardboard carton measuring $4\frac{7}{8} \times 2\frac{1}{16} \times 2\frac{1}{4}$ in., which could be conveniently carried in the pocket. The Pacific compo (6-men) pack was contained in a fully sectionalised case, each tin having a separate 'egg-box' cell. The case was of a flat design and weighed $37\frac{1}{4}$ lb.

The Pacific Emergency Ration. This special emergency ration was produced to meet the requirements of troops engaged in tropical warfare. The ration was packed in a special hermetically sealed aluminium container provided with an additional slip-lid to slide over the top of the body of the sealed container. The slip-lid was designed to keep the contents clean when only partially consumed. This emergency ration provided a varied ration having a nutritive value of 1,400 Calories, and was very compact (27 cu. in.) and light (gross weight 16 oz.) and was suitably packed to stand up to jungle conditions. It included salt and mepacrine tablets and was only intended to be used in emergency when other sources of supply were not available.

The Mountain (Arctic) Pack Ration. This ration was specially designed for use in arctic climates and was sufficient for one man for two days, or two men for one day. It was packed in a cylindrical tin and weighed 6 lb. 11 oz. It consisted of dehydrated or tinned foods and had a value of 5,100 Calories. Ascorbic acid tablets were included in these packs and it was intended later to include vitaminised chocolate and compound vitamin tablets.

VITAMIN SUPPLEMENTATION OF RATIONS

The supplements which had been adopted at the beginning of the war for use on medical recommendation were ascorbic acid tablets (one=25 mg.) one per man per day, and marmite ½ oz. per man per day.

It was found that marmite lost its potency after three months' storage, and it was later substituted by vitamin B_1 rich yeast tablets on the scale of three tablets per man per day. Each tablet contained about 90 i.u. of B_1 (=250–300 i.u.). These were used to supplement tinned rations which were deficient in vitamin B_1.

In 1943 a *Compound Vitamin Tablet* was put into production which had the following composition:

Aneurin	1 mg.
Riboflavin	1 mg.
Nicotinic acid	10 mg.
Ascorbic acid	25 mg.

This tablet replaced the yeast and ascorbic acid tablets, until then in use, and was issued on medical recommendation when the vitamin content of the ration was thought to be low. It was also included in certain of the special ration packs. These tablets contained all the water-soluble vitamins of proved nutritional significance.

In the United Kingdom during the war certain foodstuffs were fortified on a national scale, notably (*a*) margarine which from 1940 contained added fish liver oils to give it a vitamin A content of 450 i.u. per ounce (plus vitamin D), and (*b*) National bread which was 85 per cent. extraction with added calcium. This increased the B_1 from 0·01 mg. (in white bread) to 0·05 mg., riboflavin from 0·01 to 0·03 mg., nicotinic acid from 0·2 to 0·3 mg. and calcium from 4 to 16 mg.

This National bread was issued to the Army in the United Kingdom at first in 1941 on a scale of 30 per cent. to test its popularity. This proportion was increased progressively as the troops became accustomed to it. Consideration was given to the problem of how to do the same for the bread ration in tropical theatres. The chief drawback to National flour was that it contained 14 per cent. moisture, which impaired its keeping properties in the Tropics. It would have been possible to have reduced the moisture content to 9 per cent., but the flour would have absorbed moisture again in the sack.

In the Middle East, which was supplied with white flour from Australia, 25 per cent. atta was added to the white flour and this was probably the simplest method of increasing the vitamin B content of bread in tropical countries.

When it was discovered that vitamin B_1 in army biscuits was destroyed by the sodium bicarbonate in the baking powder used in their manufacture this was replaced by ammonium carbonate which had no destructive effect on their vitamin B_1 content.

Ample stocks of ascorbic acid were held in the various theatres of war and at home. It is interesting to note that, apart from its pharmaceutical use, it was only given as a regular issue to troops in Iceland and in Tobruk.

Various methods of fortifying foodstuffs with ascorbic acid were considered. An authority on vitamin C held the view that 10 mg. per man per day was sufficient to prevent any scorbutic condition. He considered the H.S.R. contained between 5 and 10 mg. even in winter. While he considered this adequate, he suggested that a stock of jam with 10 mg. per 2 oz. ration should be held for a special commitment. The suggestion was abandoned when S.T.6 represented that it would be impracticable, as there must be a turnover and a general issue would have to be made. There were sufficient stocks of tablets and it was decided to continue this method of distribution, although giving it in jam was considered to be preferable.

Vitaminised Chocolate. It was decided to fortify all chocolate issued by the Army in field service rations or included in the special packs with vitamins A, B_1 and C in the following amounts per ounce of chocolate:

Vitamin A	1,500 i.u.
Vitamin B_1	250 i.u.
Vitamin C	20 mg.

The question of whether Torula yeast could be utilised by incorporating it in cooked rations (e.g. soups and gravies) and in chocolate was examined, but the supply situation did not permit this to be done.

NEW ITEMS OF FOOD

While the H.S.R. and F.S.R. were for the most part composed of items normally used subject to availability, the development of new items was hastened during the evolution of the various compact rations. This produced a demand for items which combined the maximum nutritive value with the minimum weight together with palatability.

The Medical Research Council had recommended high-fat biscuits, and ten of these weighing 8·65 oz. with a calorie value of 1,240 were included in the 24-hour ration pack.

Sweet Service Biscuits. These were included in the mountain pack and were popular. *Meat block* consisted of dehydrated pre-cooked meat which was ready to eat on the addition of hot water. One 4-oz. block with a value of 602 Calories was included in the 24-hour ration pack. It was not a popular item and a lot of work was carried out to improve its palatability.

Oatmeal Block. The 24-hour ration pack included two blocks weighing 1¾ oz. each with a total calorie value of 518. It was also included in the Pacific emergency ration.

Raisin Chocolate containing 20 per cent. Raisins. The 24-hour ration pack included two 2-oz. slabs yielding 544 Calories. This was a popular item. Vitaminised chocolate was included in various packs. One 2-oz. slab yielded 306 Calories in addition to vitamin A 3,000 to 4,000 i.u., vitamin B_1 500 to 660 i.u., vitamin C 40 mg. to 20 mg., vitamin D 1,400 i.u.

Milk-tea-sugar Block. These items were put up in block form for the 24-hour ration pack. Two ounces produced two pints of tea yielding 220 Calories. The mixture was also put up in powder form for other packs, e.g. 14-men compo.

The Pacific 24-hour ration included certain new food items such as chopped ham and egg, chopped ham and beef, meat biscuits, cheese blocks, fruit bars, and lemon crystals. Pemmican was included in the mountain (arctic) pack ration.

OUTBREAKS OF DEFICIENCY DISEASE

Satisfactory reports on the rations were received from all stations overseas with the exception of Gambia. The West African field service ration scale for British troops was known to be low in vitamin A and riboflavin, but late in 1942 its nutritive value was still further reduced by an almost complete lack of local fresh fruit and vegetables. Shipping losses and transport difficulties had also resulted in a reduction of the protective foodstuffs. Up to 14 per cent. of British personnel in some units showed evidence of riboflavin deficiency and R.A.F. nutritional experts found dark adaptation to be very defective. The necessary measures were taken to improve the ration.

Native troops in West Africa, especially in Gambia, reflected the B-vitamin deficiency so prevalent among the native civil population, but in the Army the incidence was only about half. An improved ration scale for all native troops in West Africa was worked out to include red palm oil, yeast and unmilled rice. It was stipulated that 25 per cent. of palm oil was to be used in the form of red palm oil; 50 per cent. of the rice issue was to be parboiled or undermilled brown rice; all types of meal were to be fortified with 0·375 per cent. calcium carbonate; tinned fruit was to be issued when native vegetables and fresh fruit were not available, supplemented by the daily issue of one compound vitamin tablet.

In August 1942 the ration scale in Malta was down to 2,200 Calories, but it became possible to raise it to 3,300 early in 1943. In spite of this reduction no cases of vitamin deficiency occurred.

WATER SUPPLIES

Shortly before the war certain important changes had been made in Army water equipment, both for units and for bulk purification.

The regimental water-cart had become obsolete with mechanisation and was replaced by a water-tank truck, 200 gallons. This was mounted on a 15 cwt. chassis, and the tank was filled either by means of hand pumps (filling time, one hour) or by a mechanical pump driven by means of a coupling from the front end of the crankshaft (filling time, ½ hour). A water-tank trailer (180 gallons) was also introduced. This was filled by hand-pumps only and the earlier models were equipped with cloth filters similar to those used in the regimental water-cart.

An important advance in the method of filtration was the substitution of compact pressure metal filters for cloth filters. The first filter of this type introduced was the meta-filter produced by the Meta-filtration Company. It consisted of six candles fixed to the movable head of a cylindrical metal chamber. Each filter candle comprised a number of monel metal rings separated from each other by minute

metal bosses and stacked around a grooved metal core and secured by pressure from the ends. The space between the rings was $\frac{1}{3000}$ in. The chamber was filled with a suspension of kieselguhr (filter powder). After pumping, a layer (or bed) of this was deposited on the surface of the candles and formed a highly efficient filter medium. The Patterson Engineering Company produced a metal filter of similar type known as the Stellar filter, in which the filter candles were constructed of monel wire wound spirally round a brass former. The space again between the spirals was $\frac{1}{3000}$ in. Exhaustive tests carried out at the Army School of Hygiene failed to demonstrate any material difference in the efficiency of these two types of filters. The water-tank truck was equipped with a pair of filters of either type, each of which gave a filtering area of one square foot. These metal filters were capable of being cleaned by a back flushing arrangement, after which the bed was reformed in the usual way.

The filter medium used consisted of specially prepared kieselguhr, of which there were eight grades. The coarsest of them gave a high rate of flow—1,000 gallons per square foot per hour—but failed to filter clay out of water. The finest variety yielded about 40 gallons per square foot per hour and gave an excellent filtrate. The grade specified for the Army yielded about 200 gallons and efficiently filtered clay, cysts and ova. Supplies were normally imported from California. In 1943, owing to a shortage of American kieselguhr, supplies of Irish kieselguhr were obtained to tide over the emergency. This powder, which had a reddish pink colour was twice as heavy as the American powder, and metal filters required double the charge, when it was used, to form an effective filter. Its use was discontinued when American supplies became available again.

Later in the war an airborne trailer (100 gallons) was designed, primarily for the use of airborne troops. Eventually, however, it was issued as normal equipment to smaller units such as field ambulances and casualty clearing stations. It was equipped with metal filters and differential hand pumps. In view of the fact that field ambulances and C.C.Ss. required very large quantities of water when they first commenced to function, it was decided that this vehicle should be equipped with a power pump. After experiments it was found that the power-pumping unit used by mobile bakeries was the most satisfactory type for the purpose. The pumping unit was to be carried in the towing jeep as a separate entity.

The standard method of sterilisation at the beginning of the war was superchlorination followed by dechlorination. This employed a dosage estimated by the Horrocks test to give a concentration of 2 p.p.m. of free chlorine after deviation by organic matter had taken place. A contact period of fifteen minutes was allowed, after which

dechlorination was effected by the addition of taste remover tablets. These were 0·5 g. tablets of anhydrous sodium thiosulphate and the dosage was two per 100 gallons.

The Horrocks Test continued to be used as a guide to chlorine dosage. This test was based on the fact that chlorine is deviated by organic matter in the water and that dosage is increased proportionately with this deviation. It had been known for some years that, with sources of water containing ammonia, such as might occur where there was a serious degree of animal pollution, this deviation was prevented owing to the chlorine being fixed by the ammonia. In consequence there was always the risk that the Horrocks test would be seriously vitiated by indicating the minimum chlorine dose for the most dangerously polluted water. For a similar reason it follows that the result of this test can never be used as an indication of the potability of a water supply.

This point is illustrated by the following extract from the quarterly report of D.D.M.S. Eighth Army for the period July 1 to September 30, 1944:

> 'The fact is still not sufficiently appreciated, even by some hygiene officers, that the Horrocks test gives NO indication of the potability of a water supply. In his report for September one hygiene officer remarked in connexion with the purity of a source of supply, that the water "gave a good colour in the first cup".
>
> 'It was interesting to compare this with a paragraph in another report for the same month: "The water supply at the N.Z. Club has been examined bacteriologically and its *B. coli* content of 180 c.cm. renders it unfit for human consumption without chlorination.... This instance gives a remarkable example of how misleading the Horrocks Box Test may be: the Horrocks test in the above case gave a blue colour in the first cup."
>
> 'The addition of a little diluted sewage effluent to a "third cup" water, will often convert it into a second, or even "first cup" water, an experiment which seldom fails to astonish the spectators, and one which might usefully be employed to drive home the true function of the Horrocks test. Contrary to general belief, on account of this quality of sewage breakdown products, water which gives a blue colour in the first cup should always be regarded with suspicion.'

For bulk purification the standard water purification set mobile adopted before the war had been devised by the chemist on the staff of the R.A.M. College. It consisted of a sterilising unit in which the electrolytic method of producing chlorine from a solution of common salt was used. The ammonia-chlorine process was adopted and this gave sterilisation in about an hour without objectionable taste. The persistence of the chloramine in the water provided a safeguard against

the risk of re-contamination during distribution. The filtration unit consisted of two large metal filters each containing 19 filter candles of the spirally wire-wound type. The pumping unit driven by an independent 8 h.p. petrol engine had a capacity of 300 gallons per hour. The equipment was mounted on a 30 cwt. well-type forward-control lorry (10 ft. body).

These mobile sets were provided as part of the equipment of corps and army engineer units for use at central water points established by R.E. They contained no provision for the storage or transport of treated water. It was visualised that when ample water existed in a few places in divisional and corps areas, which had good access, water points would be established for the refilling of unit water trucks, when the tactical situation permitted.

During the course of the war a number of water engineering firms developed mobile plants specially for dealing with fractured mains after air raids. Two types of these plants were also taken into use by the Army, viz. the Patterson Autominor and the Candy Autominor. These also made use of the ammonia-chlorine process but preferred chlorine solution dosing, which was simpler in operation. A number of sanitary assistants were specially trained in the operation of these plants at the Army School of Hygiene. Although these trained sanitary assistants could not be posted to the R.E. units which operated the mobile purification sets, it was agreed that one would be attached whenever a set was being operated.

Shortly before the outbreak of war it was recognised that there would be great need of a simple individual water sterilising outfit for the use of troops when isolated from unit supplies, and steps were taken to devise such an outfit. It was decided for this purpose to adopt halazone (para-sulphon-dichloramine-benzoic acid) which had been introduced by Dakin and Dunham in 1917 and recommended by them as being most suitable for individual use. The principle of superchlorination to a very high degree followed by dechlorination was adhered to as the Horrocks test, being an individual method, would not be available and therefore no estimate of the dosage necessary for sterilisation could be made. After the outbreak of war this was put into production. A compact outfit was eventually produced consisting of a tin box, 2 in. by 2 in. by $\frac{3}{4}$ in., containing two small glass bottles. One contained 50 sterilising tablets, each consisting of 3 gr. of a mixture of halazone 7·5 per cent., anhydrous sodium carbonate 10·5 per cent., and anhydrous sodium chloride 82 per cent. They were white in colour, and liberated 4 p.p.m. of free chlorine in a water bottle of water. The second bottle contained 50 taste-remover tablets each consisting of $1\frac{1}{4}$ gr. of a mixture of sodium chloride 85 per cent., and anhydrous sodium thiosulphate 15 per cent. These tablets were coloured blue. The bottles were

provided with waxed cork stoppers. Full directions for use were printed inside the lid of the box. A contact period of thirty minutes was prescribed after adding a white tablet and before adding a blue tablet.

Halazone did not prove to be the ideal chemical for use as an individual sterilising agent, as it was not sufficiently stable and deteriorated seriously when stored. It was known that halazone would deteriorate if exposed to a humid atmosphere, but the extent to which this took place in unopened tins was completely unexpected. Various expedients were considered or tried out for overcoming this defect. The cotton-wool plug in the neck of the bottle was suspected of acting as a wick and was discarded. One of the manufacturing firms suggested incorporating a small amount of silica gel in the stopper to act as a drying agent. The R.A.S.C. considered that stocks which had seriously deteriorated should be returned for reconditioning. In some instances local orders were issued that the sterilising tablets should be used if the deterioration had not exceeded 50 per cent. It was finally agreed that local medical and supply authorities would arrange for the tablets to be tested periodically and would issue orders as to the number of tablets to be used. The manufacturing firms found difficulty in complying with the specification, particularly with regard to the moisture content and, after much consideration, certain modifications were agreed to. The search for alternatives was actively pursued as a matter of urgency and eventually it was considered that the most satisfactory alternative to the Halazone outfit would be an outfit containing water-sterilising powder and thiosulphate in powder form. A specification for this was worked out at the R.A.M. College.

During 1944 attention was drawn to two proprietory American products which were reported to possess possibilities as a substitute for halazone, viz. bursolene (diglycine-hydriodide-phosphate) and globaline (tryglycine-hydriodate-phosphate). These iodine compounds were put up in tablet form and supplies of the former were obtained for investigation. It was claimed that one bursolene tablet of 0·112 g. sterilised the contents of a canteen in five to ten minutes and killed amoebic cysts. One tablet gave a concentration of 7·5 mg. iodine per litre. Its iodine was in inorganic form and it imparted a straw colour to the water and gave it a slight iodine taste. The possibility of its use giving rise to iodism, particularly if used in the Tropics, where large quantities of water are consumed, was considered to be negligible. The stability of the tablets in the Tropics was the unknown factor and there was no evidence to suggest that they would prove superior to halazone in this respect.

Certain modifications to the poison test case became necessary to enable the detection of water contaminated with chemical warfare gasses to be carried out. The iodo-platinate test for mustard gas was

devised and incorporated in the test case. For Lewisite, it was only necessary to convert its organic arsenic into inorganic form and carry out the normal test for arsenic. The necessary amendments were made to the card of instructions. In 1943 an improved test for the detection of nitrogenous vesicants was introduced using DB3 reagent with which test cases were equipped. For a time the instructions for carrying out this test were classified as secret, but eventually the secrecy was lifted and the necessary instructions were added to the cards in test cases.

Other modifications suggested for the poison test case included the substitution of the Gutzeit test for the Marsh test, on the ground that it was a more reliable and delicate test, and the possibility of substituting the dithiozone test for lead and other minerals to obviate the use of sodium sulphide. These were not, however, adopted.

In 1944 the prototype of a light-weight poison test case based on a pattern received from the U.S.A. was produced at the R.A.M. College. This case was lighter and more compact than the standard case in use and the reagents were in powder form. It included an orthotolidine test for the presence of free chlorine in water and would have dispensed with the necessity for a separate case, water testing, sterilisation. The case weighed only 2 lb. 1½ oz. and was favourably reported on by the staff of the Chemical Defence Experimental Establishment at Porton.

The necessity for the provision of a portable filtering apparatus for the use of detached parties was realised, and early in the war an apparatus for this purpose was introduced. It consisted of a single Stellar filter to which was bolted a differential type hand-pump, the whole being mounted on a collapsible tripod. This filter had an output of 100 gallons an hour and was suitable for parties the size of a company. The whole apparatus could be packed into two panniers of approximately 90 lb. each and could therefore be carried in light transport or by mules. (See Plate I.)

Later, a smaller and lighter portable filter, the Midget lightweight portable filter, was devised essentially for the use of a platoon or large patrol. It comprised a small meta-filter combined with a stirrup pump and yielded 20 to 30 gallons of water an hour. It weighed 11 lb. and was packed in a canvas bag which could be carried slung over the shoulder.

During 1944 it had been accepted that in jungle warfare in Burma all water must be filtered on account of the risk of amoebic dysentery. Some type of filter was necessary which would have to be light, small, compact and extremely simple to use. To meet this requirement the Millbank individual filter bag was designed at the R.A.M. College. It was intended for use by the individual soldier away from his unit on patrol, etc., and was carried with the water bottle. It consisted of a sock-shaped bag made of specially woven ('chain weave') stout cotton

treated with copper naphthenate to render it rot-proof and mould-proof. It weighed 3 oz. when dry and 5 oz. wet. It was intended to be used by scooping water into the bag and suspending the filter bag by the eyelet holes. After discarding the first pint a clean filtrate was obtained free from amoebic cysts, which was the main object of the device. Water bottles were filled with the filtrate from the bag, which was afterwards sterilised by means of the individual water-sterilising outfit.

To meet the need for an easily handled water container for use during large-scale operations, a 4½-gallon container after the German pattern 'Jerrican' was adopted in 1944. It was necessary to give the interior of the container a corrosion-proof coating, and great difficulty was experienced in finding a satisfactory process for this purpose. After trials of various processes a bituminous paint, 'Dukeron' was adopted. It was found, however, that this gave rise to taste troubles from the trichlorethylene used as a solvent for the bitumen. Eventually a procedure was devised to obviate this. It consisted of blowing the interiors with compressed air, filling with water and allowing to stand filled for a week, after which they were emptied and stored empty. It was agreed that the bituminous lining was not ideal, but no better alternative could be found at the time. Later a synthetic resin enamel was used for this purpose.

The official pattern water bottle used during the war was the enamelled iron bottle holding approximately one quart, covered with felt, shaped with a slight curve to fit against the body, and provided with a cork attached by a chain to the neck of the bottle. At the beginning of the war an aluminium water bottle with a screw top was issued, but these had to be recalled owing to the shortage of aluminium and it became necessary to fall back on the enamelled iron bottle. This bottle had been criticised as being insanitary and badly shaped, but as the water it contained was invariably sterilised, it is doubtful if the adverse criticism was really justified. In 1944 it was decided to re-introduce an aluminium water bottle primarily for the British increment for F.A.R.E.L.F., but subsequent events made this unnecessary.

POISONS IN WATER

During 1941 much consideration was given to methods for detecting poisons in water and for their removal therefrom. These included mustard gas, lewisite and other chlorarsines and cyanarsines. The possibility that water supplies in the field might be rendered unsafe by the introduction of mineral poisons, was also considered. It was necessary to convince the General Staff on a high level that the removal of poisons from water was not a medical responsibility but a purely chemical problem. It was pointed out that the medical authorities

were only concerned in giving advice on the removal of natural impurities which might cause disease and that, with regard to bulk supplies, 'Medical' advised the Royal Engineers as to the methods of purification and the R.E. applied them. It was represented that chemists should similarly be the advisers in the case of poisoned water and the R.E. should carry their advice into effect. The policy was finally agreed to and involved the introduction of water de-poisoning units, which were to be controlled by the R.E. in the same manner as the bulk water purifier. It was also agreed that the responsibility for the early detection of poisons in water would be a medical one and would devolve on the regimental medical officer who would be in an advanced position with a field force on active service. The regimental medical officer, who had a 'case, water testing, poisons' in his equipment would be responsible for carrying out the first test of a new source of water and, if he detected a poison, notifying his commanding officer, who would call in the technical officer (C.W.), a chemist, of his headquarters. The latter would confirm the findings of the medical officer and arrange for the treatment of the water by a de-poisoning plant. When treatment was complete, his duty was to certify to the medical officer that the water was free from poisons within potable limits. The medical officer was then to be responsible for carrying out a final test with his poison test case and, if he was satisfied, declaring the water safe to drink. This procedure was prescribed in A.C.I.950/42.

In order that medical officers might be in a better position to undertake their responsibilities in this matter, arrangements were made for instruction in the use of the poison test case to be given to them by hygiene officers and technical officers (C.W.). Much of this instruction was given at field hygiene sections. At home, field tests were arranged for all medical officers, and D.Ds.M.S. were called upon to certify they had all been fully trained. Instruction in this subject was also given to students at medical schools by hygiene officers.

Eventually a transportable charcoal filtration plant was produced for the removal of the decomposition products of mustard gas and for rendering water potable. In this unit water was pumped through a battery of metal filters and then through large containers filled with activated charcoal. The unit was carried on a 3-ton lorry and was capable of dealing with 1,000–3,000 gallons of water per hour. The units were held at base and issued to R.E. units as required.

In some theatres of operations, notably the Middle East and North Africa, trouble was experienced with brackish water. The salinity of the Tobruk water, for example, varied from 290–350 parts per 100,000 expressed as NaCl. One hundred parts per 100,000 can be tasted by the average person, and men could be habituated to tolerate water containing up to 300 parts.

In North Africa it was found that, in certain districts saturated with brackish water, areas of fresh water overlying it could be used. It was possible to ascertain, by trial borings, the depth of fresh water and, if care was taken to avoid sinking wells too deeply and to avoid heavy pumping, fresh water could be obtained. Instead of one large well it was better to have several smaller wells scattered widely over the area in order to avoid sucking in the brackish water by heavy pumping. In general, the transport of fresh water in tank wagons or boats was probably the most satisfactory method of supplying troops in a brackish water area. Distillation plants were in operation at certain places, notably Bardia and Tobruk, where the water was very brackish. These plants, however, required much fuel, which was usually scarce, and suffered from the corrosion troubles usual in plants of this nature.

In Tripolitania, particularly west and south of Zuara, it was found that the limited supply of water from wells contained considerable quantities of sodium and magnesium salts. Magnesium sulphate gave the water a bitter taste and an aperient action. This water could, however, be consumed in small quantities by troops over a brief period without causing inconvenience.

O.C. 3 Mobile Hygiene Laboratory devised a field test for detecting magnesium salts which proved of value and arrangements were made to remove the salts by precipitation with lime water. Some trouble, however, was experienced in procuring a good quality lime for this purpose.

In desert areas water supplies from deep wells were developed into bulk water points by the R.E. and water had to be transported considerable distances—anything up to 150 miles. Frequently the ration had to be restricted to 1 gallon per man per day.

In a few instances wells taken over from the enemy were found to have been contaminated with bone oil.

CLOTHING AND EQUIPMENT

A matter of considerable hygienic interest was the soldier's clothing and equipment. Experience during the War of 1914–18 had shown that the infantry soldier was grossly overloaded, that the load was not arranged to best advantage from the anatomical and physiological aspects, and that his clothing was too tight and restrictive.

In 1932 a War Office committee known as the Braithwaite Committee was appointed to examine the dress and equipment of the infantry soldier and to make recommendations to the Army Council for such alteration as was considered necessary. In formulating their recommendations the committee expressly ignored considerations of appearance and military smartness and had regard only to utilitarian factors. The dress they designed was intended to meet the needs of the infantry man solely as a fighting man.

The committee recommended:

(*a*) That the load should not exceed 40 to 45 lb. weight. This was based on the physiological research carried out by Professor Cathcart of Glasgow University and his co-workers which had shown that the maximum load which could be carried without impairment of efficiency was one-third of the body weight: the average weight of the soldier being estimated at 130 to 195 lb.

(*b*) That the amount of ammunition carried should not be more than 50 rounds of S.A.A.

(*c*) That the main load should be carried high up on the shoulders.

(*d*) That no article should be hung loose from the waist, with the single exception of the bayonet.

(*e*) That clothing should be loose particularly in the regions of the neck, chest and legs.

The uniform which the committee designed and which was the subject of much discussion by the public and in the press, consisted of the following main articles:

(*a*) 'Deer stalker' pattern cap.

(*b*) Jacket of drab serge with a rolled open collar (in place of the high stiff collar of the uniform then worn) with patch pockets, two pleats in the body at the back and buttoned cuffs.

(*c*) Shirt of khaki angora; wool 70 per cent. and cotton 30 per cent., with attached collar which was intended to be worn outside the collar of the jacket but could, if desired, be worn inside with a tie.

(*d*) Drab serge loose peg-top trousers.

(*e*) Webbing gaiters to replace the puttees then worn.

(*f*) Boots of a lighter pattern, not to exceed 4 lb. in weight (approx.).

(*g*) The pack was divided into two separate smaller packs both of which were to be carried in marching order, but the lower one was intended to contain articles with which the soldier could dispense and could be detached and dumped before going into action.

(*h*) Waterbottle to be carried inside the pack.

(*i*) Entrenching tool to be carried strapped to the pack.

This dress and equipment, which reduced the total load by about 7 lb., was subjected to field trials during the training seasons of 1933 and 1934 and was eventually adopted by the Army Council in 1935. The production and issue of this dress was held up pending a decision being reached on the question of issuing a blue walking-out dress.

Then followed a period in which the increasing mechanisation of the Army gave rise to another consideration in the matter of dress and the

'Braithwaite' uniform was found to be unsuitable in several respects for mechanised infantry.

Various kinds of overalls in denim and other materials had been produced to meet the demands of mechanised units and to protect their serge clothing from grease. One type in particular, a two-piece outfit consisting of blouse and loose trousers in khaki drill, had been evolved in Egypt and was favourably reported on. After some experimentation with alternative materials and some modification, this design, translated into drab serge, was ultimately adopted as the battle dress for all arms. While different in design and appearance from the Braithwaite dress, yet it incorporated the main recommendations of that committee.

During 1941 battledress became a general issue to the troops and completely replaced the tunic pattern dress previously worn. At first there was a complaint that battledress was not warm enough, particularly at the lower part of the back from the waist downwards, due to the absence of a skirt to which men had been accustomed when wearing tunics. The upper part of the trousers was then given a drill lining to overcome this. This form of dress became very popular with the troops and was widely adopted.

The field service cap replaced the peaked forage cap but later this in turn was replaced by the beret.

HOT WEATHER CLOTHING

For tropical wear an alternative to the khaki drill tunic was required. It was appreciated that, as coolness was the first essential, the design of the garments should be loose fitting to allow for ventilation and evaporation by diffusion through the material, and the latter should be smooth, non-irritating, and as light in weight as possible. Since the prevention of malaria was of paramount importance in the Tropics, the necessity for mosquito-proof clothing ruled out the use of loosely woven materials. These considerations led to a bush shirt being designed with the skirt worn outside the trousers for better ventilation; long loosely fitting sleeves worn folded up by day but capable of being turned down and buttoned at the wrists after sunset for protection against mosquitoes; open at the neck but capable of being buttoned-up when necessary. A belt of the same material was worn with the shirt for smartness. The bush shirt was made of a drab-coloured, thin, closely woven cotton drill material, except in India, where a cellular material was used, although this was not mosquito-proof. Loosely fitting trousers of the same material were worn with canvas gaiters and boots. Shorts were permitted by day in certain tropical countries, but owing to the risk of malaria they were withdrawn in certain operational theatres. Thin cotton cellular vests and drawers were usually worn.

COLD WEATHER CLOTHING

During 1941 the Military Personnel Research Committee of the M.R.C. undertook an investigation into the most suitable type of clothing for troops serving in cold climates.* In this the Scott Polar Research Institute, Cambridge, collaborated. From this investigation it emerged that the Brynje system possessed the most outstanding advantages. The system enabled heavy work to be undertaken without the outer clothing becoming saturated with sweat, and at the same time it enabled warmth to be preserved under static conditions without the use of heavy overcoats, thus giving much greater freedom of movement.

Essentially the system consists of a string vest of large mesh worn next the skin. The word 'Brynje' is the old Norwegian term for 'chain mail'. The value of the Brynje vest depends on the retention of a layer of air next the skin in the meshes of the vest by underclothes worn over the vest. During periods of violent exercise when the body is sweating, ventilation is arranged by leaving the clothing open at the neck. At rest, however, arrangements must be made to seal the neck and for this a neck cloth is provided. This results in the retention of a layer of warm air next the skin. It is important that the neck should not be sealed until all sweat on the skin surface has had time to evaporate. In conditions where cold winds may be encountered it is essential to use a light windproof outer garment if the advantages of the Brynje system are to be appreciated. These three garments, viz. string vest, neckcloth and special windproof smock constitute the normal Brynje equipment.

The Brynje is worn next the skin and, although it looks rough, is actually quite comfortable to wear. Over it at least one vest must be worn, and under cold conditions two thin vests, to cover the Brynje vest, are more successful than one thick one.

Used correctly, the system provides a method by which a man can maintain his skin surface at a comparatively steady temperature without adding or removing garments in spite of considerable variations of air temperature or exercise. When remaining still after exercise the man seals the neck region of his garments before he becomes cold, but after having ceased sweating and having allowed the sweat to evaporate. The best moment to seal the neck is only appreciated after a little experience.

A number of field tests were arranged on the Brynje system of clothing, at the request of the M.P.R.C. of the M.R.C.:

(*a*) A test was carried out at Corby in a heavy battery R.A. of 2nd A.A. Division, which was supervised by the D.A.D.H. Cambridge Area

* *See* the Medical Research Volume of this History, Chapter 2.

and in which a member of the staff of the Scott Polar Research Institute acted as adviser. During the period of the test visits were paid by two physicists of the M.R.C. who recorded their observations.

(*b*) It had been arranged with O.S.7 for 500 windproof Brynje vests and scarves to be despatched to Iceland (C) Force for a further trial to be carried out at the Iceland school.

(*c*) A large scale trial was also carried out in Canada.

It was thought that the Brynje vest might also prove advantageous in a tropical climate where it is very desirable to prevent the clothing from becoming saturated with sweat. For such a purpose the inner garment would be required to maintain an air space with ventilation between the outer garment and the skin. This inner garment would have to be such as would (*a*) not absorb a large quantity of sweat, (*b*) retain its elasticity when wet in order to prevent contact of the outer garment with the skin, (*c*) be as soft as possible, as the weight of the pack must be distributed without discomfort, and (*d*) be non-irritating.

Laboratory tests had been carried out in a room equipped with radiant heaters, the air temperature being maintained between 100° and 120° F. and the humidity between 24 and 28 per cent. Subjects wearing Brynje vests under their bush shirts were more comfortable and lost less weight while exercising in these conditions than subjects who wore a bush shirt alone. These experiments were inconclusive but it was thought that the indications were sufficiently favourable to warrant more extended field trials in the Tropics. In consequence it was arranged for a trial of the string vests for the properties enumerated in the previous paragraph to be carried out in West Africa.

In all these trials the Brynje system of clothing was very favourably reported on and the advantages claimed for it were fully substantiated. The string vest was found to be thoroughly serviceable and was very popular with the troops who used it. The Director of Hygiene, after these trials, recommended that an issue of the Brynje vest, in lieu of the ordinary vest, for winter and summer wear should be made as widely as possible, but questions of supply and production restricted its use to the purpose for which it had been designed.

M.T. Driver's Coat. A warm, short, fleece-lined coat was produced for M.T. drivers for use during cold weather in Italy in 1943.

Special Clothing for A.T.S. A sub-committee of the M.P.R.C. of the M.R.C. studied the problem of winter clothing for A.T.S. personnel employed in operational sites of A.A. command, where they were subjected to considerable exposure.

The special clothing introduced for these personnel included a warm 'duffle' smock with a transverse flap level with the abdomen which

could be used as a muff, special gloves and gum boots. The boots were of men's sizes to enable the trousers to be tucked into them in addition to the socks. Experiments were made with various types of chemical heaters. These usually consisted of a sachet the contents of which generated heat on the addition of a little water and were intended to be placed in the large inner pocket of the battledress blouse. Used in this way the sachet retained its heat for from six to twelve hours but could be revived by the addition of a little more water.

A.T.S. M.T. drivers were provided with gauntlet gloves for protection against chilblains.

A.T.S. personnel working in stores or on the cold job of vehicle maintenance were provided with long woollen pants. Some kind of waterproofed garments were considered to be necessary for those employed in vehicle maintenance duties and the Army Medical Directorate advised that there would be no objection to the rubberised training jacket and trousers being used for this purpose as they were unlikely to be worn throughout the day.

PROTECTIVE CLOTHING

A. Overall Garments

(*a*) *Anti-gas Clothing.* These oilskin overalls resisted penetration by the blister gases. Being impermeable, this type of clothing seriously interfered with the evaporation of sweat and body cooling, and in consequence the amount of hard physical work which could be carried out when these garments were worn was limited to very short periods. Various expedients were used experimentally with a view to prolonging the period of wearing decontamination clothing, such as using a wetted garment over the oilskin suit, and the use of a Brynje vest, but without any notable success in delaying the onset of fatigue and muscular cramps, which were noted to be constant effects when working in anti-gas clothing.

(*b*) *Anti-louse Clothing.* This consisted of step-in overalls which could be sealed at the wrists and neck by a purse string, gauntlet gloves and rubber boots; two suits of overalls, two pairs of gauntlet gloves and one pair of boots were issued to each man requiring special protection. Based on this allocation a scale per disinfector or disinfestor was devised:

(i) Three men in field hygiene sections and units holding static hot-air disinfestors.

(ii) Four men in mobile bath units and field ambulances.

(iii) Six men per C.C.S.

(iv) Ten men per general hospital.

(*c*) *Flame-proof Clothing*. Owing to the incidence of burns from cordite flash among personnel in A.F.Vs. a lightweight overall tank suit made of flame-proofed material was devised for the protection of this class of personnel.

(*d*) *Denim Overalls*. This clothing was designed on the same lines as battledress with the object of protecting the soldier's serge clothing when employed on domestic or dirty jobs.

B. Impregnated Clothing

(*a*) *A.V. Clothing*. Battledress impregnated with chlorine compounds with the object of rendering the vesicant gases inert was introduced early in the war. This type of proofing did not possess the disadvantage of interfering with body ventilation, differing in this respect from the impermeable protective clothing. A very few cases of dermatitis were reported among British troops who wore it and authority was given for the issue of non-impregnated battledress to individuals affected in this way. The Canadians reported cases of dermatitis, nausea and headache among workers in Canada handling A.V. battledress, but no such cases were brought to notice in this country.

During 1942 a return was kept of non-impregnated battledress uniforms issued on these medical grounds, but as in one three-month period only some 29 cases were reported from the entire United Kingdom, this return was cancelled. It was concluded that there was every indication that the incidence of A.V. battledress dermatitis was very low and that no increase was observed during the hot weather. A more serious disadvantage was the fact that A.V. battledress did not stand up to steam disinfection, as it was found that the cotton thread used in the stitching rotted owing to the liberation of hydrochloric acid through the action of the steam. This was investigated and was attributed to the clothing being impregnated after being made up so that the cotton thread also got impregnated. It was believed that impregnation of the cloth before making up would have avoided the rotting of the thread. It was decided, pending a more permanent solution, that all A.V. battledress, after disinfection, would be returned to salvage.

(*b*) *D.D.T. Impregnated Clothing*. See section on Insecticides.

D.M.P. Impregnated Veils, Gauntlets and Socks. The older cage-type veils were superseded in 1944 by $\frac{3}{8}$ in. mesh fish-netting impregnated with D.M.P. This netting was made into veils, gauntlets and oversocks. The veil was more efficient when it lay in contact with the skin. The gauntlet was designed to allow for an overlap of 4 in. or 5 in. beyond the man's fingers and was

open at the end which enabled the man to handle his weapons without restriction or risk of tearing the netting. All these items were carried in a wallet of D.M.P. proof material with two pockets —one for the veil and individual D.M.P. container and the other for socks and gauntlets. The veils, gauntlets and socks were wrapped in lint saturated with D.M.P. while in the wallet. The addition of two dessertspoonfuls of D.M.P. per week to the contents of the wallet kept the repellent properties at an effective level. Each wallet contained simple instructions printed on a waterproof card on the use and maintenance of the veils and repellent.

Mite-proof Clothing. For protection against *Trombiculid* mites, socks and trouser bottoms were impregnated with D.B.P. by the troops themselves, using for troops at risk 1 oz. D.P.B. each fourteen days or when clothes were boiled each seven days. D.B.P. was found to be effective after being washed eight times in cool soapy water. D.M.P. could also be used for this purpose but was not so lasting.

OTHER TYPES OF PROTECTIVE CLOTHING AND EQUIPMENT

Sun Helmets. Before the outbreak of war the sun helmet had been regarded as an indispensable item of clothing for soldiers serving in tropical countries and much work had been carried out to improve its heat insulation properties by providing it with a loosely attached aluminium foil lining. The types used were 'helmet United Kingdom' and the Indian pith hat. A composition type was investigated but, as it was 41·4 per cent. heavier than the cork, its adoption was not recommended by A.M.D.5.

During the war doubts began to be expressed as to the necessity for the sun helmet, more particularly in the Middle East. The Director of Hygiene referred the matter to the M.R.C. for an expert opinion in October 1942. He asked the following questions:

(*a*) Is the solar topee necessary at all in any tropical country?

(*b*) So long as the soldier's head is covered and the headgear is well ventilated is anything else required?

(*c*) Is it not more a question of shading the eyes from glare than protecting the head?

The M.R.C. obtained the opinions of their tropical experts. The general view held by them was that protection of the head from solar rays had been overstressed in the past, but they would not say that helmets were unnecessary. They were of the opinion that the head should be covered and that any lightweight type of headgear would give full protection from the sun so long as it was well ventilated and shaded the eyes from the direct glare of the sun.

In notifying the Director of Controlled Stores (D.C.S.) of this expert opinion the D. of H. expressed the view that the Army could not dispense altogether with the solar topee, whatever the type, until a big-scale trial in India or Iraq had been carried out during the hot weather. He agreed, however, to the cutting out of the helmets United Kingdom from the clothing scales of Iraq, Persia, East Africa and West Africa and the substitution of the Indian pith hat for the first area and the slouch for the second and third areas. He was of the opinion that so long as troops were likely to be landed in say the Red Sea area, India or Iraq, some form of solar headgear must be carried on the voyage, but the substitution of the American steel helmet would obviate the necessity of carrying helmets United Kingdom as the inner lining was sufficiently protective against the sun.

The following paragraph was included in the S.M.Os. (troopships) pamphlet:

> Sun Helmets:
>
> Sun helmets are not normally required during the voyage and will not be issued to troops except in the case of personnel going ashore at ports where the use of sun helmets is considered necessary. During disembarkation at certain ports abroad it may be necessary for all troops to wear sun helmets and arrangements will be made to complete issue before disembarkation commences.

The slouch (felt) hat was also used by British troops in S.E.A.C. and was very popular with them as it combined comfort and smartness. A jungle hat was introduced later in the war and this form of headgear was also effective as it was well ventilated and had a brim which afforded shade to the eyes.

Steel Helmets. The M.P.R.C. of the M.R.C. investigated the question of sunproofing the British pattern steel helmet for the Tropics. The London School of Hygiene and Tropical Medicine collaborated in this investigation. Aluminium foil was used as the insulating material and experiments were carried out with this material cemented by a rubber solution (latex) to a khaki cloth cover with a ventilation space between it and the helmet, and also used in the form of a lining for the inside of the dome and as an interior drop lining. The dome lining was preferred as being the most serviceable. Eventually it was decided to replace the British pattern helmet with the American pattern which had an inner insulating drop type lining.

Respirators, Anti-gas. The Hygiene Directorate became concerned in this article of equipment when it appeared that certain individuals contracted dermatitis caused by sensitisation to the rubber facepiece. This was attributed to a chemical used in the rubber mix. The facepieces made by certain manufacturers appeared to be incriminated

oftener than those made by others. The Avon facepiece had the best record. The incidence of this form of dermatitis remained very low, but it was essential that it should be diagnosed accurately and that confidence in the efficiency of this item of equipment should not be undermined.

A.M.D.5 arranged for all cases of dermatitis suspected to be due to this cause to be investigated by dermatologists, who were instructed to carry out patch tests with Avon rubber on those cases where it was considered that the dermatitis was in fact due to sensitisation to rubber, and not due to some extraneous factor such as the antiseptic used to clean the facepiece. Where the patch-test was negative the individual had his respirator exchanged at the hospital for one with an Avon facepiece and before being discharged from hospital his reaction was tested by wearing the respirator. Discs of Avon rubber were obtained by the senior dermatologist at each hospital from the Chief Superintendent, Chemical Defence Experimental Establishment, Porton. O.S.8 arranged for supplies of respirators with Avon facepieces in different sizes to be made available at military and general hospitals to which dermatologists were attached. A comparatively few hypersensitive individuals were, however, found to be sensitive to Avon rubber as well as the other rubbers. A special mix facepiece was produced for issue to such cases. Full details of investigations carried out in all cases of respirator dermatitis were entered in the medical history sheets of the individuals concerned.

Anti-dust Respirator. The anti-dust respirator Mark IV was introduced for the use of personnel exposed to dust hazards where there was a possible risk of silicosis, e.g. dental mechanics using pumice powder substitutes which were found to contain 30–40 per cent. of free silica. The American 'Dustite' respirator was issued in some overseas stations but was found to be less efficient than the respirator anti-dust Mark IV.

Goggles. Goggles were extensively used as a protection against sun- or snow-glare and to exclude dust. The main faults with goggles issued to despatch riders (D.Rs.) were limitation of vision at the sides by non-transparent side-pieces, the use of tinted lenses in this country under conditions of poor visibility, and fogging of the lenses due to condensation. The production of goggles, which would keep out dust and at the same time prevent fogging of the lenses, offered considerable difficulty, as improved ventilation prevented fogging, but, on the other hand, admitted dust.

In these circumstances the Consulting Ophthalmologist and D. of H. decided that the use of the anti-gas eyeshields, plain and tinted, afforded the best all-round protection and the following provision was therefore recommended:

A. Temperate climates.

(1) Eyeshields anti-gas should be issued to drivers M.T. and D.Rs.

B. Climates such as Middle East, North Africa and Southern Europe.

(1) Spectacles tinted No. 3, to be issued to:

(*a*) Drivers M.T.

(*b*) A.A. personnel.

(*c*) Traffic police.

(*d*) Up to 5 per cent. of total force to be supplied on certificate of M.O. or ophthalmic specialist.

(2) Goggles D.R. tinted, to be issued to motor cyclists.

Towards the end of 1943 the Consulting Ophthalmologist had the anti-glare goggles used by A.A. gunners tested for light-ray and heat-ray transmission at the National Physical Laboratory. It was found that while they cut out dazzle they did not exclude heat rays, and thus could not be relied upon to obviate the risk of retinal burns in the case of personnel, such as A.A. observers and others who have to look into the sun.

In consequence the following revised provision had to be made for troops in tropical and sub-tropical (Mediterranean) countries:

(1) Drivers M.T., traffic police who had to look into the sun. Spectacles tinted No. 1—100 per cent. issue.

(2) A.A. Gunners. Special anti-heat spectacles to obviate retinal burns—100 per cent. issue.

(3) Other troops. (*a*) A general issue of anti-gas shields, 4 ordinary, 2 tinted.

(*b*) Spectacles tinted No. 3—Only issued when a soldier was certified by an ophthalmic specialist or medical officer as being particularly affected by glare (probably 5 per cent. of all personnel).

Ear Plugs. Various types of manufactured plugs for the protection of R.A. personnel from blast injury to the ears were investigated, but it was found that a well-fitting cotton-wool ear plug afforded the best protection. It was recommended that the method of applying the ear plug should be included in the training of R.A. personnel.

Crash Helmets. A satisfactory type of crash helmet was issued to D.Rs. and parachute troops. A hygienic problem which arose in connexion with these was a proposal that units and schools which held motor-cycle courses should be permitted to hold a pool of such helmets for the use of students. Attention was drawn to the necessity for care in this matter owing to the risk of transfer of such conditions as seborrhoea of the scalp, head lice, dandruff, impetigo and barber's itch. The following alternative solutions were recommended:

(*a*) If the helmets were transferred daily from one man to another the use of a clean linen lining to the helmet and flaps would be necessary.

(*b*) If the helmets were changed only at the conclusion of a course of say one or two weeks then spraying the inside of the helmet and side pieces with a 5 per cent. formalin solution would be satisfactory. Formalin could not be used daily owing to the risk of the irritating fumes lingering in the helmet and sidepieces.

The same principles were applied to pools of crash helmets for officers.

MOSQUITO NETTING

The standards for cotton netting (bobbinet) and metal screening in force at the beginning of the war were as follows:

Cotton netting

1. Mosquitoes:	Meshes to square inch	28/29
	Cotton	30/40
2. Sandflies:	Meshes to square inch	46
	Cotton	120

Metal Screening

1. Mosquitoes:	Galvanised woven wire gauze meshes to linear inch	16
	1 S.W.G.	27
	Diameter of wire	0·0164 in.
	Width of aperture	0·0461 in.

During the course of the war supplies of bobbinet netting did not keep pace with demands and various lace substitutes had to be accepted. Since in these substitutes the yarn used and the weave were very different from that of the bobbinet, the specification of the latter could not be used. It was therefore necessary for a new specification to be drawn up for these lace substitutes in which it was considered desirable to lay down the maximum area of the aperture and the dimensions of either a side or a diagonal of the hole when the latter was rectangular or square. Members of the staff of the Liverpool School of Tropical Medicine undertook the task of advising on a formula which could be made the basis of a specification for the alternative types of netting.

It was suggested that a standard for mosquito netting should be based on the following data:

(*a*) The longest diagonal of the aperture.

(*b*) The maximum aperture area (not more than 3 per cent. of apertures to exceed this).

(*c*) The average aperture area.

(*d*) The minimum number of holes per sq. in.

In the case of the standard mosquito netting (bobbinet) the average aperture area was 0·00277 sq. in. and the longest diagonal was 0·065 in., and it was intended that the measurements of the lace substitutes should approximate to these.

The proposed specification ensured a safe netting and was accepted by the Supply department but, from the medical point of view, it was desirable that the air permeability of the netting should also be allowed for and should be as high as possible. It was considered that the minimum air-flow should not be appreciably lower than the air-flow in the standard netting conforming to the old specification. This question was submitted to the Yarn and Textile Testing Bureau, Nottingham, which undertook to get the trade's research organisation to work out a test intended to form the basis of a clause in the specification which would ensure the necessary minimum air-flow and at the same time be acceptable to the trade.

Similarly it became necessary to draw up standards for sandfly netting substitutes, when the yarn and weave were such that the netting could not be judged by the pre-war specification. Sandfly netting was required to conform to the following:

1. The longest diagonal of the aperture should approximate to 1·2 mm. (0·0475 in.)
2. The average aperture area should approximate to 0·8 sq. mm. (0·00124 sq. in.).
3. Not appreciably more than 3 per cent. of apertures should exceed 1 sq. mm. (0·00155 sq. in.).
4. The percentage of free space to total area to be not less than 50 per cent.
5. The minimum number of holes of standard size per sq. in. to be 350.

In the meantime, pending the production of satisfactory substitutes, sandfly netting was accepted by M.E. and P.A.I.C. for the replacement of mosquito netting, and A.M.D.5 recommended that it should be included in future provision for these theatres. For East and West Africa, Burma and S.E. Asia, on the other hand, sandfly netting was considered to be too fine and likely to make sleeping conditions intolerable. Mosquito netting was therefore insisted on.

For the greater part of the war three types of mosquito nets were in general use:

1. The large curtain with a hoop for use in hospitals (G.S. Mark I).
2. The boot shaped bar net (Mark II) for use by troops in rearward areas in huts, tents etc.
3. The bush net for forward troops.

The hospital nets were white, while the others were dyed for camouflage.

In 1944 stocks of the hospital type curtain G.S. Mark I became exhausted. The Army Medical Directorate agreed, in order to simplify supply problems, to accept replacement for hospitals by the boot and bar type curtain (Mark II) of the camouflage shade since the material was dyed in the piece before making up.

In 1944 a special jungle mosquito net was devised for use in S.E.A.C. It was made of Admiralty cambric D. At first it was proposed that this should be impregnated with D.M.P., but to economise supplies of the latter it was agreed that the material should be waterproofed instead.

CHAPTER 3

THE ARMY HYGIENE SERVICE (Cont.)

Environmental Hygiene

DISPOSAL OF WASTE MATTERS

It has always been recognised that the satisfactory disposal of waste matters is one of the most difficult problems with which an army can be confronted. Its successful solution is of the greatest importance owing to the valuable part it plays in the conservation of manpower. In almost every campaign intestinal disease makes its appearance sooner or later, and its incidence rate inversely reflects the efficiency of the methods adopted to dispose of waste matters. The War of 1939–45 did not prove to be any exception and the proneness to intestinal disease of some units and formations newly arrived in a battle area reflected their poor standards of sanitation. Improvement only occurred when the simple lessons learnt from experience in previous campaigns had been re-learned.

It was found in certain theatres of war that the nature of the operations and the type of country, whether desert, jungle, etc., necessitated some modifications being made to the generally accepted sanitary methods for the disposal of waste matters outlined in the *Army Manual of Hygiene and Sanitation* and to the appliances described in it.

This was found to be the case in the Middle East theatre where problems presented themselves owing to the great mobility of units engaged in active operations which took place over large areas of trackless country, the need for units to be widely dispersed and often subdivided, and to the almost insuperable difficulties of supply and transport. Instead of being able to budget for sanitary appliances, etc. on a basis of percentage of unit strength, methods had to be adopted which could be applied to the unit that found itself split up into small sections operating independently as well as to the comparatively static camp in rear areas. It was found to be essential that structures designed for sanitary purposes in the field should be either readily portable or easily constructed at short notice from materials which could be obtained wherever a unit might find itself leaguered for a short stay.

To overcome the difficulty of meeting demands for sanitary stores every endeavour was made to induce units to standardise their demands for supplies and appliances by using similar methods and materials as far as possible.

An unrelenting problem in the Middle East was that of preventing fly-breeding. This was favoured by the climatic conditions, and was

greatly aggravated by the rapidity with which it occurred following the slightest sanitary lapse.

Field Latrines. In static and semi-static conditions in the Middle East the deep trench latrine, when properly constructed and maintained, was found to be the most satisfactory type. It had the disadvantage, however, of requiring a superstructure which had to be carried by the unit when moving camp. This was largely overcome by the development of the M.E. portable superstructure which combined the advantages of portability, ease of construction and economy of materials. The standard type multi-seated superstructure, however, was found to be useful for camps in base and rear areas which were not widely dispersed.

The M.E. portable latrine superstructure was designed as a transportable, squatting pattern, two-seater for use by British, Indian and native troops. It could be carried flat on the floor of a 15-cwt. truck and took up very little space. It consisted of a platform made of wood or corrugated iron measuring 6 ft. by 3 ft. 6 in. by 3½ in., intended for fitting over a trench 5 ft. in length. The platform had two rectangular openings large enough to allow both defaecation and urination in the squatting position. Lids were made self-closing with rubber hinges made from pieces of disused outer tyre covers. The component parts together weighed just over 60 lb. These superstructures were made available for issue to units in spheres of active operations on a scale of one for every five vehicles of a motorised unit or one for forty men in other units.

In rear areas this superstructure was used in connexion with a deep trench 5 ft. long which was at least 2½ ft. wide to allow excavation to a depth of 8 ft. Under mobile conditions in the forward areas, however, it was rarely possible to construct a deep trench of these dimensions because of the time factor and, in the Western Desert, the nature of the ground also. It was found that a trench only 4 to 5 ft. deep made fly-proof with a suitable superstructure, and carefully sealed when a unit moved, was satisfactory and did not give rise to fly-breeding.

The best form of this latrine was constructed as follows:

A trench of the following dimensions was excavated—5 ft. long by 2 ft. 6 in. wide by 4–5 ft. deep. As fly-larvae breeding in the trench would have only a short distance to travel to reach ground surface, it was necessary, as an additional precaution, to fly-proof the sides of the trench. The soil was removed to a depth of 6 in. for 4 ft. all round the trench and a layer of oiled sacking or canvas was laid with its inner edge hanging 6 in. down the side of the trench. The soil was then replaced on top of the sacking layer and beaten down and an M.E. portable superstructure was then placed in position. A trench of these dimensions filled fairly rapidly. Before the level of the contents reached the sacking, or when the unit was preparing to move, the latrine was

sealed in the usual manner with oiled sacking and filled in with sand or soil beaten down hard.

A novel type single-seat incinerator latrine was devised for the use of armoured and mobile formations in the Western Desert. It was readily improvised from 4-gallon petrol tins which were available whenever a unit leaguered and the unit only had to carry the light fly-proof wooden seats which had self-closing lids. One latrine of this type was sufficient for fifteen men or the crews of three A.F.Vs. in a dispersed leaguer.

Three petrol tins were required and these were arranged in a pit 28 in. by 19 in. by 9½ in. to form two compartments—a rear compartment for faeces consisting of one petrol tin (from which both ends had been removed) superimposed on another (from which the top end had been cut away) and a front compartment for urine consisting of a petrol tin (with top removed and bottom perforated) superimposed on a small soak pit filled with stones. The latrine could be constructed for use as a squatting type or with a raised seat as desired. The two upper tins were fitted with a fly-proof wooden seat made to fit tightly over the ends of the upper tins placed side to side.

The faeces and paper in the rear compartment were destroyed twice daily by the addition of a small quantity of petrol and sump oil, half and half, to the rear compartment, which was then ignited after removal of the seat. The fire burnt for about twenty minutes destroying the paper and reducing the bulk of the faeces to one-third of its volume by drying and partial burning. It was found that normally one of these latrines would last fifteen men for a fortnight, which was rather longer than the usual time a fighting unit stayed in one camp site. Before leaving the site a final burning was carried out and the latrine was sealed by placing a square of sandbag soaked with oil on top of the latrine contents and then filling with earth which was well packed down.

The advantages claimed for this type of latrine were that fly-breeding was impossible as any eggs deposited in the faeces were destroyed by the heat; a very small area of ground was fouled; the single seat feature of the latrine allowed for easy dispersal throughout a camp area; burning rendered the contents practically odourless; only the light seat required to be carried by the unit as petrol tins were usually readily available when the unit leaguered.

Bucket latrines were suitable for static camps only. The bucket contents were disposed of either by burning in a closed incinerator or an A.S.H. faeces destructor or by emptying into an Otway pit. The latter consisted of a cubical pit 10 ft. by 10 ft. by 10 ft. provided with a fly-proof cover of timber lined with oiled canvas or of metal sheet. Such a pit dealt with the faeces of a hundred men almost indefinitely when properly looked after. The Otway pit, however, was suitable only for base and semi-permanent camps and where digging was possible, and

the large cover was expensive in materials and far from portable. It was, however, found to be a satisfactory method of faeces disposal in the proper circumstances. Occasionally Otway pits were also used for the disposal of wet swill and offal, but in this case it was essential that faeces and offal were not mixed in the same pit.

Field Urinals. In static camps it was found that the normal standard appliances such as funnels and troughs used in connexion with 4 ft. cubical soak pits were satisfactory. For mobile conditions, however, a small modified soak pit used with an appliance improvised from petrol tins known as the 'desert rose' was adopted as the standard urinal for halts of short duration. As they were of small capacity and very quickly constructed it became the practice to scatter them very liberally throughout a camp. The soak pit was 1½ to 2 ft. cubed into which was inserted a petrol tin from which the upper end had been removed and the bottom end perforated. One half of a petrol tin which had been cut diagonally was superimposed on this. The lower edge of the upper tin was also perforated.

Cookhouse Waste. The efficient disposal of refuse and swill was found to depend on its careful separation into 'dry' and 'wet' refuse which were collected in separate fly-proof receptacles placed on a hard standing. Galvanised iron bins with lids were supplied by Ordnance for the purpose but were of poor quality and were easily dented and knocked out of shape, so that lids ceased to fit tightly. Refuse containers were also improvised from available materials which varied from petrol cans to tar barrels, the only essential being that they should be waterproof and fly-proof. Incineration was the method of choice in the ultimate disposal of this type of waste.

Incinerators. It was found in practice that for L. of C. and temporary camps, incinerators should be either portable or easily improvised, so that when a unit moved it need not be without an incinerator in its new site. In the Middle East the following types were preferred of which (*a*), (*b*) and (*c*) were portable and (*d*), (*e*) and (*f*) improvised

(*a*) The semi-closed graduated feed incinerator which was easily constructed from sheets of corrugated iron held together with wiring.

(*b*) The open corrugated iron incinerator which was simply constructed from 4 sheets of corrugated iron wired together and fitted with removable firebars. This structure could be folded flat for transport.

(*c*) The inclined plane incinerator, constructed from three sheets of corrugated iron wired together. It could be folded flat and was readily portable.

(*d*) The Bailleul incinerator improvised from petrol tins was used largely before the introduction of the A.S.H. faeces destructor. Being a closed incinerator it could deal satisfactorily with any form of waste including the contents of latrine buckets.

(*e*) The A.S.H. faeces destructor. Improvised types of this incinerator were found to be ideally suited to desert conditions where fuel was scarce and waste oil was readily available and it was preferred to the Bailleul on account of its efficiency.

(*f*) The open square incinerator built of petrol tins filled with puddled clay. It was simple to construct and was suitable for the disposal of all kitchen and other waste except faeces.

Under mobile conditions the incinerators preferred for mobile units were the portable inclined plane or a simple type improvised from a tar barrel. (*See* Plates II—VI.)

Burial of Refuse. The disposal of raw refuse by burial was restricted to conditions where the tactical situation made the production of smoke from fires undesirable. In these circumstances, if digging was easy and time permitted, it was considered preferable to excavate one large pit 10 ft. by 10 ft. by 6–8 ft deep. It was essential for the refuse to be collected in fly-proof receptacles which were emptied into the pit once daily and immediately covered with at least 6 in. of soil. When the pit was filled to within 3 ft. of the surface it was closed in the following manner. The pit was filled to within 6 in. of the surface with soil; the final 6 in. was rammed down hard with a quantity of soil mixed with waste oil. Where the soil was powdery it was better to substitute a layer of oiled sacking for the oiled sand layer. It was estimated that such a refuse pit would, as a rule, last 100 men for ten days.

Where digging was difficult, shallower pits or trenches could be used provided each day's addition was covered immediately and the pits were sealed as described above. This method, however, was wasteful in labour and used a lot of ground.

Waste Water. In the desert special care was necessary in the disposal of waste water as patches of sand continually kept moist by greasy water around ablution and kitchen wash-ups not only attracted flies but often acted as breeding places by providing the moisture necessary for the development of the larvae. A saving provision in this respect, however, was the limitation of the water supply, which was rationed.

In rear areas it was necessary that wash-up and ablution benches constructed by the R.E. should be provided with hard concrete standings suitably sloped and drained. The standard grease trap was satisfactory when properly constructed so that the capacity was at least 50 gallons for a cookhouse serving 200 men; the length of the trap was at least three times its breadth; the baffles were removable for cleaning purposes; the trap was waterproof and was provided with a cover.

The waste water was ultimately disposed of in the usual manner either into a soak pit or by means of a system of herring-bone drainage. An alternative method which proved to be ideal for hot dry climates was the use of evaporating pans. In this method a series of level pans each

measuring about 30 ft. square were constructed by building up low earth walls to a height of about a foot. For 300–400 men six of these pans were constructed in two parallel rows of three, the main drain running between the rows with branches to each pan which could be opened or blocked as required. The pans were used in rotation for each day's flow of sullage and sufficient pans were necessary to ensure that the first pan was completely dried off when its turn to be refilled came round again. The depth of water in the pan was not allowed to exceed 9 in. Evaporation assisted by a certain amount of soakage was generally complete in from two to five days leaving a grey flaky deposit which was brushed off and packed on top of the ridge round the pan. The pans created little nuisance from smell but it was usual to site them 300 yd. or more downwind from the camp. The planting of canna lilies and the cultivation of maize and vegetables round the pans considerably accelerated the disposal of the sullage water. There was no risk of fly or mosquito breeding associated with these pans.

In the case of mobile units it was found that waste water in small quantities could be disposed of effectively in a 'desert rose' constructed in a similar manner to the urinal, except that the lower petrol tin was filled with brushwood or scrub to strain off the grease. This filling required to be changed daily and burned.

Conservation of Water. The rationing of water to one gallon per man per day or less made it difficult to maintain sanitary structures in a cleanly condition and attention was given to the clarification of sullage water by chemical precipitation so that it could be used again for this purpose. This was accomplished in 40-gallon oil drums to which a bibcock was fitted 10 in. from the bottom. A strainer was necessary to remove coarse débris from the sullage water and one improvised from a petrol tin was fixed into a wooden lid. Clarification was carried out by the addition of ferrous sulphate and lime dissolved or suspended in water, the exact dosage being determined by Hattersley's method. The test was carried out on a sample of waste water in a 4-gallon petrol tin using a W.C.P. scoop (3 scoops = 1 oz.) to measure the ferrous sulphate and a W.S.P. scoop (15 scoops = 1 oz.) to measure the lime. One scoop of ferrous sulphate dissolved in water was added to the sample. Scoopfuls of lime suspended in water were then added until a green precipitate formed in the water. The amounts required for 40 gallons of water were ten times the amounts required for the 4-gallon sample. The water thus clarified was fit to use again for washing, cleansing utensils and latrine superstructure.

Small and mobile units improvised sand filters using petrol tins filled with sand on a bed of stones for this purpose. The sullage water was first boiled and the scum removed before being passed through the filter.

SELECTION OF CAMP SITES

Although active operations in the Middle East were to a large extent carried out over vast expanses of trackless country, where it might be imagined that the choice of possible sites would be so wide as to make it unnecessary for sites previously occupied by other units to be used, it was found to be inevitable that for many reasons the same areas of ground along the axis of a formation were used again and again by different units. This still further emphasised the obligation on all units for maintaining a high standard of sanitation in their camp at all times, in order to prevent the sins of an advanced unit from being visited upon those who followed them, and upon whom they probably depended for their maintenance and supplies.

In forward areas there was often the temptation to occupy the dug-outs and slit trenches vacated by the enemy, but it was found, almost invariably, that they had been fouled and that it was advisable to avoid them in so far as the tactical situation permitted, particularly as there was evidence that a high incidence of intestinal disease existed among the enemy forces. Where the situation made their occupation unavoidable it was essential for them to be thoroughly cleaned up at the earliest opportunity.

In the United Kingdom the waste products which gave rise to most difficulty in disposal were night soil and sullage water.

DISPOSAL OF NIGHT SOIL

The methods used in the Army at home during the war were:

(i) Disposal into a sewage system.
(ii) Deep trench or bored hole latrines.
(iii) Bucket system with removal by contractors.
(iv) Bucket system and disposal by incineration.

During 1941 a census was carried out in commands at the request of the D. of H. to ascertain to what extent the various methods of disposal were being used by the troops. This, when consolidated for the United Kingdom, gave the following results:

53·0 per cent. were on a water carriage system;
2·2 per cent. used deep trench latrines and a negligible percentage used bored hole latrines;
34·3 per cent. were on a bucket system with removal by contractors;
0·4 per cent. used a bucket system with incineration;
7·1 per cent. used buckets with burial of night soil;
2·1 per cent. used other methods (disposal in sea, etc.).

No difficulties were experienced in those barracks and camps which were fortunate enough to be on a water carriage system, but where other methods of disposal had to be adopted they were often beset with difficulties in greater or less degree.

PLATE I: Army School of Hygiene. Portable Water Steriliser, unpacked, showing Filter

PLATE II: Army School of Hygiene. A General View of Incinerators, Disinfectors and Disinfestors

[*facing page* 104

PLATE III: Army School of Hygiene. A Field Incinerator

PLATE IV: Army School of Hygiene. A Field Incinerator made of Sods

PLATE V: Army School of Hygiene. A Bailleul Incinerator built of Brick

PLATE VI: Army School of Hygiene. A Bailleul Incinerator built of Earth-filled Petrol Tins

For example, the bucket system with removal by contractors, which was most commonly used in the absence of a water carriage system, was found to be a very expensive method indeed with the numbers involved. It was estimated in 1941 that this method had cost one command alone £50,000 in a period of three months. Furthermore, in many instances contractors merely disposed of the night soil by trenching in the neighbourhood, a practice which gave rise to the same objections as were raised against the Army's deep trench latrines. As the war progressed and the number of units increased, contractors began to experience a shortage of man-power and in some districts great difficulty was experienced in arranging contracts for removal. Again the method was not suitable for the assembly areas used when the invasion of Normandy was being mounted, on account of the necessity for security.

For temporary camps and newly constructed hutted camps, where a water carriage system could not be installed or pending its installation, it was the policy in the Army to use deep trench latrines or bored hole latrines, as the necessity for handling and subsequent disposal of night soil were thereby eliminated.

Bored hole latrines were considered to be specially suitable for units of a strength not exceeding 60, instead of the bucket latrine system, wherever the conditions permitted and the period of occupation justified such provision.

This decision, however, was not always well received by the civil authorities and led to frequent complaints from medical officers of health and water companies about the risk of contamination of their water supplies by latrines of this type. They took particular exception to the use of bore holes. It is probable that risk was exaggerated since it had been shown that there was a very limited cone of contamination from them in the direction of the subsoil water flow, but there were, of course, undoubtedly risks where fissures and faults existed in the underground strata. In order to allay the anxieties of the civilian authorities on this score it was decided that, before adopting any method of disposal of excreta direct into the ground, the local authorities would be consulted as to the possibility of any contamination of water supplies arising, and their agreement to the proposed method of disposal would be obtained.

The disposal of excreta by burning in W.D. incinerators suffered from the handicap that it entailed the handling of latrine buckets by the troops. Although this method was used to some extent in most commands, one general officer commanding-in-chief refused to countenance it in his. Eventually the Adjutant-General was asked to give a ruling on the subject and he ruled quite definitely that only in exceptional circumstances would troops be asked to handle night soil and that civilian labour would be employed for this purpose. Another difficulty in disposal by incineration was the scarcity of fuel.

One promising proprietary incinerator was tried out in various commands—the Riley incinerator—and was favourably reported on after certain modifications had been made to it. Its main feature was a special iron bucket, which was handled by tongs. When loaded this bucket was placed directly in the oven and the contained night soil was completely incinerated in one hour leaving an innocuous ash. It was found, however, to be rather extravagant in fuel and it required coal, which was scarce, as fuel. This led to the exploitation of the oil and water flash fire for incineration purposes in which waste sump oil was utilised and to the development of appliances in which this type of fire could be used.

The experimental work in this connexion was carried out at the Army School of Hygiene and resulted in the production of the A.S.H. faeces destructor, which proved to be the most efficient and rapid destructor for faeces devised so far. One standard A.S.H. faeces destructor was capable of dealing with the faeces and urine of 500 men. It depended for its success on the production of a steady, easily regulated and fierce fire of the oil and water flash type by employing a specially designed ventilating burner which made it possible to utilise waste sump oil as the fuel, after straining and removal of water. This incinerator was constructed by the R.E. to the War Office specification and drawing, but improvised types could also be made locally.

It was built of 9 in. brickwork, 1 ft. 9 in. (seven courses) in height and measuring $6\frac{1}{2}$ ft. by $3\frac{1}{2}$ ft. outside and had a concrete foundation. It incorporated a baffle arch, a 9 in. by 9 in. flue terminating in a chimney composed of oil drums to a total height of approximately 12 ft. The floor was of loose bricks to conserve heat. Sheet iron doors in front gave ready access to the interior and, in conjunction with a damper in the flue, afforded complete control of draught. The top of the destructor was formed in lime concrete 4 in. thick supported on corrugated iron sheets. It was reinforced with expanded metal and had a filling opening closed by a stout sheet-metal lid. The removable hearth was of heavy corrugated iron sheet, with turned up edges, supported on iron bars fixed at levels which gave it a fall towards the flue where it overhung a sheet-iron tray 3 in. in depth. The hearth and tray were so situated that, by suitable manipulation of the draught control, the whole of the heat generated by the burner could be passed over or under them. Solid excreta on the hearth and liquid excreta draining into the tray were thus rapidly dried and were combusted to a residuum small in quantity and of the nature of a white ash. A hot water tank could be incorporated if desired. It was found convenient to have these destructors constructed in pairs for any number of men over 500 as this effected economy in building materials, conserved heat, and provided a spare destructor should one go out of order.

Where brickwork was impracticable the walls of the incinerator could be constructed of petrol, or similar tins wired together and solidly filled with clay. The necessary height was obtained by two courses of tins, the total number required being thirty-eight. Other details were improvised on the lines of the standard type but a concrete foundation was not required for the temporary petrol tin types. Field hygiene sections constructed many incinerators of this type which proved to be most successful.

The A.S.H. destructor consumed 1½ gallons of waste sump oil daily for every 100 men. In the United Kingdom this commodity had been collected and stored by the Director of Salvage pending a scheme to have it refined. The D. of H. was able to arrange with the Director of Salvage for the supply of waste oil for incinerators to be authorised, and it was agreed that oil for this purpose was to be given priority over any scheme for refining. The amounts of waste oil required were obtained direct from salvage depots. It was estimated in October 1942 that some 273 destructors had been completed or were in course of construction in the United Kingdom. Working to full capacity it was estimated that these would use about 750,000 gallons of waste oil per annum or about 60,000 gallons per month. Sufficient supplies of waste oil were available for this although it was also used on a large scale by the Army Catering Corps for oil and water flash fires for cooking purposes owing to the scarcity of other forms of fuel.

A water-borne system for the disposal of both sewage and sullage at newly constructed hutted camps was adopted when all alternative methods were either impracticable or more costly, or where removal by a contractor though less costly would necessitate cartage involving undue consumption of petrol and wear of tyres.

The officers in charge of administration of commands were empowered, subject to certain limitations, to decide whether a water-borne system was to be adopted at any camp, taking into account the relative initial and recurrent costs and factors affecting the particular camp site, e.g. shortage of labour, transport facilities, disposal difficulties, possibilities of incineration and density of population in the immediate neighbourhood. In calculating recurrent costs it was assumed that the subsequent period of occupation of war-time hutted camps would be three years.

The water carriage systems installed either involved connexion to a local authority's main sewer or the construction of an independent sewage disposal plant. The cheaper of these alternatives was always adopted.

In hutted camps where a sewage disposal plant was not installed and the disposal of sullage water by soakaways was impracticable, a sullage disposal plant was provided subject to the cost being kept within certain prescribed limits.

Officers in charge of administration of commands were empowered to authorise schemes for the disposal of sewage and sullage without prior reference to the War Office, provided the normal approvals for complete projects had been obtained and subject to the estimated costs not exceeding the following figures:

(i) Capital cost of providing a water-borne sewerage system including connexion to the local authority's sewer, but excluding the cost of latrines and surface water drainage . .	£4 per head
(ii) Additional capital cost to (i) for providing sewage disposal plant where main sewer is not available	£4 per head
(iii) Capital cost of providing sullage system including disposal plant	£3 per head

War Office authority was necessary when capital payments in excess of these sums were involved.

In some instances where there were grounds for assuming that a connecting sewer, when laid, would be of benefit to the local authority in providing means for the sewerage of existing or prospective private properties in the neighbourhood, the local authority was asked to bear some part of the cost of the work.

Except where it was proposed to dispose of sewage into an existing public sewer, it was the rule to consult the senior regional officer of the Ministry of Health at the earliest possible opportunity regarding the means to be adopted for the disposal of sewage in all new temporary or hutted camps constructed within the regional area. The liaison was usually carried out jointly by the D.C.E., and D.D.H., of the Command.

DISPOSAL OF SULLAGE WATER

In temporary camps and hutted camps provided with a piped water supply the disposal of sullage water was a tremendous problem, especially during wet weather. Care in the selection of camp sites so as to ensure that there would be adequate drainage from them was a consideration which was often neglected. The capacity of the soil to absorb water for a prolonged length of time was also an important consideration.

The standard method for the disposal of sullage water involved separation of grease and the ultimate disposal of the effluent. The separation of grease was effected by means of the cold water grease trap which was reasonably efficient provided the trap was of adequate size and was properly constructed. The effluent from the grease trap was directed into soakage pits, but these were frequently overworked and required to be duplicated or relieved by laying from them a long length of sub-soil

agricultural drain pipes about one foot below the surface of the ground with a slight fall.

The disposal of sullage water directly into a watercourse, even after fat removal in cold water grease trap, usually resulted in a nuisance being caused sooner or later, since soap was not removed by passage through this type of trap and fat removal was often incomplete.

At a Q.M.G. conference early in 1941 the D. of H. suggested that in a newly constructed camp an installation should be provided for the clarification of sullage water, using the ferrous sulphate and lime process which had been worked out at the School of Hygiene between the wars. It had been shown that ferrous sulphate and lime used together formed a most effective precipitant removing both grease and soap from sullage water almost completely. When sufficient doses of these chemicals are added to sullage water a dark green flocculent precipitate appears in the water and begins to settle immediately, carrying down grease and suspended particles as it settles, leaving the supernatant water clear. The usual dosage per gallon of sullage water is 30 g. of ferrous sulphate and 30–40 g. of lime. The object of the lime is to obtain the correct degree of alkalinity, which results in the maximum precipitate formation. This occurs at *p*H9, at which level the colourless indicator phenol-phthalein turns pink. The point can be ascertained by trial and error using phenol-phthalein test papers or by Hattersley's method. The amount of lime required depends on the amount of washing soda present in the water from cookhouses.

Eventually it was decided to instal special sullage disposal plants in all new camps not on main drainage. This involved putting in a drainage system leading from all sources of sullage water to the disposal plant situated on lower ground so as to secure a fall. Foul drainage and surface water were carefully excluded from these sullage systems.

The disposal plant consisted of a set of concrete collecting tanks, similar to the sedimentation tanks of a sewage plant, in which the sullage was treated. The tanks were of sufficient capacity to hold half the day's output and were constructed in pairs, so that one could be filling while the treated water in the other was settling. Each collecting tank had three pipes taking off from different levels, through which the cleared water could be drained off after treatment, and a drainage pipe from the base by means of which the sludge could be forced out on to the drying beds. Two small cisterns were erected over the tanks to hold strong solutions of the chemicals used to dose the tanks: one for the ferrous sulphate solution (1 lb. to the gallon of water) and the other for a suspension of lime (1½ lb. to the gallon). When a tank was filled with sullage water, it was dosed with one gallon of each of these solutions per 250 gallons of sullage, but the dosage of lime often required adjustment to obtain the necessary degree of alkalinity. The plant included a mechanical stirring

apparatus for mixing the chemicals thoroughly with the sullage. After two or three uses, when a quantity of sludge had collected, considerably less of the chemical solutions was required to obtain precipitation and this was progressive until de-sludging was necessary. The contents of the sullage tank were thoroughly mixed on two occasions—immediately after dosing and again after half an hour. In from one to three hours the clear supernatant water could be allowed to run off direct into a water-course, without risk of giving rise to any nuisance even after prolonged use. When the sludge accumulated in the tank until it had risen to within four inches of the lowest of the three effluent outlet pipes, the filled tank was deluged by opening the sludge drain pipe. The weight of the water above it forced the sludge into one of the drying beds. The drying beds were constructed of hard clinker about 1½ to 2 ft. in depth. The crude sludge was not allowed to cover the drying beds to a greater depth than 9 in. The sludge was inoffensive and, when dried, was scraped up, removed and buried.

A small scale sullage plant was constructed at the Army School of Hygiene for the instruction of sanitary assistants and of the civilian personnel employed to operate these plants under close supervision, when they were first introduced, and to ensure that the personnel employed to operate them understood their duties. After a few initial difficulties had been overcome, these plants proved to be the most successful adopted thus far. These plants were so designed that they could be utilised as sedimentation tanks if sewage disposal plants were installed at a later date.

Simpler installations using the same principles were sometimes constructed in permanent camps and proved to be very successful.

DISINFECTION AND DISINFESTATION

During the inter-war period a good deal of research work had been carried out at the Army School of Hygiene with the object of evolving a portable disinfector suitable for use in the field. This work resulted in the production of a disinfector which was known as the A.S.H. disinfector and later as the Disinfector Field Portable (D.F.P.) No. 1.* After being thoroughly tested this disinfector proved to be satisfactory and was accepted. It was of the downward displacement current-steam type and consisted of two identical cylindrical boilers which were heat insulated and rotatable. Each container was mounted on trunnions on its own stand and had a loose lid which was held by clamps. A flexible rubber hose conducted steam from an asbestos lagged cylindrical boiler mounted between the containers and capable of being connected to either of the containers as required. The original burner used was a

* *See* Plate II.

Rutherford type W3 burner but this was later substituted by two Hydra burner units S.B. Type E. The filled containers were steamed lid downwards and the steam escaped from a hole in the lid. The disinfector had an output of 150 blankets per hour. It was carried on a special 3-ton lorry and weighed (boiler empty) 2,000 lb. This disinfector was issued to field hygiene sections mobilised at the beginning of the war.

Early in the war, two senior officers on the staff of the Inspection Department, Engineer and Signals Stores, took in hand the task of designing a portable disinfector intended primarily for blankets, clothing and 'biscuits', which would use the same general principles but would be lighter, with steam jacketed containers and boiler on one unit, thus having a higher mechanical efficiency. Their work resulted in the production of the disinfector field portable No. 3 weighing 950 lb.—probably the most efficient disinfector available at that time. It consisted of two fixed metal containers of rectangular section which were jacketed by steam and were loaded and unloaded from the top. The containers were steamed simultaneously, except when loading or unloading, when one was steamed and the other opened up. Current steam was admitted to the container from the steam space forming the jacket and the downward displacement principle was used. The boiler was heated by a Hydra burner unit S.B. Type E. The output of the disinfector in terms of blankets was 200 per hour. It could be mounted on any vehicle from the 15 cwt. personnel carrier upwards. This disinfector superseded the D.F.P. No. 1, which was later withdrawn from field units to which it had been issued. One D.F.P. No. 3 was issued to field hygiene sections, general hospitals and mobile laundries.

The same team of workers designed a small light-weight disinfector suitable for pack transport known as the disinfector field portable No. 2. Its design was based on the principles used in the T.O.T. disinfector. It consisted of a steam jacketed metal container of rectangular section fitted with a steam-tight lid. Steam issuing from the boiling water, surrounding the outside of the inner container, passed over its top edges down through the charge and out to atmosphere through a $\frac{3}{4}$ in. pipe welded to the container bottom. The bottom of the disinfector was arched enabling it to be heated either over a trench fire or by a Hydra burner unit, which was the usual method of firing. The capacity of the container was ten blankets and it had an output of fifty blankets per hour. One D.F.P. No. 2 was issued to field hygiene sections, field ambulances, C.C.Ss. and field dressing stations.

These two disinfectors had a high rate of output and, in the case of the No. 3, this was limited more by the capacity of the working party to handle the output than by the rate of disinfection.

A great number of improvised types of disinfectors were devised during the war, using dustbins, large oildrums and barrels as the

containers. In general two types of construction were used in these improvised models, one where the steam boiler was separate from the disinfecting chamber, such as in the Serbian barrel, the other, where the boiled and disinfecting chamber were made in one unit, the boiler being the outer container and the disinfecting chamber being within it, a principle embodied in the Ds.F.P. No. 2 and No. 3. Many of these models were fully described, from time to time, in the *Journal* of *the Royal Army Medical Corps*. The best of the unit type made use of two steel oil drums one being rather smaller than the other, in the construction of which difficult pipe connexions and plumbing were eliminated. The boiler, which was the bottom of the larger tank, was heated by an oil and water flash fire.

In one barrel-type model, with a separate boiler, an ingenious method for super-heating the steam leaving the boiler was incorporated with the object of ensuring that steam entered the barrel at approximately 100° C. after compensating for the heat loss during its passage through the pipe connexions.

In view of the great importance attached to the provision of adequate disinfestation facilities in the field, work was put in hand, in 1938, to design a portable hot-air apparatus suitable for this purpose. The idea originated from a dry-heat apparatus—the Thedeco—brought to notice by the Swedish Chamber of Commerce. Following a series of experiments carried out at the R.A.M. College over a period of two years, during which the apparatus was elaborated, the Millbank hot-air disinfestor was perfected and put into production early in 1940. The objects kept in view, in evolving this apparatus, were that it should be readily transportable by mechanised or animal transport, and capable of being easily erected for use and quick dismantling for transport. The general principle of the apparatus consists in the circulation of large quantities of air, at very high temperatures, in a closed circuit through contact chambers, in which the materials to be dealt with are suspended, so as to produce a minimum surface temperature of 70°C. throughout the whole of the clothing in a maximum period of 30 minutes. This was done by means of a powerful fan driven by a small pilot engine which passed hot air through a patent form of heater. This temperature (70°C.), gradually produced, is adequate for the destruction of the louse in all its stages and also of the *Sarcoptes scabiei* and its eggs.

Each apparatus had two double-walled canvas contact chambers supported on a framework of tubular-steel measuring 12 ft. by 6 ft. by 6 ft. high and heating was effected by two oil-fired pressure burners. The apparatus could deal with 100 blankets or their equivalent in an hour and its weight was such that it was capable of transport on a 30-cwt. lorry. The trained personnel required to operate this disinfestor consisted of one N.C.O. and four men. One of these machines was

issued to each divisional mobile bath unit with a reserve of four held at the disposal of corps headquarters for distribution as circumstances might require. It was largely used for disinfestation at home and abroad until the advent of D.D.T. later in the war and improved methods in the treatment of scabies rendered its use no longer necessary.

A suggestion that a fumigant might replace the hot air in the Millbank hot-air disinfestor was investigated by the entomological Sub-committee of the Military Personnel Research Committee of the Medical Research Council. Various gases and liquids were tried out but without any conspicuous success.

Methyl bromide was investigated and appeared to be an excellent method of disinfestation as it required no heavy equipment, was simple and effective to use and the risk was negligible. It was found that its action depended on temperature, and disinfestation might take as long as two and a half hours, against twenty minutes with steam or hot air, and even then lice might still be alive although they died within twenty-four to forty-eight hours afterwards. As methyl bromide was scarce and was considerably used in fire-extinguishers for planes and tanks it was concluded that it was unlikely to be available for disinfestation.

In 1942, in view of reports of outbreaks of typhus on the Continent and forecasts that there was likely to be wide extension of the disease, it was decided, after consultation with the General Staff, to make provision in the planning arrangements for invasion, for the triplication of disinfectors and disinfestors with field hygiene sections and mobile bath units, and to provide each medical officer, with forward troops, with one small portable disinfector (D.F.P. No. 2). This decision was eventually put into effect.

During 1944, after it had been conclusively demonstrated in the Naples typhus outbreak that infestation and typhus could be controlled by dusting with D.D.T. in powder form, the decision was made to alter the whole policy with regard to the method of disinfestation in the field. It was appreciated that hot-air and steam apparatus had been rendered obsolete for disinfestation, although some steam disinfectors would still be required for dealing with other infectious diseases. It was then decided that the heavy disinfectors, carried by field hygiene sections, should be replaced by dusting apparatus. It was known that Ordnance held a stock of power-driven air-compressors, used for inflating motor tyres, which would be suitable, when fitted with the necessary trigger-operated dust-guns or liquid-spraying apparatus, for dispensing D.D.T. dust or spray. This apparatus easily fitted on a jeep trailer and would constitute an efficient mobile anti-insect unit. It was decided to withdraw from field hygiene sections the 3-ton lorry used for the transport of the D.F.P. No. 3, now no longer required, and replace this by two jeeps and trailers equipped with power sprayers. (21 Army Group, however,

preferred to give up the two-seater car and the 15-cwt. truck instead of the 3-ton lorry). Hand dust-guns were also issued on a scale of twenty-five to each field hygiene section. With this change, a field hygiene section had a disinfestation capacity of approximately 1,000 men per hour, and with its D.F.P. No. 2 a disinfection capacity of forty-five blankets or eight sets of clothing per hour. Mobile bath units were issued with eight hand dust-guns each to replace their hot-air disinfestors, which gave them the capacity to bathe and disinfest 240 men per hour.

Table 15 shows the revised scale of disinfecting and dusting apparatus with field units.

INSECTICIDES

During the entire period of the war there was the most intensive research into the development of synthetic insecticides, both in Great Britain and in the U.S.A. In the development of insecticides valuable advice and assistance were received from the Insecticide Development Panel, which consisted of eminent entomologists and chemists. The problems of the Services regarding the control or destruction of insects were submitted to this panel. In addition there was an Inter-departmental Co-ordinating Committee, which consisted of the representatives of the Services, India Office, Colonial Office, Ministries of Food, Health, Production and Supply, which met at monthly intervals, or oftener when necessary, to discuss various problems which had arisen and make decisions regarding policy. There was also the Entomological Sub-committee of the M.P.R.C. of the Medical Research Council, always ready to receive problems and to arrange for their investigation.*

Entomological field units were formed to carry out field trials of insecticides under development. One team in India carried out experiments with the impregnation of clothing with dimethyl phthalate and dibutyl phthalate as a protection against mites and mosquitoes. Another in North Africa tested the lousicidal value of dichloro-diphenyl-trichlorethane impregnated shirts.

The best of the insecticides in use before the war contained pyrethrum or derris, but the main sources of supply of these became unavailable during the course of the war and the need to find alternatives became urgent. Thousands of chemical compounds were screened by testing their efficiency against various insects in different ways until finally D.D.T. and later gammexane (the gamma isotope of benzene hexachloride), emerged. The discovery and application in practice of these multi-purpose insecticides constituted the most outstanding development in recent years in the field of preventive medicine.

Perhaps the most immediate problem after the outbreak of war was that of finding an effective lousicide. The normal provision for this

* *See* the Medicine and Pathology Volume, Chapter 17.

TABLE 15

Revised Scale of Disinfecting and Dusting Apparatus with Field Units

Unit	Equipment			Capacity	
	Steam disinfectors	Hand dust-guns	Mechanical dusting units	Disinfection	Disinfestation
Field hygiene or field sanitary sections	Field portable disinfectors No. 2	25	2	45 blankets or 8 sets of clothing and equipment per hour	1,000 men per hour
Field ambulances, C.C.S., Field dressing station	Field portable disinfectors No. 2	6	—	45 blankets or 8 sets of clothing and equipment per hour	180 men per hour
Hospitals— 200 beds, 600 beds, 1,200 beds	Field portable disinfectors No. 3	6	—	200 blankets or 8 sets of clothing and equipment per hour	180 men per hour
Mobile bath units	—	8 (2 per section)	—	—	240 men per hour + bath
Mobile laundry	Field portable disinfectors No. 3	—	—	50 shirts and sets of underclothing per hour	—
L. of C. areas	—	—	10	—	1,300 men per hour
Commands at home	—	—	For use at ports	—	200 men per hour

The above scales do not make allowances for reserves. Wastage of dust-guns and mechanical units is high.

purpose in 1939 was N.C.I. powder which had emerged during the War of 1914–18 and consisted of:

Crude naphthalene in powder	96 parts
Creosote	2 parts
Iodoform	2 parts

This powder was used for dusting on garments. It had an irritating effect on some men with sensitive skins and no effect on nits, as its potency lasted only for one week.

This was superseded early in the War of 1939–45 by A.L. 63 Mark I, which was developed by Messrs. Cooper, McDougall and Robertson Ltd., and was made up as follows:

Naphthalene	50 per cent.
High boiling tar acids	2 per cent.
Derris root (to give 1 per cent. rotenone and a minimum of 3 per cent. total derris extractives)	q.s.
Phosphoric acid (85 per cent. pure)	1 per cent.
China clay	to make 100 per cent.

The scale of issue was $\frac{3}{4}$ oz. per man per week.

Later, when supplies of derris became reduced, it was decided to substitute cubé extract for derris. Cubé is the name given in South America to a species of *Lonchocarpus*, the insecticidal properties of which depend on the content of rotenone and similar substances. The amended formula known as A.L. 63 Mark II had the following composition:

Naphthalene	10 per cent.
High boiling tar acid	2 per cent.
Phosphoric acid	1 per cent.
Cube extract in china clay (4 per cent.)	87 per cent. (variable depending upon the rotenone content)

A number of American synthetic insecticides with marked lousicidal properties were tested viz, lauryl thiocyanate, thanite, lethane 384 and lethane 384 special. These insecticides, of which lethane special was probably the best, were more persistent in their action than A.L. 63 Marks I and II, being effective for one month and destroying the louse and nit whereas A.L. 63 did not persist long enough to be effective against the larval louse after hatching from the nit. Experiments were made to find out how the persistent action of this chemical could best be exploited. Experimental work showed that the best method of application was to spray them on garments.

To obtain the benefit of the maximum period of effectivity, garments could only be washed monthly. The spraying required special apparatus and trained personnel to carry it out. Treated garments had a rather unpleasant odour and, when excessive doses were used, produced erythema in susceptible persons. It was expected that this effect would be aggravated in the Tropics. In the field, arrangements for re-spraying garments at mobile laundries were made. Another method of application that was tried was the use of belts impregnated with lethane 384 or lauryl thiocyanate. The belt was made of shelice belting which is material so woven as to be covered with folds making it very attractive to body louse. Although these belts proved efficacious they were never officially adopted for Army use, as they were found to cause erythema and acute discomfort to many white skins. This effect was not noted when they were used by native labour personnel. These insecticides had to be imported from the U.S.A. and, as the supply situation was always difficult, they were never generally adopted. Lethane was also tried out for the eradication of *Pediculosis capitis* among A.T.S. personnel.* After application it had to be left on the hair for ten days without washing and was not found to be altogether satisfactory. A method which included combing and cleansing, as well as the use of an insecticide, was preferred. The use of small quantities of A.L. 63 rubbed into the hair was found to destroy lice, after a very short period of contact, and to cause the nits to fall away from the hair so that they could easily be removed by combing. No segregation was necessary and the method was expeditious when large numbers had to be dealt with. Previously a powder consisting of cubé root and kaolin had been tried out at A.T.S. training centres. It was dusted on the hair with a pepper castor. Although effective in killing lice it made the hair sticky and difficult to comb and was unpopular.

Of the insecticides used for anti-mosquito work at the beginning of the war most reliance was placed on the use of (*a*) a non-residual spray containing liquid extract of pyrethrum 1 part, kerosene 63 parts, for indoor spraying against adult mosquitoes, (*b*) an anti-mosquito cream as a repellent and (*c*) Paris green and malariol for larvicidal work.

(*a*) The basis of non-residual spray was pyrethrum extract. The efficiency of the spray is directly dependent upon the amount of the active principles (pyrethrins I and II) which it contains so that extracts of pyrethrum required to be standardised according to their pyrethrin content. The British specification was that it should contain not less than 2 g. pyrethrins I and II per 100 c.c.

The standard British Army spray was 0·1 per cent. wt./vol. pyrethrins in kerosene and, in 1943, the U.S. Army standard spray was 0·18 per cent. wt./vol. pyrethrins in kerosene.

* *See* Chapter 8.

Many substances, including thanite, lethane 384, lethane 384 special, indalone 930, and sesame oil were examined for their adjuvant action in sprays depending on pyrethrins alone for insecticidal effect against both flies and mosquitoes. With the exception of sesame oil, all these substances proved to be rather disappointing for this purpose either because of their varying effectiveness under different conditions, their unpleasant odour or their non-availability. Non-residual spray was dispensed by hand sprayers, pressure type sprayers or power sprayers.

It was found that a concentrated insecticide dispersed in the form of a fine mist was the most effective method of using anti-adult mosquito spray. The mist was produced either by an aerosol bomb in which freon was used as the propellent, or by an individual insecticide sprayer (sparklets) in which CO_2 was the propellent. The original insecticide mixture in the bulbs was:

Pyrethrum extract (20 per cent w/v, pyrethrins I and II)	1·0 per cent.
Sesame oil	5·0 per cent.
Acetone	50·0 per cent.
Kerosene	44·0 per cent.
Carbon dioxide	q.s.

(*b*) Continuous efforts were made to produce more effective repellents for smearing on exposed skin surfaces, which would give longer protection from mosquito bites and would not be unpopular with the troops. The Entomological Committee of the M.R.C. carried out a lot of experimental work, and field trials were arranged in West Africa. The earlier repellents were greasy preparations. The official anti-mosquito cream issued early in the war consisted of the essential oils cassia and citronella in a base of soft paraffin. Dover's cream was a modification of this preparation. Later the War Office specification was changed to:

Oil of citronella	18·25 per cent.
Camphor	1·0 per cent.
Cedar wood oil	9·0 per cent.
Paraffin durum	26·75 per cent.
Paraffin molle white	45·00 per cent.

Early in 1942 it was decided on the advice of the London School of Hygiene and Tropical Medicine, to delete cedar wood oil and camphor from the formula which was then changed as follows, and this became the standard Army cream:

Oleum citronella	28·25 per cent.
Paraffin durum	26·75 per cent.
Paraffin molle	45·00 per cent.

The question of replacing ol. citronella by pyrethrum extract and the base by a vanishing cream was also considered and investigated.

Later, work in the Middle East showed the advantage of having a non-greasy preparation of the vanishing cream type, whatever repellent was used. For this purpose a stearine base was adopted and it was claimed that a pyrethrum–sesame–stearine cream afforded protection for a longer period—up to eight hours. Middle East Mark II cream had the following formula :

Stearic acid	16 per cent.
Mineral oil (P 40)	4 per cent.
Oil of sesame	2 per cent.
Aq. solution of ammonia	0·55 per cent.
Pyrethrum extract (X100)	4 per cent.
Water	74 per cent.

(P 40 was a mineral oil of the liquid paraffin type (Shell). It replaced glycerine which was scarce. Pyrethrum extract (X100) was a local designation for a concentrated pyrethrum extract containing 10 per cent. pyrethrins, so that the final cream product contained 0·4 per cent.).

This cream was used by Eighth Army in the Middle East in 1943 and a factory was set up for its production with an output of 80 tons a month. A double-ended container was used to hold anti-mosquito cream and mepacrine.

It was found that when this cream was used it was important that it should be rubbed in for at least three to five minutes so that the pyrethrins were equally distributed and introduced well into the skin.

The formula used in India consisted of oil of citronella and pyrethrum extract (0·3 per cent. pyrethrins) in a stearic acid base.

The discovery of the insect repellent properties of D.M.P. was of outstanding importance. This repellent, a clear colourless non-greasy liquid with a period of effectiveness of two to five hours, claimed several advantages. It was found to be more pleasant in use than the cream or ointment types as it was non-greasy and odourless, spread rapidly and was therefore easier to apply. Its disadvantages were that repeated application on a sunburnt or chafed skin caused irritation and that it was an irritant to the eyes if some inadvertently got in during application or subsequently by sweating. Being inflammable it was used by the troops for the lighting of fires. Its manufacture was commenced in the United Kingdom but it remained necessary to import large quantities from the U.S.A. When supplies became available during 1944, D.M.P. rapidly superseded the citronella oil preparations previously used. It was issued in 2-oz. glass bottles or tins on a scale of 1¾ oz. per man per week, or 40 gallons per 1,000 men per month.

Of the many substances tested in the United States, two other outstanding effective insecticides emerged—indalone and Rutgers 612. It was claimed that a mixture of D.M.P., indalone and Rutgers 612, in the proportions 6:2:2 respectively, overcame the disadvantage of specificity attendant on the use of any one singly. Experiments were made in the United Kingdom and in the U.S.A. to obtain a preparation of D.M.P. in solid or semi-solid form, in order to overcome the difficulty of packaging and wastage in handling a liquid preparation in the field. These experiments were attended by a certain amount of success and it was claimed that the preparation in the form of a cream gave a longer period of protection, but in general it appeared that a liquid non-greasy preparation was preferred by the troops. The use of D.M.P. in the field was extended to the impregnation of wide mesh nets, veils, sleeves and socks issued to troops in advanced positions in malarious areas. These veils etc. were carried in a special wallet and were impregnated with D.M.P. weekly or oftener if required. The wearing of these impregnated veils etc. gave a high degree of protection against mosquito bites and the protection appeared to be enhanced when the nets were in contact with the skin.

(*c*) The mosquito larvicides provided on the outbreak of war were Paris green and Malariol, which had been well tested and were known to be efficient. There were few developments of importance in this field during the war until the discovery of D.D.T. Cuprous cyanide (140) was given field tests with satisfactory results. This compound, like Paris green is applied as a dust or as a suspension and is also an intestinal poison. Its chief advantage was that it was found to be effective against anopheline larvae at a dosage of 2 oz. per acre as against Paris green which requires a dosage of 1 lb. per acre. It does not possess a selective action against anopheline larvae like Paris green, but also destroyed cubicine larvae when the dosage was increased to 16 oz. per acre.

During operations against the Japanese in the Far East and during the training of troops in Ceylon and India for jungle warfare, the incidence of scrub typhus made it imperative to find an effective repellent against *Trombiculid* mites. It was reported from work carried out by the Americans that D.M.P. and D.B.P. were both effective mite repellents. Most of the work done within the Empire on the control of the scrub typhus carrying mite Trombicula, was carried out in Australia and as a result of this research D.B.P. was officially adopted. D.B.P. is a colourless fluid. It kills larval mites but rather less rapidly than D.M.P., which paralyses them in two minutes whereas six minutes are required for D.B.P. Clothing impregnated with D.B.P. remains effective after being washed eight times in cool soapy water, whereas with D.M.P. bites were recorded after three weeks. The action of both these substances is therefore miticidal rather than repellent. D.B.P. was applied to socks,

shirts, trouser bottoms etc. and not to the skin. The best method of application was found to be that of rubbing the fluid into the cloth by hand; one fluid ounce being used for one set of clothes and the process being repeated fortnightly. The Americans preferred D.M.P. for this purpose because of its quicker action and because its use obviated the necessity for two repellents.

Early in the war benzyl benzoate was found to be an effective acaricide and was adopted as the method for treating scabies. It was used in the form of a 20 per cent. emulsion painted on the affected individual from the neck to the toes. This was repeated again and on the third day the patient had a cleansing bath. This method dispensed with the necessity for disinfecting the clothing of the affected individual.

Although many very valuable insecticides were discovered and used during the war, far and away the most revolutionary discovery was that of D.D.T., which was found to possess unusual insecticidal properties. Because of its effectiveness against the principal insects of medical importance, it was subjected to the most intensive programme of research in many parts of the world, both to explore its possibilities and to find out the best methods for its application. Its manufacture on a large scale also presented many problems which had to be overcome.

Dichloro-diphenyl-trichlorethane (*D.D.T.*) was first synthesised by Zeidler, a German chemist, in 1874. No use was found for it until 1936–7, when J. R. Geigy A.G. of Basle demonstrated its insecticidal powers while searching for a moth-proofing substance. This firm found it to be effective against bugs and later gave it a successful field test in the control of a plague of Colorado beetle which had seriously threatened the Swiss potato crop. D.D.T. first came to the notice of the British Government in 1942 when pyrethrum and derris were no longer available in sufficient quantities owing to the entry of Japan into the war. The urgency was so great and the preliminary reports on the value of this insecticide so enthusiastic, that facilities for its large-scale production were put in hand at once without waiting for the research programme to be completed.

D.D.T. is a fine white crystalline substance which is remarkably stable. It is insoluble in water but readily soluble in most oils and other organic solvents. Commercial D.D.T. is not pure, containing a percentage of relatively inactive isomers and a pure D.D.T. content of 60–70 per cent. It acts as a contact and stomach poison to most forms of insect life. The effect is not immediate but appears at a variable time after contact with the insecticide, depending upon such factors as dosage, period of contact and the genus of the insect. D.D.T. is practically non-toxic to man in the preparations and circumstances in which it is normally used, but contamination of food with dust or sprays must be carefully avoided and precautions are necessary for personnel dispensing

oily solutions. The residual action of D.D.T. is one of its most useful properties.

D.D.T. was used in the following preparations:

Anti-louse Powder. A.L. 63 Mark III, a dusting powder containing 5 per cent. D.D.T. in china clay, superseded the Mark I and II anti-louse powders. A.L. 63 Mark IV contained 10 per cent. D.D.T. in china clay and later became the official issue.

Non-residual Spray. This consisted of not less than 0·5 per cent. pyrethrins I and II, 0·3 per cent. D.D.T. and 5 per cent. oil of sesame dissolved in a soluble grade of kerosene.

Residual Spray. A 5 per cent. solution of D.D.T. dissolved in a suitable grade of kerosene was generally used. Its efficiency depends on the fact that surfaces sprayed with it remain lethal to insects alighting on them for a considerable period. The solvent evaporates leaving a residual film of fine D.D.T. crystals on the treated surface. This solution was made up in the field from the raw materials.

Emulsion Concentrates. The production of a concentrate containing a high percentage (50 per cent.) of D.D.T. which would form a stable emulsion when diluted with water in the field was investigated. Several were produced with a D.D.T. content of 20–40 per cent. Such concentrations obviated the necessity for transporting large quantities of kerosene, or other solvents. Emulsions proved to be as effective as oil solutions.

Aerosol Sprays. D.D.T. was incorporated in the contents of the aerosol bomb and the individual insecticide dispenser; 0·5 per cent. D.D.T. was added to the formula already given, which included 1·0 per cent. extract of pyrethrum for quick knock-down effect.

Smokes. D.D.T.-containing smokes were tried with varying success but were not generally adopted.

The following apparatus was used for dispersing D.D.T.

For D.D.T. dusts, the hand dust-gun ('Dobbin' Pattern and Hudson Admiral) was found to be efficient for dusting clothing with A.L. 63 powder and the power operated dust-gun was used for mass disinfestation.

For dispensing solutions, the standard equipment used included hand sprayers, small (of the Flit gun type) and large (of the Four Oaks, Mannay, Ross and Mish types), pressure sprayers (Kent type) and for treating large surfaces a spray-gun operated by a power driven air compressor. Experience showed that the nozzle aperture for D.D.T. spraying should have a $\frac{1}{32}$ in. bore. Although aircraft spraying had great possibilities, it was beset with technical difficulties, which were the subject of investigation. Dusts were found to be unsuitable for this purpose owing to their tendency to lump.

Mosquito-control by D.D.T. Adult mosquitoes were found to be particularly susceptible to the effect of indoor residual spraying and these

effects were enhanced when combined with routine spraying of non-residual spray or an aerosol. The results were soon apparent, and lasted for at least two months. For the destruction of adult mosquitoes outdoors, 'area' and 'barrier' ground spraying were carried out with varying results. As a larvicide, a 5 per cent. oil solution used with a coverage of one quart per acre dispersed as a film on the water surface was found to kill all mosquito larvae within a period of from thirty minutes to twenty-four hours. Used as a larvicide in dust form D.D.T. was not found to be so effective as oil emulsions and had no advantage over Paris green or cuprous cyanide.

Fly Control. Before D.D.T. became available the official fly spray was a solution of extract of pyrethrum in kerosene (1 in 64). D.D.T. was found to be an insecticide of unprecedented value against adult flies, used in the form of selective residual spraying and hand-painting of surfaces on which flies congregated in kitchens, latrines etc. coupled with the treatment of breeding places. Neither eggs nor pupae were affected and larvae only to an insignificant extent.

Louse Control. Lice proved to be highly susceptible to D.D.T. which was found to be of immeasurable value in preventing louse infestation. Eggs (nits) were unaffected but since it is a persistent insecticide the larval lice were killed when they hatched. The presence of D.D.T. on clothing prevented infestation, which was of the greatest importance when dealing with large numbers of infested individuals. The introduction of D.D.T. completely changed the policy of louse disinfestation in the Army. A dosage of 2 oz. of A.L.63 Mark IV was generally considered necessary for each individual for the complete dusting of all his clothing. It was applied by hand sprinkler or hand dust-gun or, when large numbers are being dealt with, by a power operated dust-gun. Specially trained dusting teams were employed for large-scale dusting operations. It was decided that when troops had to operate in areas in which typhus was likely to occur, the best method of protecting personnel with restricted hygiene facilities against acquiring louse infestation, was the issue to each man of one garment, preferably the shirt, impregnated with D.D.T. in a strength of 1 per cent. by weight of the garment. The shirt was selected for impregnation, as the type of underclothing worn by the troops varied considerably, These shirts (termed shirts A/T) withstood two washings by laundry processes without the loss of insecticidal efficiency. Arrangements were made for their impregnation in the field at mobile laundries. Shirts A/T were eventually issued to troops of 21 Army Group before the invasion, on the scale of two shirts per man. The shirts had no odour and no harmful effect on the skin. Preparations containing D.D.T. were found to be equally effective in the treatment of cases of infestation with head, body and crab lice.

Other Insects. It was found that the use of D.D.T. as a 5 per cent. residual spray was most effective in the eradication of sand flies, bed bugs and fleas, all of which are very susceptible to it.

Another important insecticide developed during the war was gammexane or benzine hexachloride (666). It was first produced by Imperial Chemical Industries and its insecticidal properties were discovered by the research workers of that firm in 1942. It is a mixture of four isomers of benzine hexachloride of which the gamma isomer possesses infinitely the greatest insecticidal activity. Gammexane was not used by the Army to the same extent as was D.D.T. for the reasons that the latter was first in the field, was satisfactory and was being produced and used in exceedingly large quantities. Replacement would have caused much disruption.

ACCOMMODATION

Before the war the scale provided in barrack accommodation in the United Kingdom was 60 sq. ft. per man. This enabled beds to be three feet apart and avoided overcrowding. The provision of 600 cu. ft. of air space was important from the point of view of adequate ventilation and perhaps the prevention of aerial infection.

With the enormous expansion of the Army which took place on the outbreak of war, it was found that the accommodation then in existence was completely inadequate. A programme of camp construction was commenced immediately and was supplemented by the requisitioning of houses and buildings of all kinds on a very big scale.

The 60 sq. ft. scale was immediately reduced to 45 sq. ft. which resulted in beds being only 2 ft. apart, and caused much concern owing to the increased risk of outbreaks of the droplet infections, more particularly cerebro-spinal fever and influenza. It was necessary to enforce head-to-toe sleeping. The adequacy of ventilation under these conditions was rendered more difficult and this was immensely aggravated by the necessity for maintaining a blackout at night. All windows had to be provided with blackout shutters to comply with Passive Air Defence (P.A.D.) Regulations, and the problem was so to modify these shutters that when in use ventilation was adequate. In barrack rooms they were removed after lights out whenever possible and various devices were employed for ventilation while in use. In some areas sisal kraft screens were used while others used three-ply shutters converted to include a Hinckes-Bird ventilator or made with a light-obscured gap, or provided with a modified Tobin's tube, but eventually Colt blackout ventilators which were easy to incorporate in the shutter, were widely used.

In many places serious overcrowding undoubtedly occurred but fortunately it was usually of a temporary nature due to the sudden

arrival of drafts etc.; nevertheless much vigilance was required to ensure that it did not become permanently accepted.

To relieve pressure on space the question of double-bunking was examined and, from the medical point of view, it was accepted as safer than having beds closer than 3 ft. provided certain standards were complied with. These standards were varied from time to time to meet certain exigencies.

At first the double bunks were constructed in groups of eight and placed in the middle of rooms with 7 ft. between the nearest sides of groups. It was prescribed that the distance between the upper and lower bunks should be 3 ft. 4 in., the lower bunk about 1 ft. 6 in. from the floor so that a box could be placed under it; adjacent bunks should be provided with a partition 2 ft. 6 in. high; a rail should be available on the outer side of upper bunks; and bunks should be used so that heads would be centrifugal. The minimum air space permitted in double-bunked accommodation was 345 cu. ft. per head and double bunking was prohibited in rooms which were less than 10 ft. in height.

Later the grouping was not insisted on and in certain instances such as Nissen and Ministry of Works Pattern (M.O.W.P.) hutting, where it was possible to lay down definite conditions regarding ventilation, the minimum height of 10 ft. was also relaxed. Double bunks were at first constructed of timber but when this became scarce tubular steel was used. The ends were plugged to prevent infestation by bugs. In A.T.S. accommodation the top bunks were provided with a guard rail and short ladders were made available.

In May 1942 the exigencies of the situation made a further reduction in the scale of accommodation necessary from 45 sq. ft. to 30 sq. ft. per man, whether double bunks were used or not. Double bunking in these circumstances made it possible to achieve a better use of floor space but did not enable greater numbers to be accommodated. The new scale implied not less than 300 cu. ft. per head. This reduction was not applied to A.T.S. accommodation. When these standards were applied to requisitioned accommodation, hygiene officers were empowered to direct that the scale of 30 sq. ft. per man was not to be applied if the accommodation was considered to be unsuitable on account of low ceiling height, absence of cross-ventilation etc. The scale of ancillary provision was also reduced to obviate or minimise any consequential increase in latrine and ablution requirements on account of the increased numbers accommodated.

It was fortunate that a very large number of well designed militia camps had been constructed before the outbreak of war. Many of these consisted of 'spider huts' in which the sleeping accommodation was connected with a central hut in each group which contained baths, ablutions and latrine facilities.

The hutted camps constructed after the outbreak of war were of the types included in the following table which gives details of size and accommodation:

TABLE 16

Types of Hutting

Hut	Size	Sleeping accommodation for				Remarks
		Men		A.T.S.		
Type		No.	Type of bunk	No.	Type of bunk	
Nissen	36 ft. × 18 ft.	18	6 single and 6 double	12	Single or double	2 sq. ft. louvred ventilators in gable ends and 2 ventilator cowls to be provided (one of which could be the flue)
M.O.W.P. curved asbestos	36 ft. × 18 ft.	17	Single only	12	Single only	
M.O.W.P. Standard	59 ft. 8 in. × 18 ft. 6 in.	28	Single or double	24	Single or double	
M.O.W.P. Hall type (plaster board)	61ft. 7 in. × 18 ft. 6 in.	28	Single or double	24	Single or double	
M.O.W.P. B.C.F.	61 ft. 2 in. × 18 ft. 6 in.	28	Single only	24	Single only	B.C.F. (British Concrete Fabrications)
Tarran	61 ft. × 18 ft. 6 in.	28	Single or double	24	Single or double	
Tarran	37 ft. × 16 ft.	18	Single or double	12	Single or double	
Maycrete	55 ft. × 15 ft. 6 in.	26	Single or double	18	Single or double	
Maycrete	36 ft. × 15 ft. 6 in.	18	Single or double	12	Single or double	

The M.O.W.P. standard hut was provided with two sets of louvred gable ventilators at each end of the hut (measuring 16 in. by 26 in.). There was considerable pressure to increase the number of occupants from twenty-eight to thirty-six. Finally, after the ventilation of these huts had been examined by a member of the staff of the London School of Hygiene and Tropical Medicine, who carried out experiments in one of them, it was agreed that the numbers could be increased to

thirty-six using double bunks, providing the following alterations were made which, it was estimated, would provide 700 cu. ft. of fresh air per man per hour:

(*a*) Standard stoves to be placed 16 in. from side wall and 18 ft. from the corner facing the entrance.

(*b*) Fresh-air inlets with a gross area of 12 in. by 27 in. each to be built into the wall at floor level behind the stoves, with side walls connecting to the stove, forming a duct open at the top.

(*c*) Where blackout screens could be removed during the summer months and windows opened the gable ventilators normally provided would suffice. If blackout screens could not be removed the large four-piece gable ventilator (giving 5 sq. ft. ventilation area in each gable) would be necessary. These ventilators were provided with a movable shutter for closing one half during cold windy nights.

No increase in the numbers accommodated in this type of hut was permitted until these alterations had been completed.

Owing to the shortage of accommodation it was necessary for a large proportion of troops to be under canvas. During the construction of new camps troops were often accommodated under canvas in the vicinity so that the hutted ancillaries, which were constructed first, could be utilised.

One of the problems with tented camps was how best to comply with the P.A.D. Regulations regarding blackout. One suggestion was the erection of three bell tents inside a store tent, which was not altogether satisfactory.

During the summer months tented accommodation proved to be satisfactory but it became necessary to use this type of accommodation also during the winter. This was agreed to subject to the following conditions:

(*a*) Double fly-marquees or double tentage to be provided, i.e. G.S. or other types inside store or hospital marquees or similar tentage.

(*b*) Heating and lighting to be provided.

(*c*) Extra blankets to be provided as and when required.

(*d*) Proper flooring to be provided.

BATHING, ABLUTION AND LAUNDRY

MOBILE LAUNDRY AND BATH UNITS

During the War of 1914–18 there was no unit specially designed to provide bathing or laundering facilities for forward troops and the need for such a provision was very keenly felt on account of the amount of louse infestation which existed among the troops and the high incidence of trench fever and other 'dirt' diseases which raised the problem

in an acute form. Divisional baths had to be organised by field medical units during rest periods and, although much useful work was carried out in this way, the arrangement could only be regarded as an improvisation to meet an emergency.

In the inter-war period, at the instance of the Army Medical Directorate, it was definitely established that the medical services would not be called upon in future to be responsible for bathing healthy troops. This was to become the responsibility of another service—probably R.A.O.C., who viewed the suggestion without enthusiasm.

After the outbreak of the War of 1939–45 the need for the immediate provision of bath units was recognised and steps were taken by Ordnance to devise and arrange for the production of suitable bathing equipment and in this connexion there was close liaison with A.M.D.5.

Mobile bath units (M.B.U.) were formed on a scale of one for a division, corps troops, army troops and L. of C. sub-area. Initially the personnel were found by various combatant units but they were subsequently transferred to the Pioneer Corps. They were trained in the technique of bathing and disinfestation at the Army School of Hygiene during the formation of the units.

The M.B.U. could operate as a unit or could be divided into four sections of equal capacity which could operate independently. The equipment which included four bathing sets and one hot-air disinfestor (H.A.D.), was transported on lorries. Each set of bathing equipment comprised:

(*a*) A hot water boiler, an oil burner, semi-rotary pump, couplings and fittings.

(*b*) Shower trestles each with 5 or 6 showers, pipe work fittings and soap containers.

(*c*) Rubber coupling hoses and fittings.

Each set had incorporated in it an ingenious thermostatically controlled mixer which regulated the temperature of the water leaving the sprays. The unit was provided with tentage for housing the showers and for use as undressing and dressing rooms when buildings were not available.

The M.B.U. had the capacity to bathe 12,000 to 18,000 men each week. Allowing each man five minutes for a shower each section was capable of dealing with 60–70 men per hour according to the number of showers. The hot air disinfestor normally provided for each M.B.U. had an output equivalent to 100 blankets in each maximum treatment cycle of thirty minutes' disinfestation at a temperature of 70° C.

As the work performed by these units was of considerable interest to hygiene officers, the latter assisted them in every possible way and were always consulted as to where M.B.Us. should be located. It was

found to be convenient to site them adjacent to field hygiene sections, so that the latter could help them with their administration. This raised the question of their amalgamation with field hygiene sections, but as this was contrary to War Office policy it was never seriously entertained.

The first M.B.Us. mobilised were despatched to formations of the B.E.F. where they carried out some very useful work and gained much valuable experience in operating under field conditions.

The first R.A.O.C. mobile laundry units were devised while the B.E.F. was still in France but no experience in the working of these units was obtained from operations in that theatre.

After the evacuation from Dunkirk it was decided to transfer responsibility for B.M.Us., from the Pioneer Corps to the R.A.O.C. and this decision led to the obvious step of amalgamating mobile laundries and mobile bath units into one combined unit—the mobile laundry and bath unit R.A.O.C. (M.L.B.U.).

The Army Medical Directorate agreed to the amalgamation of the M.B.U. and the M.L. subject to three provisos:

(*a*) The importance of maintaining the mobility of the former unit was stressed in order that it might continue to serve forward troops.

(*b*) Disinfestation must have medical control and the apparatus for it must be available when required.

(*c*) If typhus was present medical control must be complete. There was the gravest danger to personnel handling contaminated clothing and infested personnel. Should this disease become prevalent it would be most necessary for the medical authorities to establish cleansing centres where the soldier or civilian could be shaved, bathed and disinfested and where clothing could also be treated.

Mobile laundry and bath units were provided on a scale of one per division, corps troops, army troops, and L. of C. sub-area. A number of independent M.B.Us., however, were retained to meet the requirements for this type of unit in certain circumstances.

The M.L.B.U. consisted essentially of a laundry section and a bath section. Initially the equipment of the bath section remained practically the same as that used by the original M.B.Us., except for the proposal for triplication of the hot air disinfestor in typhus areas, for the transport of which one extra lorry was provided. The equipment of the laundry section, however, was modified from time to time as a result of experience in operations or to meet particular conditions such as jungle warfare.

The M.L.B.U. (Type A) was a multi-trailer self-contained unit with two sections—a laundry and decontamination section and a bath section.

The laundry and decontamination section was devised for the washing of the troops clothing or for the decontamination of their clothing and equipment. It was capable of:

(*a*) washing the shirts, vests, pants, socks and towels for 18,000 soldiers in one week;

(*b*) decontaminating in one working day the protective clothing, personal clothing and equipment of the estimated daily casualties of 18,000 soldiers on a basis of 12 lb. of clothing for each casualty.

The laundry and decontamination section could operate as a complete section or as two separate sub-sections of equal capacity.

The bath section could operate as one section or could be divided into four sub-sections of equal capacity.

The equipment of the laundry and decontamination section was carried on ten trailers and included the following:

Rotary washing machine
Hydro-extractor
Soap boiler
Drying tumblers (for cotton articles)
Continuous drying machine (for woollen articles)
Steam boiler

The Mark I equipment had a capacity for dealing with 400 lb. dry weight of clothing per hour and the Mark II equipment with 600 lb.

The laundry equipment of the latter M.L.B.U. (Type B) comprised four single trailer laundries (Type C.C.S. Marks II and III). Each laundry was completely self contained and included the following:

Trailer 4-wheeled 5-ton laundry
Washing machine
Hydro-extractor
Drying tumbler
Drying cabinet.

Each laundry trailer was capable of processing 90 lb. dry weight of clothing per hour. It could deal with the underclothing for 12,000 men per week or decontaminate the clothing and equipment of the estimated daily casualties of 12,000 on the basis of 12 lb. of clothing for each casualty.

The M.L.B.U. (Type B) was normally provided for divisions and the M.L.B.U. (Type A) was retained for operation in the corps troops and army troops area.

In planning for operations in the Far East it was considered that the weight and size of the single trailer type equipment, with which the divisional M.L.B.U. (Type B) was equipped, ruled that unit out as a practical proposition for jungle warfare in forward areas.

Accordingly a new type of M.L.B.U. was designed equipped with light weight laundry and bathing equipment which was air-portable and capable of being towed on a 10-cwt. trailer behind a jeep. This new unit therefore took the place of the M.L.B.U. (Type B) provided for divisions.

With the introduction of D.D.T., a modification was made to the scale of disinfestors held by units in the field. Hot air disinfestation was abandoned and was replaced by apparatus for dispensing D.D.T. Steam disinfectors were reserved for dealing with the clothing and effects of actual cases of typhus and other infectious diseases. Consequently in M.L.B.Us., the hot air disinfestor was withdrawn from the bath section and was substituted by eight hand dust-guns which gave a disinfestation capacity of 240 men per hour. The laundry section was provided with a field portable disinfector No. 3 which had a disinfection capacity of fifty shirts and sets of underclothing per hour.

Mobile laundries and bath units were of immeasurable value in preventing infestation of the troops in theatres of operations. They were employed in forward areas to provide hot baths for the troops, to give them a clean change of underclothing and to launder the soiled clothing handed in. One M.L.B.U. was capable of providing clean clothing and a bath for every man in the division once a week. In general they operated very efficiently except in areas where there was a shortage of water. Very often they worked double shifts in order to meet the heavy demands made upon them. They were very popular with the troops and made a great contribution to morale as well as to hygiene. In Italy, by liaison with the A.K.S. and N.A.A.F.I., it was frequently arranged to site a mobile canteen and a cinema alongside the M.L.B.U. thus combining welfare and entertainment with the relaxation of a hot bath and clean change of underclothing. Sometimes an efficient repair service was organised in connexion with these units by employing local women as was done in Italy. It was found that these early repairs to clothing and bedding greatly reduced demands on the base and resulted in great economy of both stores and transport.

M.L.B.Us. carried out the re-impregnation of shirts A/T (anti-typhus) in the overseas theatres where these shirts were issued to the troops. For this purpose an emulsion concentrate containing D.D.T. known as A.T.S.O. (anti-typhus soluble oil) Mk. II was used by adding to the rinsing water at the rate of 1 pint to every 40 lb. dry weight of shirts. The shirts, after treatment, contained at least 0·5 per cent. of their dry weight of D.D.T.

The activities of these units in the Middle East were restricted because of the shortage of water in many places where the troops had to operate, in the Western Desert, for example. It therefore became necessary to form base laundries in areas where water was plentiful and the few

M.L.B.Us. which Middle East possessed were employed in the Delta or in Syria/Palestine to augment base laundries.

In North Africa although the operation of the mobile laundries was greatly hampered by scarcity of water they nevertheless performed excellent work.

In the early stages of some campaigns the laundry sections of these units concentrated on providing clean linen and clothing for hospitals until relieved by base hospital laundries.

C.C.Ss. were equipped with a mobile laundry similar to the single trailer type equipment used in the Type B units.

It is of interest to note that in Gibraltar, when preparations were being made for siege conditions, a special laundry known as the 'Rock' laundry was constructed which had several special features. To conserve drinking water it was specially designed so as to use sea water which made it independent of the drinking water supply. For washing purposes it used sea water treated with a special compound to enable a lather to be obtained and it included a distillation plant to provide sufficient fresh water for rinsing.

Civilian Mobile Cleansing Plants. During the war several local authorities became interested in the equipment of the Army's mobile bath units. Among the equipment used by them were:

(*a*) Clarkson mobile cleansing plants which were in all essentials similar to the equipment supplied to M.B.Us.

(*b*) The S–J portable bath set which was on similar lines to the transportable shower bath described in the *Army Manual of Hygiene and Sanitation.*

UNIT SHOWER BATHS

(*a*) *Portable Bathing Apparatus.* A portable bathing apparatus on similar lines, but on a much smaller scale to that used by mobile bath units, was designed for issue to field force units late in 1945. Efforts were made to make this apparatus as light as possible and it was intended for issue to major units. A.M.D.5 had asked for this policy to be reviewed, as many small units were in need of this or similar equipment, but the end of the war brought work on this particular equipment to an end.

(*b*) *Improvised Showers.* Much ingenuity was used in devising improvised showers and this received the usual impetus during the war. The showers improvised varied from the simplest design to more elaborate types.

(i) The simplest form of shower bath was made by perforating the bottom of a drum, but this was found to have the practical disadvantages that it was essential to have some method of turning the shower 'off' and 'on' to allow the bather time to lather himself, and it did not permit

the man time to fill up and fix his shower before undressing. The following simple method was used to overcome these difficulties:

A five-gallon oil drum was made to pivot on a support by passing a firebar through the drum about one inch above the centre of gravity. Perforations in the side of the drum near the top end formed the spray. Strips of camouflage tape were tacked on to the supports to act as a stop and prevent the drum from passing beyond the horizontal when operated by tilting it on to its side by means of a length of wire.

The 5-gallon drum held 3½ gallons of water up to the pivot and gave a strong shower for three minutes, running continuously. It could be turned 'on' and 'off' at will and was fixed in position before the bather undressed. The hot water was drawn from Soyer stoves, or other improvised water heaters, in the drum which was lifted into position and was then ready for use. These showers could be set up in rows as required.

(ii) A more elaborate type of portable shower disinfestor unit was described in the *Journal of the R.A.M.C.* This apparatus was designed to meet the requirements of the smaller type of unit where only a cold water piped supply was laid on, but it could also be used where no piped water supply existed, but where there were streams or wells, using buckets or stirrup pumps. This improvised apparatus, when erected as a shower bath, consisted essentially of a collapsible wooden trestle to support two tanks —the main tank 3 ft. 8 in. from the ground and a cold water tank 7 ft 4 in. from the ground. The main tank was improvised from a 40-gallon tar drum which was fitted with a sheet iron screw-down lid and the cold water tank was made from a 10-gallon oil drum. Just raised off the ground was a boiler heated by a Hydra burner. The necessary connexions were made by water piping. Four showers were provided from a shower pipe 6½ ft. from the ground leading from the main tank and supported by a bracket of wood at the other end. The showers were controlled by a tap.

When the shower was erected it took roughly fifty minutes for the main tank to be full of hot water. It was found that this apparatus could provide fifty men with five minutes' continuous hot water each in an hour. The cold water supply to the upper tank was kept continuously turned on to give the necessary pressure and could be adjusted to keep the showers at a hot even temperature.

The apparatus was designed so that it could be converted into a Serbian barrel disinfestor. For this purpose the shower unit was disconnected and the 40-gallon drum was placed on bricks and the pipe connexions adjusted so that steam from the boiler was conducted to the top of the barrel. The cold water pipe attached to the boiler was left for the dual purpose of acting as a safety valve and for refilling the boiler when empty. The top of the barrel was unscrewed for packing

with clothing to be disinfested. The lid was replaced and screwed down and the Hydra burner lit. The time taken to disinfest 16 blankets was twenty-five minutes from the time of lighting the burner.

Using only the boiler, hot water could be produced in five or ten minutes for use in cookhouses and ablutions. If a slow steady stream of cold water was added a constant flow of hot water was available. As soon as cold water was added to the boiler, hot water came out.

The apparatus could be dismantled and the various parts packed inside the main tank for moving. All that there was to be carried was one barrel and the collapsible wooden supports. It was possible for the supports to be made of lengths of jointed piping which could be unscrewed and which would then allow all the components to be packed inside the main tank, thus making the unit portable in one barrel.

(iii) One of the home commands tried out with some success copper-coil shower baths which operated on the geyser principle and were portable.

THE SOAP PROBLEM

The hygiene problems in connexion with soap stemmed from the fact that this essential commodity was strictly rationed. Medical requirements were that the ration should be adequate without permitting waste and that special provision should be made for personnel employed in the dirtier occupations when the basic ration was inadequate for this purpose.

Soap other than shaving soap became a rationed commodity in the United Kingdom with effect from February 9, 1942. The rationing scheme was implemented by issuing a weekly coupon to personnel which entitled the holder to purchase the following through N.A.A.F.I. or any retailer:

4 oz. of hard soap
or
3 oz. of toilet soap
or
3 oz. of soap flakes
or
6 oz. of soap powder (No. 1)
or
12 oz. of soap powder (No. 2)
or
6 oz. of soft soap.

A war scale of soap for issue to personnel was included in the A.F.G1098 of all field force units and the rationing scheme did not entail any alteration to that scale beyond that which could be achieved by economical supervision.

The personal ration of soap for military personnel was reduced by 50 per cent. with effect from July 26, 1942 owing to the necessity for rigid economy in the consumption of soaps and soap powders. This was implemented by restricting the issue of coupons to personnel to one coupon every two weeks instead of weekly as before. Officers commanding units were, however, permitted to draw up to one additional coupon for every four weeks for each officer and man on the W.E. of the unit. These additional coupons were treated as a pool to be issued at the discretion of officers commanding during the ensuing four-weekly ration period, to personnel actively employed on certain types of work duties, for whom it could be established that the basic ration of two coupons for each four-weekly period was inadequate. The duties specified for the issue of supplementary coupons included:

1. Pioneer Corps personnel employed on smoke producing duties.
2. Ammunition examiners.
3. Armament artificers.
4. Boiler-men.
5. Blacksmiths and hammermen.
6. Coppersmiths and welders.
7. Constructional work personnel.
8. Fitters and turners.
9. Motor mechanics, drivers I.C., driver-mechanics.
10. Petrol issuers.
11. Personnel of bomb disposal units.
12. Sanitary orderlies.

The additional coupons issued to personnel were strictly controlled and soap purchased with supplementary coupons was at the expense of the individuals concerned.

Patients in military hospitals received a free issue of 3 oz. of toilet soap every two weeks but this was later reduced to 3 oz. every four weeks to comply with the national rationing scheme applied to patients in E.M.S. hospitals.

It was emphasised that these scales of issue were a maximum and that in cases where the full scale was not essential only those quantities actually required were to be indented for and consumed.

A further reduction in the soap ration was made with effect from July 28, 1945 when it was reduced by one-eighth of the ration previously authorised. This was effected by cancelling the soap coupon every eighth fortnightly period, i.e. one in sixteen weeks. The pool of coupons held by officers commanding units for issue to certain personnel was also reduced by one-eighth so that the pool authorised amounted to one coupon a month for 88 per cent. of all ranks on unit strength.

Foot Soap. Following the experience in France during the War of 1914–18, foot soap and foot powder were both made available during the

campaign in North-west Europe to enable the 'toilet' of the feet to be carried out as a measure in the prevention of trench foot.

The formulae for soap and powder used and found effective in the War of 1914–18 when trench foot was a problem were:

Soap	
Soft potash soap	1,000 parts
Powdered camphor	25 parts
Powdered sodium borate	100 parts
Powder	
Powdered talc	1,000 parts
Camphor	25 parts.

During the War of 1939–45, however, owing to shortage of supplies (notably of camphor) and manufacturing difficulties, it was necessary to agree to certain alterations to the formulae, and in 1944 the following were accepted:

Foot soap	
Soft potash soap	1,000 parts
Powdered camphor	25 parts
Foot powder	
Powdered talc	1,000 parts
Camphor	10 parts
Boric acid	15 parts.

It was recommended, however, that a return should be made to the original formulae of both preparations as soon as the supply situation permitted.

The scales of issue were:

Foot soap	500 lb. per 1,000 men per month
Foot powder	250 lb. per 1,000 men per month.

Issue to 20 per cent. of the force for twenty days in each month during the winter.

All Purposes Soap. During 1943–4 a general purposes marine soap was produced and given extensive trials in the Army. It was designed to be used for the following purposes:

(*a*) As a toilet soap and as a shampoo for men.
(*b*) For cleansing mess tins and similar equipment.
(*c*) For the manual laundering of clothes.
(*d*) For use as a shaving soap.

It was particularly suitable where only brackish water could be obtained, e.g. Gibraltar and the Western Desert.

For the trials, 5,000 tablets were sent to S.E.A.C. and 5,000 tablets were issued for use in transports. In general the trials proved to be

satisfactory but the reports indicated that it was least successful as a substitute for shaving soap.

In view of the general opinion expressed in the reports of the trials, the D. of H. recommended its introduction for the purposes indicated at (*a*), (*b*) and (*c*) above but for (*d*) only in places where brackish water was obtainable and if no other soap specifically designed for this purpose was available.

Arrangements were made by Ordnance for the N.A.A.F.I. to stock this soap for sale in stations and garrisons where a personal issue of soap was not made, e.g. Gibraltar.

Tetmos Soap. The use of tetra-ethyl-thiuram-monosulphide (Tetmos) had been advocated as an efficacious agent in the treatment of scabies following its use in a few civil clinics in the United Kingdom. It had not been used in the Army. It had been stated that a 10 per cent. concentration was sufficient to prevent scabies in animals and that the application of a soap lather for forty seconds was lethal to the mite. Reports concerning its efficiency were conflicting; some scientists holding that it was more effective than benzyl benzoate, others that it was less so.

The Hygiene Directorate became interested in it when it was shown that it could be incorporated in soap and that in this form it might be found to be a valuable prophylactic measure against scabies.

In 1943 arrangements were made for a preliminary trial of the value of Tetmos in the treatment of scabies to be carried out in Western Command under the direction of a member of the staff of the School of Tropical Medicine, Liverpool. Tablets of impregnated soap for this purpose were supplied by the manufacturers (Imperial Chemicals (Pharmaceuticals) Ltd.). I.C.I. had used a very good quality soap for this purpose and it was anticipated that this would give rise to difficulties in cost and supply if issued in bulk, so A.M.D.5. was more interested in the impregnation of ordinary soap such as 'yellow bar' or 'white ivory', the only type of soap which it would be practicable to issue in large quantities. By arrangements with Ordnance a supply of yellow soap was made available for the investigation, half of which was impregnated with 10 per cent. Tetmos and the remainder with 20 per cent. Tetmos. Investigations on this subject were also undertaken by a sub-committee of the M.P.R.C.

Although these investigations showed that Tetmos impregnated soap had a definite value in the prophylaxis of scabies, it was never generally adopted. The sub-committee of the M.P.R.C., concerned in the investigation, advised that the M.R.C. should recommend the Ministry of Supply to hold a stock of Tetmos-impregnated soap so that, if necessary, it could be available against demands from government departments, municipal authorities, etc., but the matter was left in abeyance. The

Royal Navy and Royal Air Force decided in 1945 not to make Tetmos soap a standard issue and A.M.D.5 advised Ordnance that they were not prepared to advise its adoption by the Army, for the reasons that there would be great difficulties of supply and distribution and, most important of all, it would be very difficult to ensure that men would use the soap either in their units or at home.

Medical Recategorisation in the United Kingdom, 1943 and 1944*

Data for this account came from the unit weekly medical return (A.F. W3181) consolidated at district/command level in A.F. W3180. The latter, formerly in force in the United Kingdom (and some small stations elsewhere), was superseded by A.Fs. W3166 and 3167. Successive audits of these United Kingdom returns disclosed disturbing inaccuracies with respect to figures cited in them. Thus total numbers examined and net numerical increases and decreases recorded for each medical category were deficient. On the other hand, it was justifiable to regard any such figure as a lower limit of the true one, because cases included could be reasonably considered as items of a representative sample. Percentages of cases upgraded and downgraded from any given category could therefore be taken as reliable.

'X' categories for men over 41 are included in military other ranks tables. A.1 cases are not shown in 1943 (except for net numerical changes) since the necessary information was not recorded in that year. Category C was not divided into C.1 and C.2 until the end of 1943. With regard to A.T.S., A.W.5 and B.W.5 were not introduced until 1944. V.A.Ds. are included from February 1944, onwards. Throughout, category E cases refer only to discharges from the Army carried out directly from units in contradistinction to total discharges, many of which took place in hospitals.

To bring into relief changes with respect to relative frequencies of upgradings or downgradings from a given medical category, it is helpful to have an index so defined that its value is: (*a*) zero when upgradings and downgradings balance; (*b*) positive when upgradings exceed downgradings, reaching a maximum of + 100 when all regradings are upgradings; (*c*) negative when downgradings exceed upgradings, reaching a maximum of — 100 when all regradings are downgradings. If u_c is the percentage of upgradings from the medical category *c*, d_c is the percentage downgradings ditto, and $r_c = (u_c + d_c)$ the percentage regradings, being the total of downgradings and upgradings, the regrading displacement index (D_c) with the properties defined above is:

$$D_c = 100(u_c - d_c) \div r_c.$$

* From the Statistical Report on the Health of the Army 1943–45. H.M.S.O. 1948.

Tables 19 (males) and 22 (females) exhibit the value of this index for the four quarters of 1943 and 1944 and for each year as a whole.

The general impression which Tables 17–20 convey is one of all-round deterioration, i.e.:

(*a*) to an excess of the percentage upgradings over the percentage downgradings in 1943, there corresponds a smaller excess or even a deficiency in 1944;

(*b*) to an excess of downgradings in 1943 there corresponds a greater excess of downgradings in 1944.

Among circumstances contributing to this deterioration are the following:

(*a*) During the greater part of 1944 there were frequent complaints by the training authorities that recruits entering the Army were generally of poorer physique than were those of 1943.

(*b*) During 1944 there was a large increase of units receiving mobilisation orders. In these circumstances all military personnel are examined with respect to medical categories, and there may well be a tendency to set a higher standard for overseas service.

(*c*) M.Os. with overseas experience may have more exacting views about suitability for overseas service.

(*d*) There were increasing numbers of sick and wounded transferred from overseas theatres and of repatriated prisoners-of-war.

(*e*) Of Army Selection Centres set up in 1943, four were functioning during the second half. At the outset they dealt chiefly with category C personnel, and large numbers were invalided out of the Army. These centres (later included in 45th Division) were working throughout 1944, and dealt more and more with Army 'misfits' of any medical category. They also reviewed categories from A.1–B.7. The result was an increased amount of downgrading.

With reference to changes in 1944:

(*a*) Much of the movement may have been the result of difference of medical opinion with reference to the demarcation of A from B or with respect to B.2 and B.7 in the locomotion categories.

(*b*) Variation with respect to visual assessment seems to have been responsible for the regrading of a considerable proportion of men formerly placed in categories defined by defects of vision.

(*c*) During the last quarter of 1944 the type of Army recruit improved greatly, consequent upon the volunteers for the Royal Navy and R.A.F. having been made available for the Army.

Table 20 shows net numerical changes among male personnel with respect to each category during the two years. Such figures can give only a lower limit below which the true figure cannot lie. The striking fact in this table is a net numerical decrease of over

90,000 cases of A.1. Broadly speaking, there was a net decrease with respect to all A categories (mainly A.1), a slight increase of middle B categories (mainly B.2), and a heavy increase of B.7 and C categories. (There was an increase of E too, but discharges from the Army are dealt with elsewhere.) As a result of recategorisation in the United Kingdom there was thus a large net transfer during 1943 and 1944 from highest to lowest categories, involving considerable internal wastage.

Tables 21–23 show that downgradings from A.W.1 in the A.T.S. numerically exceeded the total of upgradings from all other categories.

SUMMARY

The outstanding features of medical recategorisation in the United Kingdom in 1943 and 1944 were as follows:

(*a*) Steady deterioration among male personnel throughout the period with respect to the ratio of upgradings to downgradings, resulting in a substantial excess of downgradings over upgradings for every major category at the end of 1944.

(*b*) Consistent (though decreasing) excess of upgradings over downgradings with respect to A.T.S. other ranks in categories other than A.W.1, but a numerical excess of downgradings from A.W.1 over the total of upgradings from all other categories.

(*c*) Considerable internal wastage caused by large scale net transfer of male O.Rs. from highest to lowest categories.

MEDICAL RECATEGORISATION IN PHYSICAL DEVELOPMENT CENTRES, JANUARY 1944–JUNE 1945

Information for this account came from returns submitted directly to the War Office by physical development centres. Figures refer to the three 6-monthly periods from January 1944–June 1945. Although all three P.D.Cs. were already established in 1943 there was no uniform return for all centres until the end of that year. Before then, each one submitted its own return, and no satisfactory consolidation was practicable. Tables shown include British male other ranks only. In addition to cases completing courses they include casualties for which the centres themselves had documentary responsibility, i.e. (*a*) cases rejected as unsuitable after the beginning of a course; (*b*) injuries sustained during training. The tables show separately individuals in A.1—(i.e. potentially A.1, but as yet sub-standard). A shift from A.1— to A.1 counts as an upgrading. No downgradings took place in P.D.Cs. Hence, all cases recommended for downgrading have to be included in the unchanged group.

In assessing the significance of figures shown in this section two important qualifications must be borne in mind: (*a*) it cannot be assumed

TABLE 17

General Recategorisation Table; Male Other Ranks, 1943

Initial category	Numbers examined	Final category (as percentage of numbers examined in each category)												
		A.1	A.2	A.3	A.4	A.5	B.1	B.2	B.2a	B.5	B.6	B.7	C.1	C.2	E
A.1															
A.2	87,604	6·9	**84·2**	0·2	0·1	0·1	0·7	2·4	0·1	0·0	0·1	3·1	0·1	1·5	0·5
A.3	24,926	5·8	0·7	**87·5**	1·8	0·1	0·3	0·4	0·6	0·3	0·1	0·5	0·1	1·3	0·5
A.4	58,950	2·8	0·4	1·1	**90·7**	0·3	0·3	0·2	0·1	1·1	0·1	0·3	0·1	1·9	0·7
A.5	5,821	1·9	2·4	1·1	2·7	**82·8**	0·6	0·8	0·1	1·4	0·3	1·9	0·2	3·0	0·9
B.1	158,887	6·4	1·6	0·2	0·2	0·0	**85·6**	0·7	0·1	0·1	0·2	0·8	0·2	3·0	0·9
B.2	59,986	1·8	3·2	0·2	0·3	0·1	1·9	**85·8**	0·1	0·1	0·1	2·8	0·1	2·7	0·8
B.2a	4,202	2·1	1·1	2·8	3·8	0·5	3·8	2·0	**77·2**	1·8	0·1	0·7	0·2	2·8	1·1
B.5	9,364	0·9	0·5	0·4	2·7	0·8	3·4	2·5	0·8	**82·4**	0·2	0·5	0·2	3·4	1·4
B.6	11,084	1·1	0·1	0·0	0·2	0·1	1·5	0·4	0·0	0·0	**90·9**	0·3	0·2	3·6	1·6
B.7	48,853	0·4	0·9	0·0	0·1	0·1	0·7	2·5	0·1	0·1	0·0	**91·8**	0·2	2·2	0·8
C.1	4,985	0·6	0·1	0·0	0·1	0·0	1·5	0·4	0·1	0·1	0·2	0·8	**68·9**	22·0	5·0
C.2	89,088	0·8	0·2	0·0	0·1	0·0	2·0	0·7	0·1	0·1	0·2	1·2	3·5	**86·8**	4·2

MEDICAL RECATEGORISATION IN THE UNITED KINGDOM

TABLE 18

General Recategorisation Table; Male Other Ranks, 1944

Initial category	Numbers examined	Final category (as percentage of numbers examined in each category)												
		A.1	A.2	A.3	A.4	A.5	B.1	B.2	B.2a	B.5	B.6	B.7	C.1	C.2	E
A.1	547,460	**87·7**	1·3	0·3	0·2	0·0	2·9	1·4	0·0	0·0	0·2	1·3	0·8	2·8	1·1
A.2	64,915	3·8	**84·3**	0·2	0·1	0·1	0·7	3·6	0·1	0·0	0·1	4·1	0·5	1·8	0·6
A.3	20,468	5·6	0·5	**87·0**	1·7	0·1	0·4	0·3	1·1	0·3	0·0	0·4	0·4	1·5	0·6
A.4	45,695	1·9	0·2	1·1	**90·9**	0·4	0·2	0·1	0·1	1·4	0·1	0·3	0·6	1·9	0·9
A.5	3,518	1·0	1·8	1·0	2·5	**83·4**	0·4	0·7	0·0	2·3	0·2	1·2	1·8	2·5	1·1
B.1	139,590	3.6	0·7	0·0	0·1	0·0	**87·5**	0·8	0·1	0·1	0·2	0·9	0·9	3·7	1·4
B.2	56,097	0·9	1·6	0·1	0·1	0·0	1·1	**87·9**	0·1	0·1	0·1	3·5	0·9	2·6	1·0
B.2a	3,384	0·9	0·6	1·7	1·3	0·1	4·2	1·8	**80·9**	1·8	0·0	0·8	1·3	3·0	1·4
B.5	8,543	0·5	0·1	0·2	1·7	0·5	2·5	1·2	0·8	**84·7**	0·2	0·6	1·5	3·8	1·8
B.6	11,309	0·6	0·0	0·0	0·0	0·0	1·1	0·3	0·0	0·2	**88·8**	0·3	0·7	5·1	2·7
B.7	59,699	0·3	0·6	0·0	0·0	0·0	0·4	1·5	0·0	0·0	0·1	**92·5**	1·0	2·3	1·1
C.1	33,192	0·6	0·1	0·0	0·1	0·1	2·1	0·6	0·0	0·1	0·2	1·3	**80·8**	10·7	3·3
C.2	109,700	0·5	0·1	0·0	0·1	0·0	1·5	0·4	0·0	0·1	0·1	0·7	8·0	**83·2**	5·3

TABLE 19

Regrading Displacement Index; Male Other Ranks, 1943–4

	1943				1944				Totals	
	January–March	April–June	July–September	October–December	January–March	April–June	July–September	October–December	1943	1944
A.1 . . .	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0
A.2 . . .	− 4·5	− 3·8	− 20·3	− 26·7	− 37·3	− 52·0	− 61·7	− 59·5	− 12·1	− 51·6
A.3 . . .	+ 11·3	+ 14·7	− 5·0	− 12·5	− 6·7	− 6·5	− 1·9	− 15·4	+ 4·0	− 7·0
A.4 . . .	+ 3·7	− 1·1	− 19·2	− 23·3	− 21·5	− 28·0	− 29·1	− 45·7	− 7·5	− 29·7
A.5 . . .	+ 14·3	+ 4·4	− 27·7	− 28·7	− 17·1	− 25·6	− 17·5	− 39·2	− 5·8	− 24·1
B.1 . . .	+ 29·7	+ 26·3	+ 5·9	− 4·3	− 14·8	− 31·0	− 41·8	− 38·5	+ 16·7	− 29·6
B.2 . . .	+ 20·5	+ 10·8	− 2·9	− 18·6	− 19·3	− 39·4	− 50·0	− 47·7	+ 4·9	− 37·2
B.2a . . .	+ 60·6	+ 36·6	+ 30·2	+ 29·6	+ 19·1	+ 17·8	+ 5·1	− 7·4	+ 41·5	+ 11·0
B.5 . . .	+ 51·0	+ 45·0	+ 19·5	+ 16·4	+ 9·9	+ 7·7	− 18·8	− 16·3	+ 36·0	− 2·0
B.6 . . .	− 8·9	− 18·1	− 42·9	− 34·8	− 38·5	− 58·0	− 63·2	− 75·0	− 25·3	− 57·1
B.7 . . .	+ 29·9	+ 27·8	+ 19·0	− 1·3	− 1·6	− 11·4	− 30·1	− 38·2	+ 19·5	− 20·0
C.1 . . .				− 73·7	− 61·0	− 40·2	− 30·3	− 37·7	− 73·7	− 45·8
C.2 (incl. C) . .	+ 22·6	+ 22·0	+ 6·7	+ 62·4	+ 68·1	+ 39·2	− 0·8	− 14·0	+ 36·4	+ 37·3

MEDICAL RECATEGORISATION IN THE UNITED KINGDOM

TABLE 20

Net Numerical Increases (+) and Decreases (—) of Medical Categories; Male Other Ranks, 1943–4

	1943				1944				Totals	
	January–March	April–June	July–September	October–December	January–March	April–June	July–September	October–December	1943	1944
A.1	— 8,802	— 8,908	—10,082	— 9,369	—11,558	—15,334	—13,079	—16,297	—37,161	—56,268
A.2	— 113	+ 129	— 171	— 195	— 240	— 73	— 547	+ 98	— 350	— 762
A.3	+ 230	+ 113	— 16	— 22	— 27	— 197	— 67	— 60	+ 305	— 351
A.4	— 434	— 527	— 577	— 390	— 603	— 759	— 556	— 317	— 1,928	— 2,235
A.5	+ 24	— 28	— 35	— 81	— 25	+ 5	— 23	— 42	— 120	— 85
B.1	— 2,020	— 1,840	— 806	— 114	— 11	+ 176	+ 639	+ 1,892	— 4,780	+ 2,696
B.2	+ 987	+ 670	+ 910	+ 919	+ 1,175	+ 2,170	+ 1,506	+ 1,666	+ 3,486	+ 6,517
B.2a	— 63	+ 7	+ 9	— 11	+ 29	+ 46	+ 30	+ 30	— 58	+ 135
B.5	— 114	— 17	+ 27	— 5	+ 52	+ 33	+ 9	+ 45	— 109	+ 139
B.6	+ 369	+ 332	+ 293	+ 162	+ 148	+ 122	— 63	+ 82	+ 1,156	+ 289
B.7	+ 2,573	+ 2,469	+ 2,406	+ 1,829	+ 2,464	+ 2,883	+ 2,330	+ 2,497	+ 9,277	+10,174
C.1				+ 2,741	+ 5,111	+ 2,135	+ 1,210	+ 1,841	+ 2,741	+10,297
C.2 (incl. C)	+ 4,412	+ 4,665	+ 4,291	+ 786	— 864	+ 4,084	+ 4,323	+ 4,067	+14,154	+11,610
E	+ 2,951	+ 2,935	+ 3,751	+ 3,750	+ 4,349	+ 4,709	+ 4,288	+ 4,498	+13,387	+17,844

TABLE 21

General Recategorisation Table; A.T.S. Other Ranks, 1943–4

(*a*) A.T.S. Other Ranks, 1943

Initial category	Numbers examined	Final category (as percentage of numbers examined in each category)								
		A.W.1	A.W.2	A.W.3	B.W.1	B.W.2	B.W.3	B.W.4	C.W.	E
A.W.1										
A.W.2	2,594	17·8	**79·1**	1·1	0·3	0·3	0·1	—	0·8	0·4
A.W.3	1,797	5·3	1·7	**91·0**	0·2	—	0·3	0·1	0·6	0·8
B.W.1	10,984	14·5	0·6	0·3	**82·6**	0·2	0·1	0·0	0·6	1·0
B.W.2	596	6·5	4·2	1·8	6·5	**78·7**	0·2	—	1·2	0·8
B.W.3	345	6·7	0·6	7·8	2·9	0·6	**79·1**	0·3	0·6	1·4
B.W.4	98	5·1	—	2·0	3·1	1·0	1·0	**83·7**	3·1	1·0
C.W.	786	5·2	0·3	0·3	6·7	0·4	0·1	0·3	**80·3**	6·5

(*b*) A.T.S. Other Ranks and V.A.Ds., 1944

Initial category	Numbers examined	Final category (as percentage of numbers examined in each category)										
		A.W.1	A.W.2	A.W.3	A.W.5	B.W.1	B.W.2	B.W.3	B.W.4	B.W.5	C.W.	E
A.W.1	108,231	**97·7**	0·1	0·1	0·0	0·7	0·0	0·0	0·0	0·0	0·8	0·6
A.W.2	2,045	16·1	**78·7**	1·5	0·2	0·8	0·5	0·1	0·1	0·1	1·3	0·7
A.W.3	1,902	3·4	1·7	**92·3**	0·7	0·1	0·1	0·2	0·1	0·1	0·8	0·6
A.W.5	462	8·9	—	0·4	**88·5**	0·2	0·2	—	0·2	—	1·1	0·4
B.W.1	8,619	11·9	0·4	0·2	0·1	**84·4**	0·2	0·0	0·1	—	1·6	1·2
B.W.2	576	6·2	0·9	0·7	0·3	6·1	**81·8**	0·2	0·2	0·2	2·3	1·2
B.W.3	267	1·9	1·5	8·2	1·5	2·2	0·4	**80·5**	1·5	1·1	0·4	0·7
B.W.4	119	0·8	—	0·8	—	3·4	—	0·8	**89·9**	—	0·8	3·4
B.W.5	39	5·1	—	—	—	2·6	—	—	—	**84·6**	2·6	5·1
C.W.	1,580	4·7	0·1	0·1	0·1	6·8	0·6	0·1	0·2	0·1	**80·3**	6·7

MEDICAL RECATEGORISATION IN THE UNITED KINGDOM

TABLE 22

Regrading Displacement Index; A.T.S. Other Ranks, 1943–4

	1943				1944				Totals	
	January–March	April–June	July–September	October–December	January–March	April–June	July–September	October–December	1943	1944
A.W.1	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0	−100·0
A.W.2	+ 77·1	+ 71·9	+ 65·6	+ 61·0	+ 62·7	+ 51·1	+ 38·0	+ 43·3	+ 71·2	+ 51·2
A.W.3	+ 47·7	+ 73·9	+ 60·9	+ 20·0	+ 27·1	+ 46·3	+ 26·3	+ 39·0	+ 55·6	+ 33·3
A.W.5					+ 76·0	+ 45·9	+ 39·3	+100·0		+ 61·7
B.W.1	+ 74·9	+ 86·4	+ 72·6	+ 69·5	+ 73·3	+ 64·0	+ 54·7	+ 45·8	+ 77·1	+ 61·5
B.W.2	+ 75·5	+ 88·0	+ 64·4	+ 86·9	+ 92·0	+ 38·0	+ 48·2	+ 47·9	+ 79·3	+ 56·0
B.W.3	+ 79·0	+ 54·2	+100·0	+100·0	+ 41·8	+ 84·5	+ 63·4	+100·0	+ 73·0	+ 61·9
B.W.4	+100·0	− 34·1	+ 49·8	+100·0	− 34·0	+ 50·3	+ 20·7	—	+ 50·0	+ 16·8
B.W.5					—	+ 33·3	+100·0	−100·0		0·0
C.W.	+ 59·6	+ 33·3	+ 19·4	+ 35·8	+ 43·4	+ 6·0	+ 38·5	+ 36·6	+ 34·0	+ 32·0

TABLE 23

Net Numerical Increases (+) and Decreases (—) of Medical Categories; A.T.S. Other Ranks, 1943–4

	1943				1944				Totals	
	January–March	April–June	July–September	October–December	January–March	April–June	July–September	October–December	1943	1944
A.W.1 . . .	+162	+239	− 80	−202	+ 6	−266	−285	−395	+ 119	−940
A.W.2 . . .	− 60	− 89	− 56	− 13	− 75	− 94	− 62	− 54	− 218	−285
A.W.3 . . .	+ 24	+ 53	+ 20	+ 9	− 8	− 2	− 2	0	+ 106	− 12
A.W.5 . . .					+ 5	− 1	+ 1	+ 11		+ 16
B.W.1 . . .	−438	−519	−269	−101	−223	−133	− 53	− 14	−1,327	−423
B.W.2 . . .	− 11	− 30	+ 15	+ 7	− 1	− 4	− 15	+ 1	− 19	− 19
B.W.3 . . .	− 10	− 9	− 5	− 1	− 13	− 7	− 10	− 3	− 25	− 33
B.W.4 . . .	+ 2	+ 5	− 1	+ 4	+ 11	+ 5	+ 3	+ 13	+ 10	+ 32
B.W.5 . . .					+ 7	0	+ 4	+ 2		+ 13
C.W. . . .	+103	+160	+162	+110	+129	+250	+164	+208	+ 535	+751
E . . .	+228	+190	+214	+187	+162	+252	+255	+231	+ 819	+900

that standards of medical category remain unchanged in one and the same centre, or are consistent for the three centres as a whole; (*b*) there had been no comprehensive follow-up of men who had completed a course at a P.D.C. It cannot therefore be certain to what extent the upgradings recorded were permanent or to what extent they were a just measure of improvement. Subject to these reservations, results obtained in the year and a half cited were striking.

P.D.Cs. obtained their cases from two distinct sources: (*a*) primary training centres or Ministry of Labour boards, i.e., new recruits; (*b*) other units, i.e. soldiers with a record of service in the Army. The phrase 'from primary training centres' includes cases who went direct to a P.D.C. on the recommendation of a Ministry of Labour board. During the period under review the proportion of total cases received in P.D.Cs. from primary training centres rose steadily from approximately 75 per cent. to 90 per cent.

Proportion of Total P.D.C. Cases received from Primary Training Centres and from Other Units

	From P.T.Cs.	*From Other Units*	*All Cases*	*Crude Figures*
1944 1st half . .	76·1	23·9	100·0	6,773
2nd half . .	85·8	14·2	100·0	6,885
1945 1st half . .	89·3	10·7	100·0	7,126

The category distribution of cases received from the two sources differed. P.T.C. cases were approximately evenly distributed between categories A.1—and B.1; and there were only about 10 per cent. in other categories. Those from other units included a much higher proportion of A.2 and B.2 cases (foot defects) and a lower proportion of B.1 (constitutional defects).

Distribution of P.D.C. Cases by Initial Category and Type of Unit from which received, January 1944 to June 1945

	From P.T.Cs.	*From Other Units*	*All Cases*
A.1—	44·8	53·0	46·1
A.2	4·3	15·2	6·1
B.1	45·7	16·4	41·0
B.2	1·8	6·3	2·5
Others	3·4	9·0	4·3
Totals	100·0	100·0	100·0
Crude figures	17,425	3,359	20,784

Table 24 shows an overall picture of results achieved during the whole period. Over 20,000 men were dealt with, of whom 78 per cent. were

upgraded. Of A.1— cases 88 per cent. 'improved' (i.e. became A.1). and 75 per cent. of B.1 were upgraded (almost all to A.1). Table 25 shows separately for P.T.C. cases and others the proportions upgraded with respect to major categories during the three 6-monthly periods. In general, there was a rise of the percentage of each category upgraded between the 1st and 2nd halves of 1944 and a slight fall in the first half of 1945. This trend was more consistent in respect of cases from P.T.Cs. than of those from other units. Among P.T.C. cases, the proportion of A.1— upgraded rose to nearly 95 per cent. in the second half of 1944 and was still over 90 per cent. in the first half of 1945. Over 75 per cent. of B.1 were upgraded and between two-thirds and three-quarters of A.2 and B.2 cases. Among cases received from other units the proportion upgraded was lower. A comparison between the two groups over the whole period appears below. All differences are statistically significant with the exception of the one relating to B.2.

Percentage Upgraded in P.D.Cs. by Initial Category and Type of Unit from which received, January 1944 *to June* 1945

	From P.T.Cs.	*From Other Units*	*All Cases*
A.1—	92·6	65·5	87·6
A.2	66·4	45·7	58·0
B.1	76·0	60·1	74·9
B.2	74·8	68·1	72·1
Other categories	40·0	51·0	43·7
All cases	81·8	60·5	78·3

Only 65 per cent. of A.1— from units other than P.T.Cs. were upgraded compared with over 90 per cent. for P.T.C. cases. With respect to B.1 the figures were 60 per cent. and 76 per cent. respectively. Men from units other than P.T.Cs. showed a higher upgrading rate for other categories. This is because that item in this group refers mainly to B.7 and to C. Among men from P.T.Cs. it was made up largely of A.3 and A.4 (eye defects) which could not be upgraded, even if a defect of locomotion or poor constitution was remedied. Net numerical changes of medical category resulting from courses in P.D.Cs. appear below:

Net Numerical Increase (+) *or Decrease* (−) *of Medical Categories in P.D.Cs., January* 1944 *to June* 1945

	1944		1945	
	1st half	*2nd half*	*1st half*	*Totals*
A.1	+4,660	+5,507	+5,515	+15,682
A.1—	−2,467	−3,106	−2,822	− 8,395
A.2	− 160	− 177	− 109	− 446
B.1	−1,808	−2,043	−2,456	− 6,307
B.2	− 138	− 136	− 81	− 355
Other categories	− 87	− 45	− 47	− 179

MEDICAL RECATEGORISATION IN PHYSICAL DEVELOPMENT CENTRES

TABLE 24

General Recategorisation Table (P.D.Cs.); Male Other Ranks, January 1944 to June 1945

Initial category	Numbers treated	Final category (as percentage of numbers treated in each category)												Totals upgraded	Totals unchanged or recommended for downgrading
		A.1	A.1 —	A.2	A.3	A.4	A.5	B.1	B.2	B.2a	B.5	B.6	B.7	C.1 and C.2	
A.1 — .	9,585	87·6	12·4												87·6	12·4
A.2 .	1,263	58·0	—	42·0											58·0	42·0
A.3 .	190	5·3	—	0·5	94·2										5·8	94·2
A.4 .	147	2·0	—	—	1·4	96·6									3·4	96·6
A.5 .	10	—	—	—	—	50·0	50·0								50·0	50·0
B.1 .	8,518	73·5	—	1·3	0·0	0·0	—	25·1							74·9	25·1
B.2 .	523	40·1	—	22·2	—	0·8	—	9·0	27·9						72·1	27·9
B.2a .	156	11·5	—	0·6	63·5	1·3	—	1·9	0·6	20·5					79·5	20·5
B.5 .	120	3·3	—	—	0·8	66·7	1·7	0·8	—	—	26·7				73·3	26·7
B.6 .	3	—	—	—	—	—	33·3	—	—	—	—	66·7			33·3	66·7
B.7 .	161	11·8	—	30·4	—	—	—	1·9	11·2	—	—	—	44·7		55·3	44·7
C.1 and C.2 .	108	30·6	—	5·6	—	0·9	—	20·4	2·8	—	—	—	2·8	37·0	63·0	37·0
Totals .	20,784														78·3	21·7

MEDICAL RECATEGORISATION IN PHYSICAL DEVELOPMENT CENTRES

TABLE 25

Percentage Upgraded in P.D.Cs. by Initial Category and Unit from which received; Male Other Ranks, January 1944 to June 1945

	From P.T.Cs.			From other units			All cases		
	1944		1945	1944		1945	1944		1945
	1st half	2nd half	1st half	1st half	2nd half	1st half	1st half	2nd half	1st half
A.1— . . .	91·7	94·3	91·6	58·4	74·5	67·0	83·0	91·1	88·0
A.2 . . .	60·5	68·6	70·5	46·9	54·9	29·0	53·3	64·1	58·4
B.1 . . .	69·4	80·8	77·2	59·9	57·8	65·8	68·3	79·4	76·9
B.2 . . .	73·1	80·2	69·4	72·0	65·3	63·4	72·5	74·6	67·5
Other categories .	38·8	35·6	46·4	58·3	47·2	41·9	46·7	38·6	44·9
All cases . . .	77·3	85·2	82·2	57·5	66·4	59·2	72·6	82·5	79·7

Bearing in mind the qualification mentioned with regard to possible relapse, these figures show that there was a net gain of over 15,000 cases to A.1 during the year and a half covered, i.e. approximately 10,000 cases a year. This was almost entirely at the expense of the A.1— and B.1 groups. If the fact that rather over 10,000 cases were treated in P.D.Cs. before the introduction of a uniform return at the end of 1943 is taken into account the figures in this table become swollen by some 50 per cent. to complete the record of P.D.Cs. throughout the war.

HEIGHTS AND WEIGHTS OF ARMY INTAKES

Information for this account came from a sample analysis, supplied by A.G. Co-ordination, of two intakes into the Army, one in October 1942 and the other in February 1944. In so far as it is reasonable to assume that heights and weights do not vary substantially within any particular age group, it is possible to derive an overall picture of all recruits from the proportion of total intakes made up by each of the age groups cited. Relevant figures for the period July 1942–June 1945 were obtained through the War Office Personnel Selection Branch (S.P.2) and the basic figures in each part of Table 26 were weighted appropriately in order to obtain overall figures (Table 28). For example, since 33 per cent. of total intakes during the period were 18 or under, the block of figures relating to this age group should contribute one third to the total, while the 19-year olds who made up only 18 per cent. of all recruits should contribute proportionately less to the overall total. Since the age distribution of the S.P. 2 figures was not the same as that in Table 26 it was necessary to make certain adjustments before the appropriate contribution of each age group could be determined. It must be emphasised that figures in Table 28 refer only to the period defined and it is probable that the age-composition, and consequently the overall height and weight distribution of recruits was quite different in the early part of the war, when age groups were being called up *seriatim*.

Figures in Table 27 show that the mean height for each age group specified did not vary materially from 5 ft. 7 in. On the other hand, mean weight increased steadily from 9 st. 3 lb. among the 18-year olds to 9 st. 11 lb. among recruits over 32 years of age. Table 28 shows that 74 per cent. of all cases were 5 ft. 4 in.—5 ft. 9 in. high. Only 2 per cent. were over 6 ft. 1 in. and 7½ per cent. were less than 5 ft. 4 in. As regards weight, 75 per cent. were between 115 lb. and 150 lb., 10 per cent. weighed less, and 15 per cent. more. Only 2½ per cent. were over 170 lb. (12 st. 2 lb.)

TABLE 26

Height and Weight Distribution per 1,000 *of Sample Intakes*

(*a*) Age 18 years

Height in inches	Weight in pounds						Totals
	99 and under	100–114	115–129	130–149	150–169	170 and over	
60 and under	1	2	2	—	—	—	5
61–63	3	36	21	2	—	—	62
64–66	2	70	165	64	2	—	303
67–69	—	23	179	211	28	2	443
70–72	—	1	28	94	38	5	166
73 and over	—	—	1	8	10	2	21
Totals	6	132	396	379	78	9	1,000

(*b*) Age 19 years

Height in inches	Weight in pounds						Totals
	99 and under	100–114	115–129	130–149	150–169	170 and over	
60 and under	8	6	1	—	—	—	15
61–63	3	35	25	5	—	—	68
64–66	2	48	159	79	7	—	295
67–69	—	14	155	212	36	2	419
70–72	—	1	26	102	40	5	174
73 and over	—	—	—	9	15	5	29
Totals	13	104	366	407	98	12	1,000

(*c*) Age 20–31 years

Height in inches	Weight in pounds							Totals
	99 and under	100–114	115–129	130–149	150–169	170–189	190 and over	
60 and under	—	3	1	—	—	—	—	4
61–63	1	20	27	11	—	—	—	59
64–66	1	31	144	115	17	1	—	309
67–69	—	8	113	241	66	10	2	440
70–72	—	—	11	77	61	13	4	166
73 and over	—	—	—	9	11	2	—	22
Totals	2	62	296	453	155	26	6	1,000

(*d*) Age 32 years and over

Height in inches	Weight in pounds							Totals
	99 and under	100–114	115–129	130–149	150–169	170–189	190 and over	
60 and under	—	4	4	2	1	—	—	11
61–63	—	23	41	16	3	—	—	83
64–66	1	37	141	142	33	4	—	358
67–69	—	8	93	198	69	17	4	389
70–72	—	—	9	62	52	16	4	143
73 and over	—	—	—	3	7	3	3	16
Totals	1	72	288	423	165	40	11	1,000

TABLE 27

Mean Height, Mean Weight and Proportions of Total Intake within each Age Group; July 1942 to June 1945

Age	Mean height (inches)	Mean weight (pounds)	Proportion of total intakes
18 years . .	67·30	129·4	33·4
19 years . .	67·27	131·2	18·4
20–31 years . .	67·30	136·5	27·8*
32 years and over .	66·84	137·3	20·4*
All ages . .	67·20	133·3	100·0

* Estimated from available figures to conform with age groups here used.

TABLE 28

Estimated Height and Weight Distribution of All Intakes per 1,000; July 1942 to June 1945

Height in inches	Weight in pounds						Totals
	99 and under	100–114	115–129	130–149	150–169	170 and over	
60 and under .	2	3	2	—	—	—	7
61–63 . .	2	29	27	8	1	—	67
64–66 . .	2	48	153	97	13	1	314
67–69 . .	—	14	139	217	48	9	427
70–72 . .	—	1	19	84	48	11	163
73 and over .	—	—	—	8	11	3	22
Totals . .	6	95	340	414	121	24	1,000

Special Hygiene Problems

ARMOURED FIGHTING VEHICLE CREWS

Hygiene problems which arose in connexion with A.F.Vs. included the following:

An improved system of issuing rations to A.F.V. crews on operations.
Protection of crews against fire hazard.
The ventilation of tanks to remove gun fumes.
Postural injuries sustained by tank drivers.
Medical supplies for A.F.Vs.
Disposal of dead from A.F.Vs.

Most of these problems were referred to the sub-committees of the M.P.R.C. of the M.R.C. for investigation.

Rations. It was represented to the Rations sub-committee of the Medical Research Council in 1941 by a senior staff officer of an armoured

formation, who had just returned from Libya, that some improvement in the system of issuing rations to personnel of A.F.Vs. would be of material advantage. He pointed out that the system obtaining, in which, for example, a tin of condensed milk was issued for the meals of the crew during the course of twenty-four hours, was unsatisfactory. After the tin had been opened for the first meal, the milk remaining in the tin was apt to get soiled or to run out, and not infrequently the subsequent meals had to be taken without condensed milk. He therefore asked that several smaller tins be issued, each tin to contain sufficient for one meal for the crew of three or four men.

Secondly, he stated that, when a loaf or loaves of bread were issued for the use of a tank crew, if the loaf was cut in the morning, by the evening the bread had not infrequently become mouldy. To ensure that the bread should be fresh for each meal, he suggested that bread be done up in cellophane packets, each packet containing the quantity sufficient for one meal.

Thirdly, he stated that the tea, milk and sugar ration was reduced during the summer months, which was the time when men were inclined to drink more tea. He therefore hoped that it would be possible to increase the tea ration during the summer months rather than reduce it.

The introduction of special ration packs at a later date ensured that personnel of A.F.Vs. had food available in the most convenient form when normal feeding and cooking on a unit basis was impracticable for operational reasons.

A pack was designed specially for the use of A.F.V. personnel. This pack known as the 'A.F.V. Pack' was made up in three sizes, viz. 2-men, 3-men and 5-men. The design of the packs was improved and there were two types of each pack available (old and new). The A.F.V. Pack was essentially a reserve ration to be carried in A.F.Vs. and certain ancillary vehicles. Special metal boxes were fitted in the A.F.Vs. to carry a three days' reserve for the crew.

Details of both types are given in Tables 29 and 30.

Methods for keeping food hot in thermos flasks or insulated containers were also considered. It appeared from a trial carried out in M.E. that only the thermos flask would meet the stringent conditions laid down by the R.A.C. for the length of time that meals had to be kept hot, but that it had the great disadvantage of being fragile. In view of the fact that the thermos would be used for beverage items chiefly, breakage of the thermos would not rob the crew of food, but rather of tea or soup, which, though very desirable for the comfort of the crew, did not represent much in the way of food value. It was in any case not considered that such beverages would be very attractive after over twelve hours in an insulated container.

The question, therefore, was whether the advantage to the tank crew in having a really hot beverage outweighed the risk of loss of the hot part of their meal, through breakage of the thermos flask.

TABLE 29

The A.F.V. Ration Pack (Old Type)

Size	Item	No. and size of tins in each pack	Ration (approx.)	Description of package
2 men	Meat, preserved	2 × 12 oz.	12 oz.	Fibreboard case
	Milk, condensed	1 × 6 oz.	3 oz.	Measurement, 8⅜ in.
	Sardines	1 × 4 oz.	2 oz.	× 5 5/16 in. × 4⅛ in.
	Margarine	1 × 2¾ oz.	1⅜ oz.	Gross weight 5 lb.
	Tea	1 × 1½ oz.	¾ oz.	
	Sugar	1 × 3 oz.	1½ oz.	
	Beans, canned	1 × 8 oz.	4 oz.	
	Jam	2 × 4 oz.	4 oz.	
	Latrine paper	12 pieces	6 pieces	
	*Biscuits, Service	2 × 10 oz.	10 oz.	
3 men	Meat, preserved	3 × 12 oz.	12 oz.	Fibreboard case
	Milk, condensed	2 × 6 oz.	4 oz.	Measurement, 9 in. ×
	Sardines	2 × 4 oz.	2⅜ oz.	7⅛ in. × 4⅛ in.
	Margarine	2 × 2¾ oz.	1⅜ oz.	Gross weight 8½ lb.
	Tea	2 × 1½ oz.	1 oz.	
	Sugar	2 × 3 oz.	2 oz.	
	Beans, canned	1 × 12 oz.	4 oz.	
	Jam	3 × 4 oz.	4 oz.	
	Latrine paper	18 pieces	6 pieces	
	*Biscuits, Service	3 × 10 oz.	10 oz.	
5 men	Meat, preserved	5 × 12 oz.	12 oz.	Fibreboard case
	Milk, condensed	2 × 6 oz.	2⅜ oz.	Measurement, 9 11/16 in.
	Sardines	3 × 4 oz.	2⅜ oz.	× 9 9/16 in. × 5⅜ in.
	Margarine	3 × 2¾ oz.	1⅜ oz.	Gross weight 13 lb.
	Tea	3 × 1½ oz.	1 9/16 oz.	
	Sugar	3 × 3 oz.	1⅜ oz.	
	Beans, canned	1 × 8 oz. 1 × 12 oz.	4 oz.	
	Jam	1 × 4 oz. 1 × 16 oz.	4 oz.	
	Latrine paper	30 pieces	6 pieces	
	*Biscuits, Service	5 × 10 oz.	10 oz.	

* Biscuits, Service were not contained in the A.F.V. Ration Packs, but were issued separately.

In view of these considerations, and appreciating the undoubted effect on morale of a hot drink to a tired man, A.M.D.5 supported the recommendation for the provision of vacuum flasks for A.F.Vs.

Clothing. It was found desirable that tank crews should be provided with some form of protection against the hazard of burns caused by cordite flash or flaming petrol, of which the former appeared to be the greater risk.

TABLE 30

The A.F.V. Ration Pack (New Type)

Size	Item	No. and size of tins in each pack	Ration (approx.)	Description of package
2 men	Sausages, tinned	1 × 16 oz.	8 oz.	Fibreboard case
	M. and V. ration or meat, luncheon	1 × 12 oz.	6 oz.	Measurement, 8½ in. × 5½ in. × 5 in.
	Sardines	1 × 4½ oz.	2¼ oz.	Gross weight 6 lb. 6 oz.
	Cheese	3 × 1½ oz.	2¼ oz.	
	Beans, canned	1 × 16 oz.	8 oz.	
	Tea, sugar and milk powder	2 × 5 oz.	5 oz.	
	Jam	2 × 4 oz.	4 oz.	
	Sweets, boiled	1 × 5 oz.	2½ oz.	
	Latrine paper	12 pieces	6 pieces	
	*Biscuits, Service	2 × 10 oz.	10 oz.	
3 men	Meat, preserved	1 × 12 oz.	4 oz.	Fibreboard case
	Sausages, tinned	1 × 16 oz.	5½ oz.	Measurement, 9½ in. × 7½ in. × 4⅞ in.
	M. and V. ration or meat, luncheon	1 × 16 oz.	5½ oz.	Gross weight 9 lb. 3 oz.
	Sardines	2 × 4½ oz.	3 oz.	
	Cheese	2 × 3 oz.	2 oz.	
	Beans, canned	1 × 16 oz.	5½ oz.	
	Jam	3 × 4 oz.	4 oz.	
	Tea, sugar and milk powder	2 × 5 oz.	3½ oz.	
	Sweets, boiled	1 × 5 oz.	1⅝ oz.	
	Lemonade powder	1 × 5 oz.	1⅝ oz.	
	Latrine paper	18 pieces	6 pieces	
	*Biscuits, Service	3 × 10 oz.	10 oz.	
5 men	Sausages, tinned	1 × 16 oz.	3½ oz.	Fibreboard case
	Pork and vegetable ration	5 × 16 oz.	16 oz.	Measurement, 9¾ in. × 9⅛ in. × 6 in.
	Bacon, tinned	1 × 18 oz.	3⅜ oz.	Gross weight 14 lb.
	Pudding, sweet	1 × 19 oz.	3 oz.	
	Cheese	3 × 3 oz.	1⅜ oz.	
	Beans, canned	1 × 20 oz.	4 oz.	
	Tea, sugar and milk powder	3 × 5 oz.	3 oz.	
	Sweets, boiled	1 × 5 oz.	1 oz.	
	Latrine paper	30 pieces	6 pieces	
	*Biscuits, Service	5 × 10 oz.	10 oz.	

Note: The nutritive value of the New Type A.F.V. Packs was approximately 3,500 calories.

* Biscuits, Service were not contained in the A.F.V. Ration Packs, but were issued separately.

The problem was considered by the A.F.V. Sub-committee of the M.R.C. and in due course a very satisfactory flame-proofed light-weight oversuit was devised for the protection of R.A.C. personnel.

Before adoption the treated cloth was subjected to wear and tear tests and the effects upon it of saturation with mineral oil were examined. It was found that the properties remained effective and that the flames

could easily be extinguished by beating with the hands, or by a strong current of air, without the fabric getting burnt,

Ventilation of Tanks. The question of the ventilation of tanks to provide for the removal of gun fumes was studied by special investigators for the A.F.V. Sub-committee of the M.R.C. This sub-committee submitted reports on the results of their investigations which were taken into consideration subsequently in the design of A.F.Vs.

In a Parliamentary inquiry addressed to the Secretary of State, regarding the effects of intense heat on our troops in Libya, it was suggested that air-conditioned tanks were being used by the Germans. This rumour however could not be substantiated either from medical or general staff sources. It was pointed out by the War Office in reply that the possibility of air-conditioning tanks had not been lost sight of from the medical point of view but it was understood that the technical difficulties of providing air-conditioning, as commonly known, were so great as to render provision unlikely.

Postural Injuries. Apart from injuries due to specific accidents, to which R.A.C. personnel are rather prone from the nature of their work, it was found that tank drivers were liable, after prolonged periods of driving, to sustain injury which was attributed to strains imposed on them by the uncomfortable drivers' seats provided. These drivers complained of pain in the lower part of the back (lumbar, sacral and sacro-iliac regions). This is illustrated in the following extract of a report made by the unit medical officer at the request of the War Office, after a court of inquiry concerning the circumstances in which two officers and thirty-seven other ranks of the Fighting Vehicle Proving Establishment sustained injuries while driving A.F.Vs. on test:

> 'The position of a tank driver, at its best, is uncomfortable and it would appear that his comfort is considered least and last. This position, however, has been worked out mathematically, and is the optimum position for getting the maximum potential pressure to bear on the controls, brakes, etc.; to obtain this his left hip and knee are bent up; the right hip is partially bent; the right knee is almost straight and held rigid; in consequence he rests little on his thighs but his weight is on his buttocks at the ischial tuberosities only. There is no ratchet arrangement for adjusting the seat; consequently long men and short men work at a mechanical disadvantage, the former being huddled up and the latter unduly stretched out.
>
> 'This, however, is not the only drawback. When the position was worked out to yield maximum pressure on the controls, it appears to have been assumed that the driver could at the same time thrust himself back into his seat so that the lower part of his back was brought firmly in contact with the back of the seat. In practice, however, this does not appear to be the case, as the present standard seat has no proper back,

but merely a curved bar which crosses the driver's back about the level of the shoulder blades. Some patterns have a bucket seat but here again the shoulder blades are pressed against the back of the seat, and contact is relaxed at the lower part of the back. In both cases the consequence is support given to the back about the level of the shoulder blades; the lower part of the back is unsupported and tends to sag and bulge into the hiatus between seat and shoulders, and any attempt to thrust back into the seat makes the matter worse.

'After a few months of such driving very many drivers begin to get pain in the lower part of the back, due partly to fibrositis and partly to overstrain on the vertebral joints. In many cases the disability has become permanent. In at least one case there appears to be an actual displacement of an intervertebral disc, without any other trauma.

'The drivers are very definite about the cause of their disability and try to modify the pattern of the seat by putting a folded greatcoat at the lower part of the back. What is needed is a seat the back of which is shaped so as to remain in contact with and give support to the driver's back.

'These test drivers of the Fighting Vehicles Proving Establishment are deliberately subjected to very severe strains, driving six hours a day for weeks over the roughest country at top speed'.

A.F.V. units, however, did not make this complaint, and this was accounted for by the fact that they did not do enough driving to bring the trouble to light. As the regimental medical officer of the F.V.P.E. remarked: 'except in actual battle a tank driver in a unit will probably drive about two hours a week'.

Medical Supplies. It had always been the practice to provide each A.F.V. with a first-aid box. The Army Medical Directorate was also alive to the necessity for ensuring the availability of morphia for use by the crew of an A.F.V. and it had been included in the first-aid outfits since the beginning of the war.

While there was general agreement that morphia should be available there was not the same agreement as to the method by which it should be made available. This was the subject of a recommendation by the A.F.V. Sub-committee of the M.R.C. which considered that the morphia should be included in the first field dressing but no suggestions were made as to the form in which morphia was to be supplied or the method of packing in the dressing.

The following facts were represented to the sub-committee by A.M.D.5 in order that they might reconsider the implications of their recommendation:

'The first field dressing is not a medical supply.

'To ensure provision to A.F.V. crews would involve the preparation and issue of a special type of dressing for A.F.V. personnel or the addition of morphia to all first field dressings manufactured.

'Three million first field dressings are manufactured every year for maintenance of supplies at home and abroad. The addition of morphia to all first field dressings would involve a considerable amount of the drug.

'With the means of presentation at present available, there is no reasonable guarantee that the drug would be fit for use when required in view of the violence to which the dressing is exposed during wear.

'The difficulty of providing the drug in a suitable form remains a predominant factor if morphia is to be added to all or any field dressings.

'The dangers of addiction and over-dosage are not the most influential factors in this problem and A.M.D.5 felt that they ought to reassure the committee on this point'.

The Commander-in-Chief, Middle East, was asked to give his views on the subject and these are summarised below:

(*a*) The necessity for the inclusion of morphia in first-aid outfits in tanks is agreed.

(*b*) Ampoules are preferable to tablets.

(*c*) Chloroform craquettes replaced tubonics in recent operations with success.

(*d*) Individual issue is not agreed. Wastage due to breaking of tablets is enormous and there is temptation to traffic in a high-priced market.

(*e*) Experience has shown that the first-aid box is left behind if the crew bale out when an A.F.V. is hit.

(*f*) A small emergency first-aid outfit containing morphia and craquettes and three shell dressings is required for carriage outside the back of the tank in a non-vulnerable part. The outfit must be sealed for security against sand and weather and is to be *additional* to the first-aid outfit (less morphia and craquettes) inside the tank. This policy is agreed by A.F.V. representatives.

On receipt of this information from Middle East, action was taken to prepare an outfit of the type recommended. A trial outfit after inspection by the A.F.V. authorities was passed to the Department of Tank Design for consideration of the most suitable method of carriage on the outside of the tank.

The question of a personal issue of morphia was also discussed with an A.D.M.S. of an armoured division who had had considerable battle experience in the Middle East and his views corroborated those given above.

Disposal of Dead from A.F.Vs. A problem in which hygiene officers were required to give advice was the method of treating dead and more particularly fragmented corpses in tanks to obviate offence from smell due to decomposition before final disposal. It can readily be understood that this problem was considerably aggravated in the desert campaign in the Middle East owing to the heat and prevalence of flies. It was not encountered on the same scale in operations in North West Europe

where A.F.Vs. were recovered more rapidly and the climatic conditions were less trying.

Among the methods to which consideration was given were the following:

(i) The procedure employed in the Navy as described in Royal Naval Medical Bulletin No. 8 (p. 19, para. 55) which is as follows:

'Corpses.

'The best material to use on corpses to eliminate the smell is a mixture of bleach and sawdust. When one volume of bleach powder is mixed with about five volumes of slightly damped sawdust and sprinkled freely over the decomposed bodies, the atmosphere becomes perfectly tolerable.

'The bleach and sawdust mixture is light and can be used inside a coffin if necessary, but it must be remembered that the sawdust must be damp so as to avoid the possibility of ignition.

'The Compartment.

'To cleanse the compartment itself a wash down with bleach and water one in twenty is adequate. This mixture will corrode metals unless they are first covered with grease and vaseline'.

(ii) The use of charcoal. This was referred to the Chemical Research Department who reported as follows:

'It is not possible to make a clear recommendation here without knowing the frequency with which men are not merely killed, but more or less fragmented, in tanks. If it is a question of dealing with fragments lodged in really inaccessible places, it is doubtful whether, in view of the queer air pockets and currents in tanks, placing of charcoal in various places would be adequate. If the charcoal were sprinkled on and around the fragments it would no doubt be of use, but if the degree of accessibility allowed of this it would allow of more radical measures. Bleach and sawdust as used by the Navy would probably be at least as good and probably better, but it could not be left there long.'

(iii) A special oil composed of creosote oil with the addition of a lighter oil was adopted and used successfully in the desert.

This disinfectant fluid when sprayed on corpses or fragments prevented smell and was repellent to flies. It was issued to R.E.M.E. recovery units together with the necessary spraying equipment. 21 Army Group used a heavy creosote oil undiluted for this purpose. This and the spraying equipment were issued to all armoured and R.E.M.E. units in 21 Army Group.

Field hygiene sections personnel were frequently called on for assistance by R.E.M.E. recovery units and armoured units in carrying out this task, which some commanders considered the fighting troops should not be called upon to undertake on the grounds that it was detrimental to morale.

AIRBORNE FORCES

Parachute Units. Reinforcements of personnel for parachute units were found from volunteers from other arms of the Service. A.M.D.5 was concerned in prescribing medical standards for these volunteers to ensure that only suitably fit personnel were selected for these duties in view of the fact that parachute troops were required to be capable of reaching the highest standard of training. Volunteers selected for parachute training were medically examined to ensure that they complied with the following standards laid down in A.C.I. 952 of 1943:

1. Age limits . 18½ to 32 years.
2. Height . not to exceed 6 ft. 2 in.
3. Weight . not to exceed 182 lb. without clothes and must correlate normally with the height.
4. Visual standards. The visual acuity was not to be below 6/12 in each eye and personnel were to have normal or colour defective safe colour vision. Men wearing glasses were not accepted.
5. Hearing standards. The acuity of hearing to comply with hearing standard 2, i.e. the man standing with his back to the examiner and using both ears must be able to hear a forced whisper from 10 ft. away. No man with otorrhoea or a perforation of an ear drum was accepted and the eustachian tubes had to be patent.
6. Dental standards. Personnel were required to be dentally fit and not be in possession of either a full upper or lower artificial denture.
7. General. During the medical examination special care was to be taken to ascertain that the circulatory system was normal and that there were no disabilities of limbs especially of the bones and joints; and that in all respects the man was fit for army medical category A.1.

Some relaxation of these standards was agreed to later, e.g. standard III vision was allowed but spectacles were not to be worn while jumping.

When it was decided that candidates for the Parachute Regiment A.A.C. could be selected from among G.S.C. personnel at primary training centres, there was a strong recommendation for the abolition of the lower age limit of 18½. After consultation with D.D.M.S. Airborne Troops this suggestion was not approved by A.M.D.5., as experience had shown that these younger men could not stand up to the strenuous demands for physical endurance required by units of the Parachute Regiment. This had no connexion with actual jumping. For this reason it was felt that the age at which a parachutist should join his unit should not be lower than 19 years.

Volunteers were examined initially by their unit medical officers and then appeared before a parachute selection board. Those who were accepted for parachute training were posted for a probationary period of twenty-one days to the Airborne Forces Depot before being taken on the strength of the latter.

Owing to the exacting standards required in the training of parachute personnel which demanded the highest level of physical and mental fitness in volunteers, there was a high percentage of wastage among them before they reached operational parachute units. As the result of a complaint in this connexion an analysis was made of the causes of this wastage to ascertain the proportion of rejections made on medical grounds.

The following facts emerged:

(*a*) Volunteers could be rejected by their unit medical officer if the latter did not consider them up to standard laid down in A.C.I. 952/43. There was, however, no record of these rejections. These men were not, of course, examined by the Parachute Selection Board.

(*b*) Volunteers who reached the Parachute Selection Board could be rejected either by the medical officer or by the personnel selection officer (P.S.O.). The rejections on this account in the United Kingdom during the month of May 1943 are shown in the following analysis:

Rejections:

Total volunteers appearing before parachute boards	*Rejected by M.O.*	*Rejected by P.S.O.*	*Voluntary withdrawals*	*Total of rejections*
1,525	406 (26 per cent.)	390 (25 per cent.)	61 (4 per cent.)	55 per cent.

(*c*) Wastage occurred among volunteers accepted for training at the training centres at Hardwick, Ringway, or at the parachute battalions. The following analysis was based on available figures over a period of three months:

Wastage:

(i) At Hardwick.

12 per cent. of men reaching Hardwick were rejected, of which

56 per cent. were on physical grounds.
12 per cent. were on psychiatric grounds.
26 per cent. were voluntary withdrawals.

i.e. Average per cent. rejections on medical grounds (physical and psychiatric)—8·1 per cent.

(ii) At Ringway.

11 per cent. of men reaching Ringway were rejected, of which

48 per cent. were refusals to jump
34 per cent. R.T.U. as unsuitable
15 per cent. injured

} Majority of these were temperamentally unsuitable for parachuting.

i.e. Average per cent. rejections on medical grounds—1·65 per cent.

(iii) At battalions.

This varied considerably but over a period of 12 weeks the average wastage worked out at 11 per cent. of which
75 per cent. were 'refusals' or 'R.T.U. unsuitable'.
25 per cent. Y-listed due to accident or disease.

i.e. Average per cent. rejections on medical grounds at battalions—2·75 per cent.

From these analyses it was evident that the causes of wastage were not confined to those made on medical grounds. Some of the causes such as 'refusals' and 'R.T.U. unsuitable' apparently defied accurate definition.

Air Landing Units. Medical standards for air landing personnel were considered at a meeting attended by representatives of airborne divisions and A.M.D.5 and it was agreed to adopt a category A standard for the arm of the Service to which they belonged.

Glider Pilot Regiment: Army Air Corps. The following medical standards of fitness for army personnel volunteering for training as glider pilots and transfer to Army Air Corps were laid down.

Age limits . .	From 18 years to 31 years.
Height . . .	Not less than 5 ft. 4 in.
Medical standards .	Medical category A.1. Candidates were required to pass a further medical examination at the Aviation Candidates Selection Board stage to determine their fitness for employment as army glider pilots.

Operational Feeding. The airborne pannier was devised for the conveyance of supplies by air, either in gliders or powered aircraft. With this pannier the ordinary compo (14-men) ration pack could be used—three such ration packs in original cases (total 42 rations) being packed in a pannier.

When the bomb-type supplies-dropping apparatus was used, 28 rations to the precise scale of the compo (14-men) ration pack could be dropped by air but required special packing.

It was sometimes necessary, owing to limitations of time and equipment, to subsist isolated groups of men from the air by free dropping. Experience had shown that free dropping of cased supplies packed in tins resulted in considerable loss due to breakage of containers on impact with the ground. Free dropping with minimum losses was possible when the rations dropped were 'dry' items as opposed to processed items, and were packed in large double hessian sacks and the contents restricted to 40 lb. In this way items such as flour, biscuit, salt, sugar, tea, milk powder, cheese (crated), margarine (packet), bacon M.C. could be dropped successfully and, when quick consumption could be assured, dehydrated meat and vegetables in tins packed in sacks could likewise be dropped.

Air-sickness Prevention. It was brought to notice by Airborne Division that while men were waiting to emplane in gliders or powered aircraft, and while actually flying, particularly in gliders, there was a considerable degree of nervous tension, which increased the liability to air-sickness. The medical authorities airborne division recommended that this tension might be relieved by an issue of chewing gum, a practice which the Royal Air Force had adopted with beneficial psychological effect. This was agreed to.

Load carried by Airborne Troops. It had long been recognised that the optimum load which a soldier could carry without a disproportionate loss of efficiency was 30 per cent. of his body weight, i.e. roughly 50 lb. On this standard the load which it was proposed that a soldier of airborne troops should carry was an example of overloading. The details worked out in 1942 were as follows:

TABLE 31

The Load carried by Airborne Troops

	lb.	*oz.*
Battledress and clothing	14	1
Respirator and anti-gas cape, etc.	6	8
Rifle and bayonet	10	7
6 Bren gun magazines, filled	16	2
2 grenades	3	0
50 rounds of S.A.A.	3	2
Equipment basic (includes haversack) (greatcoat omitted)	4	7½
	57	11½
Contents of haversack	*lb.*	*oz.*
Water-bottle, full	3	14
Mess tin	1	4
Ration, special	1	0
Emergency ration		8
Knife, fork, spoon		6½
Cardigan	1	7
Towel	1	4
Shaving kit	1	0
Socks		9
Cap comforter		9
Shirts	1	7
Shoes	3	0
Underwear	3	0
	19	4½
		oz.
Clasp knife		5½
Braces		4½
Pay-book and identity discs		2½
		12½

Total weight carried, 77 lb. 12½ oz.

It is the responsibility of the Army Medical Directorate to make available information of this kind, but it does not follow that in war such

advice can be transformed into action. Considerations other than physiological commonly determine what shall be done.

Special Airborne Equipment. Much equipment was specially designed for airborne troops. Equipment of interest to hygienists included:

(*a*) The airborne water tank trailer (100 gallons).

(*b*) The air-portable M.L.B.U. devised for use in jungle warfare.

DIVERS

It was necessary to select and train certain R.E. tradesmen as divers and the following standards were laid down for this exacting work:

Selection. Candidates were required to be of good physique and able to swim. Any marked tendency to obesity disqualified. Exceptionally tall or short men would have difficulty in using diving dress. Tradesmen for initial training were accepted up to 36 years, provided they satisfied other medical requirements, and up to 45, if they were already experienced divers.

Medical Examination. All candidates were given an X-ray examination of the chest and the medical officer was required to ensure that the films were kept available for future reference. A copy of the radiologist's report was attached to the soldier's documents.

A careful physical examination of the various systems (including examination of the urine) was carried out. A healthy state of the ears, nose and throat was essential. The eustachian tubes had to be patent and the septum not deflected. The presence of hernia, marked varicose veins or any constitutional complaint disqualified. Men of nervous or excitable temperament were rejected. Active skin or venereal disease disqualified. Operation scars, if healthily and soundly healed, did not disqualify if the medical officer was of the opinion that the man was capable of working under water. Finally, the medical history sheet was scrutinised regarding repeated entries for respiratory or other complaints.

A certificate was made out by the unit medical officer, counter-signed by the officer commanding the unit and attached to the soldier's documents together with the radiologist's report.

The following additional instructions were issued regarding the medical supervision of tradesmen divers R.E. when employed on this work:

(*a*) They were to be medically examined before diving, except when continuous diving was taking place, in which case they were to be examined at least twice weekly.

(*b*) They were forbidden to descend immediately after a heavy meal and were required to remove dentures (if any) before going down.

(*c*) Every diver was medically examined annually in order to ascertain if he was still fit for work under water. The result of this examination was recorded on his medical history sheet.

CHAPTER 4

THE ARMY HYGIENE SERVICE (Cont.)

Certain Diseases of Military Importance

CEREBRO-SPINAL FEVER*

HAVING in mind the experience of the War of 1914–18, when cerebro-spinal fever had proved to be such a serious cause of sick wastage among troops under training in the United Kingdom, measures for the prevention of this disease became one of the major pre-occupations of the Hygiene Directorate during the early part of the War of 1939–45. Cerebro-spinal fever was always regarded as a grave disease with a high mortality in the absence of early and adequate treatment, and although it might occur in individuals of all ages, young men lately transferred from civil to military life appeared to be especially prone to attack.

Incidence. It was found that cerebro-spinal fever achieved its maximum incidence in the United Kingdom during 1940 and thereafter declined gradually until it eventually became a relatively unimportant cause of sick wastage. The incidence expressed as a ratio per 1,000 was as follows:

1940	1941	1942	1943	1944
1·09	0·46	0·3	negligible	

During 1940 there were 1,447 cases in the United Kingdom. It was expected that there would be a big carry over in 1941 but fortunately this did not materialise, as the following figures show:

	1940	1941
January . .	130	109
February . .	271	99

Whereas in the early weeks of 1940 there was a progressive increase in cases, during the same weeks of 1941 the figures remained fairly steady—reaching their maximum during the week ending February 22, 1941 and afterwards declining until they had reached 16 at the end of May, after which they remained fairly constant at that level.

Week ending	4.1	11.1	18.1	25.1.	1.2	8.2	15.2	22.2	1.3
Army 1941	17	30	35	27	26	25	33	36	30
Army 1940	14	23	38	55	52	91	67	61	57

* For further information consult the Statistical Volume, the Volume on Medicine and Pathology, Chapter 6, and Civilian Health and Medical Services, Vol. I., Chapter I.

Week ending . . .	4.1	11.1	18.1	25.1	1.2	8.2	15.2
Civil population 1941 .	232	266	287	307	332	345	376
Civil population 1940 .	53	107	144	184	299	406	557

Army mortality rate 1940 = 10 per cent.
Army mortality rate 1941 = 1·5 per cent. in 260 cases.

With a view to determining whether the incidence of the disease was influenced to any extent by the type of accommodation provided, i.e. barracks, hired buildings, billets or huts, medical officers in notifying cases were required to state the type of accommodation in which the case occurred. An analysis of the information provided in this way did not show any significant difference in the incidence in these various types of accommodation.

The only overseas theatres in which the incidence of this disease was noteworthy were in France during 1939–40 and in India.

Between October 1939 and May 1940, 346 cases were reported in the B.E.F. giving an equivalent annual ratio per 1,000 of 1·4. The following observations were made by D.D.H., B.E.F. concerning these cases:

'It was noted that there were few instances where more than one case occurred in the same unit, and there were no instances of more than one case occurring in the same billet. It did not appear to occur only in crowded conditions where it might be expected, but occurred in many instances where there was ample accommodation and good ventilation.

'At first cases were treated in French hospitals and the death rate was high; but when it was arranged for cases to be admitted to C.C.Ss. and general hospitals where immediate modern treatment was given, there was an astonishing fall:

Death rate in the first 98 cases . .	16·3 per cent.
Death rate in the next 92 cases . .	3·3 per cent.
Death rate in the next 31 cases . .	3·0 per cent.
Death rate in the next 15 cases . .	0·0 per cent.
Death rate in the next 21 cases . .	5·0 per cent.
The average was roughly . .	8·0 per cent.

'The age incidence was:

19–21	28·3 per cent.
22–24	25·5 per cent.
25–27	13·4 per cent.
28–30	10·6 per cent.
31–33	4·2 per cent.
34–36	8·5 per cent.
37–39	8·9 per cent.
40	0·7 per cent.
Average age	26·6 years

'When the epidemic in the B.E.F. was at its height, there were no cases in the French Army during the early stages and only sporadic

cases among the civil population, mostly children of about 11 years. Later, cases began occurring in the French Army in alarming numbers. The British Army was obviously the source of infection.

'It appeared that although the organism found in the cerebro-spinal fluid was almost always type I, carriers were type II and cases did not show the presence of the organism in the naso-pharynx.

'At first contacts were swabbed, but this was discontinued, as it was found to be of no practical value.

'A small scale experiment was carried out to determine the effect on carriers of M & B 693 administered by the mouth and as a gargle. This drug did not appear to have any marked effect in eliminating the organism from the naso-pharynx.'

In India, cerebro-spinal fever was not on the whole an important cause of sick wastage and nothing in the nature of an epidemic ever occurred. At the same time a steady number of cases occurred annually, mainly in the northern recruit-training centres. The disease was much less prevalent among British than among Indian troops. The rate among Indian troops showed a tendency to increase during the war years while the British rate remained steady as shown in the following table :

TABLE 32

Incidence of Cerebro-spinal Fever, India, 1938–43

Year	1938	1939	1940	1941	1942	1943
British .	0·1	0·1	0·2	0·1	0·2	0·1
Indian .	0·2	0·2	0·6	2·4	2·7	1·6

Prevention. Experience had shown that it was rare for a contact of a case of meningitis to develop the disease; nevertheless, it was the practice for close contacts of a case to be kept under daily medical surveillance for ten days, while other contacts were ignored. When two or three cases occurred in a group of individuals in contact with each other, the evidence suggested that the disease was contracted from those harbouring the meningococcus but not suffering from cerebro-spinal fever. Moreover, since carriers were much more numerous than cases and since cases were safely isolated in hospital, while carriers pursued their normal association with their fellows, the carrier was by far the more important source of infection.

Although the carrier rate might be high during an outbreak this was not invariably so. Post-nasal swabbing of large groups of individuals, for the estimation of the carrier rate, was found to serve no useful purpose in controlling the incidence of the disease and was abandoned very early in the war.

It was found that carriers could be successfully eliminated by small doses (2 g.) of sulphadiazine or sulphathiazole administered to all in the community involved. This greatly simplified the problem of dealing with carriers, and their bacteriological examination and segregation was no longer necessary. This form of prophylaxis was indicated on the occurrence of:

(i) a case when overcrowding was unavoidable, e.g. on board ship.
(ii) more than two cases in a camp or station per 1,000 of strength per week.

Since there was no valid evidence to show that gargling, douching, spraying and inhalation or preventive inoculation had any prophylactic value, none of these measures were recommended.

At all times, but particularly during periods in which the general incidence of cerebro-spinal fever was high, preventive action was directed to measures to secure the amelioration of those conditions which were known to favour the spread of the disease, viz. over-crowding and inadequate ventilation of quarters. From time to time orders and instructions were issued emphasising the necessity for paying particular attention to the following points:

Overcrowding. In sleeping quarters, the minimum distance allowed, in war-time, between the centres of beds, was 5 ft. When it was necessary to reduce the space to this minimum, every alternate bed was turned round so that each man slept with his head next to his neighbour's feet. In peace-time the space allowance in sleeping accommodation was 60 sq. ft. but during the war this was progressively reduced, first to 45 sq. ft. and then to 30 sq. ft. To relieve pressure on space double-bunking was introduced and, from the medical point of view, was accepted as safer than having beds closer than 3 ft. The minimum air-space in double-bunked accommodation was 345 cu. ft. per head and, except in certain types of standard hutting such as Nissen and M.O.W.P., double-bunking was prohibited in rooms which were less than 10 ft. in height.

The most dangerous periods in sleeping accommodation were when the troops were going to bed or getting up. Unless a number of the occupants were suffering from coughs the projection of infected droplets was much less during sleep. It was important to prevent overcrowding in dining halls. Under epidemic conditions it was recommended that men should if possible sit on one side of dining tables only.

Ventilation. This was of prime importance and, combined with the avoidance of overcrowding, was the sheet anchor in the prevention of cerebro-spinal fever. All occupied rooms, including barrack rooms, institutes, dining rooms, lecture rooms etc., should at all times be so ventilated that there was a free circulation of air. As the maximum intensity of the occupation of buildings by the soldier occurs during

winter evenings, it was necessary that particular attention should be paid to the provision of a sufficiency of effective ventilator openings. Rooms should be adequately aired to prevent dead space air from accumulating. This problem was rendered infinitely more difficult by the necessity for maintaining a blackout during the hours of darkness to comply with the P.A.D. regulations. It became essential to insist that suitable forms of louvred shutters should be provided to ensure ventilation as well as the obscuration of lights.

The provision of adequate ventilation in some buildings was not an easy matter but all officers commanding units were required to make every effort to ensure that the best ventilation possible was obtained in every occupied room. In order to ensure that satisfactory ventilation was maintained constant inspection by officers or senior N.C.Os. was necessary.

Efficient heating of occupied buildings and an adequate supply of blankets for the beds during the cold weather was essential, otherwise all efforts to maintain satisfactory ventilation would be circumvented.

Measures to allay dust were important, such as the oiling of wooden floors with spindle-oil. This measure was widely used in the prevention of droplet infections.

Since meningococcal infections were most readily transmitted when people were crowded together in ill-ventilated rooms, during epidemic periods it was recommended that as much time as possible should be spent in the open air away from canteens, cinemas and other likely sources of infection. At the same time, over-fatigue and long periods without hot meals were to be avoided, as young recruits might thus become liable to colds and other minor disabilities that might render them susceptible to a blood-stream invasion of the meningococcus, should this organism reach the naso-pharynx.

Early recognition of cases and efficient treatment succeeded in reducing the mortality from this disease from 10 per cent. in 1940 to 8 per cent. in 1941 and about 2 per cent. in the later years of the war.

Pamphlets. The excellent pamphlet *Memorandum on Cerebro-spinal Fever among Troops*, 1942, notified in Army Orders for June 1942, which was issued to all medical officers, supplied all the essential information concerning the early recognition, treatment and prevention of this disease.

DYSENTERY AND DIARRHOEA*

It is convenient to consider diarrhoea, bacillary dysentery and amoebic dysentery together. No hard and fast differentiation exists between the first two as diarrhoea is frequently the precursor of dysentery and many mild attacks of dysentery are miscalled diarrhoea. All three are of great

* *See* Volume on Medicine and Pathology, Chapters 1 and 7.

importance to armies in the field and more especially those operating in tropical and sub-tropical countries.

Incidence. Dysentery has been, beyond others, the disease of armies in the field. During the War of 1914–18 it was the most common medical cause of inefficiency; it was responsible for many deaths and left many more men more or less permanently disabled. The incidence of dysentery in the Dardanelles campaign reached the remarkable figure of 250 per 1,000 per annum. During the War of 1939–45 dysentery was only outstripped by malaria and V.D. in tropical and sub-tropical theatres as the highest cause of admission to hospital but, although it never attained the proportions it did in 1914–18, it nevertheless remained a very serious cause of sick wastage. The highest incidence recorded in any theatre of war was 62 per 1,000 per annum in 1940 in the Middle East. In some theatres, particularly the Middle East, the disease appeared to be of milder type than that experienced in the War of 1914–18. The course of the bacillary type of the disease was considerably influenced in the War of 1939–45 by the introduction of the sulphonamide drugs for treatment, and particularly early treatment. The particular drug used was sulphaguanidine and this not only reduced the time spent in hospital but, it was claimed, rendered the stools non-infective. It would seem that among armies in the field, epidemic dysentery is, with an occasional exception, always of the bacillary type and is related to the fly season. In careful surveys only about 5–10 per cent. of the dysentery cases were found to be amoebic. The amoebic form was prevalent wherever Indian and native African troops were employed. Exceptionally, it once occurred as an epidemic in Burma in 1944 during the rains when flies were not prevalent. This led certain medical officers to attribute its origin to water in preference to the more generally accepted causes—carriers and flies. It is possible that this outbreak during the rains may have been the result of chills through wetting as it only occurred among the forward division which was presumably more exposed. The rearward troops who had shelter and means of drying their clothes were not affected.

In India the incidence of these diseases increased considerably compared with pre-war years for both British and Indian troops. This was a reflection of the deterioration of sanitation, mainly inevitable, which took place during the war. In addition to the increase in all diarrhoeas and dysenteries it was noted that there was a relative increase in amoebic dysentery compared with bacillary. This was attributed to the fact that during the war the main concentration of troops was shifted from the north-west of India to the east and, to a lesser degree, to the south. In India the incidence of amoebic dysentery has always been higher in the moister climates of the south and east than in the north and west.

The following table shows the incidence per 1,000 of strength over six years for both varieties of dysentery and for diarrhoea:

TABLE 33

Incidence of Dysentery, India. 1938–43

British Troops

Year	1938	1939	1940	1941	1942	1943
Amoebic dysentery	3·4	2·5	2·8	4·0	6·5	8·4
Bacillary dysentery	13·7	17·7	20·5	18·3	19·2	17·0
Diarrhoea	18·0	18·2	25·0	55·4	72·7	43·6
Totals	35·1	38·4	48·3	77·7	98·4	69·0

Indian Troops

Year	1938	1939	1940	1941	1942	1943
Amoebic dysentery	0·8	0·6	0·9	1·1	1·0	1·3
Bacillary dysentery	10·6	11·2	13·2	9·4	6·5	4·6
Diarrhoea	7·5	6·3	10·9	23·7	32·7	25·7
Totals	18·9	18·1	25·0	34·2	40·2	31·6

It was estimated that, during the first few months of the campaign against Italy in Libya and the Western Desert, of every 500 men evacuated by ambulance train, over 60 were suffering from dysentery. Although this figure became very much lower later, it still showed a tendency to increase every time fresh troops arrived in the area. This latter point was discussed in a memorandum by D. of H. to D.G.A.M.S. in December 1942 of which the following is an extract:

'The question is, how can we get the combatant to take hygiene advice seriously? Practically every report from overseas includes a statement that units newly arrived have no sanitary conscience and it is only after sad experience that they learn the lesson.

'There was a big epidemic of dysentery in the 51st Division lately arrived in the Middle East, which was attributed to a complete lack of sanitation. We spend much time and labour in instructing officers and men at the Army School of Hygiene and at field hygiene schools throughout commands. I presume the regimental medical officer is also advising his unit and still it is the exceptional officer commanding who takes any heed of the medical advice.

'We also know that it is only when the soldier gets "the wind up" . . . that he really gets down to it and takes notice.

'The number of officers and O.Rs. trained at the Army School of Hygiene to date is:

Officers	8,905
O.Rs.	35,978
Total	44,883

'The numbers trained by hygiene officers in commands must double this figure.'

In the *Middle East Training Pamphlet No. 17 Part I* this increased incidence among troops newly arrived in the area was attributed to a large extent to lack of appreciation of the importance of sanitary discipline under active service conditions in the Middle East, and to ignorance of ways and means of overcoming the many difficulties in this respect that were peculiar to that command, where many factors existed which made the prevention of epidemic excremental disease a major problem.

These factors were enumerated as follows:

1. Contact with a native civil population, a large percentage of whom were 'carriers' of intestinal diseases and who owing to their lack of sanitation were liable to spread the infection to the troops.
2. Contact with troops from parts of the Empire where these diseases were prevalent, and among whom the 'carrier' condition existed.
3. Contact with an enemy whose sanitary discipline was poor and who had a high sick rate from dysentery, etc.
4. The liability of encountering in the Middle East organisms of severe types of dysentery which did not occur at home and to which the average British soldier had therefore acquired no immunity.
5. The very much greater prevalence of flies which, because of the ideal climatic conditions, multiplied more rapidly in that theatre than in Europe.

Outbreaks of diarrhoea and dysentery, usually of the *Sonné* type, occurred in summer among troops in the United Kingdom and in North-west Europe. Much concern was also caused by the number of outbreaks of diarrhoea which occurred in troop transports, as is shown in the following memorandum, dated January 1943, addressed to the Director of Movements from D. of H.:

'1. Outbreaks of diarrhoea on board ship are extremely common, and cases are referred to in the majority of voyage reports. I have been perturbed by the number of sizeable epidemics which have been reported, and the extreme difficulty in assigning any definite cause. None of these outbreaks has been serious but they are caused by infective organisms and where a mild infective agent can pass, a dangerous one could also do so. It is for this reason that I take a very serious view of what many people—the ship's officers in particular—regard rather lightly.

'2. Investigation has shown that washing arrangements for soldiers' eating utensils are unsatisfactory in practically all transports. This has been commented on in many S.M.O's. reports, especially in recent months, by American medical officers. The communal washing vessel of tepid water is a very potent source of infection, and it may well have been responsible for many of the outbreaks recorded.

'3. It is requested, therefore, that Sea Transport be asked to take this matter up, and to ensure that adequate arrangements are provided in all ships. The type of provision will vary with the circumstances, but I suggest as standard, a double trough of adequate size, one half filled with hot water, the other with boiling water heated by means of steam jets; at least two of these sets to be provided per 1,000 men on the agreed capacity of the transport. It is essential that they be placed where easy access and two-way traffic can be arranged.

'4. In view of the prevalence of dysentery in the United Kingdom I would urge that this matter be given priority.'

Voyage reports frequently referred to outbreaks of enteritis, usually affecting both officers and other ranks, following upon calls at Freetown, Cape Town or Durban. At the time these were variously attributed to water, food, or chilling of the abdomen, but seldom with any confidence. Outbreaks were generally explosive, affected large numbers and subsided rapidly.

The following is a typical report (*H.T. Britannic*, March 1942):

'An epidemic of diarrhoea among the officers and sisters started while lying off Freetown. No cause was found and it cleared up with conservative treatment. A second and more severe epidemic affecting all ranks, and apparently the crew, occurred soon after leaving Durban. No specific cause could be found and the only common factor was the water. It is possible that the water at this date came from the same tank that was in use at the time of the first epidemic. This epidemic also responded to conservative treatment.'

Occasionally inquiry directed suspicion to a particular source.

A court of inquiry (*H.T. Moloja*, May 1942) was held into an outbreak affecting 87 men, who suffered from diarrhoea, colic and vomiting, which began the day after leaving Freetown and lasted for eight days. In this instance infected ice placed in water and drinks was suspected, but the use of dirty water for the washing of utensils was also mentioned.

The difficulty of being able to pin any outbreak of enteritis down to a definite cause was appreciated, but the association of so many of these outbreaks with calls at ports was considered to be very striking and D.D.M.S. West Africa and A.D.M.S. Military Mission, Pretoria were requested to undertake an investigation and take any appropriate action which was found to be necessary. Both replied in due course that there was no evidence to suggest that the outbreaks had originated at these ports.

Prevention. The high incidence of dysentery which occurred among troops newly arrived in certain theatres of war once again emphasised that in campaigning anywhere, and more particularly in the Tropics

and Sub-tropics, the least carelessness in field sanitation will be punished by an epidemic of dysentery.

At home every effort was made to instruct officers and other ranks in the essentials of hygiene before they proceeded overseas by giving priority in the allotment of vacancies for courses in hygiene at the Army School of Hygiene to units and formations preparing for overseas service. This instruction was reinforced by divisional field hygiene sections forming schools of instruction for personnel of their own formations. In most of the overseas theatres schools of hygiene were formed and these carried out an enormous amount of excellent work in inculcating the essentials of practical field hygiene among the troops. The reports about the ignorance of sanitation on the part of newly arrived formations overseas were very disappointing, and it can only be concluded that it is extremely difficult to impress on the soldier at home the importance of maintaining a high standard of sanitation overseas and of the risks which follow sanitary lapses until he has personally experienced the necessity for it. The brief periods spent by troops at home on exercises in the field were insufficient for them to learn in a practical manner how to maintain themselves in the field and apply the lessons they had been taught at the schools of instruction they had attended. The schools of hygiene overseas had the advantage that their students had already appreciated by personal experience the necessity for maintaining good sanitary discipline under active service conditions.

The main measures in the prevention of outbreaks of dysentery were directed to the prevention of fly-breeding and the destruction of adult flies, since the latter constitute far and away the most important vehicle by which epidemic diarrhoea and dysentery are spread. There is a close correlation between an increase in the prevalence of flies and the incidence of dysentery.

In the War of 1914–18 the greater use of animal transport and the great difficulty in disposing of manure considerably increased the sources of fly-breeding in the field. In the War of 1939–45 the virtual disappearance of the horse from modern war removed this fertile source of fly-breeding, so that suitable breeding places for flies were reduced for practical purposes to those provided by the troops themselves in failing to dispose of their own waste products efficiently. This was particularly the case in desert zones where there was no civil population. The tendency to regard fly-breeding as inevitable required to be strenuously opposed.

The eradication of breeding places for flies was the fundamental step and this resolved itself into the efficient disposal of all waste, excreta, manure, offal, swill and organic refuse within the area under control. In practice it was rarely possible to abolish all places for fly-breeding, and outside actual camp areas, fly-breeding could not possibly be

prevented altogether; therefore the use of destructive measures against adult flies on a wide scale was also necessary.

The introduction of D.D.T. in 1943, when supplies became generally available, provided a powerful weapon for the destruction of flies. It has a powerful lethal action against adult flies but no repellent effect; it does not prevent their laying eggs; eggs, larvae and pupae are unaffected.

For the treatment of breeding places which cannot be removed, it was used by covering the surface of the breeding area with a residual film of D.D.T. in sufficient amount to kill flies alighting on the surface or emerging from pupae. The dose required for this was found to be 100 mg. of D.D.T. for each square foot of surface i.e. 8 oz. of 5 per cent. D.D.T. in kerosene for each 100 sq. ft. Manure heaps, garbage dumps, refuse pits and the contents of latrine trenches were covered with a uniform spray by hand-guns or knapsack sprayers—according to the size of the area. This method was not of value for the treatment of breeding places to which fresh material was constantly being added or for an area in which new breeding places appeared daily.

For the destruction of adult flies residual spraying with D.D.T., using 2 quarts of a 5 per cent. solution or emulsion for each 1,000 sq. ft., was the method of choice. When flies were very prevalent, with many breeding, all surfaces of all rooms, huts, tents or other buildings were treated. After a time lag of three or four days good results became more and more apparent. Where flies were not so numerous as to be beyond control except by universal spraying, selective spraying with D.D.T. was preferred, as this killed the maximum number of flies with the minimum expenditure of material. In this method, which required to be adapted to local conditions, spraying was done on walls and ceilings of cookhouses, ration stores, preparation rooms, butchers' shops, slaughter houses and dining halls. In addition, night resting places of flies, corners of walls near ceilings, electric light cords, windows and surrounds —inside and outside—and both sides of gauze screens on doors and windows were also treated. The outdoor resting places of flies such as swill-bins, incinerators, latrine seats and screens etc. were also included in the areas treated. In fly control the use of such a powerful insecticide as D.D.T. did not permit any relaxation in the normal sanitary measures necessary to prevent fly-breeding but merely stopped the inevitable leaks which these measures by themselves could not avoid.

Before the advent of D.D.T., great use was made of fly swats and fly-traps of various designs such as the baited (Bruton) trap, poison (sodium arsenite) trap and the tanglefoot trap. These traps proved to be very useful but, with the introduction of D.D.T., became subsidiary means for controlling flies.

Measures were also essential to prevent the fly-contamination of food, drink and messing utensils and much ingenuity was used in devising

portable fly-proof food safes for food storage and wire and muslin gauze covers for the protection of food on tables. It was necessary for the closest attention to be paid to cookhouse hygiene and to the cleanliness of cooks. On active service, however, it was considered to be preferable to institute measures for improving the standard of unit hygiene than to subject pathological laboratories to endless requests for stool examinations for dysentery organisms.

When it was not possible for cookhouses to be properly fly-proofed, the use of chicks or fish netting, ¾-in. mesh, hung loosely over doors and windows was found to be a useful method for preventing the entry of flies. The adequate provision of nail-brushes, soap and towels was essential.

Cooks required medical supervision to exclude the employment of carriers or mild cases, as did all personnel employed in handling food. It was imperative, especially during epidemics, that mild cases should be searched for and treated. It was considered that infection by food-handlers in a general epidemic was probably commoner than was generally supposed.

It was found that much dysentery was spread by troops visiting civilian cafés, restaurants and the like and the fullest possible control of these establishments was of the greatest importance. Those which refused to implement medical recommendations for the improvement of the hygiene of their premises were placed out of bounds to the Forces. It was found to be more effective when action on these lines was co-ordinated between the various Services and Allied Forces and this was usually achieved by joint hygiene committees and by the allocation of one of the various areas in a city to one particular Service for the medical supervision of the cafés and restaurants located therein. Hawkers of food and drink were usually prohibited from entering unit lines.

The fly-proofing of latrines required unremitting attention to prevent the mass infection of this most important vehicle in the spread of dysentery.

Water was a relatively unimportant vehicle for the transmission of the organisms of diarrhoea and bacillary dysentery, and the method of purification practised in the Army dealt with them efficiently. The extent to which water could convey the cysts of *E. histolytica* was more doubtful, since the standard method of sterilisation by chlorine does not kill cysts. For the removal of cysts preliminary filtration is essential, and the metal filters used in the standard water trucks could be relied upon for this purpose. The Millbank bag was devised with this object for individual use by detached troops in F.A.R.E.L.F. where this type of dysentery was prevalent.

Ice was not often a factor in the spread of dysentery but it was always advisable to ascertain if it had been made from a safe water supply before permitting its use in drinks.

EFFECTS OF HEAT*

Incidence. In Egypt, the Western Desert and North Africa casualties from the heat were remarkably few; but in certain parts of India, Iraq and Persia and at Red Sea ports, where temperatures were much higher, the risk was more serious both for effective troops and for the sick. There was a high incidence of heatstroke casualties in Tenth Army during the hot weather and among British personnel employed on railway duties in Persia.

The majority of cases of effects of heat occurred near the Persian Gulf, a well known danger area. Between May and September 1942, 2,964 casualties from heat occurred in this area. Half occurred during the month of August, 65 per cent were men newly arrived in the Tropics, and 65 per cent. occurred on board ship or during, or shortly after, disembarkation.

Bad administration at the beginning of a campaign on occasions led to the occurrence of heatstroke cases which could have been prevented if proper arrangements had been made. The following examples are cited:

1. An Indian draft numbering 1,134 disembarked at a tropical port one morning in August. The conditions on that day were—shade temperature max. 116° F., min. 87° F., relative humidity 23·5 per cent. The ship had docked the previous evening and the troops had spent the night between decks in the torrid heat of the docks. They disembarked at 0400 hours, marched to the station, entrained in goods waggons and arrived at the transit area at 0900 hours. Upon arrival, they were marched, carrying their kit, for nearly half a mile to their camp, where they had to draw and pitch their own tents. This was the last straw; weak with hunger, exhausted and overwhelmed by the heat, the men went down like ninepins and a hundred cases were admitted to hospital. It was shown at the enquiry that owing to heat and monsoon storms, the feeding arrangements had broken down on board ship, and that many of these men had had little or no food for two days; a fact which had an important bearing on the occurrence.

2. A detachment of Indian troops (total 386) was disembarked from a transport to a paddle-steamer, on which they were packed very tightly. The journey to the jetty on this steamer should have taken about fifteen minutes, but since there was a convoy crossing the ferry, the detachment was kept close-packed on the paddle-steamer, in mid-stream for four hours. They had been suffering from sea-sickness and the effects of heat and were in poor general condition and had not had a meal before leaving the transport. When finally put ashore they had to march about a mile to the camp; 59 cases of heatstroke resulted.

Heatstroke casualties were also not infrequent on east-bound transports, more particularly in ships where medical recommendations regarding troop capacity and berthing arrangements had been over-ridden on account of operational necessity, with resulting overcrowding. In

* *See* Volume on Medicine and Pathology, Chapters 1 and 10.

this connexion the D. of H. was unfortunately obliged on a number of occasions to make representations concerning the increase in the numbers carried in transports beyond the figures advised by the medical branch.

Salt and Water Requirements. In view of the importance of fluid and salt depletion of the body as a predisposing factor in the causation of heatstroke, measures were taken to investigate the adequacy of the salt intake from the rations, in those areas where heatstroke was likely to occur and augment it where necessary. In 1942 it was represented to S.T.6 that the salt ration in Tenth Army was ½ oz. per man per day, while in the Western Desert it was ¾ oz. per man per day although the temperature in Tenth Army area was much higher. The salt ration in the Middle East had been increased previously as a means of preventing heat exhaustion. It was therefore recommended that the salt ration in Tenth Army be raised immediately from ½ oz. to ¾ oz. per man per day. It was, however, appreciated from experience in the Middle East that merely raising the salt ration was no guarantee that men would, in fact, get more salt in their food, but such an increase in the ration would provide extra salt for use in cooking and for adding to drinking water on the recommendation of the medical authorities. It was considered that an issue of salt tablets would on the whole prove to be the most satisfactory way of ensuring an adequate salt intake, particularly in the case of small and scattered units, special service troops, A.F.V. crews, *et. al.*

Two types of tablets were recommended:

(*a*) A lime-flavoured salt tablet which had been submitted for consideration to the Rations Sub-committee of the M.R.C. and had the following specification:

Sugar (icing)	40 g.
Salt ground to pass 60 mesh	10 g.
Tartaric acid	0·63 g.
Soluble saccharine	0·45 g.
30 per cent. gum arabic solution	2·5 c.cm.
Lime flavour (10 per cent. lime oil)	0·7 c.cm.

The mixture was granulated, dried, and made up into 1½ gramme tablets. One tablet contained approximately 5 grains of salt. This tablet, while supplying the necessary salt, made a palatable and thirst-quenching sweet, which ensured its consumption by the troops.

(*b*) A plain tablet containing 5 grains of salt in a suitable medium.

Eventually it was decided to adopt a plain 10 grain salt tablet. Salt tablets became available for issue in 1943, and it was agreed with S.T.6 that they should be distributed to every unit when the senior administrative medical officer recommended their issue, in the same way as was done in the case of ascorbic acid tablets. They were intended to be used

when the water intake exceeded 1½ gall. daily; one tablet was dissolved in every pint of water drunk (or 2 tablets to a water bottle). The tablet enabled an accurate dose to be taken. Salt tablets were eventually incorporated in certain operational ration packs designed for use in the Far East.

The ration scale for troops on H.M. transports (*T.*194 *Sea Transport Regulations—Appendix*) contained approximately 17 grammes of sodium chloride—this included two-sevenths of an ounce (approx. 8 grammes) issued as salt. The fresh-water scale for all purposes was a minimum of 10 pints (approx. 6 litres) within the Tropics.

Since at this time it was agreed among the physiologists that 25 grammes of sodium chloride (including 14 grammes as NaCl) was sufficient to meet the requirements of men in a hot climate with water intakes of up to 8–10 litres daily, assuming that only half the salt issued as such was consumed, it appeared that the salt ration of two-sevenths of an ounce issued on H.M. transports was inadequate when the temperature was high.

The following recommendations were therefore made to Q(M)2 by A.M.D.5:

1. The salt ration on H.M. transports should be increased to 4/7 oz. daily when recommended by the S.M.O.
2. A reserve of salt should be held on board to be used for salting drinking water on the recommendation of the S.M.O.
3. The pamphlet '*Notes for guidance of S.M.Os. on Transports*' to have the following section added:

Prophylaxis of Heatstroke and Heat Exhaustion

'A. The attention of S.M.Os. is directed to the chapter on Heatstroke (pp. 113–117) in W.O. "*Memoranda on Medical Diseases in Tropical and Sub-tropical Areas 1941*".

'B. Additional notes on the regulation of water and salt intake to prevent heatstroke are given below:

1. Water. 'When the external temperature reaches or exceeds that of the body, heat can be lost from the body only by the evaporation of water from the skin. Therefore an adequate water intake is essential to provide the body with sufficient fluid for the increased sweat secretion which occurs in hot climates.

'The amount of water required will depend on the environmental temperature, and no absolute figures can be given. As far as possible a man's water requirements should be left to his own discretion, and his demand for water to drink should be carefully respected by those responsible for his efficiency. The minimum daily allowance of water for all purposes for each individual embarked on H.M. transports is laid down in *T.*194 (*Sea Transport Regulations—Appendix*) as 8 pints when out of the Tropics and 10 pints when within the Tropics. The latter minimum amount is inadequate when the temperature is high, especially

if there is a high relative humidity, and, when such conditions are encountered, the S.M.O. should collaborate with those responsible to ensure that the water supply for *drinking and cooking purposes only* should allow up to 3 galls. per man daily, e.g. by use of distilling apparatus on ships provided with this, and by curtailment of fresh water for ablution and washing of utensils.

'The urine volume varies inversely with the amount of sweat secreted but a certain minimal secretion of urine is essential for the elimination of waste products of metabolism, and the daily urine volume should never in any circumstances be allowed to fall below 500 c.cm. (just under one pint). In conditions of great heat and high relative humidity, the S.M.O. should arrange to have the daily urinary output of a number of men measured, and take the necessary action if the output is at or near the danger level.

2. Salt. 'Salt as well as water is lost to the body in the sweat, and, unless this loss is made good, a condition of salt deficiency will arise. This is a definite predisposing factor to heatstroke and may also give rise to the conditions of heat cramp—painful muscular cramps, affecting first the muscles of the hands and feet, then the limbs, and finally of the abdominal wall; each spasm may last for anything from a few minutes to a few hours.

'The body obtains salt from that present in foodstuffs and the salt added to food in cooking or at the table. The foodstuffs comprising the ration issued on board H.M. transports contain approximately 9 grammes of salt, and $\frac{2}{7}$ oz. (8 grammes) is issued in addition for culinary purposes, some of which will, of course, not be eaten. This ration is sufficient under normal conditions, but when temperature and humidity are high, the daily salt ration should be increased to $\frac{4}{7}$ oz., giving a minimum intake of 25 grammes. The S.M.O. should therefore inform O.C. troops when he considers that this increase in the salt ration should be made. This salt intake is adequate where the daily water intake does not exceed 2 galls. If the water intake exceeds this figure, it is advisable to ensure a corresponding increase in salt intake by adding salt to the drinking water in amounts of 10 grains to the pint ($\frac{1}{6}$ oz. to the gallon) as long as conditions of great heat are present.

'The S.M.O. should ensure that troops are receiving a sufficient salt intake by:

'1. Ensuring that the full salt ration is used in the cookhouse and dining halls.

'2. Arranging for salt to be added to the drinking water when in his opinion circumstances demand it.

'3. Examining the urine of selected men for chlorides by the method described on p. 115 of the *Memoranda on Medical Diseases in Tropical and Sub-tropical Areas* 1941. Great diminution in the urinary chlorides in an otherwise healthy individual in a hot climate is a premonitory sign of heatstroke, and if the S.M.O. finds such reduction, he must take action by recommending the addition of salt to the drinking water.'

Meteorological Conditions. It was of course essential that due warning of the likelihood of the occurrence of heatstroke should be obtained by keeping a careful watch on meteorological conditions. A wet bulb temperature of 83° F. (28·4° C.) with little or no air movement represents the danger point. It was therefore decided to equip all troop transports with wet and dry bulb thermometers to be used by S.M.Os. for this purpose. It had long been the practice in India to keep meteorological records in all military stations, more particularly in the North-west, where cases of heatstroke were likely to occur.

Heatstroke Centres. In all areas where heatstroke was liable to occur the provision of barrack and camp heatstroke centres was essential together with adequate facilities for the treatment of this disease in hospitals, not only to treat incoming casualties but also because febrile patients in the wards were always liable to develop hyper-pyrexia. Such patients required to be closely watched.

Iraq, Persia and particularly around the Persian Gulf became a notorious area for heat effects, and it is therefore not surprising that this was the main trouble in P.A.I.C. Here, heatstroke centres were used extensively and these usually were mud-brick buildings cooled by *khas-khas tatties* and supplied with the necessary drugs and equipment.

The static type of heatstroke centre comprised a treatment room with a concrete floor suitably drained and tiers for stretchers and a recovery room. The entrance to the treatment room faced the prevailing wind and was provided with a *khas-khas tattie*, which was kept wet with water from a tank above it, which cooled the air by evaporation as it passed through it. The building preferably was double-walled with an air-space between and, when possible, was air conditioned.

Mobile heatstroke centres were devised to accompany convoys. Such a centre consisted of a closed 3-ton lorry, the body provided with two covers separated from each other by a 2-in. air space, and treated with aluminium paint, or lined with aluminium foil, to reflect the radiant heat of the sun. A *khas-khas tattie* covering an opening behind the driver's seat was kept wet by a tank in the roof. The water was collected in a tank below the screen, from which it could be recovered and again poured into the upper tank. The vehicle was fitted with stretcher racks, an ice-box and lockers for medical equipment.

Special air-conditioned heatstroke wards were provided in hospitals and in addition 10 per cent. of all hospital beds were in air conditioned wards.

Acclimatisation. Acclimatisation was probably the most valuable prophylactic measure. It included not only the conditioning of officers and men but also the education of unit commanders in common-sense precautions. Most troops for overseas stations, when the Mediterranean route was closed, had to cross the equator twice and when they arrived

at their destinations they were more or less acclimatised to heat. But they were not acclimatised to work in the heat since it was impossible to give them much active exercise in a crowded transport. This point was of the utmost importance, as many casualties due to heat occurred immediately after disembarkation from transports. Troops were given as far as possible daily exercise during the voyage, vigorous enough to make them sweat freely. After disembarkation the work they did required to be carefully supervised until they had become acclimatised. The first few days after arrival were regarded as critical. Working in the heat was the best method of getting acclimatised to work in the heat, but it was essential that at first this work should be strictly controlled. During the greater part of the day the troops were limited to light duty and protected from the sun, but once a day, for an hour to an hour and a half, they were given exercise in the heat, sufficiently strenuous to increase sweating and not severe enough to cause exhaustion. After a week the period of exertion was gradually lengthened until after three or four weeks they could work for long periods without distress. It was found, however, that troops who had become soft after a long voyage under conditions of great overcrowding required even greater care in acclimatisation.

Clothing. In the prevention of heatstroke the protection of the head from solar rays, which had been overstressed in the past, was regarded as of subsidiary importance. General issues of sun helmets were discontinued except in the Sudan, Transjordania, and in the desert areas of Lebanon, although specially exposed personnel such as sentries were issued with them in Egypt, the Western Desert, Palestine, non-desert areas of Lebanon, Syria and Cyprus. For these, sun helmets were held on a 4 per cent. basis. In certain areas, however, sun helmets were issued for the use of newly-arrived personnel, being withdrawn when they had become acclimatised.

In Persia and Iraq the 'hat pith' was used and in East and West Africa a slouch hat with a special lining. More important than the protection of the head was the protection of the eyes from the direct or reflected glare of the sun, by the use of tinted glasses which were a general issue.

Man-management. Heatstroke outbreaks could often be traced to ignorance and lack of initiative on the part of regimental officers. It was recognised that conditions liable to produce heatstroke called for the highest degree of man-management and the following rules were drawn up for strict observance and enforcement by officers in command of men:

Rules for Regimental Officers

1. Don't work the men too hard until they have become acclimatised. At best this process will take from a week to a fortnight.

2. Remember that men can only become acclimatised to work in the sun by working in the sun, but such work must be graduated and carefully controlled.

3. See that some form of artificial shade is provided during periods of rest, if natural shade does not exist.

4. See that men are properly clothed. When topees are required, the strictest discipline must be enforced.

5. Never ask men to work on a completely empty stomach.

6. Pay unremitting attention to meals, especially as regards variety and attractiveness.

7. Watch for any man who appears to be in distress on the march. He may be only half conscious of what he is doing. Make him lie down, remove his kit, loosen his clothing and get him into transport.

8. At halts in the march, make the men take off their equipment, and fall them out in the shade where the maximum breeze is felt. Do not let them crowd together.

9. Select camp sites in open ground so that full advantage may be taken of any air movement.

10. Most important of all—provide as much drinking water as possible whether on the march or in camp. Remember that you cannot accustom men to lack of water. Drinking water must always have first priority. See that the men use salt tablets when necessary. Before starting a march or a job in the sun, see that every water-bottle is full. When supplies are available in ample quantities, encourage the men to drink even more water than they would do from natural inclination. It is found that left to themselves men often drink less water than is desirable. The water should be cool, but not iced.

Propaganda. The subject was brought to the attention of all ranks by means of lectures, orders and pamphlets, of which the following may be cited:

Service in Hot Climates 1943*: A pamphlet for Officers* (one issued to each officer).

Health Memoranda for British Soldiers in the Tropics (one issued to each other rank).

Hints on Health in India and other Tropical Countries (one issued to each officer).

Memoranda on Medical Diseases in Tropical and Sub-tropical Areas 1942 (for Medical Officers).

Notes for the Guidance of Senior Medical Officers, Medical Officers and Warrant Officers doing Duty in Transports (placed on board for use of S.M.O. *et al.*).

Notes on Effects of Heat for Medical Officers in Troopships.

Field Service Hygiene Notes, India 1940.

Effects of Heat in Persia and Iraq (D.M.S. Persia and Iraq Force Medical Memorandum No. 4 of 1943).

INFECTIVE HEPATITIS*

Outbreaks of jaundice have been reported in the majority of campaigns during the past hundred years. During the two World Wars 1914–18 and 1939–45 widespread explosive epidemics of non-spirochaetal jaundice occurred.

During the period between the two World Wars, catarrhal jaundice, as it was then called, was reported as of common occurrence in most parts of the world, its incidence varying from an occasional sporadic case, commonest among children, to explosive outbreaks of almost epidemic intensity. Such outbreaks, often limited to one unit or small area of a large garrison, were not uncommon in the British Army in India.

Between the wars the main controversy centred about the relationship between epidemic jaundice and sporadically occurring 'catarrhal jaundice'. It came to be generally accepted that these conditions were indistinguishable and the term infective hepatitis was used as a more accurate label to cover both.

Careful epidemiological studies had shown that there was a long incubation period of about one month, and that on this basis many apparently sporadic cases could be linked in a chain epidemic. Convincing evidence from liver biopsy studies had demonstrated, in sporadic cases of so-called catarrhal jaundice, a true hepatitis with no evidence of catarrhal changes in the bile channels. While the cause of the disease was not known with certainty, its infective character, together with the failure to isolate any bacterial agent, suggested that it was almost certainly a virus infection, but the seasonal incidence supported the view of spread by droplet infection.

It was noted in India that the incidence was strikingly greater among British than Indian troops as the following table shows:

TABLE 34

Incidence of Infective Hepatitis. India. 1938–43

	Ratio per 1,000					
Year	1938	1939	1940	1941	1942	1943
British troops . .	0·7	1·1	0·4	0·5	3·8	18·5
Indian troops . .	0·6	0·5	0·1	0·3	0·3	1·0

In peace-time the incidence of the disease in India was low but in war-time, with the movement of troops into endemic areas, there was often local high incidence.

* For further information consult the Statistical Volume and the Campaign Volumes; also the Volume on Medicine and Pathology, Chapter 9.

Incidence. Infective hepatitis was exceedingly prevalent in almost all theatres during the War of 1939–45. During 1942 it reached epidemic proportions in the Middle East where an explosive outbreak comprising some ten thousand cases occurred during the last four months of that year. This epidemic was the subject of close clinical study, both in the field and at the base, in which one Medical Research Section of the Directorate of Medical Research participated and which brought out some interesting points of epidemiological importance.

The outbreak started during late September 1942, among the New Zealand and 9th Australian Divisions which were holding positions in the Alamein Line, some 40 miles from Alexandria. It spread rapidly to other formations in the vicinity, many field units losing up to 8–9 per cent. of their effectives. From its starting point in the Western Desert the infection spread rapidly throughout the Middle East. Large numbers of cases were admitted to hospitals in Egypt, Palestine, Syria, Malta and Cyprus. The incidence remained at epidemic height during the four months, October–January, and then receded to a smouldering low level of sporadic fresh cases, only to flare up again the following autumn (1943) with epidemic intensity in North Africa, Sicily and Italy.

In the early days of the outbreak there was a heavy incidence among certain units and formations but as the disease spread it also became more thinly distributed and a comprehensive survey in Syria and Cyprus showed that 478 cases were drawn from 208 different units.

Jaundice commonly broke out after units were moved into the battle zone, the epidemic usually reaching its height after severe operations. In certain otherwise comparable units, the incidence in those which spent the entire summer in the desert was three times that of other units which spent the summer in the Delta before moving into the battle zone.

In contrast to the usual 'chain epidemics' observed in civilian communities there was a marked tendency for massive outbreaks to occur over short periods of time (in one regiment all except one of 59 cases occurred within the space of three weeks).

In R.A.C. units it was uncommon for more than one member of a tank crew to develop the disease and a similar absence of spread to close contacts was manifest among men in vehicle groups.

It was noted that the spread of infection among patients in hospital and from patients to hospital staffs was rare. Thus, in a New Zealand general hospital which admitted over 2,000 cases of the disease from the New Zealand Division, only one nursing sister among the whole staff caught the infection, although the majority of the patients arrived in the early and presumably highly infectious stage of the disease. Throughout the 1942–3 epidemic in Syria, only one nursing officer contracted the disease.

The attack rate in officers was 4·7 times as high as in other ranks. This was a feature of the epidemic disease throughout the Middle East and North Africa and was much commented on, but there were some notable exceptions. The heavily infected New Zealand Division reported no such tendency nor was it observed in the Royal Navy or in the United States Army. In the Royal Air Force, flying crews, commissioned or non-commissioned, suffered more heavily than ground staff.

Some dark-skinned races appeared to be relatively immune to infective hepatitis. Thus, the incidence among Indian Sepoys was less than one-tenth of that among white troops in the vicinity. Similarly Maoris, who were in the line at Alamein alongside heavily infected New Zealand troops, escaped very lightly. The same relative immunity was noticed among the coloured troops of the Union Defence Force (South Africa) and of the United States Army. The incidence of hepatitis was also relatively low among Maltese and Cypriots. On the other hand, a brigade of native troops from the Belgian Congo suffered heavily and had a relatively high mortality from this cause. Later, the incidence of infective hepatitis among native Indian troops in India and Burma was about one-third of that among British troops in the same theatre of war.*

Enemy troops in prisoner-of-war camps suffered from the disease with a similar high incidence in officers but there was little spread from prisoners recently captured to those already in the camps.

In home commands there was an apparent rise in the incidence of jaundice in 1942. This may have been attributable to returns being more reliable after attention had been drawn to the problem by the widespread occurrence of infective hepatitis abroad and after greater emphasis had been placed on its notification. During this year the monthly rate increased from 0·03 per 1,000 in July to 0·13 in November. During the first three months of 1943 there was a further increase to 0·17 per 1,000.

Owing to the movements of personnel and close contacts with the civilian population, it was more common to get a series of apparently disconnected cases than actual epidemics. Several small outbreaks did however occur, usually in the form of chain epidemics. In one outbreak which continued for 6 months, 50 out of 70 cases were officers but in general the higher attack rate in officers at home was not such a marked feature as it was in the Middle East epidemic. There was no apparent relationship to the incidence of other infectious diseases.

Jaundice was a notifiable disease in the Army under paras. 596 and 599 *Regulations of the Army Medical Services*. In the United Kingdom it was not made notifiable to the civil authority until 1943, and then

* For further information consult the Statistical Volume, Medical Ethnography.

only in East Anglia. The introduction of the *Jaundice Regulations* 1943 provided for the statutory notification to medical officers of health in the Eastern Region of the following forms of jaundice :

Catarrhal jaundice
Acute inflammation of the liver
Acute necrosis of the liver
Acute yellow atrophy of the liver
Toxic jaundice
Infective jaundice

In consequence D.D.M.S. Eastern Command was requested to issue instructions that copies of A.F. A35 were to be rendered to the civil medical officers of health in those areas in which the regulations applied in respect of the forms of jaundice specified above occurring among military personnel.

While these regulations were in force a M.R.C. team made an epidemiological survey of jaundice in East Anglia in which both military and civilian cases were included. The team was chiefly concerned with the infective and aetiological aspects of the problem. Detailed investigations on a selected number of cases were carried out. These included attempts at transmission of the disease to animals, a search for a specific serological test and a study of liver function tests at different stages of the disease and of changes in the blood picture.

Epidemiology. The observations from the Middle East made it difficult to explain the rise in incidence by case-to-case spread, either by contact or by droplet infection. This led observers to suggest that infective hepatitis, in its epidemic form, might be a 'place disease'—that infection might depend more on visiting a locality where other cases had occurred than on case-to-case infection. Although flies were particularly abundant in these areas, no definite evidence in favour of an insect vector was found and most authorities were of the opinion that insect transmission was unlikely. The anomalous character of the epidemic suggested the alternative possibility of a latent infection activated by secondary factors, such as physical strain, or dietary deficiency, which might lower resistance.

In contrast to these observations from Middle East, reports of civilian outbreaks confirmed previous studies and suggested that in the United Kingdom the disease was transmitted by case-to-case spread with an incubation period of three to five weeks. The period of infectivity was thought to be confined to the first few days after the onset of symptoms, terminating before, or soon after, the appearance of jaundice.

Prophylaxis. The disease presented great diagnostic difficulties in the pre-icteric stage and in mild cases which failed to develop clinical icterus. No specific serological test was available.

Since neither the cause nor the epidemiology of infective hepatitis had been fully worked out, the course that the hygienist could take was far from obvious. All that could be done was to take such general measures as were suitable to the prevention and control of droplet and faecal infections, remembering the possibility that the causal organism might be water-borne.

POST-ARSENICAL AND HOMOLOGOUS SERUM JAUNDICE*

During the war years great interest was aroused by the increasing incidence of these allied forms of jaundice. The incidence of post-arsenical jaundice increased greatly during the years 1941–3 and it was noted that it increased out of all proportion to other toxic reactions to arsphenamine therapy used in the treatment of syphilis. Several causes were advanced to account for this increase which it was thought might act together or separately:

Increased toxicity of the arsenical, either due to the type of the arsenical or the dosage.

Super-added infective hepatitis with increased liver susceptibility following arseno-therapy.

Specific dietary deficiency increasing liver susceptibility to the toxic action of arsenic.

The problem was thoroughly investigated by a number of research groups and eventually authoritative opinion came to the conclusion that post-arsenical jaundice was caused by the introduction, by way of an imperfectly sterilised syringe or needle, of blood or serum containing a minute trace of the virus of infective hepatitis or some allied icterogenic agent. Special precautions were accordingly taken in the sterilisation of needles and syringes between individual injections and the incidence of jaundice from this cause was appreciably diminished.

During the war a relatively high incidence of jaundice was also noted following the injection of certain products containing human serum, notably yellow fever vaccine. At one stage this homologous serum jaundice following yellow fever inoculation was a serious problem.

Only a few batches of yellow fever vaccine were found to be icterogenic but the long incubation period of the jaundice led to their being widely used before their harmful nature was discovered.

It became evident from reports from various sources during 1942–3 that jaundice could follow the use of other products which contained human serum—for example, mumps and measles convalescent serum and dried plasma and that it could also follow blood transfusion. The risk appeared to be greatest with pooled sera and when only traces of serum were involved—as in syringes contaminated by venepuncture.

---

* For further information *see* the Volume on Medicine and Pathology, Chapter 9.

MALARIA*

Incidence. Malaria constituted one of the outstanding hygiene problems of the war. In certain overseas theatres it remained a constant menace and required the unremitting attention of all ranks, combatant and non-combatant alike, to keep it in check.

It was recognised that the essentials in the control of malaria in overseas commands and theatres of operations where malaria was prevalent were:

(*a*) The creation of an adequate anti-malarial organisation to deal with it.
(*b*) Anti-malarial training and the enforcement of all measures of personal protection by strict unit discipline.
(*c*) An adequate supply of anti-malarial stores and equipment to malarious theatres.
(*d*) Constant research in connexion with the development of new insecticides and all aspects of malaria therapy—both suppressive and curative.

Anti-Malarial Organisation. At the War Office, D. of H. and the Consulting Physician advised D.G.A.M.S. on all matters connected with the control of malaria. In 1943 a consulting malariologist was appointed to augment the advisory staff.

Various committees were formed:

The M.R.C. formed a Malaria Committee with the Consulting Physician to the Army as chairman. The committee dealt mainly with the therapeutic aspects of mepacrine administration and it had teams which worked on such problems as the blood concentrations necessary in suppression, treatment, toxic manifestations etc.

The Ministry of Production formed the Insecticides Development Panel which included among its members eminent entomologists and chemists.

The Inter-departmental Co-ordinating Committee was formed and consisted of the main users of insecticides and had as its members representatives from the Services, Colonial Office, India Office, Ministries of Food, Production and Supply.

In malarious theatres of operations consultants or advisers in malariology were appointed, e.g. a consulting malariologist in Middle East and an adviser in North Africa etc.

It was generally accepted that the responsibility for carrying out anti-malaria measures could be divided into (*a*) medical and (*b*) combatant.

* For further information *see* the Campaign Volumes; also the Volume on Medicine and Pathology, Chapter 7.

The main anti-larval work was a medical responsibility but the responsibility for ensuring that measures of personal protection were carried out rested with the combatant.

The anti-malarial organisation in the field in 1941 included:

Mobile malaria field laboratories
Field hygiene sections
Equipment for anti-malaria squads
Equipment for units.

Malaria field laboratories were formed and despatched to overseas theatres as required. Three were sent to Middle East, one to North Africa and one to West Africa etc.

The establishment of a malaria field laboratory consisted of three malariologists, one entomologist and three laboratory assistants. It had a very complete scale of equipment and its function was to undertake malaria surveys, prepare malaria maps and advise on the best methods of control. It also carried out instructional work for medical and non-medical malaria officers.

The anti-malarial work, mainly anti-larval, was carried out by field hygiene sections to which a gang of local labour was attached, acting as anti-malaria squads, the number depending on the situation. The equipment included everything required for clearing bush, draining swamps, and treating breeding places with Paris green or oil, for which they were provided with mixers, blowers and sprayers. The scale of anti-malaria squads was four to a division and four to a corps. So, a corps of two divisions had twelve squads. These squads were later organised into malaria control units.

The unit equipment for a company included a hand sprayer for spraying tents, huts etc., Pyefly solution (1 part pyrethrum in 64 of kerosene), a shovel and a collector's ladle.

The anti-malarial organisation in the field was reviewed from time to time and as a result of experience was reorganised as described in the section on 'Hygiene Organisation', page 31.

Measures of Personal Protection. While all the measures necessary for personal protection were based on medical recommendations, their enforcement became the joint responsibility of the staff and unit commanders.

In countries where malaria was seasonal, there was occasionally difficulty in getting these orders strictly enforced at the beginning of the malaria season, due perhaps to a reluctance to adopt a troublesome routine which had not been necessary previously. Once malaria casualties occurred, however, there was usually little difficulty in getting the necessary measures instituted.

That the highest authorities fully appreciated the importance of the medical aspects of modern warfare is shown in the following India Army Order by Field Marshal Sir Archibald Wavell:

> 'In theatres where future operations are likely to take place we may well find that disease, and especially malaria, is a more dangerous factor than enemy resistance. We have already had experience of the effects of a bad malarial season in Assam.
>
> 'We must prepare to meet malaria by training as strict and earnest as against enemy troops; we must be as practised in the use of our weapons against it—the mosquito net, long sleeves and trousers, Flit gun—as we are with the rifle; we must study the habits of the mosquito as we do the tactics of the Japanese: we must know methods of anti-mosquito work—canalisation, oiling, etc., as well as how to construct trenches to hold a position.'

The measures of personal protection upon which reliance was placed were:

(*a*) The use of mosquito nets which included:

The boot and bar net for troops in rearward areas.

The bush net for forward troops. This net had pouches at the bottom which could be filled with sand to keep it close to the ground. This was an individual issue and was simple to erect.

Bivouac tents and shelters mosquito proofed with netting were also supplied. The bivouac net used as a lining to tents and shelters could also be erected separately. It accommodated two persons.

Head veils and gauntlets were supplied for sentries or pickets who had to be out on duty at night. These were never popular with the troops and were eventually replaced by head nets, sleeves and oversocks of $\frac{3}{8}$ in. fish netting impregnated with D.M.P. which did not interfere with vision or the handling of weapons.

(*b*) Clothing—Long trousers and long-sleeved shirts were worn. At sundown sleeves were turned down and buttoned at the wrist; shorts and sleeveless shirts were forbidden.

(*c*) The use of a repellent for smearing on exposed skin surfaces. This was kept by each individual in a small tin container. Various preparations were used as improvements were effected. The first was citronella cream which was greasy and not very popular. This was replaced by a vanishing cream which was more pleasant to use and gave slightly longer protection. Finally D.M.P. was introduced and proved to be the most efficient repellent as well as being the most pleasant to use.

(*d*) The use of a suppressive drug. The most potent weapon against malaria proved to be the regular administration of suppressive mepacrine. Provided this drug was taken conscientiously and regularly by all troops an army which, without this aid, would have disintegrated through malaria, could be kept in the field more or less fit for an indefinite period. It did not prevent infection but warded off attacks of malaria. Under active service

conditions in a highly malarious country when suppressive treatment was in force, it was estimated that after the first month 10 per cent. of casualties from malaria might be expected to 'break through' each month.

Anti-Malarial Training. That troops should be given training in the methods of personal protection before they proceeded overseas seemed an obvious necessity but certain difficulties were encountered in putting this into practice. For example, owing to security reasons the force which proceeded to North Africa could not be given training in anti-malarial measures before it sailed. When they arrived at the end of March, no mosquitoes or malaria were encountered, and it was extremely difficult to convince them of the necessity for anti-malarial precautions. In consequence there was considerable slackness in carrying out anti-malarial orders, unsuitable camp sites were selected in spite of warning and it was only when some units had casualties amounting to 10 per cent. of their effectives that malaria discipline began to improve.

After the appointment of an adviser in malaria, who commenced a vigorous campaign immediately after his arrival in May, the force became the best trained formation to be found anywhere at that time.

Intensive anti-malarial training was undertaken at home in 1943 and the methods of personal protection were included in ordinary training. A pamphlet was produced and issued entitled *Malaria* 1943 : *A Pamphlet for Officers* which contained the essentials of the subject, and the anti-malaria instruction given was on the simple lines outlined in the pamphlet. A scale of anti-malarial equipment and supplies was issued for demonstration purposes. It was found, however, that it was very difficult to impress on the soldier at home the importance of the risk of malaria when serving in tropical countries; it was necessary for him to experience it personally overseas before he appreciated its significance.

Again, owing to unavoidable overcrowding it was not easy to arrange for lectures to be given on board troopships but as much instruction as possible was given to troops proceeding overseas.

It was found that lectures to troops given by medical officers were only of limited value. The most effective lectures were those given to small groups by their own N.C.Os., possibly because they were given in the language best understood by the troops.

Propaganda. A number of malaria films, cartoons and film strips were made for instructional purposes. These included the following:

Films:

'Mosquitoes and Malaria'
'You too can get Malaria'
'Malaria—Cause and Control'
'White Battlefront'
'Malaria U.S.A.'

Film strips:
'They volunteered for Malaria'
'Principles of Malaria Control'

Cartoons:
'NOFFI'
'6 Little Soldier Boys'
'Borne on 2 Wings'

Posters. During the war a number of excellent posters were also produced on this subject—many of them in overseas commands.

Anti-Malarial Equipment and Stores. For the successful prosecution of anti-malaria campaigns in all theatres of operations where malaria was prevalent, it was necessary that a great variety of anti-malarial equipment should be supplied to them.

This included the following:

(*a*) Insecticides and larvicides
Pyrethrum, D.D.T., anti-mosquito spray, Paris green, malariol, cuprous cyanide.

(*b*) Repellents:
Citronella cream (Marks I and II), D.M.P. and individual containers for repellents.

(*c*) Apparatus to dispense (*a*):
Hand sprayers, knapsack sprayers, pressure sprayers, power-operated sprayers, mixers, dust-guns, Westinghouse aerosol bombs, individual insecticide dispensers (sparklets).

(*d*) Mosquito curtains:
Hospital nets, boot and bar nets, bush nets, tents bivouac (mosquito-proofed), tents shelter (mosquito-proofed), veils and gauntlets, anti-malaria wallets.

(*e*) Special equipment for M.C.Cs. and malaria field laboratories.

(*f*) Suppressive drugs:
Quinine and mepacrine.

In the procedure for procurement of anti-malarial supplies, the Hygiene Directorate had no responsibility for supply and had to depend on D.O.S. and D.S.T., the Ministries of Supply and Production for all the anti-malarial supplies considered necessary. As can readily be imagined during a global war, serious shortages occurred from time to time in certain essential items and there were many difficulties in supply and production to be overcome before certain supplies could be provided in the quantities demanded.

Although D. of H. had no responsibility for supply, he was very seriously concerned with its adequacy and with the priorities given to essential supplies.

He was responsible for advice and recommendations regarding:

(*a*) the insecticides and types of equipment which should be supplied;

(*b*) estimates of requirements;

(*c*) scales of issue in terms of requirements for 1,000 men per month and allocations to the various operational theatres;

(*d*) phasing of shipments of anti-malarial stores to overseas commands;

(*e*) the conservation of items in short supply and the provision of substitutes;

(*f*) the introduction of new insecticides and equipment.

D. of H. obtained the utmost co-operation of D.O.S. and D.S.T. in the procurement of the supplies he considered essential but occasionally formed the impression that the Ministries concerned had failed to realise the urgency of his demands, particularly when it became a question of stepping up supplies of new and important chemicals such as D.D.T. For example, in 1944 in a communication to D.G.A.R. he complained, 'It is only now under pressure from S.E.A.C. that a search is being made for additional factories for the production of this easily manufactured chemical.' D. of H. asked if his urgent demands could be submitted through D.G.A.R. in order that they might be given the highest military priority backed by the General Staff. At a meeting of the Interdepartmental Co-ordinating Committee on Insecticides, at which the urgent need for stepping up D.D.T. production in the United Kingdom was discussed, it was decided that the matter should be brought to the personal attention of the Prime Minister. This was done and resulted in the Ministry of Production being instructed to give super-priority to the production of D.D.T.

With the introduction of Gammexane it was thought that it might be possible to conserve D.D.T. by using this, but it was held by the Insecticides Development Panel of the Ministry of Production that 666 had, at that time, been insufficiently tested both in the laboratory and in the field, so that it could not then be regarded as an equivalent.

It was necessary to augment stocks of many anti-malarial supplies by lend-lease imports from the U.S.A. The production of essential anti-malarial supplies such as pyrethrum, D.D.T. and mepacrine in both countries was pooled and proportional allocations were made to the Allies who bid for their requirements.

Pyrethrum was one of the earliest and most serious shortages experienced. Although the bulk of the available world output of this commodity was grown in Kenya most of it was sent to the U.S.A. for extraction (10 tons of flowers = 1 ton of extract).

It became necessary for the Army to obtain its requirements largely from the U.S.A.

D. of H. strongly advocated that an extraction plant should be constructed in Kenya, and, although this was supported by the Insecticides Development Panel, the proposal was not put into effect.

In 1942 world production was as follows:

British East Africa	6,518 tons
Brazil	223 tons
Belgian Congo	446 tons
Total	7,187 tons

The following allocation was recommended by the Ministry of Production:

United Kingdom	450 tons
Australia	200 tons
South Africa	300 tons
India	500 tons
	1,450 tons
American share	7,115 tons
Total	8,565 tons

The Ministry of Production also recommended that:

(*a*) The Kenya production of flowers be increased to 8,000 tons.

(*b*) The distribution from Kenya to be in proportion 5 U.S.A. to 1 U.K. instead of 10 to 1 as formerly.

(*c*) The U.K. allotment of 1,450 tons to include requirements of Australia, South Africa and India.

It was always necessary to conserve pyrethrum and its use in this country was strictly controlled. With the introduction of D.D.T. it became possible to reduce the pyrethrum content of anti-mosquito spray to 0·05 per cent. pyrethrum by the addition of 0·3 per cent. D.D.T. and 5 per cent. oil of sesame. Allotments of aerosol bombs and sparklets to malarious theatres were counted against their allocation of pyrethrum (1 aerosol bomb = 1 lb. of flowers).

In 1944 a new committee was formed—The Insecticides Applications Committee, with D. of H. as a member. Its main function was the direction and planning of uses of D.D.T. especially from the air. The distribution of D.D.T. from the ground by existing or modified apparatus was also considered. Air-spraying trials were arranged to take place in West Africa and India. These trials revealed that there were certain technical difficulties to be overcome before air-spraying could give the results desired.

An adviser in D.D.T. (methods of application) was appointed to the staff of A.M.D.5 (temporarily) and he proceeded to the U.S.A. to witness the various trials being carried out there. On return he reported to D. of H., the Consulting Malariologist, and the Insecticides Application Committee in connexion with their arrangements for air-spraying trials in West Africa.

*Suppressive Treatment.** In the early years of the war quinine was the drug used for suppressive treatment. With the entry into the war of Japan and the fall of Java into enemy hands, quinine supplies, which mainly come from this island, had to be conserved for the treatment of actual cases of malaria.

Mepacrine, the British equivalent of the German preparation atebrin, was introduced to take the place of quinine as a suppressant. Originally it was recommended that suppressive mepacrine should be taken in a dosage of 0·2 g (i.e. 2 tablets) on two days of each week with an interval of two days between. The first tablet was taken with water after breakfast and the second in the same manner after dinner.

In 1942 the suppressive treatment of malaria was considered by an expert committee with special reference to its use in hyperendemic areas. It was considered by the committee that dosages of 0·2 g. of mepacrine twice weekly or quinine 5 gr. daily were insufficient. The committee was of the opinion that the risks of an increased dose of mepacrine were not such as to outweigh the advantages of a more effective reduction in incidence.

The following dosages were recommended for use in future in hyperendemic areas:

A. Mepacrine
   Dosage 0·1 g. daily except Sunday, i.e. a total of 0·6 g. weekly.
   Commence one week before entering the hyperendemic area and continue for one month after leaving.
B. Quinine—Only to be used when mepacrine was not available.
   Dosage 10 gr. daily.
   Commence on entering the hyperendemic area—and continue for one month after leaving.

It was laid down that cases of malaria occurring after cessation of suppressive treatment were to be treated with therapeutic courses. It was also ruled that suppressive treatment be recommenced and maintained on the lines recommended above on subsequent re-entry to a hyperendemic area irrespective of the time which had elapsed since commencement of the previous completed course of treatment.

* The Australian Official Medical History, Volume I, Clinical Problems of War, Chapter 7, should be consulted for a detailed description of the work of Brigadier Hamilton Fairley and others, which has a direct and very important bearing upon this subject. *See* also the Volume on Medical Research, Chapter 4 in this Series.

It was recognised that a long-term investigation would be required to determine the minimum dose necessary to maintain suppression against various strains of plasmodia. It was held in the meantime that the standard suppressive dose laid down, although it possibly exceeded the dose necessary for some strains, safeguarded against the more resistant strains and that it would be a wise policy to adhere to it until further evidence was available.

It was ascertained that the Germans used an atebrin tablet of 0·06 g. which was issued every day of the week giving a total dose per week of 0·42 g.

Unfortunately the administration of mepacrine in suppressive doses was found to be liable to produce unpleasant side-effects in a proportion of individuals before they had become habituated to it. For example in First Army in Algiers toxic symptoms occurred on a very large scale following the administration of mepacrine. After taking 0·6 g. toxic manifestations appeared which affected 30 per cent. of the force and in some areas this was stated to be as much as 50–60 per cent. The symptoms were severe—vomiting and diarrhoea with extreme collapse and cramps in the worst cases. Whether these symptoms were partly due to an associated gastro-enteritis was never definitely established but the consensus of opinion among the medical officers was that it was caused by the mepacrine. After this unfortunate incident suppressive treatment in this theatre practically ceased for a time and it required much persuasion to induce the authorities to reinstitute it. Fortunately D. of H. was on tour in North Africa at the time and after a high level discussion the necessary orders were issued.

The following is an extract from Medical Circular Letter No. 3 dated May 23, 1943, issued by Allied Force Headquarters:

'*Malaria*'

'It must be appreciated that the regular and unfailing use of protective medication is the fabric upon which every successful campaign in a malaria territory must necessarily be founded. The ill-effects which sometimes occur in the early stages of atebrin administration have in some instances been made the excuse for minimising the importance of protective medication. To meet the difficulties experienced certain modifications in the administration of the tablets have been introduced. It is noteworthy, however, that the best and most efficient troops in the fighting zone have not been baulked by the difficulties attending the habituation to atebrin. Atebrin administration must continue. The Supreme Commander takes his tablets.

'The best soldiers have continued to swallow their medicine without fail. The determination not to be beaten by initial discomforts is proof of their fine discipline. The fact that they have become accustomed to atebrin will render their protection against malaria an easy matter if and when they are called upon to fight in malaria-ridden areas.

'Although the executive responsibility for carrying out and maintaining effective anti-malaria precautions rests with the unit commanders, medical officers are failing in their duty unless they loyally support all measures which are designed to counteract the perils of ill-health.

'There is ample evidence to show that continuous atebrin administration at the rate of 0·4 g. or 0·6 g. weekly leads in the vast majority of cases to complete tolerance or habituation to the drug. Atebrin in suppressive doses is not known to produce permanent or late ill effects in the human subject.'

Cessation of Suppressive Treatment. In general it was found that suppressive treatment should always be stopped as soon as it was practicable. Troops under such treatment contained an unknown number of potentially unfit men (i.e. cases of latent or suppressed malaria). There was the risk that such troops might break down when their services were urgently required or when hospital facilities were not adequate to cope with such a large number of sick. Their fitness was therefore an unknown quantity in any military operation. For these reasons it was essential that as soon as conditions became, or could be made, favourable, those infected should be detected and given a course of radically curative treatment.

This matter, more particularly as it concerned North Africa, was given careful consideration by the Consulting Physician, the Consulting Malariologist and D. of H., and the following recommendations were made, subject to amendment as knowledge increased and further information became available:

'When the malaria season is over but the military situation demands that as many troops as possible be kept fit to fight, then the suppressive therapy should be continued for a month to six weeks after that date.

'If, however, hospital facilities are available and the military situation will allow of it, suppressive therapy should be stopped and a full course of treatment given to those developing an attack of malaria.

'Where the percentage of infection is high, it might be considered advisable to give a blanket treatment to all the troops involved, starting off with 0·6 g. of mepacrine a day for the first two days, given in divided doses after food, and completing this course with five days' further treatment on 0·3 g. a day. Relapses occurring after this course would be largely B.T. and should be placed on special relapse curative treatment. This aspect of therapy is being given special consideration by the M.R.C. sub-committee studying malaria therapy'.

Suppressive Treatment of Malaria during Voyages. Instructions on this subject were issued to all officers commanding transports and to all H.Qs. of overseas commands in 1944. The following points were included in these instructions:

1. All military personnel should receive mepacrine for at least twenty-one days before they enter a malarious area during the malaria season. The dosage of the drug is:
   First week ½ tablet (0·05 g.) daily.
   Subsequently 1 tablet (0·10 g.) daily.
   The drug will be taken directly after a meal and be followed by copious non-alcoholic fluid (no alcohol should be taken until after the third dose). Administration will be continued either on board ship or ashore until other instructions are issued by the senior administrative medical officer of the area or formation concerned. If the voyage is fourteen days or less, the initial dosage for the first week should be 1 tablet daily.
2. The following list gives some of the malarious areas to which troops may be sent and indicates the time of the year suppressive treatment is required:

Area	*Season*
North Africa	April–December
Italy, Sicily, Sardina, Corsica	April–December
Balkans	April–December
Persia and Persian Gulf	March–November
Iraq	March–November
India	All the year
Ceylon	All the year
Burma	All the year
Malaya	All the year
S.W. Pacific	All the year
West Africa	All the year
East Africa	All the year

3. Mepacrine administration will be continued for 28 days after leaving a malarious area. The dosage during this period will be 1 tablet daily, taken after meals and followed by copious non-alcoholic fluids. Should the voyage be less than twenty-eight days, personnel will, before disembarkation, be issued with sufficient mepacrine to complete the required treatment.
4. O.C. troops will be responsible for ensuring that all officers and other ranks alike, take and swallow the necessary drugs. An order to take a suppressive drug is a lawful order and refusal to do so makes an officer or other rank liable to proceedings being taken under the Army Act.
5. O.C. troops will be responsible for ensuring that all ranks are issued with filled tins of mepacrine immediately before disembarkation.

Mepacrine Packing and Supply. Arrangements were made for mepacrine to be issued as a ration by the R.A.S.C., as this was the most convenient way to ensure that all units obtained their entitlement on a strength basis. They were also included in certain ration packs used in the Far East.

Various types of containers were used to be carried by individuals:

(*a*) The small tin of the 'shoe polish' type was considered to be satisfactory except in areas with a high atmospheric humidity.

(*b*) Middle East used a double-ended dual container which contained mepacrine tablets in one end and anti-mosquito cream in the other. These containers were manufactured locally and were not altogether satisfactory. It was found that under certain conditions the mepacrine tablets carried in these containers were prone to develop moulds which rendered them unserviceable.

(*c*) The best all round packing for mepacrine tablets was found to be the cellophane strip pack which was developed specially for use in the Far East and which protected the tablets from deterioration from high atmospheric humidity.

Malaria on Transports. During 1941–2 when convoys were routed *via* West Africa much concern was caused by the occurrence of cases of malaria in transports which had moored off West African ports where the infection had taken place. For example, during a period of three months the following cases were reported as having contracted M.T. malaria in West Africa during a voyage to the East and were hospitalised in South Africa:

1942 *Month*	*Port of Call*			*Totals*
	Lagos	*Freetown*	*W.A. Port not stated*	
June . . .	13	16	4	33
July . . .	45	107	—	152
August . .	35	20	5	60
Totals . .	93	143	9	245

Ships' moorings at these ports had been greatly extended without much regard to the risk of invasion by mosquitoes from the shore, and, for security reasons, it was not possible for ships to be moved further from the shore at night. The following anti-malarial measures were adopted:

Transports were provided with a scale of sprayers and anti-mosquito spray and every man carried his anti-mosquito cream but owing to crowding the use of mosquito nets was not possible. Suppressive treatment was instituted. The embarkation medical authorities took steps to ensure that all Os.C. troopships were fully acquainted with local anti-malarial orders as soon as convoys arrived and that these orders were enforced. It was arranged that S.M.Os. troopships were to be selected from officers who had attended a course of tropical medicine at Liverpool, London or Edinburgh. Passengers in transit by air were provided with mosquito nets in West Africa and quinine for suppressive treatment.

These measures considerably reduced the incidence of malaria among passengers in transit by air and sea *via* West Africa.

Special Arrangements to deal with Malaria occurring in Personnel returned from West Africa. In 1942 instructions were issued that all soldiers leaving West Africa were to be given:

(*a*) Sufficient mepacrine to last them sixty days, given in 0·2 g. doses twice a week.

(*b*) A simple note of instruction laying down the importance of taking the drug in the correct dose regularly for the whole period of sixty days.

(*c*) The pamphlet *Notes on the Treatment of Malaria in Individuals returning from Service in Malarious Areas.* The soldier was instructed that should he suffer an attack of malaria when on leave he should hand the pamphlet to his doctor or to the M.O. at the E.M.S. hospital to which he is sent.

On arrival in the United Kingdom it was arranged for embarkation medical officers to check that men were in possession of mepacrine and pamphlet and to make good any deficiency. At ports where there was no E.M.O. the Ministry of Health arranged for this check to be undertaken by port medical officers who were supplied with mepacrine and pamphlets for the purpose.

The Ministry of Health also undertook to make civil practitioners malaria-minded by the publication of a treatment article in the *B.M.J.* and by a letter drawing their attention to the importance of keeping malaria well in mind when soldiers from West Africa and other malarious areas reported sick.

Precautions against Malaria in the United Kingdom. The possibility that soldiers returning from abroad might provide a reservoir, from which mosquitoes at home might become infected with malaria and transmit the disease to the civil population, as occurred in the latter part of the War of 1914–18, was carefully considered during 1941–2 by the Army Medical Directorate and the Ministry of Health.

In the later part of the War of 1914–18 large numbers of troops contracted malaria in overseas theatres such as Macedonia, Mesopotamia and East Africa. Infected soldiers reached England in sufficient numbers for the disease to spread widely among the local population in some districts. It was made notifiable and all cases reported were investigated by officers from the Ministry of Health.

The chief vector of malaria in England is *A. maculipennis var. atroparvus* which prefers to breed in brackish water; if found in fresh water it is never numerous. Bomb craters, static water tanks and trenches increased the number of suitable breeding places. The danger period was stated by the Ministry of Health to be from July to September.

In April 1942, a meeting was held with the Ministry of Health and the branches of the War Office concerned with demobilisation, to discuss measures for preventing the introduction of malaria into this country. The chief problem concerned the return of large numbers of troops from malarious areas to this country for demobilisation. A map was produced showing three areas which were dangerous from the point of view of malaria. These areas were defined as follows:

Area A—A very dangerous area	Kent Coast, South of Thames, Isle of Sheppey.
Area B—Dangerous area .	Extending from Norwich in Norfolk to Bridport in Dorset to a depth of twenty miles.
Area C—Potentially dangerous area	From York to Bridport passing through Lincoln, Peterborough, St. Neots, Oxford, Swindon to Bridport.

Later the dangerous area was amended and defined as follows:

The coastal area of Suffolk for a distance extending ten miles inland.
The whole of the County of Essex included in B area and
The part of the County of Kent in B area except Dover, Folkestone and Shorncliffe.

From the military point of view the problem fell under two headings:

(*a*) Action to be taken regarding individuals or small batches of men from infected areas returning to the United Kingdom during the war.

(*b*) Action to be taken when the war was over and large numbers of men returned from demobilisation.

As regards (*a*) it was accepted as a military responsibility that the civil health authorities were notified of their arrival in the United Kingdom, if their homes happened to be in the malaria zone. The S.M.O. troopship notified the port medical officer of the men concerned and the latter notified the M.O.H. of the district to which the soldier was proceeding. It was agreed that soldiers returning from malarious areas would not be posted to units located in the danger zone. This restriction only applied to:

Troops who had been in a malarious area within the past two years or in the season during which the mosquito could transmit malaria, i.e. July–September.

As regards (*b*) it was agreed that the areas to which demobilising troops would be sent would be kept under review by the various War Office branches concerned and that as far as possible men who had served in malarious areas would be sent to dispersal camps away from

malarial zones. In the case of men returning to the danger zone after demobilisation the medical officer of the camp would notify the M.O.H. of the area concerned.

Incidence of indigenous malaria in Great Britain following Two World Wars. After the First World War there were actually 481 confirmed indigenous cases of malaria in Great Britain and the geographical distribution of these cases agreed very closely with what is believed to have been the distribution of indigenous malaria about 1860. Thus, apart from a few cases in Shropshire, Buckinghamshire and Northamptonshire, the indigenous cases from 1917 to 1921 were largely in the Eastern counties, from Lincolnshire to Kent and along the south coast as far west as Dorset. Kent had the most serious outbreak, with no fewer than 394 cases. This was mainly due to the fact that large numbers of troops from Salonika who had frequent relapses were sent home to special camps: one such camp was actually situated in the Isle of Sheppey where *Anopheles maculipennis, var. atroparvus* is prevalent.

From 1941 to 1948 there were only thirty-four cases of indigenous malaria in England, one case in the Isle of Man, and one in Northern Ireland. Kent had only six cases, Surrey eight and Hampshire, Sussex and Devonshire three each.

From the data collected after the two world wars it appears that in twenty-six of the counties of England and Wales conditions are favourable not only for the breeding of anopheline mosquitoes but for the complete development of the benign tertian malaria parasite.

Malaria among Troops returned from Mediterranean Theatres of War. Late in 1943 when 21 Army Group was being formed in the United Kingdom a number of formations were returned from Mediterranean theatres to join it. Many of the personnel of these formations had been infected with malaria in North Africa, Sicily or Italy and the resulting relapses and spring attacks presented a considerable problem to D.M.S. 21 Army Group.

The formations affected were XXX Corps (which then included 50th and 51st Divisions), 7th Armoured Division and the S.A.S. Brigade. Units of XXX Corps began to arrive in the United Kingdom at the end of October 1943. They had been taking suppressive mepacrine throughout the malaria season in Sicily; at first 0·2 g. twice weekly, and subsequently 0·1 g. six days a week (and in some cases seven days) and were under orders to continue the suppressive treatment for one month after leaving the malarious area. In this area the malaria season ended on October 15 owing to the onset of cold weather, so that all troops whether awaiting embarkation, or at sea, or arrived in the United Kingdom would complete one month's suppressive medication by November 15. It was estimated that this one month's treatment was faithfully carried out by something over 50 per cent. of officers and men returning to England.

The Consulting Malariologist to the Army accurately forecast the manifestations of malaria which would present themselves in the spring among troops returning to the United Kingdom from a highly malarious area, and had recommended that these troops should receive a week's 'blanket' course of 0·3 g. mepacrine daily before arrival. This decision was not received in time to be acted upon by the first arrivals and its value was not easy to assess. Certain units which arrived later, having undergone the 'blanket' course of treatment, had not been exposed to the same malarial risk as earlier arrivals who had received ordinary suppressive treatment. Certain other units, moreover, which claimed benefit from the 'blanket' treatment, were armoured units having a high standard of discipline and morale, in which anti-malaria orders and suppressive treatment had most probably been carried out faithfully throughout the malaria season. Spring relapses and primary manifestations (reputed first attacks) began to appear among personnel of 51st Division in March 1944. The majority were infected with *P. vivax*, a few with *P. falciparum*.

Some concern was also felt about the incidence of malaria in 50th Division, 8th Armoured Brigade, XXX Corps troops and a battalion of the S.A.S. Brigade. As the question was a matter of treatment, it was referred to the Consulting Physician to the Army. He and the Consulting Malariologist advised that the course which was in the best interests of the patients was to allow malaria attacks to appear and give those affected the standard treatment with quinine, mepacrine and plasmoquin in a military hospital. Certain units, however, began to be seriously depleted, and, with the approach of D-day and interference with training, commanders became alarmed. Although it was clear that these spring attacks were a well known characteristic of the disease and would disappear in late spring and early summer, the question of what further suppressive or other treatment could usefully be adopted, became a problem of morale and therefore one of operational importance.

It was therefore arranged for an investigation of all infected units to be carried out forthwith. Formations were visited by the Consulting Physician, D.D.H., and A.D.H., 21 Army Group, and certain units were investigated by teams of clinicians and pathologists from Army Group general hospitals.

As a result of these investigations certain units and formations were selected for suppressive, and others for 'blanket', treatment (suppressive mepacrine 0·1 g. daily and 'blanket' treatment for seven days only were unsuccessful in preventing spring attacks of malaria), and it was considered advisable to recommend that suppressive mepacrine should be continued by those men with a history of fever or previous malaria until personnel of some of the most affected units could be relieved from

battle service. In certain cases quinine was used as a suppressant—in doses of 10 gr. t.d.s. for three days.

Malaria was not a problem during the assault, although cases were still occurring. As the summer began the expected decline in incidence took place, and the problem receded to its proper perspective.

In August the first cases of indigenous malaria made their appearance. The Americans reported that the disease was indigenous in the area of St. Mère Eglise in the Cherbourg peninsula. British troops were first infected in the Orne valley, north of Caen, where *A. maculipennis* was identified. None of the patients had left the United Kingdom before and all gave histories of recent mosquito bites. Altogether there were 46 cases of indigenous malaria during the summer and autumn of 1944. The French health authorities denied the existence of malaria in the river valleys around Caen. It appears to be probable that malaria cases from the Mediterranean did in fact act as sources of infection of local mosquitoes.

SCABIES*

During the inter-war years the incidence of scabies in the Army had shown a tendency to increase progressively in spite of all preventive measures. There was a popular belief that this could be attributed to laxity on the part of units in not preventing interchange of blankets and sports clothing or in not ensuring that their men had regular hot baths. Some, however, held that it was contracted in the same manner as venereal disease.

During the same period many medical officers of health throughout the country had been observing that the disease was increasing among the civil population as judged by the numbers voluntarily attending their cleansing centres.

Incidence. After the outbreak of war it became one of the principal causes of admission to hospital and its incidence in the United Kingdom continued to increase; and it was noted that this had occurred in spite of improved facilities for bathing and laundering. The comparative incidence of scabies in the United Kingdom and overseas expressed as ratios per 1,000 is given below:

	1937	1914–18	1940	1941	1942
United Kingdom	7·4	19·27	20·0	40·77	48·1
France . .	1914–18	42·71.			
France . .	1939–40	34·44.			

During 1941 commands were requested to complete a *pro forma* for cases of scabies which was designed to throw some light on the method

* For further information consult the Volume on Medical Research, Chapter 6, the Campaign Volumes, the Volume on Medicine and Pathology, Chapter 6, and the Civilian Health and Medical Services, Vol. I.

of spread of this disease. The results were summarised as follows:

Summary of Scabies Returns from Commands

Number of cases	2,157
Units with abnormal incidence	22
Baths weekly or more often	1,705
Baths less than once weekly	8
Bath register kept	1,467
Bath register not kept	165
Bathing facilities good	1,524
Bathing facilities not good	26
Bathing discipline good	1,132
Bathing discipline not good	37
Intelligence normal	1,326
Intelligence sub-normal (5·6 per cent.)	79
Clean men	1,430
Dirty men (12·5 per cent. *circa*)	206
Source of infection	
Civilian	499
Military	346
Body	56
Blankets	281
Clothing	47
Bedding	22
Venereal (0·5 per cent.)	10

The figures given for sources of infection were of little value since many cases came into more than one category, e.g. 'military' and 'blankets' but it did seem clear that a considerable proportion was civilian.

For the most part these figures provided purely negative evidence. It was concluded that the relatively high incidence of scabies could not be ascribed to any of the following causes:

(*a*) Infrequent baths.
(*b*) Insufficient facilities for bathing.
(*c*) Poor bath discipline.
(*d*) Failure to keep a bath register, or
(*e*) Poor hygiene in units.

It was also noted that the number of infected men of dirty habits or sub-normal intelligence was relatively small and that venereal disease was not a common concomitant. This disproved the commonly held belief that it was the unwashed, low type of soldier who was the commonest sufferer.

A test was carried out in Western Command to ascertain if enforced bathing would lower the incidence of this disease and also other skin

infections. Two units were selected with a similar incidence. It was found that bathing did not have the results expected.

A considerable body of opinion held that the civil population was the main source of infection and that mere bathing and disinfestation of blankets were unlikely to succeed in reducing the incidence of scabies in the Army.

During 1941 under the aegis of the Ministry of Health and the M.R.C. an investigation was undertaken at the Sorby Research Institute, Sheffield, into the incidence, transmission and epidemiology of scabies and into the relative merits of the various methods used in its treatment. Patients were provided by a neighbouring C.R.S. In an interim report certain interesting points concerning the part played by fomites and personal contact emerged. The experiments were as follows:

A. *Fomites*

(*a*) Volunteers used blankets one to seven days after they had been used by scabies patients—six experiments, all negative.

(*b*) Volunteers used underclothing two to seven days after it had been used by scabies patients. Six experiments, all negative.

(*c*) Volunteers used beds immediately they were vacated by scabies patients—nineteen experiments, all negative.

(*d*) Volunteers used underclothing immediately after it was removed from scabies patients—thirty-two experiments, thirty negative, two positive.

Note. The volunteer did not bath for a period of fourteen days after the experiment and in most cases he did not wash for a week preceding the experiment.
Bedding and underclothing were used by volunteers for a period of seven days—bedding slept in at night only. Underclothing was worn continuously day and night.

B. *Personal Contact*

On four occasions uninfected volunteers wearing pyjamas slept together in the same bed as scabies patients. On three occasions the volunteers and one infected man slept together for seven nights—all three volunteers became infected after periods of eight, nine and twelve days from start of experiments; in the fourth case the volunteer slept for two nights but did not become infected.

The following conclusions were reached: Infestation occurred from the civilian population: transference in barracks was negligible: bathing alone did not cure the disease in any stage: the part played by fomites in the transmission of scabies had been overstressed in the past.

It was estimated that the incidence of scabies among the civil population was four to five times higher than in the Service and this led to the *Scabies Order* 1941 which conferred powers of enforcing treatment in cases brought to the notice of medical officers of health.

In order that full advantage might be taken of this order, and by agreement with the Ministry of Health, instructions were issued for the leave address of every soldier who contracted scabies within a period of five weeks after returning from leave to be notified to the M.O.H. of the district where the soldier had spent his leave, provided there were reasonable grounds for believing that the disease was contracted while the patient was at home. The notification was made on A.F.A.35 by the medical officer who supervised the treatment and the following details were supplied:

> Diagnosis, name, rank, number, date of reporting sick, name and place of the hospital or C.R.S. where the patient was receiving treatment. The details of the suspected source of infection were not to include the names of suspected carriers of the disease but did include the full address of the premises where it was believed the disease was contracted. Under 'General Remarks' a statement as to when the patient last slept in or visited these premises was added.

It was estimated that medical officers of health would receive about 1,000 notifications per week from Service medical officers.

In order to standardise and improve treatment it was decided to centralise it in selected hospitals and C.R.Ss. In these scabies centres patients were segregated and treated and their clothes and bedding disinfested. The centres were visited frequently by command dermatologists who did much to rationalise the standard of treatment and in this way reduced the number of relapses after treatment. Courses of instruction on the diagnosis and treatment of scabies were arranged in commands for medical officers and hygiene officers.

After the simplification and improvement in the method of treatment of scabies it was felt that if cases could be treated in units by their R.M.Os. a great saving in man-days lost per year would be effected; petrol used for the transference of patients to hospital would be saved, and, if the disinfection of clothing and blankets could be omitted, there would be a further saving in labour and fuel. In 1942 it was estimated that 6,000 cases of scabies a month or 72,000 a year occurred in the Army in the United Kingdom. With treatment in hospital four working days were lost allowing for two days transferring the case to and from hospital.

Thus 288,000 man-days were lost per year, equivalent to a unit of 800 men being *hors-de-combat* for a whole year. This was represented by D.G.A.M.S., to C-in-C., Home Forces, who agreed to a trial of the treatment of scabies in units (dispensing with disinfestation of blankets and clothing) being carried out in two divisions—46th Division (South Eastern Command) and 52nd Division (Scottish Command).

Treatment. The evolution of the rapid method of treating scabies in units without disinfestation of bedding and clothing may be recounted briefly as follows:

In January 1940 the Adviser in Dermatology, A.M.D. 5 instituted a trial of treatment with benzyl benzoate at the Connaught Hospital.

Throughout 1940 the relative efficiency of benzyl benzoate compared with that of older methods of treatment was tested in various military hospitals and C.R.Ss. It became evident that the benzyl benzoate treatment was in many ways an advance over other methods.

At the request of A.M.D.5 supplies of benzyl benzoate were made available and the treatment was more and more widely used throughout the Army, particularly after the issue in May 1941 of the pamphlet *Notes on the Prevention and Treatment of Scabies* 1941.

In January 1942 the formula was modified and improved. An endeavour was made to find a simple method of making a water emulsion to use instead of the spiritous solutions formerly used in order to economise spirit. The emulsion was made by means of Lanette Wax S.X. in water and contained 25 per cent. benzyl benzoate.

It had been reported to the Ministry of Health that when this method of treatment was employed, the clothes worn by the individual following treatment were rendered mite-free by the medicament. The view had been expressed that it was unlikely that as high a proportion of re-infestation as 5 per cent. would occur if disinfestation of blankets and clothing was not carried out. This confirmed the view held by the military dermatologist at Tidworth who, since October 9, 1939, had not had the clothing or bedding of scabies cases disinfected, yet maintained in his area a lower scabies incidence than elsewhere in the command (14 cases per 10,000 men per year as compared with 51 cases per 1,000 men per year).

In the field trials carried out in the 46th and 52nd Divisions all uncomplicated cases of scabies were treated by officers in medical charge of units using the following method:

(*a*) As soon as possible after the diagnosis was made the patient without any preliminary bath was painted from neck to foot with benzyl benzoate solution or emulsion.
(*b*) After this had dried a second application was made.
(*c*) After the second coat had dried the patient put on his clothes and returned to duty; he was instructed not to wash for twenty-four hours.
(*d*) The painting (two applications) was repeated on the following day and twenty-four hours later he had a bath. The patient was instructed to report to his medical officer once weekly for a period of six weeks to ensure that there was no relapse.

The results of the field trials may be briefly summarised as follows:

72 per cent. of cases were cured with one treatment in their units.
23·4 per cent. of cases were cured with two treatments in their units.
4·6 per cent. of cases were failures and were admitted to a C.R.S. or military hospital for treatment.

The time taken for one treatment was approximately half an hour or less as compared with an average duration of 93·6 hours by the usual method of treatment. In addition bedding and clothing were not disinfected, which resulted in a very considerable saving of fuel and in wear and tear of clothing and blankets.

The success attending these field trials resulted in a general change of policy in the treatment of scabies. While the former policy of treating all cases of this disease in scabies centres was well adapted for the static conditions which had prevailed until then, it was felt that in view of the probable opening of a 'second front' the general adoption of this rapid method of treatment of uncomplicated cases in units would have the following advantages:

(*a*) Economy in man-hours saved by not removing patients from duty while they are undergoing treatment. This was the cardinal factor in the policy.
(*b*) Economy in medical and nursing personnel.
(*c*) Economy in fuel used for heating water and disinfectors.
(*d*) Economy in transport used to take patients to and from scabies centres.
(*e*) Economy in A.V. battledress which fell to pieces when treated in a disinfector.

The Adjutant-General agreed to the change of policy being implemented. It was not applied to the A.T.S. initially but was extended to them eventually in 1943.

An instructional film on scabies was made by the Ministry of Health showing the life history of the mite, diagnostic features and the new rapid method of treatment. The film was made in order to improve the standard of diagnosis. Copies of the film were obtained by the Army for training purposes.

One command reported an increase of septic cases following the introduction of this method of treatment but this was held to be due to medical officers failing to supervise their medical orderlies until they had become proficient in the technique of painting the patient with benzyl benzoate. It was generally agreed that the benzyl benzoate method of scabies therapy proved to be very satisfactory from all points of view and in 1945 it was strongly recommended that it should be adopted by India and S.E.A.C.

SMALLPOX*

This is a disease which was considered to be almost completely preventable in a well-vaccinated community like the Army, even when serving abroad, where the risks of contracting the disease were so much

* *See* Volume on Medicine and Pathology, Chapter 24.

greater than at home. Nevertheless, during the war outbreaks of smallpox in areas where troops were stationed did result in cases occurring among military personnel, and not only among those who had refused vaccination but also in men who were said to have been successfully vaccinated before embarkation. A disturbing observation was that when, in the presence of outbreaks, men were re-vaccinated abroad, a significant number among those who had been regarded as insusceptible at home did in fact show normal 'takes'. These facts gave rise to considerable thought and discussion, more particularly with regard to:

Vaccination technique
The criteria of successful vaccination
The period of protection
The potency of British calf lymph.

The questions were examined by a committee of experts who made the necessary recommendations.

A number of localised outbreaks of smallpox occurred among troops in Iran, North Africa and the Middle East, where a virulent type was prevalent among the civil population.

The failure of medical officers to record clearly in A.B.64 the results of vaccination clouded the issue when it was necessary to check vaccination states in the presence of an epidemic.

Measures were necessary to prevent the introduction of smallpox into the United Kingdom by military personnel returning by sea and air. The chief difficulties in this connexion were the mild cases which had been modified by previous vaccination and were not diagnosed before disembarkation.

Notable Outbreaks of Smallpox Overseas. Early in 1943, an epidemic occurred in Iran during which there were eighty cases. Sixty-five cases occurred among British troops, thirteen among Indian troops and two among Polish troops. In all there were twenty-two deaths. Investigations showed that, although vaccination was recorded, no scars were visible in a good many cases. Some had refused vaccination. Mass re-vaccination terminated the outbreak.

About the middle of 1943, there was an outbreak of smallpox in Constantine in Algeria in which both haemorrhagic and confluent cases occurred. In this outbreak the mortality rate was 30 per cent. Again large scale re-vaccination was resorted to, when probably between 12,000 and 15,000 troops were re-vaccinated, after which the outbreak ceased. When unit vaccination states were checked, it was noted that, although entries in A.B.64 showed that these men had been vaccinated previously, the result had not been recorded. A good deal of concern was caused when it was found that 50 per cent. of the men supposed to have been protected took successfully with the local Pasteur vaccine. Similar results had been reported from the Middle East. This appeared

to indicate that 50 per cent. of the troops were not protected against the local virus. The experience of D.D.M.S., West Africa, was similar and he suggested as a possible explanation that the antigen might have altered in the course of years and might now protect against vaccinia but not against smallpox. Samples of the vaccine from North Africa and the Middle East were obtained for testing in the United Kingdom. The possibility of faulty technique in vaccination was also considered.

During 1943, the incidence of this disease in North Africa was 0·5 per 1,000 and in Italy 0·1 per 1,000. In 1944, it was 0·2 per 1,000 in both cases. These figures, however, gave no indication of the gravity of the disease in certain circumscribed areas where local outbreaks occurred. For instance, during the first quarter of 1944 there were 112 cases in the Cairo area, and the incidence of the disease among such a limited military population was somewhat striking. Again there was an outbreak in a military hospital at Taranto where 42 cases occurred among a population of 1,000.

Early in 1944 there was an outbreak of smallpox in Gibraltar among both Service personnel and civilians which made it necessary to institute certain measures to minimise the possibility of infection of personnel. The following measures were enforced:

(*a*) Vaccination within fourteen days of personnel proceeding to Gibraltar.

(*b*) Stoppage of leave and surveillance of personnel returning to the United Kingdom.

Vaccination. Before the war all recruits for the Regular Army were vaccinated on the second day after enlistment. The period of protection was regarded as seven years at home and five years in foreign stations, except in the presence of an epidemic, when vaccination of all personnel was carried out where there was not satisfactory evidence of vaccination or re-vaccination within two years. The vaccination states of units were reviewed annually in January by officers in medical charge of troops and any re-vaccinations necessary were carried out to bring the unit state of protection up to 100 per cent. Vaccination was in all cases performed by a single linear incision $\frac{3}{4}$ in. in length.

Shortly after the outbreak of war it was announced in Parliament that vaccination and inoculation in the Services were on a voluntary basis. Efforts were made by the Army Medical Directorate to have compulsory vaccination and immunisation introduced in the Army but without success. This of course resulted in a proportion of men, estimated at 5 per cent., refusing vaccination. This question was considered by the Hygiene Advisory Committee who were of the opinion that since vaccination was a certain protection this proportion of unprotected men did not constitute an increased risk to the protected 95 per cent., even as regards modified cases.

In view of the virulent type of smallpox prevalent in the Middle East and North Africa, the outbreaks which occurred among the troops in these theatres, and a high proportion of 'takes' which occurred when contacts were re-vaccinated with local lymph, a good deal of concern was caused as to whether the troops were properly protected against smallpox. An investigation into the state of protection against smallpox was carried out in selected units in 21 Army Group in 1944 and the following results were obtained:

In one unit of approximately 1,000 men—
Vaccinated in infancy . 52 per cent.
Vaccinated on enlistment—
Success . . . 86 per cent. results obtained from history.
Failure . . . 12 per cent. visual evidence on soldier's arm.

Results confirmed as success or failure in A.B.64—17 per cent.
In a second unit 70 per cent. had been successfully vaccinated as shown from the history or visual evidence on the soldier's arm.

In a third unit of 616 men—
99 per cent. had been vaccinated in the last 5 years.
59 per cent. had been vaccinated in infancy.
Records of vaccination in A.B.64 showed 1·6 per cent. successful vaccinations recorded. 76 per cent.—no record.

Overseas, in a Guards unit of 1,247 men who were contacts of smallpox, 643 men who had not been successfully vaccinated within one year were re-vaccinated. Successful results were obtained in 561 cases which were classified as follows:

Pronounced reaction . . .	18
Normal reaction	152
Modified reaction . . .	381

It was appreciated after this investigation that the following questions required further consideration:

(*a*) The period after which re-vaccination should be carried out at home and abroad.
(*b*) The number of insertions which should be made.
(*c*) The procedure which should be adopted for inspecting results of vaccination in order to detect the earlier reactions, and for carrying out re-vaccination if results were negative.
(*d*) Confirmation of the potency of British calf-lymph by the Director of the Government Lymph Establishment.

On May 5, 1944, D. of H. held a conference with D. of P. and the Consulting Physician to discuss the vaccination state of the Army, the incidence of smallpox abroad and any improvement that could be made

to increase the numbers immunised. It was agreed that the matter should be placed before the civil experts for their consideration and advice.

D. of P. called a meeting on July 26, 1944, which was attended by the leading civil authorities on vaccination together with representatives of the medical services of the Royal Navy and the Royal Air Force.

This conference made the following recommendations:

(i) Vaccination of recruits, irrespective of vaccination history, should be carried out by means of a single insertion ¼ in. in length.

(ii) Re-attempts in the event of failure to 'take' should be by means of three insertions ¼ in. in length and 1 in. apart.

(iii) The Women's Services should follow the same instructions as those in force for men.

(iv) In face of an epidemic all persons exposed to risk who had not been successfully vaccinated within fourteen days should be re-vaccinated by three insertions ¼ in. in length and 1 in. apart.

(v) The area to be vaccinated to be well cleansed with soap and water only and thoroughly dried with a sterile gauze pad before vaccination. Methylated spirit, alcohol or other agents should not be applied.

(vi) Vaccination should be carried out by making a linear skin incision through the lymph with the point of a sterile needle or similar instrument. The insertion should be just deep enough to produce a pinkish tinge to the serum but not deep enough to cause free bleeding.

(vii) Arms to be inspected forty-eight hours and one week after vaccination. The terms to be employed in recording reactions were left to be decided later.

(viii) In the event of failure to 'take' at the first attempt, two further attempts to vaccinate with three insertions should be undertaken at weekly intervals. Special attention should be paid to inspecting arms within forty-eight hours of each operation. Persistent and complete failure to be recorded as 'insusceptible'.

(ix) Re-vaccination should be carried out every five years in the case of forces remaining in the United Kingdom and every three years in the case of Forces overseas.

The conference decided that:

(*a*) The employment of Government Lymph Establishment's vaccine was to continue until such time as definite evidence was forthcoming as to the comparative 'take' values of lymphs from the Government Lymph Establishment and other institutes overseas.

(*b*) A letter should be sent by them to the M.R.C. defining the problem and asking the Council to consider the formation of a M.R.C. committee.

Vaccination and Documentation. The documentation of vaccination during the war was never considered to be entirely satisfactory, more particularly the records in the A.B.64. The vaccination table in this army book consisted of two columns headed respectively 'Date of Vaccination' and 'Initials of M.O.' In consequence this was often the only information recorded and the most important point of all—the 'result'—was omitted. Measures were taken from time to time to stress to all medical officers the importance of the correct assessment and recording of results of vaccination but, in spite of this, instances were constantly being brought to notice where documentation was incomplete as shown by the following examples quoted by A.M.D.5 in a circular letter to all commands at home and abroad:

(*a*) In India a medical officer commented on a new draft: 'A large proportion of the men had no recorded result in A.B.64'. He therefore re-vaccinated them and out of 268 men re-vaccinated, 261 gave a successful or modified result. This suggested that little attention had been paid to vaccination at their former stations.

(*b*) It was found as a result of a survey that, out of 1,016 men who gave a history or produced visual evidence of vaccination, only 18 per cent. were able to produce a record in A.B.64.

(*c*) In another survey of 616 men, the result was found to be unrecorded in 76 per cent. and there was no entry at all in the A.B.64 of a further 10 per cent.

The effects of this defective documentation were that:

(*a*) Men were re-vaccinated time and again, with resulting impatience and probable eventual refusal of the procedure.

(*b*) In the face of an outbreak the medical officer concerned could form no idea of the number of troops at greatest risk.

The Introduction of Smallpox into the United Kingdom. The Army was responsible to the Ministry of Health for ensuring that adequate steps were taken to prevent the introduction by military personnel of infectious diseases into this country from overseas. The diseases most feared in this connexion were smallpox, typhus and malaria. Smallpox, however, proved to be the most formidable danger, judging from the number of outbreaks which occurred in various places in the United Kingdom during the war, introduced by passengers and crews disembarked from ships. These outbreaks demonstrated how vulnerable a large section of the civil population was and how quickly spread of infection occurred with, in many instances, apparently little connexion between cases. This is best exemplified by the occurrences which followed the arrival of the troopship *Awatea* which docked at Glasgow on May 29, 1942 with 1,000 passengers and 200 crew.

A sick engineer on board was found to have unrecognised confluent smallpox from which he afterwards died. All on board were immediately vaccinated but by June 23 another seven of the crew, two passengers and a contact medical officer had developed the disease. This was disappointing as in five of these cases vaccination had been performed early in the incubation period—between the first and fifth days—when it usually confers protection.

The sequel was alarming. From June 26 onwards cases of smallpox began to appear in different parts of Glasgow and they were all 'primary' in the sense that they had no apparent connexion either with the ship or with each other. At first only the usual precautions were taken; contacts and neighbours were offered vaccination so as to form a cordon of protected persons round each focus of infection but as the foci multiplied the situation was deemed so serious as to necessitate vaccination on a large scale. It was believed that altogether about half a million were immunised during the month. In view of the obvious virulence of the infection the customary single-stroke method of vaccination was abandoned in favour of three strokes $\frac{3}{8}$ in. long and $\frac{1}{8}$ in. apart. It was also felt that unless there was a history of recent vaccination a single unsuccessful attempt could not be taken as evidence of immunity, and vaccination was accordingly repeated if no reaction was seen within four days. Altogether before the outbreak ceased some thirty-three cases had occurred. There were only two military contact cases from the ship —the first, a Polish officer, was modified by vaccination; the second, a B.O.R. was a fatal confluent case. He had been vaccinated on joining the Army in 1941 but no scars could be detected and it was probable that vaccination had been unsuccessful.

Of the eight cases among the crew seven had never been vaccinated previously and one had been vaccinated in infancy. This preventable sea-borne invasion had not only caused loss of life but had also interfered very considerably with the work of the port and city.

The following military action was taken:

(*a*) A quarantine camp was provided at Glasgow for military personnel ex H.M.T. *Awatea*. This was possible only because a prisoner-of-war camp in the vicinity happened to be vacant at the time. The Ministry of Health was not convinced that this measure was necessary.

(*b*) A.M.D.5 sent a circular letter to all D.Ds.M.S. drawing attention to the civilian contact cases of variola occurring in Glasgow and elsewhere and warning them of the possibility of further cases occurring among contacts of these secondary cases. They were requested to keep a close watch on the situation and to have unit vaccination states checked.

(*c*) Leave to and from Glasgow was restricted to personnel who had been successfully vaccinated within the past three years.

(*d*) Intakes of men and A.T.S. from Glasgow were cancelled until the cessation of the outbreak.

In October 1942 a further civilian outbreak of smallpox occurred in Fife with some twenty-eight cases and five deaths, and two cases occurred in Edinburgh in which the source of infection was not definitely traced to contact with the Glasgow or Fife cases. Both outbreaks however were probably sequels of the Glasgow outbreak.

A less alarming outbreak of smallpox followed the admission of an officer invalided from North Africa to Mount Vernon hospital in March 1944 whose disease was not diagnosed for some time after admission. He had been vaccinated successfully in infancy and again in 1942, and although suffering from a virulent strain of smallpox he was a mild case. A number of contact cases of smallpox occurred among the staff and visitors to the hospital, some of which were fatal. The latter were confined to those who were either unvaccinated or had not been vaccinated since infancy.

The story, however, is quite different when a case of smallpox is accurately diagnosed on board ship while at sea and contacts are immediately vaccinated before arrival as the following examples show:

H.M.T. *Naphill* from North Africa docked at Glasgow on November 25, 1943, with one military case of smallpox on board, diagnosed at sea. On board there were:

78 officers and 2,741 other ranks
300 Merchant Navy survivors.
200 crew.

The following action was taken:

(i) All contacts were vaccinated before arrival.

(ii) Thirty-nine immediate contacts, patients in the ship's hospital, were quarantined. Those suffering from other illness were isolated in hospitals ashore and the remainder were retained on board until the period of surveillance had expired.

(iii) The survivors and ship's crew were retained on board for the period of surveillance.

(iv) Military personnel were disembarked and allowed to proceed to their pre-arranged destinations. This was agreed with the M.O.H., Glasgow but it was stipulated that leave should not be granted until December 8, when the quarantine had expired.

(v) D.Ds.M.S. commands concerned were notified by teleprint of the names and the units to which personnel proceeded; that they were to be kept under surveillance until December 8; no leave was to be granted until after that date; unsuccessful vaccinations were to be re-vaccinated.

(vi) Civil M.Os.H. concerned were notified by commands.

There were no further cases of smallpox following this incident.

The *Capetown Castle* arrived in the Mersey on April 22, 1944, and disembarked a case of smallpox which had developed on April 14. All personnel were allowed to proceed to their depots but leave was stopped until the expiration of the quarantine period and all were re-vaccinated. Again no further cases occurred.

The danger of smallpox being introduced by air caused some concern in 1945, when two cases arrived by air from Lammie transit camp, Naples. These individuals developed the disease after they had proceeded on leave. One of them infected his wife, although he himself remained comparatively well, apart from what he described as 'a few spots on his face' and as a result did not report sick or see his own doctor. The attention of D.M.S., C.M.F., was drawn to the risk of these mild modified cases of smallpox being transported by air and the necessity for taking steps to prevent it.

TYPHUS*

At the end of 1941 and early 1942 much anxiety was caused by reports from M.I. branches and from other sources regarding the prevalence of typhus on the Continent and elsewhere. Its incidence was reported to be widespread in the Baltic States, Poland, Roumania and Serbia. It was also reported to be present in Spain and the French colonies on the North African coast. Information was received that Russian prisoners had introduced the disease into some German prisoner-of-war camps and that several cases and deaths had occurred among British prisoners-of-war. In September 1941 it was forecast that a wide extension of the disease was likely, more particularly as all the necessary factors, famine, squalor and overcrowding, accompaniments of war, were present. At all times, however, it was very difficult to obtain an accurate picture of the extent to which typhus had spread in Eastern Europe owing to the unreliability of the information available. Typhus thus constituted a most serious threat to the safety of a British force operating in a typhus area, and in these circumstances the Army Medical Directorate consulted the General Staff and the necessary measures for the protection of a force in such a contingency were formulated.

Preventive Measures. In view of the evil reputation of epidemic typhus as a scourge of armies in the past a considerable administrative effort was deemed necessary to combat it.

The necessary precautionary measures were drawn up before the introduction of D.D.T. which had a profound influence on them at a later date.

---

* *See* Volumes on Medicine and Pathology, Chapter 8, and Medical Research, Chapter 4.

The military measures of control were directed to:

(*a*) The prevention of lousiness in the force.

(*b*) The provision of adequate facilities for disinfestation and disinfection.

(*c*) Protection of the troops by preventive inoculation.

(*d*) Research into methods for the destruction of lice.

(*e*) Preventing the introduction of typhus into the United Kingdom.

(*a*) In the prevention of lousiness the aim was the maintenance of the highest standards of personal hygiene. To make this possible the scale of equipment was such as to make it possible to provide a bath, change of underclothing and, if necessary, disinfestation for every man once a week.

Bathing facilities for forward troops were provided by divisional mobile bath units. The bathing sets of the mobile bath unit were not increased but every effort was to be made to provide static bathing facilities whenever the opportunity arose. To each division was allotted a mobile laundry capable of washing the clothing of all men once a week. At this unit stocks of clean underclothing were held for exchange with dirty garments.

In typhus endemic areas weekly, or at most fortnightly, health inspections were to be held under all conditions, as this had been shown to be one of the most effective preventive measures in the Army. These inspections were to be held under the supervision of a medical officer but it was considered to be most important that all officers and N.C.Os. should be trained in the detection of lice on the body and on the clothing, as the inspection for vermin in a large unit, especially on detached duties, could not be undertaken by the medical officer alone. The education of the individual soldier on the dangers of lice was to be carried out by lectures, posters and films. All medical officers were issued with the pamphlet, *The Control of Epidemic Typhus* 1942, notified in A.C.Is. of June 17, 1942. This pamphlet was revised and re-issued in 1944 (notified in A.C.Is. of February 16, 1944).

Anti-louse powder (A.L.63) was provided to every man in a force operating in a typhus area on a scale of $\frac{3}{4}$ oz. a man a week, and was designed principally to prevent lousiness and not to cure it. It was sprinkled on the surface and rubbed into the seams of underclothing and retained its efficacy up to eight days (i.e. before D.D.T. was incorporated in it). The method was supplementary to steam and hot air disinfestation and was most applicable to men removed from the normal facilities for bathing and disinfestation.

(*b*) The normal provision of disinfectors and disinfestors to field hygiene sections and mobile bath units was triplicated and every unit medical officer with forward troops was provided with one F.P. Disinfector No. 2. This resulted in the disinfectors and disinfestors with a

division having a total capacity of approximately 90,000 blankets or 13,000 sets of clothing and equipment a week and this scale of equipment was sufficient to provide disinfestation for every man once a week. The extra transport and personnel required for the additional disinfestors, however, had to be provided from local resources.

In the presence of an epidemic it was visualised that all arrangements for making the best use of available resources would be co-ordinated by the formation headquarters on the advice of the senior administrative medical officer. In forward areas it would be possible to form a central cleansing centre by utilising part of the disinfesting capacity of a division —one D.F.P. No. 3 from the field hygiene section and one hot air disinfestor from the mobile bath unit and as many sets of sprays as necessary. The mobile laundry could form part of the centre. The other divisional disinfesting, bathing and laundering units, including the disinfectors from field ambulances and C.C.Ss., could be formed into subsidiary cleansing centres or mobile units according to circumstances. Similar arrangements would be necessary in L. of C. and base areas, giving special consideration to transit camps at railheads and ports.

Protective clothing was designed for the protection of personnel exposed to special risk in handling infested clothing and bedding. It consisted of:

(i) A one-piece cotton overall with trouser and stocking combined.

(ii) Rubber boots or canvas shoes, rubber sole.

(iii) Protective drill gloves sealed with adhesive tape.

The scale for units in a typhus area was as follows:

Fd. Hyg. Sec.	18 sets
Mobile bath unit . . .	24 sets
Units with D.F.P. No. 2 . .	2 sets
Fd. Amb.	8 sets
C.C.S.	12 sets
General hospital . . .	20 sets

Personnel operating field disinfectors and disinfestors were provided with protective clothing. The use of masks and anti-gas eye-shields was prescribed for the protection of personnel exposed to the danger of rickettsial infected dust on blankets, clothing etc. and a close fitting head dress to be worn by nurses.

(*c*) After the necessary supplies of Craigie's modification of Cox's typhus vaccine had become available, all troops proceeding to an area where typhus was endemic, or to an area where typhus was likely to break out, were inoculated with it. Three injections of 1 c.c. at seven or ten days interval were necessary, and re-inoculation with a single stimulating dose was recommended at the beginning of the typhus season and at three to six months intervals thereafter in an area where typhus was occurring.

Both British and U.S. authorities were rather surprised at the degree of protection apparently conferred by inoculation with Cox's vaccine, as shown by the relatively small number of cases of typhus which occurred in the Middle East and North Africa among personnel after inoculation, in spite of its prevalence among the local civilian population. It also modified the severity of the attack. The mortality rate of typhus both in North Africa and the Middle East was 33–36 per cent.

The British troops in North Africa were not inoculated until some time after their arrival and during this period twenty-nine cases were reported among troops. All the cases occurred in men who had been associated with native labour such as pioneers, stevedores, *et al.* In one case only was infestation present and then only a single louse was found. The migration of lice from a host whose temperature had risen did not completely explain the absence of nits in the clothing and it was possible that the infection had occurred through inhalation. The incidence dropped almost completely after administration of the vaccine. The U.S. troops on the other hand had been inoculated before their arrival and, in spite of the fact that they mixed more freely with the native population than our men, they only had two mild cases during the same period. Up to the middle of 1943 when troops of Eighth Army were also protected by inoculation sixty cases of typhus had been reported from the Middle East.

(*d*) At the outbreak of the war the standard lousicide was N.C.I. powder which had emerged in the First World War. This was later replaced by A.L. 63 Mark I which proved to be more effective and non-irritant. Derris was one of the main constituents in this powder but stocks of derris became scarce and a substitute had to be found for it. Eventually cubé root which could be imported from South America was found to be an effective substitute and the anti-louse powder containing this was designated A.L.63 Mark II.

Under the auspices of the Entomological Sub-committee of the M.R.C. and the Insecticides Development Panel of the Ministry of Production various substances were tested in the laboratory and in the field for their insecticidal value against lice. Lethane and lauryl thiocyanate held out much promise as they had a persistent action. These substances were investigated and cotton belts sewn into pleats impregnated with them were found to be lethal to lice and nits when worn as body belts. Their value was limited by the fact that they proved to be irritant to the skin causing discomfort and erythema to white troops. Although this did not occur in coloured individuals it was found that their potency was seriously affected by sweating so that the value of their persistent or residual action was lost.

It became known in 1943 that the new insecticide D.D.T. was a most effective lousicide and its potentialities were fully investigated both in

Great Britain and in the U.S.A. Since the particular value of this unique insecticide was its persistency, it was important to find out how this property could best be exploited and the question of impregnating underclothing was fully explored. D.D.T. in powder form was known to be harmless, and when used as an impregnate for clothing, produced no ill effects on the individual either to the skin or from toxic absorption and did not harm the garment. The shirt was selected for impregnation as it was the only garment included in underclothing that was common to all soldiers, whose choice of vests and underpants varied. After impregnation it could be washed three or four times and still remain potent for six weeks. The research in clothing impregnation was mainly carried out at the Experimental Establishment, Porton, in collaboration with the London School of Hygiene. The War Office arranged for a field test of the value of impregnated shirts to be carried out in North Africa by an entomological field unit. Before this field test was carried out it was considered that from the knowledge already gained concerning the value of this insecticide it would be justifiable to ask for the immediate impregnation of 500,000 shirts, even if the protection afforded to the garments did not prove to be 100 per cent. successful.

The field test in North Africa was carried out on Arabs in civil prisons. Three groups of thirty men were taken:

(i) The first group were given impregnated shirts with unimpregnated underclothing.
(ii) The second group wore impregnated shirts.
(iii) The third group wore unimpregnated shirts only.

The average louse population of these men was fifty and at the end of the month 80 per cent. of those wearing impregnated clothing (i) and (ii) showed a count of under fifteen. Eighty per cent. of the controls (iii) showed a count of over fifty. There was no indication of louse breeding on the clothes or on the individual when impregnated clothing was worn, while active breeding took place on the controls. These results showed that impregnated clothing had the effect of killing off the adult lice and preventing breeding. It was concluded that impregnation of this kind prevented louse breeding within a community, reduced the rate of cross infestation to negligible proportions and therefore prevented the outbreak of typhus epidemics within the community.

The issue of impregnated shirts, known as 'Shirts A/T' (anti-typhus) on a scale of two per man to all groups operating in, or proceeding to, areas where typhus was likely to occur was adopted as one of the principal methods of protection from louse infestation. Priority was given to forward troops. Arrangements were made for the re-impregnation of the shirts to be carried out in the field by mobile laundries.

D.D.T., in china clay, was adopted as an anti-louse powder and superseded those previously issued. At first the strength of D.D.T. was 5 per

cent. in A.L.63 Mark III. This was later raised to 10 per cent. A.L.63 Mark IV. The use of this anti-louse powder not only destroyed adult lice and larval lice when they hatched out but its persistent action on clothing also prevented re-infestation—a most important feature. It thus became possible to deal with large numbers of infested individuals without the use of steam or hot air disinfectors. The methods of disinfestation with D.D.T. powder are described in the section 'Disinfection and Disinfestation'.

The first full-scale application of D.D.T. in a war sector was in the attempt to halt a severe typhus epidemic in Naples at the end of 1943. Nearly 1,300,000 civilians were disinfested by dusting with a powder containing 5 per cent. D.D.T. This mass attack on the vector of typhus brought the disease under control and for the first time in the world's history a typhus epidemic was arrested in mid-winter.

Since this spectacular field demonstration provided convincing evidence that louse infestation and typhus could be controlled by dusting with D.D.T., the whole policy with regard to disinfestation in the Army was reconsidered. It was decided to make a revolutionary alteration and replace the heavy steam disinfectors of field hygiene sections and the H.A.D. of mobile bath units, which had been rendered obsolete, with D.D.T. dusting apparatus as described in the section 'Disinfection and Disinfestation', page 114.

As D.D.T. had no action on *rickettsia*, hot air and steam disinfestors were still required when dealing with typhus patients.

The British Forces which took part in the invasion of Northern France were either provided with impregnated shirts or with A.L.63 Mark III anti-louse powder. Every man of the assault force was issued with two shirts A/T. Reports received on infestation for the first five weeks indicated that the weekly infestation rate was as low as 0·6 per 100,000. This was considered to be very satisfactory, taking into consideration the fact that the troops were living under conditions reminiscent of 1914–18 when infestation was universal.

It was concluded that in a military population, although sporadic cases might occur, typhus could be brought under complete control by the combination of anti-typhus vaccine and dusting with D.D.T.

(*e*) It was considered that there was very little risk of a typhus epidemic occurring in Great Britain unless the economic state of the country became considerably reduced. The nutritional state of the population was satisfactory and the incidence of infestation was low. Nevertheless it was a matter of common prudence that precautionary measures should be taken to ensure that the disease should not be introduced by returning military personnel or prisoners-of-war, and the civil authorities requested that arrangements should be made to this end.

In North Africa and the Middle East there was some infestation among British troops during the cold weather, particularly among forward troops, but in the hot weather there was none. Enemy prisoners when taken had a high infestation rate in winter—Germans 50 per cent. and Italians 100 per cent., but in hot weather, when very little clothing was worn, this dropped considerably. Prisoners-of-war taken in North Africa were disinfested in camps as they moved back and there was little risk of them introducing typhus into Great Britain if moved here in the summer, but it was thought there would be a risk in winter, more particularly when rapid transportation direct from infected areas would greatly increase the potential danger. Plans were therefore made for cleansing and disinfestation centres to be established at ports in the United Kingdom (*see* 'Prisoners-of-War' section of this Chapter, page 258).

The following classes of personnel required consideration:

(i) Troops returning to this country
(ii) Repatriated prisoners-of-war.
(iii) Enemy prisoners-of-war.
(iv) Refugees from N.W. Europe.

The method of their disposal at the port of entry depended on whether they came from a typhus area or a non-typhus area.

Every step was taken to ensure that troops returning to this country were free from lice.

Repatriated prisoners-of-war, from a non-typhus area would be bathed and issued with new clothing before leaving their camps and could be passed through to their camps in this country without being disinfested, provided a certificate of their freedom from infestation was given them.

Enemy prisoners-of-war from non-typhus areas, provided they had a clearance certificate of freedom from lousiness by a medical officer or senior officer, were allowed to proceed to their disposal areas on arrival in the United Kingdom. Heavily infested prisoners-of-war, however, were to be disinfested overseas before embarkation if possible, otherwise disinfestation was carried out at the port of disembarkation or as soon as possible after arrival at their camps.

In the case of a prisoner-of-war from a typhus area, arrangements were made for disinfestation to be carried out overseas before embarkation, or, if this proved to be impossible, the War Office would be notified and disinfestation would be carried out at the port of disembarkation. If necessary, ships were to be directed to ports where facilities for bathing and disinfestation existed.

Provision had also to be made for the disinfestation of refugees from N.W. Europe as near as possible to their ports of disembarkation. This

responsibility was shared with the civilian authorities. The reception camp was organised by the military and the civilian authorities provided civilian technical and welfare personnel.

OUTBREAKS OF TYPHUS

(1) Eire.

Towards the end of 1942 an outbreak of typhus occurred in Eire affecting the counties of Galway, Mayo and Clare. In this outbreak it was probable that about a hundred cases occurred although only eighteen were recognised officially. The following precautionary measures were put into operation immediately:

(*a*) All privilege leave to the three counties was cancelled.
(*b*) All applications for compassionate leave to the affected areas were referred to the War Office (A.G.4a) who issued special instructions.
(*c*) Units were instructed that all such personnel were to be inspected by the medical officer before departure; that the Holyhead route would be used both going and returning and personnel would report to the embarkation authorities on both occasions.
(*d*) Facilities for disinfestation were provided at the port of Holyhead.
(*e*) On return to their unit personnel were inspected by the medical officer and segregated for fourteen days.
(*f*) Restrictions were also placed on embarkation leave to these areas. This was only granted in special cases provided the fourteen-day quarantine on return could be completed before the mobilisation date; otherwise it was banned.
(*g*) Recruiting from the affected areas was stopped and all recruits from other counties in Eire were sent to I.T.Cs. in Northern Ireland.

During this outbreak the disinfestation facilities at Holyhead were also made available for the use of civilians at the request of the Ministry of Health.

Another but more localised outbreak of typhus was reported in the Carrick-on-Shannon district, County Leitrim, Eire, in April 1943. In this outbreak it was not considered necessary to apply any restrictions on leave to the affected area. As a precautionary measure, however, it was recommended by A.M.D.5 that all volunteers whether from Northern or Southern Ireland should go to training centres in Northern Ireland instead of proceeding direct to this country, as the incidence of pediculosis in these men was fairly high. The disinfestation facilities at Holyhead were again placed at the disposal of the port health authorities for civilian travellers if required.

(2) Iran.

A serious outbreak of typhus occurred among Poles transferred from Russia early in 1943. Nine hundred cases occurred out of a total of 73,000 Poles consisting of 43,000 civilians and 30,000 military personnel.

Energetic measures were taken to deal with them on arrival and the outbreak was terminated by mass disinfestation.

(3) France

It was reported that 250 cases of typhus occurred among Russian 'Todt' workers in the Cherbourg area during the period March–May 1944.

(4) Precautions at Gibraltar.

In view of the situation of this fortress and its exposure to risk of typhus spreading from Spain, precautionary measures were taken at the instance of D.D.M.S. Gibraltar Command. The provisioning arrangements included:

(*a*) a supply of typhus vaccine;
(*b*) a special supply of 39,000 lb. A.L.63 over and above normal current demands;
(*c*) the despatch of thirty sets of protective clothing.

SCRUB TYPHUS*

Although this disease was known to be common in certain areas in the Tropics and Sub-tropics, it had not been appreciated before the war that its distribution was as widespread as proved to be the case. In India its distribution was mainly limited to Assam, Bengal and the Himalayan foothills but it was found that its endemicity in Assam and the adjacent Burma hills was much greater than was formerly thought and that non-immunes visiting this area were liable to a high attack rate. Pockets of very high endemicity were brought to light in Ceylon and the Maldive Islands and it was considered highly probable that similar pockets were scattered all over India, Burma, Indo-China, Siam, Malaya, Sumatra, Borneo, New Guinea and Northern Queensland, many of which had not been brought to light simply because non-immunes in large numbers had not entered such areas. The inhabitants in endemic areas were highly immune no doubt as a result of attacks in childhood. The attack rate was high among those who had not previously suffered.

Before the war the incidence of scrub typhus was trivial in India and Burma but during the war military operations necessitated the occupation of areas in Assam and Bengal never previously visited by British troops and certain similar areas in India and Ceylon were used for jungle training. As a result of this the incidence of this disease considerably increased and small epidemics occurred in Burma, Assam, Ceylon and the Maldives.

The disease had a seasonal incidence which varied with the geographical locality. In Burma and on the Indo-Burma frontier the typhus season was during the last five months of the year. In 1944 the incidence

* *See* the Medical Research Volume, Chapter 4.

in Fourteenth Army commenced rising in July and in August there were 800 cases and 700 for each of the remaining months of the year to November. The monthly ratios per 1,000 men for three months were July 0·25, August 1·65, September 1·26, October 1·5, November 1·25. The mortality rate varied according to the district, but for the whole force it averaged approximately 16 per cent. in 1944 though it had been as high as 30 per cent. Scrub typhus thus became a considerable threat to Fourteenth Army owing to the risk of large endemic foci being occupied by large numbers of non-immune troops.

Transmission of scrub typhus is by the bite of the larvae of certain species of *Trombiculid* mites. Rodents in endemic areas are infested with clusters of larval mites, usually in the ears. It is only the first larval stage which attaches itself to mammals. The causal organism, *Rickettsia orientalis*, is passed from one generation of mites to another. In rodents of several kinds the disease is epizootic.

Larval mites can be picked up by way of the boots and ankles or by a person sitting or lying on the ground or by picking up equipment from the ground. The larva makes its way over the body for one of the sweaty areas of the skin where it feeds.

The mites are found most frequently in the ground in open jungle usually near water in rat burrows about 4 to 6 in. under the surface, especially in bunds of paddy fields and at the roots of trees, and the particularly dangerous areas are around villages which attract rats. They are highly selective in their choice of locality which explains the patchy nature of the distribution of endemic foci.

One of the military members attached to the Scrub Typhus Commission held the view that typhus areas could be detected by air survey. He maintained that where there were cultivation and human habitations, there were rats and where there were rats there were mites.

He classified the terrain into four categories:

1. Virgin jungle where there were no mites and where typhus was unlikely.
2. Secondary jungle of ten years' standing—once cultivated and, although rats had left, mites remained and might be dangerous.
3. More recent jungle with high grass; still more dangerous.
4. Cultivated land: the most dangerous of all.

It was difficult to make use of this information, however, for the reasons that the dangerous areas were so vast and that to troop movements there could be no set limits.

The bionomics of Trombicula and methods of typhus control were investigated by:

(*a*) The Medical Research Council's Scrub Typhus Commission with headquarters at Imphal.

(*b*) The U.S.A. Typhus Commission, an entirely independent team directed from Washington, was located at Myitkina. Liaison between these teams was of the closest and their lines of approach to the problems were similar. Knowledge concerning the disease and the part played in its causation by the mite vector was considerably extended by their work and that of the Australians.*

Among the methods of control investigated were:

(*a*) Mite avoidance—the possibility of being able to avoid endemic areas for camp sites by utilising air surveys. Methods of 'civilising' camp sites, e.g. by cutting paths, using gravel or sand on tent floors; utilisation of native labour (immunes) for clearing scrub, etc.

(*b*) Use of repellents—D.B.P.

(*c*) Field investigation with formations, e.g. trapping mites on the ground or on mammals, etc. in infected and in non-infected areas and the correlation of these data month by month throughout the year with the fluctuations in the incidence of the disease along the line of advance.

(*d*) Propaganda by cinematograph film.

(*e*) Trials of a scrub typhus vaccine.

Preventive Measures. 1. Of the numerous measures suggested it was found that the impregnation of all clothing with D.B.P. was by far the most effective protective measure giving, according to the experts, nearly 100 per cent. efficiency. D.B.P. was lethal to the mite in less than fifty minutes. It was most effective when rubbed on to the clothing by the hands. A definite drill for the treatment of clothing was laid down and an instructional film showing the details of the procedure was made:

> Each item of clothing was laid on the groundsheet and the soldier having dipped his fingers in the liquid and rubbed the two hands together stroked the inside of the clothing on an average five times. The undergarments and socks were rolled in the hands instead of stroking. 2 oz. of D.B.P. was required for the set of clothes.

This gave protection to the wearer for a fortnight with eight washes. The drill was normally carried out by platoons, the men being given their 2 oz. allowance of D.B.P. in tins. There were no complaints of discomfort from wearing the impregnated clothing. Men of S.A.S. and commando units, who were likely to be isolated for longish periods, were provided with individual containers.

---

* *See Clinical Problems of War*, Chapter 9. This is the first of the Medical series of the Official Australian History.

An outbreak of scrub typhus occurred among troops undergoing courses at a jungle warfare training school at Gudalur Nilgiris. In October a class had seventy cases; in November the next class had sixty cases; then D.B.P. impregnation of clothing was started and there was only one case per month subsequently.

2. A vaccine was prepared and subjected to trials. The chairman of the M.R.C. Scrub-Typhus Commission recommended an initial dose followed six months later by a boosting dose and subsequently every six months. He recommended inoculation in the United Kingdom to ensure a potent vaccine as refrigerators were required in the Tropics for its preservation. Its efficiency was not definitely proven.

3. Avoidance of recent jungle and cultivated land.

4. Camps to be provided with paths and tents with floors.

5. Placing seats, beds and hammocks more than one foot from the ground (i.e. the limit of the mite's climbing ability). The avoidance of sitting or lying on the ground. A groundsheet cannot be relied on to give protection from the ground.

6. Bulldozing the surface of camp sites, and burning of scrub or grass were of little value and D.D.T. did not appear to be insecticidal to Trombicula.

VENEREAL DISEASE*

Incidence. Venereal disease was found to be the most difficult of all diseases to control owing to the restrictions imposed on preventive measures by public opinion and to the manner in which it was contracted. The comparative incidence of this disease in various theatres expressed as annual ratios per 1,000 is given below:

TABLE 35

Incidence of Venereal Disease. United Kingdom and Overseas 1937–44

	1937	1940	1941	1942	1943	1944
United Kingdom	12·8	8·7	9·53	12·8	12·4	9
Middle East (Egypt, Palestine, Sudan)	34·1	62·4	79·77	25	16	13
North Africa	—	—	—	—	18	31
West Africa	—	—	56·28	53·33	—	—
Burma	65·4	—	87·53	—	—	—
Malaya	71·4	—	99·9	—	—	—
Italy	—	—	—	—	57	54

* For further information consult the Campaign Volumes, the Volume on Medicine and Pathology, Chapter 5, and the Civilian Health and Medical Services, Volume I.

In the United Kingdom the ratio of syphilis to gonorrhoea in all commands was about one to six or one to seven but the proportion of syphilis to gonorrhoea showed a tendency to rise in the vicinity of large ports. This was particularly the case in Scottish Command with the important port areas of Glasgow, Leith, Aberdeen, etc. where the ratio was one in two.

Preventive Measures. In the prophylaxis of V.D. reliance was placed on periodical lectures to the troops and the provision of early treatment rooms in units. In 1939 a leaflet entitled *A Note to Regimental Medical Officers called upon to lecture on the Prevention of Venereal Disease among Troops* was issued to medical officers as a guide. It was the intention that troops should be made aware of the risks incurred if they indulged in promiscuous sexual intercourse, of the whereabouts of the early treatment (E.T.) rooms and of the method of carrying out personal disinfection. All officers commanding units were instructed to ensure that a room or cubicle was set aside as an E.T. room which should be provided with light, hot and cold water, soap, towels, wash basin and urinal, together with a supply of tubes of calomel and oxy-cyanide of mercury ointment (E.T. Packets). Irrigation of the urethra was not recommended except where there was a trained orderly to supervise it. It was only feasible to establish E.T. centres staffed by skilled orderlies where there were large concentrations of troops.

When patients admitted to hospital suffering from V.D. were questioned, many denied ever having had a lecture on the subject and few admitted to any knowledge of facilities for personal disinfection. While soldiers' statements on the subject may perhaps be largely discounted, an analysis of venereal case cards showed that only 230 men out of 1,000 admitted having carried out any form of prophylaxis.

The attention of G.Os.C. in all commands at home was drawn to these observations and they were requested to ensure that officers commanding units took steps to remedy this state of affairs. The fact remained, however, that unit E.T. rooms were unpopular with the troops and were little used. On the other hand the larger centres staffed by trained orderlies such as those established in M.E. did extremely good work.

The incidence of V.D. in certain overseas countries in which British troops were serving gave cause for considerable anxiety and the Army Medical Directorate was strongly of the opinion that condoms, which were generally agreed to be the most effective preventative, should be made available to troops in overseas theatres. The Royal Navy and the Australians* had adopted this policy and a number of units in the British Army had done so unofficially. It was some time, however,

* *See Clinical Problems of War*, Chapter 22.

before resistance to this medical recommendation was overcome owing to the fear of a public outcry, stimulated by agitation of certain organisations, to the effect that condoms were being forced on soldiers and this policy would be a direct inducement to immorality. When the effect of these diseases on man-power was fully appreciated, and also when it was shown that the question was not really one of morality but of disease prevention, it was eventually agreed that condoms should be made available to the troops free on request in all units in overseas theatres.

It was felt that a V.D. film should be made to show how the method of personal disinfection should be carried out, for exhibition on board transports and abroad. Many difficulties were encountered in the production of such a film, as the Army was reluctant to sponsor it. Copies of an American Army film entitled 'Sex Hygiene' which emphasised the details of personal disinfection were obtained in 1943. From the medical point of view it was excellent but it rather shocked the Staff, and, while permission was given for it to be shown overseas, it was debarred from being shown in the United Kingdom. It was received enthusiastically in the Middle East. Copies were made available for exhibition in all overseas stations and on troopships, and it was generally commented on favourably. One A.D.M.S., reporting on it, stated that after exhibition in his area 'the V.D. figure fell from 192 cases to 72 cases during the month'. A U.S. Navy version of this film which was a considerable improvement on the Army one was produced in 1944. Permission was obtained for it to be shown at home to units proceeding overseas as well as in all theatres of war overseas.

A number of countries had V.D. notification acts and statutory powers to enforce treatment of persons known to be infected. The absence of any such legislation in Britain was a great handicap in reducing known sources of infection. There were many instances where several men were known to have been infected from the same person but nothing could be done about it officially. The Ministry of Health appreciated the need for introducing V.D. regulations which would give the necessary powers to compel known carriers to obtain treatment. Such action was particularly necessary in view of the influx of Dominion and Allied troops into the United Kingdom and proposals were submitted to the Minister of Health by the Chief Medical Officer.

In 1943 the necessary legislation was introduced as Regulation 33B under the Defence (General) Regulations. This regulation provided for a specified form of notification (Form I) to be completed by a 'special practitioner' or Army specialist in venereology when the source of infection could be definitely established, and for its despatch to the M.O.H. of the district in which the infected person resided. When the M.O.H. received more than one notification incriminating the same person, he

was empowered to enforce treatment. An A.C.I. to implement Regulation 33B was published, and printed instructions were issued to medical officers on the correct method of notifying contents.

Before this the Army had worked out a system for dealing with its own Service contacts, as for example when a soldier stated he was infected by an auxiliary of the A.T.S., by notification under confidential cover to the Adviser in Venereology, War Office. Arrangements were then made for the contact, whose consent was obtained, to be examined at a gynaecological centre. This arrangement worked well.

GONORRHOEA

The treatment of the venereal diseases was revolutionised by new chemo-therapeutic measures. This was particularly so in the case of gonorrhoea where the administration of sulphathiazole by the mouth in adequate dosage was adopted as the treatment of choice; 5 g. daily for two days in regularly spaced doses achieved cure in the large majority of cases.

The feasibility of treating uncomplicated cases of gonorrhoea either in their units by regimental medical officers or in field ambulances or C.R.Ss., staffed by field service units was carefully considered, as this would make it possible to treat cases in forward medical units on active service and would effect economies in the provision of hospital beds, in medical personnel, ambulance transport and in man-hours lost in hospitalising cases of this disease.

In due course a scheme of treatment was evolved. It was intended that this change of policy should be applied to field force units. It was implemented early in 1943 but later it was generally adopted in the United Kingdom, not from choice but rather reluctantly because of the shortage of hospital beds and medical personnel, a situation which it was considered was unlikely to improve in the foreseeable future.

Briefly the scheme of treatment adopted was as follows:

(*a*) When a soldier reported sick with signs and symptoms characteristic of early uncomplicated gonorrhoea, two thin evenly spread smears were taken and sent without delay to the nearest pathological laboratory.

(*b*) Having made a diagnosis of early clinical gonorrhoea the medical officer, without waiting for the results of the pathological examination, prescribed sulphathiazole as follows:

First and second day—4 tablets in the morning, 3 at midday and 3 in the evening, 5 g. on each of two consecutive days. The tablets were given crushed in the presence of the M.O. or M.I. room orderly if the M.O. was not available.

Patients were not allowed to take tablets away with them and stocks of tablets were kept under lock and key and checked periodically

by the medical officer. Each dose was accompanied by 2 pints of water. A copy of Army Form I1243 (*Instructions to Soldiers suffering from Gonorrhoea*) was given to each patient to read and its contents explained.

(*c*) Army Forms I1247 and I1247A were made out for each case and the diagnosis entered thereon as soon as the results of the smears were received. If gonococci were reported present the diagnosis was gonorrhoea. If absent, the diagnosis was urethritis. In the former case the directions as to observation given below were followed; in the latter the patient was admitted to the V.D. department of a hospital. When a patient was sent to hospital for treatment or for observation A.F.I1247 accompanied him.

(*d*) All cases of gonorrhoea treated under unit arrangements were notified on A.F.W3181 (revised).

(*e*) M.Os. were advised to communicate with the nearest specialist in venereal disease in all cases of doubt or difficulty.

(*f*) Soldiers suffering from simple uncomplicated gonorrhoea were admitted to a field ambulance or C.R.S. whenever reasonably practicable and retained there during the two-day period of chemo-therapy, or as long as the discharge persisted. Soldiers treated by their unit M.Os. were normally marked 'Attend C' for this period. During the period of preliminary surveillance (i.e. the five-day period immediately following chemo-therapy) they were normally marked 'Attend A' but could be marked 'Attend B' or 'Attend C' at the discretion of the M.O.

(*g*) If, as was usually the case, the discharge ceased and the urine became clear, the case was seen daily by the M.O. for five days following termination of treatment and thereafter once weekly for three weeks. The final test of cure was carried out by a specialist in venereology approximately three months after completion of treatment. If, after seven days from commencement of treatment, there were signs of failure of cure, or if relapse or complications occurred at any time, the patient was admitted to hospital.*

A confidential leaflet entitled *Notes for Medical Officers on the Diagnosis, Treatment and Observation of simple Uncomplicated Gonorrhoea under Unit Arrangements* was issued to all medical officers.

In 1944 instructions were issued for the dosage of sulphathiazole to be changed to 5 g. daily for four days, as it was found by experience that this dosage was superior in therapeutic efficiency to 5 g. daily for two days. It was found that this increased dosage could be given without appreciably increasing the risk of side effects.

* This method of treatment of gonorrhoea was commonly made very difficult by the conditions under which the troops had to live and in which the provision of ablution facilities was next to impossible. It certainly calls for much care on the part of the regimental medical officer.

It soon became apparent after operations on the Continent that a sulphonamide resistant strain of gonococci was being encountered. This was attributed to the fact that civilian doctors were known to be giving these drugs to women in tolerated brothels and they appeared to be readily obtainable from chemists. This complication was not satisfactorily overcome until penicillin became available for the treatment of V.D. The allotment of penicillin for sulphonamide resistant gonorrhoea had a comparatively low priority until January 1945, when it was made freely available for this purpose.

SYPHILIS

The problem in connexion with the treatment of syphilis was to ensure that men carried on with their continuation treatment without interruption until they had completed the full course. Interruptions frequently occurred as a result of postings etc. To obviate this the following scheme of treatment of cases of early syphilis at home was drawn up and put into effect in 1942.

1. Every soldier suffering from early syphilis will, as heretofore, invariably be admitted to the venereal wards of a military hospital and retained there until he is considered by the venereologist to be no longer contagious.
2. On discharge from hospital he will be posted to a unit in the vicinity of an approved military hospital, and will remain in the vicinity of such a hospital for a period of twelve months, or until certified by a specialist in venereology as having received an adequate amount of treatment, whichever period is the shorter.
3. When discharging a case of early syphilis, O.C. hospital concerned will notify O. i/c Records that the soldier should be posted in the vicinity of an approved hospital, giving him as much notice of the probable date of discharge as possible.
4. O. i/c Records will notify O.C. hospital concerned that the soldier has been posted in the vicinity of such a hospital and will also notify O.C. unit to which the soldier is posted the reason for such posting.
5. Should it be deemed necessary for a soldier to be posted away from the vicinity of the hospital at which he has been receiving outpatient treatment he will be posted to the vicinity of one of the other approved hospitals. In this case O. i/c Records will notify O.C. unit in which the man is serving and O.C. unit to which he is posted, and similarly the O.C. both the hospitals concerned.
6. It will be the duty of O.C. unit to which the man is posted to see that he attends regularly at the hospital named as required and of O.C. hospital that the soldier receives the necessary treatment.
7. All notifications will be marked *confidential* and treated as such.

Notes: (*a*) Early syphilis is defined as within four years of date of infection.

(*b*) Vicinity will normally mean within 20 miles or one hour's travelling time.
(*c*) A list of approved military hospitals in the United Kingdom was supplied.

When the soldier had been posted to a unit in the vicinity of one of the specified military hospitals for a period of twelve months, or was certified by a specialist in venereology as having received an adequate amount of treatment, a certificate to this effect was completed by the O.C. military hospital and sent to:

(*a*) O. i/c Records (2 copies)
(*b*) O.C. unit with which the man had been serving while under treatment.

It was considered, as a general rule, inadvisable for soldiers to be posted to mobilising units during their first year of anti-syphilitic treatment if it could possibly be avoided and this was adopted as the policy with regard to sending syphilis cases overseas.

The policy with regard to the employment of soldiers under treatment for syphilis as cooks, etc., was reviewed in 1944. Until then they had been excluded from such employment. It was felt however that these men did not constitute a danger to health when employed as cooks, bakers and food-handlers and their suspension from such duties had led to a loss of skilled personnel.

It was decided that the following conditions would be applied in future:

(*a*) A soldier under surveillance for venereal disease could be employed provided he did not show active signs of disease and in the case of gonorrhoea was not under treatment, and was certified by a specialist in venereology as being non-contagious.
(*b*) A soldier under treatment for syphilis could be employed provided all surface lesions had healed and he was certified by a specialist in venereology as being non-contagious.

Central Syphilis Register. Towards the end of 1944 it was decided to establish a central syphilis register at the War Office with branches in overseas commands to ensure and check the adequacy of individual treatment. By this means a full record of every case of syphilis in the Army would be kept, details of treatment would always be available and men under treatment could be traced and steps taken to ensure that continuation treatment was effective. It was also anticipated that the register would be of value in assessing the therapeutic value of the various methods of treatment and especially that by penicillin.

The central syphilis register was found to work very well in practice. It seemed likely that it would remain a permanent feature in the control of the treatment of this disease.

Until 1944 the normal method of treatment for syphilis was the long-term treatment. Massive arsenotherapy had been tried by some venereologists in view of the substantial advantages of accomplishing in five days what usually took a year or even more. It was decided, however, that the drawbacks of this treatment outweighed its advantages and it was not recommended for general adoption. Mild and moderate reactions were common, especially primary and secondary fever, nausea, vomiting, headache and toxicodermas. Peripheral neuritis was a more severe reaction which occurred, although rarely if mepharsin was used instead of neoarsphenamine, and haemorrhagic encephalitis was a serious risk.

With the introduction of penicillin, a short-term treatment (twenty days with arsenicals, seven days with penicillin) was adopted as the routine treatment. At the same time it was decided that cases already on long-term treatment should be given seven days penicillin.

All cases were retained in hospital until the course was completed. Serological tests, after short-term therapy, were conducted at two-monthly intervals for six months and then at three months and six months. During the surveillance period clinical observations were made by a V.D. specialist and if necessary by a physician or neurologist. The rendition to the War Office of A.Fs. I1220 on completion of treatment and at serological testing and observation enabled the central register at the War Office to be maintained and checked.

The allotment of penicillin for syphilis was given sixth place on the priority list but later a higher priority was made for infections which had proved resistant to arsenic and bismuth or for cases where these remedies were contra-indicated.

THE CONTROL OF V.D. IN AN EXPEDITIONARY FORCE

In planning the control of V.D. in the expeditionary force the following considerations were regarded as essential:

1. *Policy*

A consulting venereologist should be appointed to advise the D.M.S. on all matters pertaining to the prevention, diagnosis, and treatment of V.D. and the disposal of cases.

He should pay regular visits to V.D. treatment centres in general hospitals and satisfy himself on the standards of treatment and adequacy of equipment.

He should also arrange for the training of M.Os. in the treatment of V.D. in forward areas.

V.D. treatment centres should be attached to those general hospitals selected by the D.M.S. and a pool of specialists should be created before the commencement of operations.

The numbers of treatment centres, beds and specialists required will depend on the size of the force and distribution of general hospitals and the prevalence of V.D. among the civilian population.

It was considered that an incidence of about 30 per 1,000 per annum among troops was probable for most European countries, and it was estimated that approximately one case in five would require hospitalisation. It was suggested that, as a general rule, straightforward cases of gonorrhoea should be treated in forward medical units and only cases refractory to chemo-therapy or with complications should be admitted to hospital. Cases of syphilis should invariably be admitted to a V.D. section of a general hospital.

During active operations it might be necessary to evacuate V.D. cases and clear mobile medical units but the scheme of forward treatment would save man-power and hospital beds.

To ensure continuity of treatment and adequate surveillance every soldier suffering from V.D. would be provided with a field case card—modified V15—which would be carried in his pay book (A.B.64). In the case of soldiers admitted to hospital A.F.I1247 would be made out in addition.

2. *Prevention*

The measures taken to control the incidence of V.D. would include the following:

(*a*) Lectures by medical officers should be given periodically on the lines laid down in the leaflet *A Note to R.M.Os. called upon to lecture on the Prevention of V.D. among Troops.*

(*b*) Condoms and E.T. packets should be available free on request in all units.

(*c*) E.T. centres (P.A. rooms) should be established in all static units and in all areas where there are considerable concentrations of troops. The latter centres should be similar to those established in the Middle East (class A and B) under W.E. VI/198/1 notified in A.C.Is. August 6, 1941.

(*d*) Brothels and/or brothel areas may be required to be placed out of bounds.

(*e*) A close liaison should be established with the local Health authorities and with the A.P.M. in order that concerted measures may be taken with regard to brothel areas and in tracing and dealing with sources of infection and contacts.

(*f*) Every effort should be made to provide facilities for exercise, recreation and entertainment for all troops not engaged in active operations. These should take the form of games, canteens, clubs, libraries, cinemas, concerts, etc.

3. *Diagnosis*

An attempt should be made to diagnose as many V.D. cases as possible in the forward areas. Smears for gonorrhoea and dark ground examinations in the case of suspected syphilis and soft sore should be examined in C.C.Ss. or mobile laboratories. This would save many cases being evacuated to the base.

4. *Treatment*

Cases of straightforward gonorrhoea, non-gonococcal urethritis, balanitis, etc., where the diagnosis can be made locally should be

treated in F.D.Ss.; usually one F.D.S. per division should be chosen for this purpose. Treatment should be carried out by a selected officer who has had previous experience in V.D.; failing such, an officer should be given a short course of training lasting about a week at a V.D. department of a general hospital.

All cases of syphilis and soft sore and cases of other forms of V.D. showing complications should be admitted to the V.D. department of a general hospital.

V.D. treatment centres of 100–200 beds on the lines of those authorised in M.E. (W.E. VI/268/1 notified in A.C.Is. 15 Oct. 41) should be attached to selected general hospitals and equipped in accordance with authorised scales. Standards of treatment of uncomplicated gonorrhoea, syphilis and soft sore should be laid down and adhered to as closely as possible.

5. *Surveillance and Disposal of Cases*

Straightforward cases which react satisfactorily to treatment should be retained in forward areas and returned to duty as soon as they are considered to be free from infection; this will usually be after a week or ten days. They should be seen periodically by the unit M.O. and attend for a final clearance test at the nearest unit which carries out treatment of V.D.

Cases admitted to general hospitals—especially cases of syphilis—should be retained in hospital till all surface lesions have healed and they are considered non-contagious. They should then be returned to their units and continuation treatment and surveillance carried out in those forward medical units selected for the treatment of V.D. Final tests of cure in the case of syphilis should invariably be carried out by a specialist in venereology.

Cases which on leaving hospital are considered unfit for all duties should be sent to a convalescent depot till they have regained full physical efficiency.

No case of V.D. which is likely to recover completely within three months should be evacuated to the United Kingdom.

DISCHARGE FROM THE ARMY OF MEN UNDER TREATMENT OR SURVEILLANCE FOR V.D.

Since soldiers under treatment in a military hospital or V.D. treatment centre were retained there until no longer contagious, the question of their release while still contagious did not arise. It became necessary, however, to arrange, before the end of hostilities, that men under continuation treatment and surveillance should be ensured these follow-up facilities after their return to civil life. With the co-operation of the Ministry of Health it was agreed, subject to the man's consent being obtained in writing, that the M.O.H. of the county or county borough in which the man proposed to reside should be notified in a letter marked 'Strictly Confidential' that a man about to be discharged from the Army was in possession of Ministry of Health Form V15 or its

equivalent, Army Form I1247 A or B. The notification also contained the man's address and was signed by the man himself. The form of notification after completion was despatched to D.D.M.(S)R, The War Office, who arranged for its transmission to the appropriate civil health authority.

Supplies of Form V15 were distributed to commands by A.M.D.5 and M.Os. were instructed to ensure that every man under treatment or surveillance for V.D. was issued with a Ministry of Health Form V15 and that he signed the form of notification. The object of the notification was explained to the soldier and he was informed that it was purely voluntary.

At the request of the civil health authorities, instructions were issued for the form notification to include the man's name in block letters and the approximate date of his release.

Similar arrangements were made with the Chief Medical Officer, Department of Health for Scotland, for cases released to addresses in Scotland to be notified to the appropriate M.O.H., and through the High Commissioner for Eire for residents in Eire.

A strong plea was made for the retention of Regulation 33B until the completion of demobilisation.

Penalties. When a man contracted V.D. through his own fault it had been customary for the following penalties to operate:

(1) Loss of proficiency pay.

(2) Hospital charges.

(1) Proficiency pay was lost for a variable period up to six months or more from the date of discharge from hospital and also during the period while a soldier was in hospital. The matter was taken up by the Army Medical Directorate and eventually A.C.I. 910 of 1941 was published whereby proficiency pay was restored at the discretion of the C.O. when the soldier had regained his physical efficiency. This usually happened as soon as he returned to his unit from hospital.

(2) A soldier suffering from V.D., if due to his own fault, was subjected to hospital stoppages of 1s. 6d. per day while in hospital. Since the stay in hospital might vary from a few days to a few months it appeared to be rather inequitable. Officially hospital charges were regarded as 'a partial contribution to the cost of hospital treatment'. The soldier, however, regarded it as a penalty and the soundness of the policy was called into question, more particularly as it was apt to lead to concealment.

A strong recommendation was made by the Army Medical Directorate that all financial penalties in connexion with V.D. should be abolished as it was considered that the V.D. patient should be treated in the same way as the man suffering from any other disease. This point of view was eventually accepted.

HEALTH HAZARDS (INDUSTRIAL)*

LEADED PETROL

The general adoption by the Army in 1943 of leaded M.T. 80 octane motor spirit containing up to 3·6 c.cm. of tetra ethyl lead (T.E.L.) per Imperial gallon raised apprehensions about possible health hazards from its use. A.M.D.5 was particularly concerned about its use in petrol cookers and the associated risk of contaminating food with lead, the effect on personnel operating field cookers, and the possible risk of absorption of dangerous amounts of tetra ethyl lead from prolonged contact of leaded M.T. petrol with the skin. The risk of poisoning arising from the inhalation of leaded petrol vapour among personnel employed in filling and handling this type of petrol was also given careful consideration.

The Director of Hygiene initiated an investigation to study this problem and was fortunate enough to be able to obtain the assistance of the Director of the Courtauld Institute, who undertook the estimation of the lead content of the various samples submitted to him during the course of these investigations. These included:

(i) Analyses of food samples cooked in field cookers burning leaded petrol.

(ii) Analyses of samples of air in the vicinity of petrol cookers using this fuel.

(iii) Urine analyses of cooks using petrol cookers.

It appeared from these preliminary investigations that the use of leaded petrol in field cookers did not result in the contamination of the cooked food with lead. The cooks did not show any evidence of having absorbed lead during the course of their work.

Another investigation carried out at the R.A.M. College, in which a different type of cooker—the field oven—was used with leaded petrol, did show that an appreciable amount of lead was found in food cooked in the oven although the amount was within the limits normally allowed. In consequence A.M.D.5 submitted a recommendation that the Chalex oven (No. 3 Field Cooker (oven)) should not be used with leaded petrol.

It was obvious that the problem required very careful consideration by experts and for this purpose the Director of Hygiene convened a conference in August, 1943 which was attended by representatives from interested branches of the War Office (S.T. (Catering) S.T. (Petroleum), Ordnance) and Air Ministry and a number of civilian experts. Further meetings on this subject were held in October 1943 and January 1944 in which other authorities were asked to participate.

---

* *See* the Medical Research Volume, Chapter 8.

One of these meetings recommended that further investigations should be made into the hazards involved in the use of petrol cookers and that these should be carried out at a School of Cookery. Arrangements were therefore made for an investigation to take place at the Army Catering Corps Training Centre in Aldershot. In this investigation six cooks were selected and employed in cooking with Hydra burners, using leaded petrol for a period of fourteen days, during which they worked under various conditions that might be expected to obtain on active service, e.g. in sunken cookhouses, underground shelters and above ground level. Twenty-four hour samples of urine were collected in each case at the commencement and at intervals of three days during the test.

It was found that there was no significant increase in the lead content of the urine of these cooks during the course of the tests, but in one case the lead content was raised in all specimens but was still within the range (0·02 to 0·08 mg. per litre) that might be encountered in normal individuals and therefore probably had no significance.

To give effect to another recommendation, Ordnance were asked to take up the question of producing a suitable filter, such as the steel wool filter, which could be attached to the burner of the petrol cooker for the purpose of collecting the products of combustion. This measure was expected to have the effect of lessening the risk, but its main object was to ensure the adequate ventilation of places in which petrol cookers were used. It was generally recognised by the experts that the use of leaded petrol in petrol cookers definitely introduced an element of hazard which could not be disregarded. A.M.D.5 therefore continued to press for the use of clear petrol for this purpose to obviate the possible risk from the use of leaded petrol, particularly during the winter months, when cooking by petrol cookers would frequently be carried out in enclosed spaces, but supply exigencies did not permit the adoption of this recommendation.

The use of leaded petrol in cigarette lighters was referred to the Associated Ethyl Company who had previously assisted in the investigations into the hazards from the use of this fuel. It was considered that although its use in lighters did involve some hazard it was possibly not very great and the risk could be accepted, more particularly as clear petrol could not be supplied for the purpose.

While there was doubt as to the actual degree of hazard from the use of leaded petrol in cookers, there were no doubts whatever about the seriousness of the toxic hazards to personnel engaged in handling T.E.L. products such as filling small containers with leaded gasolene and in handling packaged leaded gasolene. A summary of the conditions responsible for toxic hazards to personnel engaged in these operations was prepared together with recommendations for the avoidance of such hazards. These together with a paper on the medical aspects of T.E.L.

poisoning prepared by the Consulting Physician, P.A.I.Force were circulated for information to all overseas commands. In home commands the necessary information was published in A.C.I. 728 of 1944.

PROTECTION OF PERSONNEL HANDLING TRI-ETHYL LEAD (T.E.L.) PRODUCTS

The danger in handling leaded petrol lay in its content of T.E.L. fluid. For 80 octane M.T. motor spirit this amounted to 3·6 c.cm. per Imperial gallon and up to 5·5 c.cm. per gallon for high octane aviation spirit.

In T.E.L. fluid the proportion of lead in the molecule is such that in 1 c.cm. of T.E.L. there is approximately 1 g. of lead. T.E.L. is converted on exposure to air into tri-ethyl lead which is non-volatile.

Lead poisoning was only likely to occur in personnel exposed to high concentrations of the vapour of high octane petrol. There was little risk of absorption of dangerous amounts of T.E.L. into the body from skin contact with leaded petrol; the real hazard lay in the inhalation of vapour from it.

The conditions leading to the dangerous exposure of personnel to leaded petrol vapour were:

(*a*) Inadequate ventilation of buildings in which the filling or handling of containers was carried out.

(*b*) Excessive spillage within enclosed or inadequately ventilated areas, especially spillage in such a manner that virtually complete evaporation of the spilled petrol might occur, e.g. that spilled in thin layers upon the surfaces of containers and equipment.

(*c*) Spraying of droplets in the air from filling nozzles or moving parts of equipment upon which the petrol had been spilled.

(*d*) Filling of large quantities of containers by means of improvised facilities in the absence of proper precautions.

(*e*) High temperature in filling areas with the consequent rapid evaporation of the T.E.L. and petrol.

(*f*) Excessive leakage from damaged containers within the confined spaces of the holds of ships and barges.

The precautions which it was necessary to take to avoid hazardous exposure of personnel to vapour from leaded petrol were:

(*a*) Container filling was to be carried out under conditions of maximum natural ventilation, preferably in the open air.

(*b*) Where filling was carried out in buildings or under cover, the structure was to be open to the air on three sides or otherwise freely ventilated. The roof was to be as high as possible to ensure the least interference with the free movement of air. The floor was to be such as to prevent the pooling of spilled petrol and if surfaced with concrete or similar material was to be hosed down frequently if facilities existed.

Where recourse to artificial ventilation was necessary extractor fans were to be used with ducts to the source of vapour. The provision of through ventilation by forced methods was not nearly so positive and in consequence was the least satisfactory of all methods.

(*c*) Spillage was to be prevented as far as possible by adequate supervision to eliminate carelessness.

(*d*) When filling was carried out by improvised methods, and when leaking containers were being handled in the holds of ships or barges, leading to conditions where undue contact of clothing and foot wear with leaded petrol and in which the vapour could not be avoided, the following special precautions were necessary:

(i) Clothing and footwear worn during work were to be segregated and kept clean and suitable for regular use.

(ii) Facilities for washing the body and changing clothes at specified intervals were to be provided.

(iii) An essential measure was the rotation of labour so that personnel were not continuously exposed to the hazards.

(*e*) The washing of containers of leaded petrol was to be carried out in adequately ventilated areas or out of doors.

(*f*) To avoid damage to containers and leakage of petrol, care and continuous supervision were necessary in stacking and in loading trucks, rail wagons, barges and ships.

(*g*) Careful inspection with a view to the elimination of leaking containers before storage and during loading operations was essential.

In P.A.I.Force medical supervision of the personnel engaged in this work was carried out as an additional precaution. They were medically examined before employment and at periodical (monthly) inspections during employment. Personnel under 20 years of age were rejected as well as individuals suffering from vascular, liver or kidney disease.

Some Occurrences of T.E.L. Poisoning. Personnel employed in loading and unloading ships and barges who had to work in the holds were subject to special risk. The danger was greatest in hot climates. For example, instances were recorded in P.A.I.Force where I.W.T. personnel employed in stowing drums or tins of T.E.L. petrol in the holds of barges were affected when leaking containers resulted in a heavy vapour concentration collecting 5–6 ft. above the floor boards of the hold. As many as thirty workers were known to have become unconscious from this concentration of vapour in barge holds in a single day.

It was reported that a number of cases occurred in December 1944 among civilian employees at a dry cleaning establishment near Rome which had been used by U.S. 5th Army. Some were reported as having died of encephalitis, which further investigation showed were actually cases of lead encephalopathy caused by using T.E.L. petrol in the dry cleaning process. The local health authorities, however, were uncooperative when asked to supply further details of these cases.

LEAD PAINTS

From time to time a number of inquiries were received by the War Office regarding the provision of extra milk, as a prophylactic measure against lead poisoning, to personnel engaged in painting operations. To enable them to make any recommendations necessary, A.M.D.5 consulted various interested branches of the War Office (F.W.1., S.T.3., M.M.3., and M.M.6) regarding the extent to which lead entered into the composition of the various paints used in the Army and the application of the provisions of the Lead Paint (Protection against Poisoning) Act 1926 to military practice.

It was clear that various A.C.Is. had been issued from time to time bringing Army Regulations into line with civilian practice. According to the regulations in force the following was the situation so far as buildings were concerned:

1. Lead paint was not to be used in the form of a spray in the interior painting of buildings.
2. Unless the painted surface was known not to contain any lead:
   (*a*) The surface was not to be rubbed down or scraped by a dry process.
   (*b*) all debris produced by rubbing or scraping was to be removed before it became dry.
3. Special washing facilities were to be provided for personnel employed in painting.

Regarding the painting of vehicles, artillery equipment, etc., none of the paints authorised for spray painting in military workshops was a lead paint within the meaning of the Act referred to above. It appeared that the normal precautions in force in static ordnance workshops were such as would reduce the possibility of poisoning to a minimum even if the paints used did contain lead. It was considered that the amount of painting carried out by units in the field would not be sufficient to cause any danger to health. It was concluded that as far as could be ascertained there was no indication for the issue of extra milk as a prophylactic against lead poisoning to army personnel employed on painting, but instructions were issued to all home commands directing that, when applications for an issue of milk for this purpose were received, the particular circumstances of each case would be investigated locally by the medical and other services affected in co-operation before representation was made to the War Office. Every representation submitted would state the facts in detail.

An authoritative opinion on the value of an extra milk issue to lead workers was obtained from the Senior Medical Inspector of Factories of the Factory Department of the Ministry of Labour. It was as follows:

'This question of the provision of extra milk for workers exposed to lead and other hazards, is a very difficult one these days when there is not sufficient milk to go round. However desirable it may be for certain classes of workers exposed to toxic hazards, there is no evidence to my mind that it is essential. As you know before the war there was a great drive by the Milk Marketing Board to publicise the drinking of milk in factories and among the populace generally and many firms provided supplies at a cheap rate: there can be no doubt but that this was a measure of great value in promoting health. This was generally appreciated and the restrictions necessitated by war circumstances bore hardly on factory workers, as well as others, who had come to regard the extra milk as a necessity.

'The Ministry of Food naturally tempered the wind, but had to limit the wholesale supply of milk to factories. In this they were guided by considerations of workers who were engaged in processes in which they might be exposed to such materials as lead and fluorine among others and where additional milk might possibly have special beneficial effects.

'With the milk restrictions bearing quite heavily on all the populace who are not in the priority classes, a greatly increased number of requests and suggestions for additional milk supplies were received as has evidently been your experience as well as mine. It is very desirable that the position should be clearly stated and I have endeavoured to do so in the Chief Inspector's Annual Report for last year, which is published to-day: on page 40 you will see I have put a paragraph or two about the matter in the endeavour to ease the situation.

'You will see from the Annual Report how I see the position but no doubt there are other considerations than purely medical and scientific which would necessarily have to be taken into account by the Ministry of Food in deciding their policy with regard to this difficult question, the more difficult because milk supplies in factories had almost reached the height of a fashion before the war and no doubt those workers who have been restricted or cut off will feel the deprivation hardly and do what they can to get restrictions ameliorated'.

The extract on page 40 of the Annual Report of the Chief Inspector of Factories for the year 1943 stated:

'The supply of milk, for example, often causes much discussion. The impressions are widely held not only that milk has a unique action in preventing ill effects from industrial dusts and fumes, but also that everybody working where dusts and fumes may be encountered is entitled to a daily ration of milk at the works. This is not the case, and the only certain way of preventing ill effects is to ensure that the dusts or fumes do not gain entrance to the system in the amounts which are harmful.

'Pure milk is undoubtedly a food of the highest value and a most important dietary constituent. Milk, too, in sufficient quantity, mainly because of its content of mineral salts and water, has its proper place in treatment when too much of some materials like lead and fluorine have

entered the body but that is a different matter and the taking of milk cannot be regarded in any degree as a substitute for appropriate preventive measures directed towards preventing exposure to harmful dusts and fumes.

'There is, however, conclusive scientific evidence of the needs of the growing youngster and the expectant mother for milk.

'Therefore at a time when the supply of milk is so much less than the demand, the priority needs of these classes must be satisfied first, and the allocation of milk at cheap rates to factories which was so rapidly expanding before the war has had to be severely cut down.

'There is no statutory requirement for a supply of milk to factory workers except one which requires not less than half a pint daily of milk or cocoa made with milk for women and young persons employed in certain lead processes in potteries who commence work before 9 a.m. to be provided for each such worker at the expense of the occupier of the factory (Regulations for the Manufacture and Decoration of Pottery S.R. & O. 1913, No.2—Regulations 6 (1)).

'The Ministry of Food has, however, endeavoured to ensure that the restrictions in the supply of milk shall be as little onerous as possible, and allows, as far as the situation permits, allocations of milk from time to time to workers in certain processes, specified on the advice of the Special Diets Committee of the Medical Research Council and in addition has recently found it possible to extend the supply of National Milk Cocoa to all workers under 21'.

In view of the foregoing the position could be summed up as follows:

(i) There was no statutory requirement for a supply of milk to factory workers except under the *Regulations for the Manufacture and Decoration of Pottery*.

(ii) Milk was of value in correcting dietary deficiencies in the workers but there was no evidence that it has any specific action in preventing ill effects from industrial dusts and fumes.

(iii) Appropriate preventive measures directed towards preventing exposure to harmful dusts and fumes constituted the only certain way of preventing ill effects from lead absorption.

Eventually, however, a special meal for paint sprayers in home stations was authorised in A.C.I. 736 of 1944. The special meal, which consisted of cocoa (1 pint) made with milk, and a slice of bread (1½ oz.) could be provided daily for all military and civilian personnel engaged in paint spraying in W.D. Workshops where:

(*a*) the composition of the paint used and

(*b*) the conditions under which paint spraying was carried out were, in the opinion of the O.C., prejudicial to the health of the personnel concerned. A.M.D.5 recommended that this special ration could be issued in lieu of the sanitary drink authorised in *Regulations of the R.A.O.S.* para. 230.

INFORMAL JOINT SERVICES AND FACTORY DEPARTMENT INDUSTRIAL COMMITTEE

In view of the fact that knowledge concerning the toxicity of many of the large and expanding group of industrial solvents used in modern industrial processes was lacking or fragmentary, and in order that the Services and the Ministry of Supply might be in a better position to deal with other toxic hazards, it was decided, in conjunction with the Factory Department of the Ministry of Labour and National Service, to set up an *ad hoc* committee to advise on these questions.

The committee was formed in 1945 and was composed of representatives of the three Services and the Factory Department, Ministry of Labour and National Service. It was fortunate in being able to have H.M. Senior Medical Inspector of Factories, as chairman.

The Director of Hygiene was a member of this committee and was instrumental in its formation, since problems of this nature arising in the Army were invariably referred to A.M.D.5.

It was arranged that requests for information regarding any particular compound or process would be referred to the appropriate member of the committee. The committee held meetings from time to time at which reports of investigations carried out into hazards arising in the Services were considered, current problems connected with industrial hazards were discussed and up-to-date information, on recent work in this connexion, was circulated.

MISCELLANEOUS HAZARDS

The following were some of the miscellaneous hazards which were experienced:

(*a*) *Tropical Varnish* (V.130/1)

The potential hazards arising from the use of a tropical varnish containing 2 per cent. of pentachlorphenol at the Tropicalisation Experimental Establishment at Mill Hill were given consideration.

There was very little knowledge as to the potential hazard from the use of this chemical as a proofing agent in industry. From the literature it appeared, however, that there was a liability for personnel handling this varnish to contract dermatitis. The skin hazard was usually more important than the systemic hazard, although men engaged in handling it might complain of loss of appetite, sickness, headache, vague abdominal pains, loss of weight, etc. The conclusion was reached that in general it was less toxic than many chemicals in every day use although a certain degree of hazard did exist.

Both in the United Kingdom and in America it appeared that these types of varnishes offered such great advantages over other alternative preparations that they had to be used despite the hazard to health.

Until further information became available as to the possible effects from the use of this varnish, it was considered advisable that those employed in handling compounds containing pentachlorphenol should be under special medical supervision. Fortnightly medical inspections of the mechanics handling tropical varnish were prescribed with a view to detecting cases of dermatitis or any of the other toxic manifestations noted above. Spraying of the varnish was carried out under exhaust ventilation and protective garments were provided.

(*b*) *Rot-proofing Processes for Wood*

At the request of the R.A.O.C. (Packing Organisation) a representative of C.R.D.5, Ministry of Supply and the Consulting Dermatologist collaborated in considering the possible hazards of dermatitis accruing to (*a*) user and (*b*) applier, when the following methods of rot-proofing timber were used for packing cases:

(i) Pressure impregnation of the wood by means of Ministry of Supply formula CS.2100 which had the following composition:

Sodium	25 per cent.
Di-sodium-hydrogen-arsenate	25 per cent.
Sodium chromate	37·5 per cent.
Di-nitro-phenol	12·5 per cent.

(ii) Non-pressure impregnation in which the following compound was applied by hand usually by means of a brush:

Potassium-hydrogen fluoride	18 ± 2 parts
Di-sodium-hydrogen arsenate, or Potassium di-hydrogen arsenate	18 ± 2 parts
Potassium di-chromate	28 ± 2 parts
Di-nitro-phenol	2 ± 0·5 parts

Sodium carbonate — as much as necessary to *p*H of 6–8.

As the first formula was to be applied by commercial firms the Army was only concerned with user's risk. It was agreed that user's risk was very slight and that no objection would be raised to this formula.

The second formula, known in the trade as Walman's Salts, was a recognised industrial process, the benefits of which were believed to outweigh the hazard of dermatitis which this type of application undoubtedly carried. It was agreed that the Army should not be debarred from the use of this recognised commercial procedure provided every effort was made to ensure that the appliers received as much protection as was given in civilian life. The usual precaution was to supply the worker with a rubber apron and suitable leather gloves. The Consulting Dermatologist considered that these precautions would be adequate provided the men were selected to exclude those suffering from cutaneous abnormality and provided the men were supervised to see they did not discard their gloves. It was not considered that ointment prophylactic

(G.S.1499) was a suitable barrier substance for protection against Walman's Salts but if a barrier cream was to be issued to personnel applying Walman's Salts the cream supplied should consist of a mammalian fat, preferably wool fat, softened with a vegetable oil, such as Crodal ointment.

It was considered that user's risk from wood impregnated with Walman's Salts was slight and might well be negligible.

Another process for rot-proofing wood and cordage involved the use of copper naphthenate. A.M.D.5 raised no objection to this process when the matter was referred to them.

(*c*) *Processes for Waterproofing Crates and Packages*

The preparations used in these processes incorporated trichlorethylene as a solvent. This is a chlorinated hydrocarbon which is not inflammable but is decomposed by passage through a flame with the formation of a proportion of phosgene. It had been shown that this could occur by passage of the vapour through a lighted cigarette. The vapour is heavier than air and caused narcotic effects in those exposed to it.

A.D.M.S. East Central District reported the development of ill-effects among A.T.S. personnel engaged on waterproofing crates and the matter was referred by A.M.D.5 to H.M. Senior Medical Inspector of Factories. The latter confirmed that the symptoms complained of were quite in consonance with undue exposure to trichlorethylene; they were what might be expected from the nature of the work and, as the vapour was heavier than air, the system of ventilation used was inadequate for this class of work. He pointed out that there would be engineering difficulties in arranging for brush work of this description to be carried out on the fume cupboard principle with exhaust ventilation applied to the cupboard and the latter so designed that the fumes were drawn away from the operatives. The alternative of carrying on the work in the open air was not considered to be a satisfactory solution for several reasons, one of which was that, having to bend over the work, the auxiliaries would still inhale a considerable amount of fume; another was that it would involve enormous wastage of solvent and other material. For satisfactory ventilation the fumes at the breathing level would have to be reduced to a concentration of trichlorethylene in the air of the order, at the outside, of not more than 200 parts per million. In view of the difficulties in overcoming the risks to operatives it was decided to suspend this process pending the development of an alternative method of waterproofing.

It was reported that certain personnel at the Ordnance Depot, Chilwell, employed on sealing packages of M.T. spares for consignment to the Far East were complaining of ill-effects which were attributed to the sealing compound 'Bostik C' used for this purpose. D.A.D.H.(b) War Office accompanied by a medical representative from

the Factory Department of the Ministry of Labour and National Service, visited this depot to investigate the matter. It was found that the complaints were due to the inhalation of the fumes of trichlorethylene which was the solvent used in the Bostik C sealing compound.

It was considered that the installation of localised ventilation was impracticable in the shed where the packing was done, and that it would therefore be necessary to investigate the possibility of using an alternative sealing compound.

(*d*) *Bomb Disposal Work*

The disposal of the explosive filling of flying bombs carried out by bomb disposal units of the R.E. entailed steaming the filling, which resulted in the operator absorbing the vapour by inhalation and through the skin.

The explosive filling consisted of a mixture of two components:

Component A (*about* 60 *per cent.*)	
Cyclo-trimethylene-trinitramene	14–16 per cent.
Dinitro-benzene	54 per cent.
Ammonium nitrate	30–32 per cent.
Component B (*about* 40 *per cent.*)	
Cyclo-trimethylene-trinitramene	15–17 per cent.
Ammonium nitrate	60–65 per cent.
Calcium nitrate	18–22 per cent.
Water	1– 2 per cent.

The men engaged in this operation who handled the explosive with bare hands were apt to suffer from the following symptoms—headache, sickness, ashy pallor and blueness of the lips.

The precautions adopted for the protection of personnel during steaming operations included the provisions that they should wear full anti-gas clothing including respirator and that men subject to jaundice, anaemia or gastritis should not be employed on this work.

It was found that men who steamed out the explosive in full anti-gas clothing and respirator suffered no ill-effects other than fatigue. They were employed on and off for six hours during the operation.

(*e*) *Chrome-dyed Socks*

The Hygiene Directorate was asked to advise on a proposal by the trade to use chrome dyes in officers' hose, as they were experiencing a difficulty in using non-chrome dyes, said to be due to an incompatibility between the vat dyes and the chemicals used to make the garments unshrinkable. This led to difficulty in obtaining the correct shade of colour. The use of chrome dyes would introduce a potential hazard of dermatitis.

The Consulting Dermatologist and a representative of Ordnance met a trade deputation to consider the matter.

The conference agreed that there would be no objection to the chrome dyeing of officers' hose provided that:

(i) The percentage of any residual water soluble chromium compounds did not exceed 0·01 per cent. calculated as potassium dichromate. The tests to be made under acid and alkaline conditions simulating the effect of sweat on hose.

(ii) That a satisfactory procedure was evolved by the trade for ensuring that this specification was observed. These safeguards proved to be acceptable and D. of H. therefore advised D.C.S. accordingly.

(*f*) *Radio-active Materials*

The instructions regarding the handling of radium compounds in R.E.M.E. workshops were laid down in ***Electrical and Mechanical Engineering Regulations***. These included the safety precautions to be adopted during storage and use, and were based on the regulations in force in civil factories at the time.

Certain additional safeguards, however, were introduced by the Factories (Luminising) Health and Safety Provisions Order 1942 made by the Ministry of Labour and National Service under Regulation 60 of the Defence (General) Regulations 1939 and the Factories (Luminising) (Health and Safety Provisions) (Amendment) Order 1943.

After consulting H.M. Senior Medical Inspector of Factories, A.M.D.5 recommended that these additional safeguards should be incorporated in E.M.E. Regulations, so that the practice in R.E.M.E. workshops should not fall below the standards adopted in the best factories.

The safeguards included medical examination once a month of personnel using radio-active material and blood examinations every quarter, or more frequently if the results of the medical examination rendered it advisable. In addition it was prescribed that two tests of materials should be carried out at the National Physical Laboratory—one quarterly and the other when the results of the first test and the results of the blood examinations rendered it advisable.

(*g*) *Kerosene Vapour*

An inquiry was received from G.H.Q. India, asking for information about the risks and the precautions which should be adopted to safeguard personnel from kerosene vapour in a medical store in India.

In the absence of precise information regarding the conditions present inside the store it was considered possible that a concentration of 1 per cent. kerosene might be reached in the air inside the store in a tropical temperature. Such a concentration, it was considered, was quite likely to produce toxic symptoms after only a few minutes' exposure. The flash point of kerosene was stated to vary between 110° F. and 120° F.

The precautions for personnel entering the store were therefore given under two headings, medical and electrical, with the suggestion that the Indian authorities should adopt such of them as the local conditions warranted:

Medical. In view of the concentration of kerosene likely to be present in the atmosphere, the provision of some form of breathing apparatus for personnel entering the store was advised. The type considered most suitable was the 'Antipoys' short distance breathing apparatus which is worked by a bellows and has a 60-ft. air line. Alternatively the 'Salvus' (Davis's patent) breathing apparatus, self-contained type, might be used, but this is a more complicated apparatus and the oxygen cylinders would require replacement.

Electrical. The following precautions were advised against the risk of explosion:

1. All electrical fittings to be flame-proof (Group 2 standard). Any electrical torches used inside the store to be intrinsically safe and of brass construction.
2. Earthed metal rails to be fitted at the entrance for the discharge of static electricity from personnel entering.
3. If non-spark floor cannot be provided personnel should wear rubber boots.
4. Manifestation of equipment etc., inside store to be reduced to a minimum to minimise the risk of generating static electricity.

(*h*) *Other Hazards*

(i) In order to economise diminishing stocks of pyrethrum, in 1943 a formula for an insecticidal spray containing carbon tetrachloride was introduced as a stop-gap measure. This is another chlorinated hydrocarbon which can be decomposed by passage through a flame with the production of phosgene.

On the advice of the scientific adviser to the Ministry of Production, action was taken to stop the production of this insecticide and no further quantities were ordered.

(ii) Attention was drawn to the danger of poisoning by methyl bromide which was used in fire extinguishers. The potential risks were either poisoning by the vapour or burns caused by contact of liquid methyl bromide with the skin.

A M.R.C. directive on the medical aspect was circulated through medical channels.

(iii) D.D.M.S., P.A.I.C. requested information regarding the possible hazards from cumene in a cumene filling installation and what precautions were necessary. H.M. Senior Medical Inspector of Factories supplied the necessary information which is summarised below:

Cumene (isopropyl benzene) has an acute narcotic action but like other higher homologues of benzol is regarded as less toxic than benzene itself and of comparatively slight industrial hygienic importance. It has been shown that cumene is considerably more acutely toxic than benzene or toluene with a minimum lethal concentration for mice of 10 mg. per litre (2,000 p.p.m.).

Fortunately, however, the volatility of cumene is relatively low. The boiling point is approximately double that of the more volatile benzene and, for this reason, under ordinary conditions of temperature and pressure, acute hazards from its use are less likely to occur, or at least could be controlled with less difficulty than hazards from benzene or toluene. The effect of very high atmospheric temperatures must, however, be borne in mind.

There appears to be no evidence to suggest that continued exposure to cumene fumes might produce a chronic form of poisoning analogous to chronic benzene poisoning.

Prisoners-of-War

ENEMY PRISONERS-OF-WAR

The main hygiene problems concerning enemy prisoners-of-war arose in connexion with their accommodation and the measures necessary for their reception and clearance on arrival in the United Kingdom from overseas theatres so as to eliminate any risk of importation of cases of the major infectious diseases—typhus, smallpox, plague, cholera and yellow fever and for dealing promptly with louse-infested personnel.

Quarters. The earliest prisoner-of-war camps were located at race courses in various parts of the country. Before the outbreak of war these had been surveyed and plans made for their conversion when the necessity arose. Race courses had many advantages, i.e. isolation, space, buildings and the essential services—electric light, water supply, water-borne sewerage already provided, and could be quickly and economically converted for this particular purpose.

Early in 1942 it became necessary to undertake a building programme for the provision of prisoner-of-war camps and it was arranged that commands were to be represented at reconnaissances arranged by the Ministries concerned.

In 1943 various hutted camps and requisitioned buildings vacated by British troops were taken over for housing prisoners-of-war. The scales of accommodation for prisoners-of-war were identical to those for British troops. There was some pressure to get these scales reduced, but the Director of Hygiene would not agree, pointing out that if the accommodation standards were lowered increases in the ancillary accommodation would be required. He did agree, however, in the case of the M.O.W.P. hut (60 ft. by 18½ ft.) to forty being accommodated instead of thirty-six provided double bunking was installed and provided prisoners-of-war were not kept in these conditions longer than one month.

Late in 1944 the pressure on accommodation of all types was extremely acute and, in view of the urgent necessity of providing still further accommodation for prisoners-of-war, it was accepted that overcrowding would unavoidably have to take place. It was found necessary to increase the density of prisoners-of-war to the extent of 50 per cent. over

that for which the accommodation was designed. D.Ds.M.S. commands were invited to take up the matter of doing everything possible to preserve the health of prisoners-of-war in these circumstances, with particular reference to the following measures, as might be found necessary:

(*a*) Improved ventilation.
(*b*) Adequate spacing as far as conditions permitted.
(*c*) Heating in hutted camps and the provision of extra blankets.
(*d*) Adequate cooking facilities.
(*e*) Sanitation of camps.

When the emergency measure of 50 per cent. overcrowding over austerity scales had been adopted, a series of visits was made to prisoner-of-war camps in Western, Scottish and Northern commands by War Office 'M' 'Q' and 'E' representatives. It was found that, generally speaking, conditions were not intolerable but that certain of the tented sites in Scotland were unsuitable for winter use.

Measures for Clearance on Arrival in United Kingdom. The first prisoners to arrive in the United Kingdom in large numbers were Italian prisoners-of-war from the Middle East who had been routed *via* South Africa early in 1942. In this instance louse infestation was not considered likely to be a problem, as these prisoners would have been cleansed in South Africa and any recrudescence on the voyage would have been dealt with.

The following proposals which were agreed to by the Ministry of Health were adopted:

All prisoners-of-war were inoculated against enteric before leaving South Africa. A brief medical history of each man was prepared before leaving South Africa or by Italian medical officers during the voyage which was of great assistance to the medical authorities in the United Kingdom in detecting infectious prisoners. Each man carried his own medical history.

Routine disinfestation at the port of disembarkation was prescribed to ensure freedom from vermin before prisoners were dispersed to camps, and in view of typhus a careful examination was made again on arrival in camps. Commands were advised that mobile bath units should be available on arrival of prisoners-of-war at the camps and that each camp should be equipped with an improvised type of disinfestor to deal with the odd cases of infestation that might arise subsequently. Incineration of night-soil was advised in camps which did not possess a water carriage system to avoid risk of contamination of underground water supplies from trench latrines. The new A.S.H. faeces incinerator was recommended to be operated by trained Italian sanitary orderlies. It was not considered that there would be any risk of malaria spreading to the civil population, as none of the camps were located in a dangerous zone and no special measures were necessary.

Commands made arrangements for batches of prisoners-of-war to be medically inspected on arrival in camp by a British medical officer with tropical experience. Suspicious cases or carriers of enteric, dysentery and malaria were investigated bacteriologically. Minor cases of sickness were admitted to the camp reception station and major cases were admitted to the nearest military or E.M.S. hospital.

Early in 1943 the Hygiene Directorate pressed for the early erection of disinfesting arrangements of a semi-permanent character at the ports of Liverpool, Glasgow and Southampton, pointing out that no reliance could be placed in future on mobile bath units being available when the next emergency arose with the arrival of prisoners-of-war direct from North Africa. In fact two large convoys did arrive from North Africa at the end of July 1943—one of 17,000 Germans and 3,000 Italians at Glasgow and another of 10,000 Italians at Liverpool. Disinfestation facilities at Glasgow could not be developed in time and, after consultation with the Ministry of Health, it was agreed that the port health authorities would raise no objection, in this instance, to prisoners-of-war proceeding direct from ship to camp without disinfestation at the port. This decision was made possible owing to the season of the year and the extension of disinfestation which had been developed in North Africa. Arrangements were made at the camps for the careful inspection and efficient disinfestation of these prisoners, particularly in the case of those who were to be re-embarked for overseas camps. The improvised arrangements made at Liverpool and Glasgow were not considered to be adequate and the Hygiene Directorate made it clear that, when it was agreed as a special measure that enemy prisoners should go straight to camps without disinfestation at ports, this was not to be taken to imply that the provision of permanent disinfestation facilities was considered to be any less necessary. It was quite certain that the civil health authorities would not countenance it, as the prisoners-of-war might come direct from the battlefield or a typhus area and it was impracticable to ensure that all prisoners-of-war were disinfested in North Africa before embarkation. Scottish, Southern and Western Commands submitted their schemes for the provision of disinfestation and cleansing facilities on the basis that each centre should provide:

1. Medical inspection to detect major infectious diseases.
2. Bathing and cleansing of personnel arriving.
3. Removal and disinfestation of clothing and issue of fresh clothing.
4. The centre to be capable of dealing with 500 cases per hour.

It was appreciated that operational necessity might result in prisoners-of-war being landed at points where there were no facilities for disinfestation or before centres were set up and that rapid clearing of landing points would be necessary. In these circumstances the Hygiene

Directorate agreed that *ad hoc* arrangements would be necessary, subject to the following conditions:

(*a*) There should be disinfestation arrangements close to the point of landing.

(*b*) Prisoners-of-war not to be allowed to pass through towns or villages on foot before disinfestation.

(*c*) Public transport not to be used. (No objection to goods rolling stock provided entraining and detraining did not take place at a passenger station.)

(*d*) Sufficient escort to be provided to prevent contact with persons not actually engaged in looking after prisoners-of-war.

In 1944, with the invasion of North-west Europe, the arrangements for the reception and clearance of enemy prisoners were revised.

(*a*) It was agreed with S.H.A.E.F. that the latter would undertake all necessary cleansing and disinfestation of prisoners-of-war before embarkation for the United Kingdom.

(*b*) As an additional safeguard cleansing and disinfestation facilities were arranged at the ports of Glasgow, Leith, Tyne, Hull, Harwich, Tilbury and Southampton.

(*c*) In view of operational requirements it was agreed with the Ministry of Health that disinfestation of enemy prisoners-of-war could be postponed until arrival at transit camps at Kempton Park (British responsibility) and near Swindon (American responsibility). It was essential that all enemy prisoners passed through these camps before final disposal.

(*d*) To ensure that the military medical authorities of the areas to which prisoners were despatched were made aware when such personnel had been contacts of typhus, 21 Army Group was requested to notify War Office (A.M.D.5) when any of the following circumstances arose:

(i) On an outbreak of typhus in any area occupied by troops (British or U.S.) or prisoners-of-war.

(ii) When any body of troops (British or U.S.) including repatriated or enemy prisoners-of-war reached the United Kingdom and had been in contact with typhus.

(iii) When it had not been possible to carry out the disinfestation of troops of 21 Army Group or repatriated prisoners-of-war before embarkation for United Kingdom.

(iv) Similar information as in (i) and (ii) was requested on the occurrence of outbreaks of smallpox.

Ration Scales. The scale of rations for non-working enemy prisoners-of-war in the United Kingdom, in accordance with Article 11 of the Geneva Convention, was based on a British depot troops scale. It was agreed that depot troops in the United Kingdom could be taken as those soldiers who did not feed in mess and who therefore fed as civilians, i.e. received the civilian scale of nationally rationed foodstuffs and points

items and purchased what they wished of non-rationed items. It was on this basis that the scale for non-working prisoners-of-war was drawn up. This was considered to be sufficient to satisfy the energy requirements of a man not required to carry out muscular work and also met at least the minimum requirements of the different essential nutrients.

The scale for working prisoners-of-war in the United Kingdom was based on the home service ration scale as regards nationally rationed items.

Special diet scales for prisoners-of-war in prisoner-of-war hospitals were prescribed in A.C.I. 1604/44. Those on ordinary diets were issued with the scale of rations for non-working prisoners. Those on special diets received the same scale as British patients in military hospitals.

The policy was to provide a standard ration of about 3,000 Calories for non-workers and a more liberal ration of about 3,300 Calories for working parties.

Excluding cash allowance, the scales for the working parties corresponded in nutritive value to the home service ration scale for British troops. The scale for other prisoners-of-war (non-workers) had a calorific value of 2,947, roughly the value of the ration for British troops in sedentary occupations and well above the figure of 2,400 Calories laid down in the League of Nations Standards 1937. At one time the potato ration was doubled at 32 oz. which raised the value of the ration to 3,352 which was actually higher than the value of the ration for German workers (3,147).

The following analyses of ration scales (exclusive of cash element) computed in 1941 are given below for comparison:

TABLE 36

Analysis of Ration Scales. Prisoners-of-war. 1941.

	Proteins (g.)	Fats (g.)	Carbo-hydrates (g.)	Calories
British Home Service Ration Scale	98	113	414	3,130
German working parties . .	92	116	414	3,147
Italian working parties . .	90	95	477	3,202
British sedentary scale . . (Nationally rationed items at civilian scale, other items at Home Service Ration Scale)	73	80	414	2,760
Other prisoners-of-war (non-workers). (With potato ration reduced from 32 to 16 oz.)	80	88	434	2,947
British prisoners-of-war in German camps. (Average of 4 recent sedentary scale reports)	59	50	340	2,081
Working parties scale (Stalag VIIIB November 15, 1941)	57	37	462	2,465

The most marked difference, apart from calorie values, between the scales for German and British prisoners-of-war was in the quantities of proteins and fats which, in the case of the British prisoner-of-war, were roughly half those given to the German prisoners.

An analysis (1941) of the scale issued to Japanese prisoners-of-war contrasted with the Indian troops ration is given below:

	Proteins (g.)	Fats (g.)	Carbo-hydrates (g.)	Calories
Indian troops ration . . .	68	60	696	3,669
Japanese prisoners-of-war ration	104	19	736	3,637

Although the calorie values of these two rations were identical they varied greatly in their constituents—the Japanese ration having a much higher protein content and a much lower fat content than the Indian ration. The Japanese prisoner-of-war ration was later revised to accord with the policy of providing about 3,000 Calories for non-workers and 3,300 for working parties and adapted to suit national customs.

During 1945 there was a general reduction in all ration scales and the scales for enemy prisoners-of-war in the United Kingdom were also revised. The revised scale for non-working prisoners had an energy value of 2,000 Calories and that for working prisoners an energy value of 2,900 Calories. In addition there was a supplement for harvesting overtime which was only issued on special representation and which raised the value to 3,340 gross Calories.

In 1944 it was proposed that the ration scales being issued to enemy prisoners-of-war in all overseas commands should be unified on the grounds of administrative simplicity and to ensure a uniform and satisfactory standard of feeding in the overseas commands, and a suggested scale was drawn up. This proposal was abandoned later owing to technical difficulties in the interpretation of what would constitute a British depot troops scale in the different commands.

Problems in the Employment of Prisoners-of-war. In 1943 it appeared that Italian prisoners-of-war were being employed as cooks for British troops, some were employed in certain civil food factories and some were extensively employed in water catchment areas particularly in Yorkshire. This caused a considerable amount of concern to the Hygiene Directorate owing to the incidence of excremental disease in Italy, the absence of medical records and the impossibility of obtaining an accurate history in respect of the prisoners. After consultation with the Ministry of Health it was ruled that these prisoners must be regarded as potential carriers and the condition excluded by the quite strict criterion laid down in A.C.I. 1727/41 para 4 :

'*Carriers.* Individuals who are free from active signs of the diseases detailed in para 2 above, but who have a history of having suffered from a disease in which a carrier condition may develop, will be subjected to bacteriological investigation so as to exclude the carrier condition. The table below shows the number of consecutive negative results necessary, in each group of infections, before a carrier condition can be excluded.

Disease	Number of tests	Interval between tests
Enteric group	Stools and urine, 12 each	3 days
Dysentery	6 stools	3 days
Bacillary food poisoning	6 stools	Daily
Haemolytic streptococcal infections Diphtheritic and throat infections	Throat and nasal swabs, 3 each	Daily

'The fact that an individual has been excluded as a carrier will be entered on his or her medical history sheet, A.F.B.178. Individuals found to be carriers will be dealt with in accordance with *Regulations for the Medical Services of the Army*, 1938, para. 507.

'D.Ds.M.S. of commands will advise on all doubtful cases and will make the necessary arrangements for carrying out laboratory examinations'.

These precautions were adopted not only for cooks but also for those employed as food-handlers, or working in civil food factories and in water catchment areas.

BRITISH PRISONERS-OF-WAR IN ENEMY CAMPS

Reports regarding the welfare of British prisoners-of-war in enemy hands were received by Prisoner-of-War Directorate from various sources including reports from the representatives of the Protecting Power and from the International Red Cross and from M.I. From these reports, which were sifted and analysed by the Hygiene Directorate with particular regard to the adequacy and nutritional value of the rations provided and the occurrence of outbreaks of the major infectious diseases, much valuable information was obtained.

RATIONS AND B.R.C.S. PARCELS

The prisoner-of war invalid comforts and food parcels section of the B.R.C.S. assumed the responsibility for despatching food parcels and medicaments to the various prisoner-of-war camps in enemy countries but had asked A.M.D.5 for advice on the contents of invalid comfort parcels, food parcels and other special parcels and on the scale of distribution. From the information at his disposal the nutritional adviser of the Hygiene Directorate was able to act as nutritional adviser to

the invalid comforts and food parcels section of the B.R.C.S. and to submit proposals for the scientific adjustment of the contents of parcels. A.M.D.5 also co-ordinated the professional advice of the Army Medical Directorate regarding the medical supplies of which the various enemy prisoner-of-war camps were in most need. Suggestions on the use of the parcels, explaining their scientific constitution, were supplied to the B.R.C.S. for transmission to medical officers in camps and hospitals. The proposals made enabled the Red Cross to standardise packing.

PRISONERS IN EUROPE

In January 1942 reports were received of outbreaks of typhus in certain prisoner-of-war camps in Germany but, as the Germans banned visits by the representative of the Protecting Power to the camps affected, it was very difficult to get an accurate picture of the typhus situation. With the information at their disposal the Hygiene Directorate formed the impression that the disease had firmly established itself and would probably rise to a maximum at the end of March. One type of standard parcel which the B.R.C.S. had been despatching (soap and disinfectants) contained N.C.I. powder, and the society was advised to increase the despatch of this item and agreed to make a general distribution to camps in Germany in view of the typhus danger.

Later when supplies became available A.L.63 was substituted for N.C.I. powder since it contained no chemical with which the Germans were not already familiar, although the special advantages of the combination used in this powder may have been unknown to them. The Prisoner-of-War Directorate was advised to arrange the despatch of louse protective clothing and typhus vaccine for the use of prisoners and medical personnel who required special protection on account of the nature of their work. Leaflets on lice and disinfestation for the information of prisoners-of-war were prepared by A.M.D.5 and distributed with parcels to camps.

A special consignment of parcels of drugs, syringes, gowns and masks was made to prisoner-of-war hospitals to enable them to deal with typhus cases. In addition supplies of typhus vaccine, protective clothing and anti-louse powder were sent to prisoner-of-war camps in North Italy on the same scale as to the German camps.

Early in 1942 the War Office made recommendations to the B.R.C.S. concerning the contents of a standard invalid food parcel of nett weight (including tins and packing) 8 lb. 1 oz. This was sub-divided by the B.R.C.S. into two parcels—a food parcel and a milk parcel—with a combined nett weight of 12 lb. 3 oz. and contained a slight variation of the items recommended by the War Office. In addition the B.R.C.S. agreed to despatch weekly, four medical parcels per 1,000 men: viz. soap and disinfectants, medicines, dressings and vitamin concentrates. The invalid food and medical parcels were distributed to camps on a

basis of 5 per cent. of strength and the numbers distributed specially to hospitals were based on information supplied by the I.R.C.C. The overall scale of 5 per cent. was decided on after consultation with the Consulting Physician and in the light of available information. The numbers of permanent invalids were estimated to be higher than that of a normal army population and were not subject to decrease. Nutritional conditions, for which the diet was a necessary adjunct of treatment, contributed largely to hospital admissions. The control of invalid comfort parcels was left as far as possible to the S.M.O. and camp trustees or men of confidence. It was also agreed in principle that a reserve should be maintained at Geneva to which consignments of food and medical supplies were despatched from time to time. Many requests were received by the B.R.C.S. direct from camps for special parcels of drugs, etc., but to avoid overlapping and equalise distribution of available supplies the B.R.C.S. agreed to forward these requests to A.M.D.5 for opinion.

The nutritional values of the ration scales supplied to British prisoners-of-war in German camps were frequently computed when reports of the items supplied were received. To begin with there was evidence that the Germans were adhering to the 2,400 Calories standard recommended by the League of Nations in 1938. Later the rations were invariably found to be inadequate both in energy value and in respect of various essential nutrients such as fat and protein. In 1941 it appeared from some reports received from the I.R.C.C. that cases of famine dropsy had occurred among British prisoners-of-war in certain German camps. These cases recovered promptly with treatment in bed and better food.

An analysis of the ration scale issued during the last quarter of 1941 (an average of seven prisoner-of-war camps) worked out at:

Proteins 62 g., Fats 44 g., Carbohydrates 357 g., Calories 2,122.

An analysis showing the daily intake from three weekly ration scales issued in Oflag VIB in February 1942 worked out at:

Proteins 48 g., Fats 33 g., Carbohydrates 357 g., Calories 1,584.

An analysis of ration scales quoted in the Protecting Power reports of visits to two prisoner-of-war camps in Germany in February 1942 showed calorie intakes of 1,728 Calories (Stalag VIIIB) and 1,553 Calories (Work Camp Rudow attached to Stalag IIID).

The progressive decrease in the ration scales issued in the first quarter of 1942 compared with those issued during the last quarter of 1941 will be noted.

The scientific adjustment of the contents of B.R.C.S. food parcels has been referred to previously and is probably best exemplified in the supply of concentrated vitamins A, B, C and D to prisoner-of-war camps. The items of the food parcels were specially selected for their high vitamin content and a number of them (viz. chocolate, jam, cocoa and

lemon curd) were fortified to make up for those vitamins most likely to be deficient in the German rations. The following comparative table shows the estimated vitamin content of the German prisoner-of-war ration issued during the last quarter of 1941, the vitamin content obtained daily from B.R.C.S. food parcels at the scale of one parcel per man per week and the estimated optimum daily requirements of the different vitamins:

TABLE 37

Estimated Vitamin Content of the German Prisoner-of-war Ration

Vitamin	Intake from German ration	Amount from 1/7 B.R.C.S. food parcel	Total daily intake (sum of 1 and 2)	Estimated optimum daily requirement
A (I.U.) . . .	2,153	3,545	5,698	5,000
B_1 (I.U.) . . .	475	108	583	600
B_2 (mg. Riboflavin) .	0·77	0·73	1·5	2–3
Nicotinic acid (mg.) .	4·0	8·7	12·7	10–25
C (mg. ascorbic acid) .	104	14	118	50–75
D (I.U.) . . .	nil	484	484	300–400

The table shows that when prisoners-of-war received one parcel per week, which the B.R.C.S. attempted to secure for them, the vitamins obtained from this parcel plus those from the German ration, were sufficient to prevent deficiency disease.

The standard invalid food parcel which was intended for prisoners-of-war in hospital requiring dietetic treatment was designed to supply all the vitamins necessary for a man for a week. In addition concentrates of vitamins A, B, C and D were included by the B.R.C.S. in their parcels of medical supplies sent to British M.Os. in the various prisoner-of-war camps.

In general it was found that when the ration scale for British prisoners-of-war in Germany was compared with that issued to German prisoners-of-war in the United Kingdom the latter was superior in energy value and much superior in protein and calcium content and in vitamins except as regards vitamins B_1 and C and nicotinic acid; but even when the intake of these vitamins was equal to or less than that in the ration given to British prisoners-of-war they were nevertheless adequate when compared with the optimum requirements. When the ration given to British prisoners-of-war was compared with the optimum requirements, it was found that it only supplied 70 per cent. of the energy requirements, due chiefly to the very low intake of fats. The major deficiencies as regards minerals and vitamins were in calcium and in the fat-soluble vitamins A and D.

During 1943 it appeared that the Germans were confiscating special vitamin parcels despatched to camps on the ground that they were so often found in the pockets of prisoners who attempted to escape. On the other hand, the vitamins contained in the medical parcels sent to all camps were passed by the Germans without question. The desirability of increasing the latter at the expense of the former was therefore considered.

During the latter half of 1944 there was evidence that the situation regarding the feeding of British prisoners-of-war in Germany had deteriorated. This was attributed to two causes:

(*a*) A general worsening of the food position in Germany due to actual shortages and difficulties in transport and distribution. There was evidence that this was causing a reduction in the ration issued to prisoners-of-war. The average energy value of the standard camp ration between July 1943 and April 1944 was 1,750 Calories; whereas out of eight reports on the rations issued in prisoner-of-war camps in Germany subsequent to April 1944 there was reduction below this level in four (in which the energy value ranged from 1,300–1,600 Calories per day).

(*b*) A reduction in the rate of issue of Red Cross parcels from one per man per week to one per man per fortnight had been called for by the I.R.C.C. as a result of the interruption of the Marseilles–Geneva route for the transport of parcels and it was estimated that there was little prospect of being able to restore the normal rate of issue for some time. At the rate of one parcel weekly the Red Cross parcel supplied about 1,900 Calories per day but, with the reduction, this fell to about 900 Calories daily.

This meant that in some camps prisoners-of-war were getting, between camp rations and Red Cross parcels, less than 2,500 Calories per day which was necessary for a man doing no physical work whatever. Working prisoners-of-war got supplementary rations but even for heavy workers the stipulated ration, let alone the ration actually received, could only provide about 2,500 Calories daily. It was obvious that with only 900 extra Calories from the Red Cross parcels the diet of the British prisoners-of-war on heavy work in Germany must have been much below the 4,000–4,500 Calories of energy expended doing hard physical work.

PRISONERS IN THE FAR EAST

The avoidance of malnutrition among British prisoners-of-war in Japanese hands in the Far East presented far greater problems than did those in enemy prisoner-of-war camps in Europe. This was due to the grosser inadequacy of the rations issued by the Japanese and to the great difficulties encountered in opening up routes for the despatch of B.R.C.S. parcels to prisoner-of-war camps in the Far East. Reports had been received that beriberi was rife among British prisoners-of-war

in Hong Kong. Towards the end of 1942 the I.R.C.C. in reporting by cable on conditions in Shishagawa Camp (near Tokio) furnished details of the ration issued to these prisoners. The Japanese had claimed that the prisoners-of-war had increased in weight since arriving in this camp. A comparison of the nutritive value of this scale compared with that supplied to Japanese prisoners-of-war maintained overseas is given below:

TABLE 38

The Nutritive Value of the British and the Japanese Prisoner-of-war Rations

Nutrient	Scale for British prisoners-of-war		Scale for Japanese prisoners-of-war		Minimum daily requirement for	
	Non-working	Working	Non-working	Working	Non-working	Working
Protein (g.)	63	64	72 (84)	78 (90)	60	70
Fat (g.)	18	18	34 (49)	35 (50)	—	—
Carbohydrates (g.)	194	201	578 (548)	676 (646)	—	—
Calories	1,160	1,190	2,800 (2,860)	3,210 (3,270)	2,500	3,000
Calcium (mg.)	339	340	180 (300)	190 (310)	550	550
Iron (mg.)	11·3	11·4	7·2 (14·7)	7·6 (15·1)	5–10	5–10
Vitamin A (I.U.)	430	430	960 (990)	960 (990)	1,400–2,000	1,400–2,000
Vitamin B (I.U.)	360	365	230 (780)	240 (790)	250	300
Riboflavin (mg.)	0·56	0·56	0·79 (1·04)	0·87 (1·12)	1·2	1·2
Nicotinic acid	11·5	11·7	16·1 (19·7)	18·5 (22·1)	10–15	10–15
Ascorbic acid	79	79	33	33	25	25
Vitamin D (I.U.)	84	84	56	56	?	?

Notes: (1) Allowance has been made for inedible waste in calculating the nutritive value of all ration scales.

(2) The values for the ration scale for Japanese prisoners-of-war have been calculated at the lowest level, i.e. dhal and not soya bean issued, and only polished rice issued. The figures in brackets indicate nutritive value of scale if soya bean is issued in place of dhal and half the rice is issued as brown rice or parboiled rice.

A.M.D.5 commented on this scale supplied to British prisoners-of-war as follows:

1. The energy value is grossly inadequate, being less than half the minimum requirements.
2. Several of the essential nutrients are inadequately represented in the ration.

We find it difficult to believe that prisoners-of-war could have increased in weight on the ration detailed in the I.R.C.C. telegram even if they were on a still more grossly defective diet before. The most that such a diet could do would be to decrease the rate of weight loss.

Possible explanations of the apparent improvement in nutrition after arriving in this camp are:

1. The statements regarding weight increases are untrue.
2. There is possibly some mistake in the cabled figures for the various items of the ration.
3. Prisoners-of-war may be receiving extra food supplied through I.R.C.C. to supplement the camp ration.

The ration scale supplied to Japanese prisoners-of-war maintained overseas, on the other hand, supplies sufficient energy value although it too is deficient in certain nutrients. Recommendations have been made for certain increases in this ration which should raise most of the nutrients to a satisfactory level.

A report received early in 1943 from the I.R.C.C. delegate gave particulars of the prisoner-of-war ration in Shanghai. The Japanese claimed that this was a larger ration than that given to their depot troops. A.M.D.5 comments on this ration were:

'The energy value of the ration is:

Meat—150 g. (= 120 g. edible) .	212 Calories
Fish—50 g.	35 Calories
Bread—4 oz.	272 Calories
Total . . .	519 Calories

'Additional vegetables supply minerals and vitamins but very little energy value: therefore this ration is a starvation one, yielding only about one-quarter of the daily energy requirement for a sedentary man (2,400 Calories). The peace-time ration for Japanese troops which is presumably that still supplied to their depot troops consists of 21·16 oz. rice, 6·6 oz. barley plus cash allowance of 9½ cents to be spent on meat, fish and vegetables. The rice and barley alone have an energy value of 2,840 Calories and the 9½ cents is said to buy enough to raise the energy value to about 3,500 Calories. It is false for the Japanese to claim that the ration detailed in the I.R.C.C. telegram is larger than that supplied to their depot troops and the survival of our prisoners-of-war must be dependent on the extras supplied by the I.R.C.C. representative'.

A list of contents for a special parcel suitable for prisoners-of-war in the Far East was drawn up early in 1942, after a computation had been made of the value of the ration issued by the Japanese, in an endeavour to fortify the latter and make it, when combined with the food parcel, adequate as regards protein, fat, carbohydrates and calories. The ration issued by the Japanese was presumed to be practically devoid of vitamins and essential minerals.* The food value per lb. of this parcel together with the daily nutritional requirements of an adult are given overleaf:

* *See* Campaigns, Volume 2, Hong Kong and Malaya narratives.

TABLE 39

The Food Value of the B.R.C.S. Prisoner-of-war Parcel

Item	Amounts per lb. in parcel	Daily requirements of an adult
Protein (g.)	52·2	70
Fat (g.)	112·2	100
Carbohydrates (g.)	136	450
Calories	1,814	3,000
Calcium (mg.)	864	750
Vitamin A (I.U.)	2,768	4,000–6,000
Vitamin B_1 (I.U.)	208	300–600
Vitamin B_2 (Riboflavin (mg.)	2·08	2–3
Vitamin B_2 (Nicotinic acid (mg.)	14·4	10–25
Vitamin C (mg. ascorbic acid)	6	30–50
Vitamin D (I.U.)	27	? 300–400

Later, certain modifications were made to the content of this parcel to make good the deficiency in vitamins A, B and C. It was then considered that a one lb. unit of the parcel would be sufficient per prisoner-of-war per day. Lists of drugs and dressings similar to those sent to German prisoner-of-war camps were also drawn up and given to the B.R.C.S.

In the latter half of 1942 it appeared from reports received that conditions in Stanley, Hong Kong, had deteriorated and that outbreaks of beriberi and pellagra had occurred. Action was taken to secure stocks of aneurin and nicotinic acid in tablet form for despatch to the Far East as soon as possible. The South African Red Cross had sent some in vessels conveying Japanese diplomats to Japan, and the American Red Cross had sent a consignment to the I.R.C. delegate in Japan by similar means. When it was learnt that a prisoner-of-war exchange ship was sailing from the U.S.A. in September 1942 negotiations were opened with the American Red Cross to arrange for the despatch of 1 million 3 mg. tablets of aneurin and 2 million nicotinic acid tablets (25 mg.). It was estimated that one tablet of aneurin per head every fourth day and one tablet of nicotinic acid every second day would, together with the amounts previously despatched, protect the 10,000 prisoners-of-war and internees at Stanley for one year.

In consultation with the Consulting Physician a list of medical supplies was drawn up to be given priority of despatch to prisoners-of-war and internees in the Far East on the last diplomatic ship sailing from New York at the end of October. The list was based on the most recent reports from Hong Kong and other places and had particular regard to the prevalence of dysentery, diphtheria, the danger of cholera, and the lack of medical supplies, especially antiseptics and anaesthetics and was calculated on the requirements of 130,000 individuals for a period of at

least one year. The list was submitted to the B.R.C.S. and the necessary shipping space was allocated on the *S.S. Grippsholm* which sailed from New York.

Previously a small consignment of medical supplies had been shipped from India and the I.R.C.C. delegate in Japan had purchased some medical supplies locally for distribution to camps.

During 1944 efforts were made to open up an air mail service *via* Moscow to Vladivostock, which could be used for the transport of relief supplies to British prisoners-of-war in the Far East, and towards the end of the year this became possible.

It appeared from a survey of the latest information contained in I.R.C.C. reports that the most prevalent diseases in Far Eastern prisoner-of-war camps were:

Beriberi	30 per cent. of total number of invalids
Digestive disorders (including dysentery) . . .	19 per cent. of total number of invalids
Malaria	15 per cent. of total number of invalids
Respiratory infections . .	9 per cent. of total number of invalids

While it was difficult to lay down the exact amounts of the various drugs for inclusion in the 4 lb. air mail parcels, as this could only be worked out by those responsible for packing the parcels, it was possible to indicate which drugs the Army Medical Directorate considered should be sent and the proportion of the total parcel weight which should be taken up by each drug.

Eventually based on the sick rates an assessment was worked out of the requirements of special drugs which was approved by the Consulting Physician and Consulting Surgeon. The list of drugs was divided into two parts:

(*a*) Drugs to be packed in camp medicine boxes for distribution to all camps irrespective of whether there was a medical officer in the camp or not (amounts were given in the form of a unit to supply 100 men for three months).

(*b*) Drugs to be sent as bulk supplies to base camps and hospitals only where they could be used under medical supervision (amounts were given in terms of a larger unit—to supply 1,000 men for three months).

The Ministry of Supply was asked to permit the B.R.C.S. to obtain these amounts of drugs additional to allocations for bulk supplies already agreed. They agreed to one three-months' consignment for 250,000 individuals at the scales recommended by the War Office.

An analysis of the nutritive value of the rations issued in five prisoner-of-war camps in the Far East (Northern Area) during the first half of

1944 showed a marked improvement on rations previously analysed, more particularly with regard to energy value. (*See* Table 40.)

REPATRIATION OF BRITISH PRISONERS-OF-WAR

The procedure for dealing with repatriated prisoners-of-war on their return to the United Kingdom included arrangements for their reception, cleansing if necessary, medical examination with a view to assessing their nutritional state, sorting out those who required immediate treatment in hospital and increased dietary for those despatched on recuperative leave.

It was agreed with Prisoner-of-War Directorate that the normal procedure would be to arrange with overseas commands for recovered prisoners-of-war to be disinfested abroad before they boarded ships for this country; and it was emphasised that this disinfestation should be carried out effectively and should include all non-Service personnel such as the Merchant Navy. Facilities for cleansing were made available at certain ports in the United Kingdom, which would be used in case of a breakdown in the arrangements made abroad when ships would be diverted to one of these ports. It was confirmed with S.H.A.E.F. that these measures would also be strictly applied to prisoners-of-war repatriated by air, as it was not practicable to provide disinfestation facilities at the various airfields in the United Kingdom likely to be used.

It was agreed between the Service ministries and the Ministry of Health that, in the case of those repatriated from India and the Far East by the 'trooping by air' scheme, the following steps would be taken:

(*a*) Personnel returning by air would be inspected before emplaning. Only persons successfully vaccinated within the last few years would travel by air.

(*b*) There would be a medical inspection at the airfield in the United Kingdom and at the reception camp before the man proceeded on leave.

(*c*) The Ministry of Health did not insist on surveillance. Instead, the importance of reporting to a doctor when a man became sick within twenty-one days of arrival was to be impressed on all ranks. The medical profession was warned by the Ministry of the possibility of major infectious diseases.

For prisoners-of-war returning by sea the normal quarantine arrangements applied. Prisoners-of-war were to proceed to reception camps organised by 45th Division in the first instance. A simple scheme for the investigation of nutritional state and freedom from infectious disease was drawn up for inclusion in the general medical examination. This was made available to medical officers in medical charge of repatriated prisoners-of-war in reception camps together with a table of average heights and weights correlated with ages, so that the weight and any

TABLE 40

Nutritive Value of Rations issued in Prisoner-of-war Camps in Japan, January to June 1944

Nutrient	(1) Formosa Camps	(1) Fukuoka		(1) Zentsuji		Optimum daily gross requirements (2) adult man	
		Camp 12	Camp 17	Main Camp	Branch Camp 3	Minimum	Optimum
Protein—total . . (g.)	56	78	84	55	72	55	100
Protein—animal . (g.)	4	12	14	4	5	?	35–40
Fat . . . . (g.)	17	42	29	20	20	—	—
Carbohydrates . . (g.)	596	751	744	460	575	—	—
Calories . . .	2,750	3,690	3,560	2,260	2,770	2,500–sedentary 3,300–moderately active 4,000–active	
Calcium . . (mg.)	350	470	310	300	350	500	600
Iron . . (mg.)	10	15	11	11	7	? 5	12
Vitamin A . (I.U.) (4)	4,900	3,840	3,970	4,170	4,500	2,000	3,500
Vitamin B_1 . (I.U.) (5)	370	390	410	350	360	400–700	850–1,350 (3)
Riboflavin . (mg.)	0·9	1·1	0·9	0·6	0·7	1·3	3·0–3·7 (3)
Nicotinic acid . (mg.)	12	22	16	14	14	9	25–35
Ascorbic acid . (mg.)	220	130	180	180	190	? 50	190
Vitamin D . (I.U.)	0	180	10	5	0	?	?

Notes (1) Allowance made for inedible waste so that figures represent nutritive value of the edible portion of the raw ration.

(2) Including an allowance for cooking and table losses for direct comparison with those given for the rations.

(3) Range given for requirements of sedentary active man.

(4) Vitamin A content due almost entirely to the vegetable issue, calculated on average vitamin A content of English vegetables. If vegetables of low nutritive value are issued, the vitamin A content will be much lower.

(5) Assessed on assumption that white bread and polished rice are the staple issues. If brown bread and undermilled rice issued, the vitamin B content would be greatly increased.

deviation from the average together with any evidence of deficiency disease or infectious disease might be recorded on the man's medical history sheets:

I. *Examination for nutritional defects.*

1. Height and weight, together with a note of the relation of the weight to the average for the height as given in the table.

2. *Eyes*:
   (i) Dryness, lack of lustre and wrinkling of the conjunctiva (vitamin A)
   (ii) Grey or yellow (Bitot's) spots on the conjunctiva (vitamin A)
   (iii) Conjunctivitis and blepharitis (riboflavin).

3. *Skin*:
   (i) Phrynoderma—dryness and roughness of the skin, with follicular hyperkeratosis (horny plugs in pilo-sebaceous follicles), especially on the extensor surfaces of the limbs (vitamin A).
   (ii) Pellagra-like eruptions—
      (*a*) dark irregular patches with a parchment-like texture on parts of the skin exposed to light, with a tendency to scaliness, cracking and peeling, or
      (*b*) scrotal eczema (nicotinic acid).
   (iii) Naso-labial seborrhoea (riboflavin).
   (iv) Oedema of dependent parts (vitamins B_1 or protein).
   (v) Angular stomatitis (cheilosis)—sodden macerated appearance of epithelium at angles of mouth, with fissuring and golden-yellow crusting (riboflavin).
   (vi) Petechial haemorrhages or areas of bruising (vitamin C).

4. *Tongue*:
   (i) Raw smooth tongue, with denudation of surface epithelium, especially along the margins (nicotinic acid).
   (ii) Purplish red tongue with fissuring and large flattened papillae (riboflavin).

5. *Gums*:
   Scorbutic gingivitis, with hypertrophy of interdental papillae, purplish hue, bleeding and ulceration (vitamin C).

6. Neuro-muscular system—evidence of peripheral neuritis, especially tenderness of the calf muscles to pressure (vitamin B_1).

Note. The vitamin implicated in each sign has been placed in brackets after the description of the sign.

II. *Examination for infectious diseases.*

1. An F.F.I. inspection for the detection of infectious or contagious disease, pediculosis, etc., should be carried out as soon as possible, preferably before embarkation or as soon as possible afterwards.

2. This would be followed by a more detailed investigation aimed at the detection of carriers of such diseases as enteric fever, dysentery or men suffering from such diseases as malaria, V.D. or trachoma. Very little in the way of investigation could probably be carried out on board ship but, we presume, medical documents would be available or would be prepared, and any man with a history of any of these diseases would be noted. The necessary investigations, examinations of stools, blood films, etc. would be carried out as soon as facilities were available, admission to hospital being arranged for the purpose if necessary.

Medical officers at reception camps were instructed that the general policy of getting men home on leave as soon as possible must not influence their examination unduly and that all repatriates showing evidence of marked loss of weight, especially if accompanied by gastro-intestinal symptoms or specific signs of avitaminosis, should be admitted to hospital.

A pamphlet, *Hints on Diet during Recuperative Leave for Liberated Prisoners-of-War*, was prepared by the Army Medical Directorate and a copy was issued to each repatriate despatched on leave who was considered to be in need of such instruction. The pamphlet contained simple dietetic instruction to aid malnourished repatriates in selecting the right type of diet to eat during the period of dietetic readjustment:

As a result of the privation you have endured as a prisoner-of-war, you have probably lost weight, and it is natural to think that the more food you eat the sooner you will recover your lost weight and strength. But you must remember that your physique as well as your weight may be temporarily below par, and this includes your digestive system. Just as you need rest at first and your muscles require gradual retraining, so your digestive system requires rest at first and then retraining in the handling of the sort of foods you normally like to eat.

To get your digestive system back to normal as quickly as possible a few simple rules that you should follow, especially if you are having trouble with your digestion, are given in the dietetic instructions below. You should show these notes and the following instructions to anyone who is giving you your meals, so that they can understand why you have to be careful about eating for a time, and what they should give you to eat.

(1) *Don't overload your stomach.* Avoid heavy meals, and eat small amounts frequently. Try eating three light meals a day, with three snacks of the biscuits and milk variety—two between meals and one last thing at night.

(2) *Remember that your digestion is weak, and at first give your stomach foods easy to handle.*

Eat: Foods such as milk and milk puddings, eggs, cereals, toast or bread, biscuits, preserves, cake and fish and tender meat if you can eat these without discomfort.

Avoid at first: Fatty or fried foods, bulky vegetables, raw salads or fruit, highly seasoned dishes, twice-cooked meats, pickles and spices, rich, heavy puddings and pastries, strong tea and coffee.

Beer and other alcoholic drinks are hard on a weak stomach, and you should take these very sparingly, if at all, for the first few days at least.

(3) *Do not hurry your meals.* Chew your food carefully, avoid rush and hurry before and after meals, and take a few minutes' rest before and after eating.

(4) *Be sure to take your full allowance of milk.* If you have been given a ration card entitling you to a priority allowance of two pints of milk per day, take the full amount, even if this makes you less able for other foods. Milk is one of the most valuable foods there are, and is not hard on a weak stomach.

Your digestive system will get back to normal as your physique improves, and you will be the best judge of this improvement. When your stomach and digestion are back to normal and you find you can eat any food without discomfort, you can forget the above rules and eat anything you like.

D. of H. accompanied by D.A.D.H.(c) visited 91 Reception Camp when a batch of newly arrived repatriated prisoners-of-war from North-west Europe were being medically examined. He formed the impression that out of 100 prisoners-of-war he had inspected personally 50 per cent. showed varying degrees of malnutrition. He visited some adjacent hospitals and camp reception stations and was impressed by the very marked improvement shown by the majority of the repatriates, even after only a few days in hospital on a régime of rest and graduated feeding, compared with the condition of the new arrivals in the reception camp.

British prisoners-of-war liberated in Italy during 1943 were authorised supplementary rations while overseas. The North African field service scale (fresh) was augmented to yield 4,400 Calories together with extra vitamin concentrates.

Arrangements had been made with the Ministry of Food in 1943 for escaped prisoners-of-war to receive double civilian rations for the period of their twenty-eight days recuperative leave and to limit this concession in the case of prisoners-of-war liberated in Italy to those most likely to require it on nutritional grounds (viz. those who had been subsisted on an Army field service or equivalent ration for less than one month from the date of their release). Upon reconsideration the War Office decided that such a policy of discrimination would be invidious and most unwise and they therefore pressed successfully for the concession of extra rations being made a general one to all prisoners-of-war liberated from Italy.

In 1944 owing to the deterioration of the rations issued in German prisoner-of-war camps previously referred to, the agreement of the

Ministry of Food was obtained to the issue of double civilian rations to prisoners-of-war repatriated from Germany.

When the period of recuperative leave was later extended to forty-two days the issue of double civilian rations for the extra fourteen days was authorised. The Ministry of Food also agreed that the concessions regarding double civilian rations should be extended to prisoners-of-war on bulk repatriation at the close of hostilities.

This arrangement catered adequately for British repatriates who proceeded to their homes on recuperative leave, but Dominion and Colonial repatriates were subsisted on the home service ration scale during the period of their stay in the United Kingdom pending repatriation to their own countries and it was generally considered that this ration contained no margin for building up. The S.M.O. South African Forces in the United Kingdom submitted a request for a supplement to the H.S.R. scale for repatriated Dominion and Colonial prisoners-of-war and this was strongly supported by A.M.D.5 on medical grounds. D.A.D.H.(c) made the following recommendations to S.T.6 which were accepted:

> The main requirements of a building diet for previously undernourished individuals are:
>
> (*a*) a calorie intake surplus to the energy expenditure. We suggest an intake corresponding to that of an active man (i.e. up to about 4,000 Calories).
>
> (*b*) a generous protein intake, especially protein of animal origin.
>
> (*c*) an intake of vitamins and minerals above the accepted requirements.
>
> We feel that a supplement to the H.S.R. scale to meet these criteria should be made in respect of all Dominion and Colonial ex-prisoners-of-war subsisted on this ration pending their repatriation, in order that they may be restored to full health before they return to their homes. There seems to be a special case for such personnel in that they do not have the period of 42 days' leave on double civilian rations (plus priority allotments of milk and eggs in certain cases) during which United Kingdom personnel can have as ample a diet as they wish within these limits.

In making the following recommendations the existing scales of supplements were used.:

(*a*)	Bread . . .	2 oz.
	Margarine . .	½ oz.
	Preserved meat .	2 oz. or salmon canned 3 oz. or herrings canned 3 oz.
	Cocoa . . .	1 pint (¼ oz. cocoa, 2 oz. fresh milk, ½ oz. sugar) (i.e. the supplement for personnel absent from meals in mess).
(*b*)	Milk . . .	10 fl. oz. (i.e. the supplement for personnel under 18 years).

These supplements would together raise the calorie value of the basic H.S.R. scale to 3,940 Calories and would provide a high protein intake (136 g.) and an intake of vitamins and minerals above the accepted requirements of a normal person, thus fulfilling the criteria above.

On the expiration of their six weeks' repatriation leave, these men reported to centres organised by 45th Division for sorting and training. To begin with the policy was simply to have them assessed for medical category and T.R. and then place them in immediate employment. This resulted in far too many T.R.7 men passing out from the A.S.T.U. associated with 45th Division and they could not all be suitably placed. It was represented by A.M.D.5 that it would be far preferable to try and improve the medical category of men where necessary by a suitably graduated conditioning course and then allocate them to employment after upgrading. The accommodation at P.D.Cs. was too limited for them to be used for this purpose. This policy was eventually agreed to and was implemented later.

The medical experience gained in the handling of prisoners-of-war recovered in Europe during and after the concluding stages of hostilities in that theatre were summarised and communicated to D.M.S. A.L.F.S.E.A. and to G.H.Q. India in the hope that such information would be of assistance to the medical authorities responsible for dealing with similar personnel in the Far East.

It was recommended that a hospital or group of hospitals should be allocated as reception units for these ex-prisoners-of-war where men could be hospitalised or not as necessity dictated. This would ensure that they were all housed and had all facilities, i.e. information bureau, clothing store, pay and welfare centres, with opportunities for keeping or becoming fit by conditioning courses, etc.

The experience gained in dealing with this problem in the European theatre was stated in general principles:

A. Statistics.
B. General notes on hygiene, diet and immediate treatment, physical conditioning.
C. Attitudes in handling returned prisoners-of-war.
D. Detailed notes on diet and immediate treatment.
E. Suggested medical arrangements on transports.

A. STATISTICS

No. of ex-prisoners-of-war dealt with through reception units of 45th Division	98,115
No. of ex-prisoners-of-war evacuated from B.L.A. through hospital channels	2,401
Grand Total	100,516

(app. to week ending 14.7.45).

Of the 98,115 dealt with by 45th Division reception units, 589 (0·6 per cent.) were admitted to hospital at once while 294 (0·3 per cent.) were admitted to C.R.S.	
Total requiring hospital treatment immediately (which includes those evacuated ex-B.L.A. through hospital channels)	2,401
Plus those sent by 45th Division	
to hospital	589
to C.R.S.	294
Total requiring immediate hospital treatment .	3,284
Therefore percentage total ex-prisoners-of-war requiring immediate hospital treatment . .	3·2 per cent.

Note: (*a*) Up to June 27, 1945, 13,058 ex-prisoners-of-war had reported to 45th Division for sorting and training. These men were being retained for further Army service and had completed their six weeks' repatriation leave.

(*b*) Of the 5,109 found to be below medical category A
882 (6 per cent.) were assumed to be correctable to A category with training.
175 (1·3 per cent.) were placed in medical category E.

(*c*) Of the 13,058 returning to 45th Division after leave
131 (1 per cent.) were admitted to hospital.

B. GENERAL NOTES

Notes on Hygiene

1. Energetic measures may have to be undertaken in the prevention of infectious disease.

(i) Epidemic Typhus. Lousiness may be a problem among certain prisoners-of-war. Dusting with D.D.T. will have to be undertaken on a fairly large scale.
(ii) Skin diseases will be common, including ringworm and impetigo.
(iii) Inoculation and sulphaguanadine for enteric and dysentery.
(iv) Atebrin for malaria.
(v) Vaccine for cholera.
(vi) Vaccination for smallpox.
(vii) Vaccination for plague.

2. The most important hygiene measures in the early stages include also:

(i) Careful feeding (see D).
(ii) Bathing.
(iii) Satisfactory housing.
(iv) Clothing and bedding.

Diet and Immediate Treatment

It is essential that during the initial stages of recovery from undernourishment, the digestive system is gradually educated in the assimilation of food. This was found necessary in Europe where many released prisoners suffered from the mistaken kindness and hospitality of the relieving forces.

It is felt that ex-prisoners-of-war in the Far Eastern theatre will be in a worse condition than that experienced in Europe and the importance of this aspect of early treatment cannot be over-emphasised.

Physical Conditioning.

It was found that many of the European ex-prisoners-of-war required physical conditioning of graduated type in order to get them into good shape once again. Though this was undertaken in the United Kingdom after the repatriated prisoner had been home on leave, the time interval between release and arrival in the United Kingdom was very short in most cases. As far as the Far East is concerned, however, it would seem essential that a scheme for maintaining or gradually achieving physical fitness should be in operation from the earliest moment. Without it, the long delay in many cases (through distance) between release and arrival in the United Kingdom will result in an unnecessary and avoidable aggravation of the general physical condition of these personnel.

C. ATTITUDES IN HANDLING RETURNED PRISONERS-OF-WAR

The returned prisoner-of-war, if he is to be properly readjusted to life, must find in those who greet him on his return certain fundamental qualities. While surrounded by hostile forces he has instinctively turned to the one friendly object within reach—his comrades, and has formed with them bonds of adversity which are not lightly replaced. The ties of loyalty between men who have suffered the common fate of capture are profound, and if the repatriate is to exchange easily these deep bonds of friendship for others, he must feel that the recipients are worthy of his choice.

He will thus expect to find complete sincerity from those who look after him on his return. No one could be more grateful for genuine help but any tendency to 'window dressing' is usually very much resented. The prisoner-of-war is an adept at looking for and detecting hidden motives, and any lack of sincerity will be immediately discovered.

As part of his ordeal the prisoner-of-war has suffered the loss of many valued comrades. Sorrows take a prominent part in his emotional outlook. With the traditional reserve of his race, he is at pains to conceal this, as well as his other emotional difficulties, from the eyes of others, but there is a need for sympathy. A real practical understanding of this want is essential in those who would help these men.

For a considerable time in desperate circumstances he has maintained his morale by an intense and vigorous underground resistance. The prisoner-of-war is a master of passive defence. These habits are not easily lost. It is hard to change the habits of many months, or even years, in a short while. The prisoner-of-war will take some time to realise that he is no longer in the hands of a hostile authority and during his re-adaptation to his new environment, much tolerance to his contrary behaviour will have to be exercised.

Finally he wants to make up for lost time. He is hungry for information and wants to bring himself up to date and is often confused and rather bewildered by the changes around him. His desire for the latest news and developments must be supplied in an attractive form. He must be helped to the greatest extent in the formation of new interests which link up with his former ties. His experiences have changed him, and the things he left behind have also changed. It is the fitting together of these two aspects of his life which constitute the problem of resettlement.

The treatment of patients suffering from starvation is omitted from this narrative as the information it provides belongs to the clinical rather than to the hygiene field. It is also readily available in the textbooks.

D. MEDICAL ARRANGEMENTS ON TRANSPORTS

If a thorough medical examination is not possible before embarkation on transports of released prisoners-of-war and internees not being evacuated through medical channels, the following measures are advised wherever practicable:

1. An adequate number of M.Os. experienced in tropical diseases should be allocated to transports to carry out a thorough medical examination of every individual during the voyage. Full use should be made of any medical specialists returning to the United Kingdom.
2. A full report of each individual should be recorded on the field medical card, which should be in the possession of prisoners-of-war and internees on disembarkation in the United Kingdom.
3. Facilities for side room pathological investigation should be available on transports.
4. The normal scale of hospital beds on transports should be increased.
5. There should be sufficient nursing officers on each transport.
6. The scale of medical comforts should be increased above the normal scale on transports.
7. The most liberal possible scale of accommodation and rations should be provided on transports.

8. All repatriates should receive blanket treatment of mepacrine, viz: 3 tablets daily for five days and thereafter 1 tablet daily for the rest of the voyage to the United Kingdom.

9. A high proportion of skin cases is anticipated, which will necessitate a special provision of drugs as under 10 below.

10. Sufficient of the following drugs should be included in medical stores placed on board transports.

Diphtheria anti-toxin, mepacrine, quinine (including intravenous preparations), plasmoquin, emetine hydrochloride, E.B.I., yatren or equivalent, sulphaguanidine, sulphasuccidine, sulphathiazole, penicillin, vaccine lymph, sulphapyridine (soluble in ampoules), urea stibamine (or equivalent antimonial preparation), oil of chenopodium, tetrachlorethylene hexyl resorcinol, carbon tetrachloride, vitamin concentrates.

Drugs for skin diseases:

Calamine lotion, lasser's paste, mercuric chloride solution tablets, benzyl benzoate, lanette wax S.Z., rescorcin, precipitated or sublimed sulphur, ichthammol.

Ointments as follows:

Zinc, sulphur, salicylic acid, dilute ammoniated mercury, iodi denigrescens, acid benzoini co., mercury, boric acid.

11. Sufficient A.P.T. instructors should be posted to transports to give graduated physical exercises under medical supervision during the voyage.

12. Special consideration will be necessary for military families.

Early in October 1945 D.A.D.H.(*c*) visited Southampton to observe the working of these arrangements in the case of returning prisoner-of-war from the Far East ex H.T. *Corfu*. He reported as follows:

> 'The medical arrangements worked smoothly—some 1,500 men being processed by 16 M.Os., plus specialists in about 16 hours working time. About 80 per cent. of the men were well nourished and apparently fit and about 1 per cent. were admitted to hospital. The remainder were sent on leave pending arrangements being made for specialist and laboratory examination during leave. Very few men were under weight and a vast majority were eating normally with good appetites'.

CHAPTER 5

THE ARMY DENTAL SERVICE*

INTRODUCTION

It is recorded that as long ago as 1626 a dental outfit, consisting of some eight instruments designed for the scaling and extraction of teeth was authorised for the use of army surgeons. This measure, however, was not related to the conservation of the soldier's health; it was to ensure that he should be able to bite off the cap from the charger before pouring the powder into his muzzle-loader. Incisor teeth in those days were an essential part of the soldier's arms. By the time of the Boer War they had ceased to be.

The sick-wastage due to dental disease reached such proportions during the early phases of this campaign, however, that for quite other reasons attention was attracted once more to the soldier's teeth. In 1900 an honorary dentist was appointed to the staff of the Yeomanry Hospitals and in the following year four civilian dental surgeons were sent out to provide treatment for troops in the field. The utter inadequacy of this first attempt to provide an army dental service was revealed by the fact that of the total admissions to hospital on account of dental caries (6,942) no less than one third had to be discharged from the Army. Dentures were not supplied and the great majority of extractions were performed without an anaesthetic.

As an outcome of the experience gained, however, eight dental surgeons were appointed in 1904 to commands at home and three more were posted to military establishments in India. They had no military status, no rank, no uniform. They were only authorised to supply dentures to 'sergeants of good character'. These events did not lead to the formation of a permanent Army Dental Service, as might perhaps have been expected, for the employment of these dental surgeons was discontinued in 1908, and thereafter all dental treatment for serving soldiers and recruits at home was undertaken by civilian practitioners under command arrangements and on a part-time contract basis.

Rejection of potential recruits on account of defective teeth (72·32 per 1,000 examined in 1905) had reached such proportions, that it was decided, as an experiment, to enlist in the Northern Command men below the prevailing dental standard but otherwise physically fit, provided that their deficiency could be made good by conservative dentistry. The treatment was to be carried out by civil practitioners and authority was given for expenditure up to £1 on each recruit. The experiment was

* The substance of this account was provided by the Dental Directorate of the Army Medical Directorate.

successful and in 1907 the system was extended to all home commands. Later, serving soldiers, both at home and abroad, were included in the scheme. In 1914 when mobilisation occurred these arrangements were still in force. Not a single dental surgeon accompanied the B.E.F.

The story is told that at the height of the battle of the Aisne, the commander of the First Army, Sir Douglas Haig, was stricken with a violent tooth-ache and was obliged to summon a French dentist from Paris. Thus becoming personally interested in the Army's needs in respect of dental attention he at once took appropriate action. Be this as it may, it is the case that in November 1914 the War Office was requested to send dental surgeons out to the B.E.F. Twelve were posted to C.C.Ss. being given temporary commissions in the rank of lieutenant, held on the general list and attached to the R.A.M.C. By the end of 1914 there were 20 such serving in France.

Although a few dental surgeons were commissioned in January 1915 for duties at home, the bulk of the dental treatment continued to be carried out by civilian dentists. Of the thousands who were volunteering for military service a high proportion was being rejected on account of defective teeth, despite the fact that with suitable treatment they could have been made acceptable. The dental standard was lowered and in consequence large numbers of such men were enlisted, trained and sent on drafts only to become a burden. The dental standard was raised again. Dental surgeons and institutions throughout the country offered free treatment to all whose dental conditions could be sufficiently improved. Lists of dentists of repute who were willing to act as honorary dental surgeons to military hospitals, were prepared by commands. Instructions were issued by the War Office to the effect that no serving soldier was to be discharged on account of decay or loss of many teeth if by dental treatment he could be rendered fit to remain in the Service. In January 1915, men with defective teeth, but willing to undergo dental treatment, could be attested if otherwise fit for general service. In February, a recruit could be passed as 'fit, subject to dental treatment'; and in the same month the amount medical officers were authorised to expend on the dental treatment of a man, including the provision of artificial dentures when considered necessary for efficient mastication, was increased to £3. In special cases the General Officer Commanding-in-Chief was empowered to authorise the expenditure of a larger sum.

It was quickly realised that this system was far from satisfactory. In those days there were many practising dentists who were without any professional qualification. They were inclined to extract rather than to repair teeth and over their activities there was no sort of control. It came to be recognised that on the staff of a D.D.M.S. of a command there should be an inspecting dental officer, to advise on all dental matters. These were duly appointed. The importance of dentistry as a

'special branch of army medical organisation' was thus acknowledged and the nucleus of an Army Dental Service (A.D.S.)* established. The inspecting dental officers were, however, seriously handicapped in their work by the shortage of commissioned dental officers (D.Os.). The passing of the Military Service Act in 1916 made the appointment of additional dental officers imperative, and a gradual increase in their number took place. Thirty-six dental officers were employed by the Army in February, 57 in May, 150 in August 1915, and 300 in August 1916, while at the end of 1916 no less than 463 were serving at home and abroad.

At first, the dental officers on the Western Front operated no further forward than the army areas, one being attached to each C.C.S. They had no facilities for the provision and repair of artificial dentures, and all men requiring such work were evacuated to base where large dental centres and clinics were eventually established. As the demand for dental treatment grew, dental officers began to make periodic tours to divisional areas, taking sufficient equipment with them in an ambulance car. This prevented evacuation for minor dental ills, but mechanical dentistry could still be undertaken only at the base. A motor dental laboratory was presented to the Army by the Civil Service Motor Ambulance Fund through the B.R.C.S. in May 1916. This proved to be so useful that eventually each of the five armies in France was presented with a similar mobile laboratory, and so facilities for all forms of dental treatment were made available in all army areas.

The somewhat casual and haphazard development of the dental service, with its frequent recourse to charity, gave rise to so many administrative difficulties that a senior dental officer (S.D.O.) was appointed to represent the dental service in the personnel branch of the staff of D.G.A.M.S. in January 1918, to advise generally on all dental questions and to co-ordinate the activities of the A.D.S. in the United Kingdom and overseas.

In March 1918, a scheme was prepared for the organisation of the dental service in army areas in France, and after consultation with the Ds.M.S. of armies and the officers in charge of the dental laboratories, it was proposed that the mobile dental laboratory should form the principal dental centre of each army, with standardised equipment and an establishment of three D.Os. and twenty-four dental mechanics, the S.D.O. to act as a dental adviser to the D.M.S. In addition, smaller dental clinics, for conservative dentistry and minor dental surgery, were to be established in the proportion of two for every division, one to be attached to the C.C.S. and the other to operate in the divisional area. The existing large dental centres at the principal bases were to

* A.D.S. is not an authorised abbreviation; it is used herein for the reason that it is helpful.

remain, but small dental clinics were to be established in other administrative areas on the lines of communication. The scheme was not altogether satisfactory, since men requiring denture work had still to be evacuated to the army area and so it was proposed that the location of the army dental centres, where mechanical facilities were available, should be at the corps depot camps. The German offensive of 1918 disorganised the development of this project and no further advance was made in the organisation of the Army Dental Service in the field before the end of the war.

At home the arrangements for dental treatment continued to be quite inadequate; in May 1918, there were only 282 dental officers employed in commands, and only a minute fraction of the men who required dental treatment could be made dentally fit before drafting overseas. To deal with the situation it was estimated that an immediate increase to 667 dental officers was required at home, exclusive of 100 required for the R.A.F. By October 1918, 690 dental officers were employed in home commands, with the result of marked improvement in the dental condition of the subsequent drafts for overseas. At the time of the armistice there were 831 dental officers serving in the Army home and abroad.

The arrangements for dental treatment in the other theatres of operations during the War of 1914–18 were either non-existent or gravely inadequate, and it would appear from the records available that such arrangements that were made were delayed reactions to the stimulus of necessity, rather than the outcome of considered planning. One interesting innovation that did emerge, however, was the conversion of a railway coach into a dental surgery in the campaign in North Russia. This moved with the hospital train to various locations along the line.

After the armistice, the number of dental officers in the Army increased slightly; in January 1919, 849 were employed. By October 1919, this number had become reduced to 378.

THE CREATION OF THE ARMY DENTAL CORPS*

On March 8, 1919, the British Dental Association put forward a proposal for the inclusion within the Army of a properly organised dental service. After nearly two years of deliberation and delays, 'The Army Dental Corps' (A.D.Corps) was at last formed by Royal Warrant, dated January 4, 1921, as an integral part of the Army Medical Services.

The new corps was administered by the Army Medical Directorate, and was a joint service for the Army and the Royal Air Force. Promotion was carried out on one general list. An inspector of dental services, a lieut. colonel, was appointed to the War Office, and four inspecting dental officers, majors, were responsible for dental administration in

* Now the Royal Army Dental Corps.

commands. The executive dental officers, all qualified dental surgeons, were appointed in the rank of lieutenant, but service as a temporary dental officer before the formation of the corps was taken into consideration for those appointed to permanent regular commissions, and this counted towards the three and a half years for promotion to captain. Promotions to the rank of major and lieut. colonel to fill establishments were made by selection.

On the formation of the A.D.Corps, the peace establishment was fixed at 107 officers, 107 clerk-orderlies and 25 dental mechanics.

When the A.D. Corps was formed there still remained in the Army many men serving on short engagements; these were generally above the normal army age and dental disease was rife among them. It would have been impossible for the dental officers available to deal adequately with all who required their attention. As the services of the civil dental profession were no longer used at home, the work of the A.D. Corps came to be selective. Dental officers were appointed to all regimental depots, and newly-joined recruits were afforded priority of treatment. Trained soldiers received dental treatment in accordance with the amount of their unexpired service, those with a longer period to serve having precedence over those with a shorter, except, of course, in cases of urgency.

Recruits were again subject to a dental standard and were required to be in possession of a sufficient number of sound teeth, or teeth that with conservative treatment could be restored to full function, for efficient mastication. Men who required extensive treatment and artificial dentures were thus rejected. The ratio per 1,000 men rejected on medical examination in 1920–21, on account of the 'loss and decay of many teeth' was 35·16, this condition being second among the principal causes for rejection. Some difficulty was experienced by medical examiners in deciding the number of teeth necessary to fulfil the requirements for efficient mastication. To clarify the position an A.C.I. was issued in 1921 introducing a system of point values. Incisors, canines, premolars and under-developed third molars in the upper jaw, in functional opposition to corresponding teeth in the lower jaw, were each given the point value of one. First and second molars and well-developed third molars were given the value of two points each. A complete, well-developed and fully functional dentition had, therefore, a total value of twenty-two points. A recruit was required to have sufficient sound or restorable teeth to give him a total of not less than eleven points.

The effect of the introduction of this strict standard was revealed in the ratios for rejection of potential recruits in subsequent years. In the recruiting year 1921–2, 49·98 men per 1,000 were rejected; in the following year, 48·49 men per 1,000 were not accepted, and defective teeth

was the principal cause of rejection. From 1924 to 1928, the ratio per 1,000 men rejected on account of the loss and decay of many teeth averaged 35·61, being second only to 'diseases of the middle ear (including deafness)' in the list of principal causes for the non-acceptance of men on examination for enlistment. In October 1928, following an experiment in Scottish Command during the previous recruiting season, the dental standard in existence before the War of 1914–18 was again adopted in an effort to reduce the number of men rejected on account of defective teeth. This allowed the acceptance of men who did not conform to the previous standard but who were physically fit and robust, and at least 6 lb. above the normal weight standard. Ordinary dental treatment was given but artificial dentures were not supplied without special War Office authority. A marked reduction in the ratio for rejections resulted; thus in 1928–9, only 26·13 men per 1,000 were not accepted. The establishment of dental officers was increased in April 1928, and again in 1929, in order to make provision for the resulting increase in the amount of initial dental treatment required by newly-joined recruits, to afford adequate attention to the men on draft before they embarked for overseas, and to increase the facilities for the maintenance treatment of trained soldiers.

It is of interest to note that the ratio of rejections increased progressively in the next few years, the dental and general condition of the young men born during and just before the War of 1914–18 who were now coming forward to enlist being distinctly poor. In 1935–6, the ratio per 1,000 men rejected was 44·36. In October 1937, the dental standard was, once again, lowered and a further increase in the establishment of the Army Dental Corps was authorised to provide for the additional commitment. At this date 98·3 per cent. of all recruits required dental treatment.

With the exception of a small dental laboratory in London District, the production and repair of artificial dentures and the construction of special appliances was centralised at the Central Dental Laboratory, Aldershot, in 1922. In addition to production, instruction to soldiers enlisted for training as dental mechanics was given at the central laboratory which ultimately developed into the school of instruction, where both officers and other ranks of the Army Dental Corps received probationary and military training.

The dental treatment card was introduced in 1922 to enable the dental officer to have before him a complete record of the dental condition of each soldier for whom he was responsible; dental treatment was thus carried out in order of urgency and without unnecessary re-inspection.

In 1922 dental officers served in all home commands, in India, Egypt, Palestine, Gibraltar, Iraq and Malta, with the Army of the

Rhine and with the British Forces in Turkey. By 1937 dental officers served in all places where British troops were stationed, with the exception of Aden, Bermuda, Ceylon, Jamaica and Mauritius. The smallness of the British garrisons at these stations could not justify the full-time appointment of a dental officer, and civilian dental surgeons continued to be employed. Dental officers were allotted to commands at home on the ratio of one D.O. to each 500 recruits per annum and one to each 3,000 trained soldiers, and to commands abroad at the rate of one to each 2,000 men.

THE FORMATION OF A.M.D.6. (THE DENTAL DIRECTORATE).

The title of the Inspector of Dental Services was changed to 'Assistant Director-General, Army Medical Services (for the Dental Service)' on May 1, 1927, and the rank of the appointment was upgraded to colonel. He was attached to a branch in the Army Medical Directorate and the section for which he was responsible was designated 'A.M.D.1(D)'. In October 1935, a further re-organisation took place which coincided with an increase in the establishment of the higher ranks in the corps to a total of three colonels. A separate branch within the Army Medical Directorate called 'A.M.D.6.' was formed for the administration and organisation of the Army Dental Service; the head of the service became 'Director, Army Dental Services' (D.A.D.S.), and the appointment carried the rank of major general or colonel, the higher rank being granted at the discretion of the Army Council. The staff of A.M.D.6 consisted of one civilian clerk only. In 1936 the inspecting dental officers at commands became A.Ds.D.S. In the following year the Inspector of Army Dental Service in India was transferred to Army H.Q. and the title of his appointment changed to that of D.D.D.S.

With the formation of the Royal Air Force Dental Branch on July 1, 1930, the dental section for the Royal Air Force was divorced from the Army Dental Corps and the establishments appropriately adjusted.

Provision was made in the inter-war years for the inclusion of dental personnel in the war establishments of medical units. Dental officers, mechanics and clerk-orderlies were to be allotted to C.C.Ss., general hospitals and convalescent depots. Dental officers and clerk-orderlies only were to be allotted to field ambulances and cavalry field ambulances. The war establishment for the medical branch of a G.H.Q. allowed for one administrative dental officer in the rank of colonel, to be called the D.D.D.S.

The first occasion on which medical units were despatched with complete dental personnel and equipment was when the Shanghai Defence Force embarked in March 1927. Four dental officers, four clerk-orderlies and two mechanics accompanied the force, which had

an average strength of 8,500 officers and other ranks. They were equipped with field dental outfits and were able to carry out emergency treatment on the transports during the voyage.

To study the treatment of maxillo-facial injuries and to make recommendations for the special training of dental officers in this subject, the Army Advisory Committee on Maxillo-facial Injuries was appointed in May 1932. In 1936 the field dental outfit was brought up to date by the inclusion of additional items for use in the immediate treatment of maxillo-facial injuries.

In July 1939, on account of the expansion of the Army Dental Service and the increase in the volume of administrative work now undertaken by A.M.D.6, an A.D.D.S. was appointed. Increases in the clerical staff had taken place earlier in the year. In August 1939 the staff of the Dental Directorate consisted of the following personnel:

Assistant Director, Army Dental Service (major)
Chief clerk (civilian)
Military clerk (sergeant—dental clerk orderly)
Temporary clerk (civilian)

Although a branch of the Army Medical Directorate, A.M.D.6 was responsible for the whole organisation of the Army Dental Service. It dealt with all personnel questions, including appointments, posting, promotion, technical training and records of service, as affecting officers of the Army Dental Corps, and all planning and co-ordination with other War Office branches. Other important activities included liaison with the Ministry of Health, the Ministry of Labour and the Department of Health for Scotland on all questions relating to the dental service within the scheme for the E.M.S., and co-operation with the Dental Emergency Committee. It was responsible through the appropriate branch of the Army Medical Directorate for recommendations regarding dental equipment, materials and approval of contractors' samples, besides the supervision of indents and the distribution of supplies. All statistics dealing with dental treatment were consolidated by A.M.D.6.

In the commands the administration of the A.D.S. was carried out by administrative dental officers at command headquarters.

The administration of the Army Dental Service abroad was carried out either by specially appointed administrative dental officers or by the senior executive D.O. in the command. In 1939 the organisation was as follows:

India. D.D.D.S. India (colonel) was responsible for the organisation of the A.D.S. He had no assistance from subordinate administrative dental officers in the various commands, but the officers-in-charge of the larger army dental centres (A.D. Centres) undertook local dental

administration in addition to their executive duties. Lieut. colonels were in charge of the centres at Rawalpindi, Secunderabad and Poona.

The peace establishment for India carried 27 dental officers (including the D.D.D.S.), 27 dental clerk-orderlies and 15 mechanics.

There were twenty-three A.D. Centres in India, eight of which were provided with alternative summer accommodation at hill stations. All but three were single-officer centres. The establishment did not permit of full-time duty at all dental centres and the personnel were required to make periodic visits to out-stations. Seventeen permanent centres were between them responsible for twenty-six subsidiary visited stations.

No central dental laboratory was established in India, dental mechanics in Northern and Southern Commands being posted to selected dental centres where a dental laboratory (A.D.Lab.) was formed. These laboratories carried out all mechanical work for a group of dental centres and were located at Rawalpindi, Lahore, Poona and Secunderabad. Single dental mechanics were attached to selected dental centres in Eastern Command and Western District.

Burma. The peace establishment for Burma was one dental officer, one clerk-orderly and one mechanic. The A.D. Centre with laboratory was established at the British Military Hospital, Maymyo.

China. The S.D.O. (lieut. colonel) was stationed at Hong Kong and combined administrative with executive duties. In 1939 the establishment was amended to include an A.D.D.S. in the rank of lieut. colonel.

The strength of personnel of the Army Dental Corps in China at the end of August 1939 was four D.Os. (including the A.D.D.S.), four dental clerk-orderlies and one mechanic.

There were four A.D. Centres in the command which were established at Murray Barracks, Hong Kong, Shamshuipoe, Kowloon, Tientsin, and Ash Camp, Shanghai. The dental laboratory was attached to the Hong Kong centre.

Egypt. Dental administration was carried out by A.D.D.S. (lieut. colonel) attached to H.Q., British Troops in Egypt. He was also in charge of the central dental laboratory for the command, situated in premises near the dental centre at Kasr-el-Nil.

The peace establishment for Egypt was eleven dental officers (including the A.D.D.S.), eleven clerk-orderlies and five mechanics. The strength of the command in August 1939 was nine dental officers, nine dental clerk-orderlies and four mechanics.

There were seven A.D. Centres in operation, three of which were worked part-time only; they were located as follows: Citadel Cairo, Kasr-el-Nil, Abbassia, Helmieh, Mustapha, Moascar and Khartoum. In August 1939 two dental officers were attached to field medical units, one located at Mersa Matruh and the other at El Daba.

Gibraltar. In January 1939, one dental officer was stationed in Gibraltar. In the following April the peace establishment was increased to two D.Os., two clerk-orderlies and one mechanic. The S.D.O. (major) carried out both administrative and executive duties.

With the arrival of the second dental officer a temporary dental centre was established in the garrison dispensary pending the alteration of accommodation in the Gunners' Barracks, Town Area. The principal dental centre, where the dental mechanic was employed, was located at the British Military Hospital.

Malaya. The S.D.O. (major) was, in addition to his administrative responsibilities, officer-in-charge of the single-chair dental centre at Singapore and of the command dental laboratory. In August 1939, the establishment was amended to include an A.D.D.S. in the rank of lieut. colonel.

The peace establishment for Malaya was six dental officers (including the A.D.D.S.), six clerk-orderlies and two mechanics. A.D. Centres were established at Singapore (Gilman Barracks), Changi, Tanglin, and Selerang. The command dental laboratory was located at the dental centre, Singapore.

Troops stationed at Taiping, Port Dickson and Penang received emergency treatment from civilian dental surgeons employed locally on a contract basis. Dental treatment for children attending army schools was provided at all A.D. Centres.

Malta. By April 1939 the peace establishment for Malta was three D.Os. three clerk-orderlies, and two mechanics. The S.D.O. (major) was known as the command dental officer. The principal A.D. Centre, called No. 1 Dental Centre, was located at Valletta; No. 2 Dental Centre was established at Paceville, near St. Georges.

Palestine. The establishment for Palestine carried an A.D.D.S. (major). In 1939 the rank of the appointment was up-graded to that of lieut. colonel. The A.D.D.S. carried out dental treatment for patients in the Military Hospital, Haifa, and was in charge of the dental laboratory. The peace establishment for Palestine was increased during 1939 to six dental officers (including the A.D.D.S.), six clerk-orderlies and three mechanics.

The four A.D. Centres in the command were located as follows: Military Hospital, Haifa; Peninsula Barracks, Haifa; R.A.F. General Hospital, Sarafand; Allenby Barracks, Jerusalem. At the end of August 1939, the Dental Centre, Peninsula Barracks, was closed and one dental officer was stationed at each of the remaining dental centres. One mechanic was employed at the Military Hospital, Haifa, and two were stationed at Jerusalem.

No dental officers served in Aden, Bermuda, Ceylon, Jamaica or Mauritius.

In August 1939 the total number of dental personnel required for service abroad and carried by peace establishments was sixty-one clerk-orderlies and thirty-one mechanics. The actual number serving overseas at this date was, however, eight under establishment in the case of both dental officers and clerk-orderlies and three under establishment for mechanics.

ARRANGEMENTS FOR DENTAL TREATMENT

A man was considered a recruit for six months from the date of his enlistment. Recruits were rendered dentally fit during the period of preliminary training at their depots and were afterwards afforded maintenance treatment whenever necessary. This maintenance treatment was ensured by periodic dental inspections, which were carried out annually in March, on change of station at home and on receipt of orders for overseas service.

By far the greater number of dental officers were employed at A.D. Centres established at regimental depots. Other centres were attached to the larger military hospitals as dental departments.

At the end of August 1939 there were 115 A.D. Centres in operation in the United Kingdom, including 38 part-time visited centres; 67 were located in barracks, 18 were attached to military hospitals and 30 were accommodated at other military establishments (i.e. camps, technical schools, houses, etc.).

The dental condition of the children of serving soldiers attending army schools had for many years caused concern; they were not eligible for any regular dental treatment and little could be done to overcome their gross neglect as there were insufficient dental officers to provide this important service. Eventually an increase of four dental officers to the establishment of the Army Dental Corps was specially authorised in August 1936; but it was not until July 1938, after more than five years' delay, that the scheme was finally launched and the regular dental inspection and treatment of army school children became a reality. The four D.Os. were allotted to Aldershot, Eastern, Northern and Southern Commands. It was arranged later for the dental officer posted to Northern Command to make periodic tours in the remaining commands and Northern Ireland District.

Special arrangements were made for the dental inspection and treatment of militiamen who joined for training in July 1939, and also for the supplementary reservists; this included the appointment of seventeen dental surgeons to temporary commissions in the A.D. Corps and a corresponding increase in the establishment for dental clerk-orderlies. In addition, new A.D. Centres were opened in many of the specially constructed militia camps.

The A.D. Lab. was located in Aldershot Command and undertook the denture work for the whole of the United Kingdom with the exception of that for London District, which had its own small laboratory at Queen Alexandra Military Hospital, Millbank.

In 1938, a dental officer, was nominated for duty as dental specialist to the command and was attached to the Cambridge Hospital. Arrangements were also made to enable the dental specialist, when he was undertaking the treatment of a case with a fractured jaw, to call upon any dental officer serving in the command to assist in the treatment and so gain valuable practical experience in this important branch of dental surgery.

ACCOMMODATION AND EQUIPMENT

By 1939 great improvements had been effected in the provision of accommodation at A.D. Centres, but in some there was still no separate office accommodation, and waiting-room arrangements were often inadequate and without any form of heating. Much rebuilding had taken place the previous year and the new centres were modern in every respect; ample space was provided for surgery, office, plaster-room, waiting-room and stores, a great advance over the cramped and unsatisfactory conditions that existed at some of the earlier centres.

Many of the dental surgeries at home had tiled walls, and coal fires were replaced by electricity or gas. Electrical water-heating systems or gas geysers were installed to ensure an adequate supply of hot water, and electric tri-cord drop pendant daylight lamps were fitted over the dental chair in most of the surgeries. Poison cupboards were also issued. Electric sterilisers were being supplied to all A.D. Centres at home.

Abroad, similar re-equipment took place and better accommodation was acquired. Most centres were supplied with pump dental chairs, electric engines and fountain spittoons and a few were equipped with complete home dental outfits. Special consideration was given to the provision of ceiling fans and to the fly- and dust-proofing of surgeries when the climatic conditions made these essential. Electrical storage water-heaters and grinding and polishing lathes were provided at centres where electricity was available. In India, however, the accommodation at some stations remained unsatisfactory. Measures had been taken to bring the table of authorised dental equipment more into line with the home standard, and a scale of furniture and other fittings was introduced. Improvements were effected in the arrangements for washing, which had been primitive and unhygienic in the past, hand-basins replaced sinks in the surgeries and sinks were installed in the plaster-rooms. Some centres were equipped with storage water-heaters, electric boiling-plates and grinding and polishing lathes.

A new building for the A.D. Lab., Aldershot, was completed and taken into use in March 1938. Benches to seat thirty-two dental mechanics were provided. Among many improvements in accommodation, equipment and fittings was the supply of adjustable stools for mechanics in place of the old fixed wooden pattern.

The need was keenly felt for the issue of a more modern type of general anaesthetic apparatus, such as a continuous nitrous oxide gas and oxygen machine with nasal inhalation attachments, and also of a special dental X-ray apparatus. Among items of smaller equipment, the supply of the following was suggested: a simple form of compressed-air atomiser, a wider assortment of impression trays and Coupland's surgical chisel.

THE DENTAL CONDITION OF THE ARMY

(*a*) *Trained soldiers.* The dental condition of the trained soldiers in the years just before the outbreak of the War of 1939–45 was reported to all commands at home and overseas to be generally very satisfactory. A high standard of oral hygiene was maintained by them and, as was evidenced by the number of men voluntarily seeking dental re-inspection, the average soldier took a considerable personal interest and pride in the care of his mouth and teeth. The number of men who refused dental treatment was negligible.

Statistics for the year 1939, show that of 77,753 trained soldiers inspected in home commands at the (March) annual dental inspection, 41,978 or 53·99 per cent. required maintenance dental treatment. There was little variation in the figures from overseas commands. The dental treatment required was seldom more than the conservation of two or three teeth and the extraction of one tooth per man. Compared with previous years these figures showed a slight increase because routine dental treatment became more difficult to provide on account of the demands made upon the Army Dental Service for the treatment of a larger intake of recruits during 1938, and a proportionately greater amount of denture work required consequent upon the abolition of the dental standard.

Gingival diseases in home commands were rare, but in certain stations abroad, particularly in Malaya and around Hong Kong, due possibly to the influence of the climate in lowering the general resistance of the body to infection and possibly also to the absence of fresh fruit and vegetables from the diet, a marked increase in the incidence was reported.

An analysis of the denture work completed for all Army personnel by the Army Dental Laboratory, Aldershot, during 1938 showed that 4,264 new and remodelled dentures were produced during the year, 2,588 for the upper jaw and 1,676 for the lower jaw. Thirty-

eight per cent. of the dentures constructed were full dentures, 15 per cent. had from 13 to 9 teeth, 37 per cent. from 8 to 5 teeth, and 10 per cent. less than 5 teeth.

(*b*) *Recruits for the Regular Army and the S.R.* The abolition of the dental standard for recruits in October 1937, resulted in a great increase in the total amount of dental treatment required by them on enlistment, and particularly in the number of dentures supplied to restore efficient mastication.

Out of 36,324 recruits for the Regular Army dentally inspected on enlistment during 1938, 35,434 or 97·55 per cent. were found to require dental treatment. Out of 4,327 recruits for the S.R. inspected during the same period, 4,288 or 99·33 per cent. were in need of dental treatment.

The examination of a group of 14,421 recruits for both the Regular Army and the S.R. who were selected for dental treatment, revealed that between them there were 27,655 unsaveable teeth and 67,006 restorable teeth, an average of 1·92 extractions and 4·65 conservations per man.

The standard of oral hygiene of the average recruit left much to be desired. Out of 14,459 specially examined in 1938, only 2·698 or 18·65 per cent. were regarded as having a good standard of oral hygiene, 6,643 or 45·94 per cent. were considered to be fair, and 5,118 or 35·41 per cent. had their standard of oral hygiene classified as neglected.

The lack of any system for the regular dental treatment of the adolescent between the ages for leaving school and enlistment was largely blamed for the inferior dental condition and indifferent oral hygiene of recruits. Unless strict management was maintained during this important period any benefit derived from the dental treatment received at school was of little value, and by the time the enlistment age was reached the damage done was irreparable. In this respect, it is interesting to record that at an inspection of 780 recruits only 100 showed evidence of having received conservative dental treatment at school, and that, of the men showing such evidence, there was no appreciable difference in the proportions for those recruited from industrial and from agricultural areas.

(*c*) *Militiamen.* The opportunity afforded by the call-up of militiamen in July and August 1939, was taken to compile important dental statistics with regard to a particular age group representing a cross-section of the male population of the United Kingdom. Special dental inspections were arranged in commands, and the results obtained are of special significance. All militiamen were between the ages of 18 and 19 years old.

Out of a total of 33,743 militiamen inspected, 31,507 or 93·43 per cent. were found to require dental treatment. A more detailed examination of 31,556 militiamen was carried out which gave the following information:

1. Between them, 52,225 teeth were considered unsaveable, that is, 1·65 teeth per man.
2. Between them, 126,005 teeth were restorable, that is, 3·99 teeth per man.
3. Between them, they were already in possession of 3,347 dentures (2,539 upper and 808 lower); that is, 10·61 per cent. of the total number of men were in possession of one denture (8·05 per cent. upper, 2·56 per cent. lower).
4. 1,606 new dentures (923 upper and 683 lower) were required to be made; that is, 5·09 per cent. of the total number of men required one new denture.
5. Of the dentures already possessed, 91 required remodelling and 27 required repairs.
6. The standard of oral hygiene was classified as: 30·38 per cent. good, 51·15 per cent. fair, and 18·47 per cent. neglected.
7. 162 cases of open bite, 30 cases of hypoplastic enamel, 6 cases of cleft palate, and 101 cases of men suffering from various gum diseases, both mild and severe, were recorded.

TRAINING

(*a*) *Officers.* The training in military duties of newly-commissioned officers of the Army Dental Corps was at first undertaken jointly with those of the R.A.M.C. In the courses of instruction, two places were allotted to dental officers.

With the introduction of short service commissions in the A.D.Corps, joint instruction with R.A.M.C. ceased and the military training of dental officers was undertaken at the A.D.Corps School of Instruction, Aldershot, which had hitherto been responsible for the technical training of other ranks only. The officers first joined as probationers. After attending the course an examination was held to determine the officers to be selected for appointment. The seniority of the successful candidates on the Army List was dependent upon their order at the examination; the syllabus of the course followed the same lines as before, but it was possible to reduce its duration to one month by the elimination of such material as was of interest only to medical officers.

Training was the responsibility of the Training Officer, A.D. Corps, who was assisted by the Commandant, the A.D. Corps School of Instruction, and his staff. The training officer (T.O.) was also A.D.D.S., Aldershot Command, and the commandant of the school was also officer in charge of the Army Dental Laboratory. The staff consisted of an assistant training officer (lieutenant quartermaster), an assistant instructor (warrant officer class I) and one dental clerk-orderly (sergeant or below).

(*b*) *Other Ranks.* Potential dental mechanics and dental clerk-orderlies were first interviewed by the T.O., who reported on their

suitability for employment. A dental mechanic was also trade tested and placed in one of the following three categories:

(i) For classification as a dental mechanic class III, II or I.
(ii) For modified training as a dental mechanic if the T.O. considered that the class III trade test could be passed after attending a course not exceeding six months' duration.
(iii) For training as a dental mechanic.

Recruits then underwent four months' recruit training at the R.A.M.C. Depot. On satisfactorily completing the recruit training they were posted to the A.D. Corps School of Instruction for training as tradesmen.

A dental mechanic placed in category (iii) as above, attended the junior course of instruction, of twelve months' duration, at a dental laboratory, and on passing the examination held at the end of the course was classified as a class III tradesman.

A soldier accepted for training as a dental clerk-orderly spent two months at a dental centre and two months at a central dental laboratory. He was eligible for grading as a dental clerk-orderly, class III, if he obtained qualifying marks at the examination and had completed ten months' total service.

Dental mechanics continued their technical training at the A.D. Lab. while dental clerk-orderlies were posted to A.D. Centres where their further training became the responsibility of the officers under whom they were serving. Yearly examinations were held for advancement in the trades, but classification was dependent also on the length of service.

MOBILISATION

THE AVAILABLE STRENGTH OF ARMY DENTAL CORPS PERSONNEL

(*a*) *Officers.* There were 187 Regular Army officers, including short service commissioned officers, and 17 officers holding temporary commissions serving with the A.D. Corps at the outbreak of the war. Twenty-five officers were held on the R.A.R.O. and 133 officers on the T.A.R.O., a total available strength of 362 dental officers.

There was no T.A. active list for the A.D. Corps. Although the introduction of this reserve had been urged in 1935 it had been repeatedly turned down on financial grounds; and it was not until June 16, 1939, that approval for its formation in principle was received, too late to be implemented before the outbreak of war or to be of assistance in any planned expansion of the Army Dental Service in the early months of the war.

(*b*) *Other Ranks.* There were 216 dental mechanics and dental clerk-orderlies serving on regular engagements in the A.D. Corps, and there were 91 reservists, a total available strength of 307 other ranks.

When general mobilisation was proclaimed, 69 officers and 100 other ranks reported at their mobilisation stations to complete the war establishments of units in the first contingent of the B.E.F., including 11 officers for the T.A. increment. Only 293 dental officers and 207 men remained to deal with the vast amount of dental treatment required by the Regular Army, the R.A.R., the T.A., the Militia and the A.T.S., a number manifestly inadequate for the purpose. In peace-time no treatment was afforded to personnel of the R.A.R. or the T.A., but these became the responsibility of the A.D. Corps as soon as they were called up or embodied.

METHOD ADOPTED FOR EXPANSION

Officers. Following the Munich crisis and at the request of the dental associations, the Ministry of Health established, on November 4, 1938, the 'Dental Emergency Committee', a body which promptly circularised all dental practitioners whose names appeared on the United Kingdom Dentists' Register asking for volunteers who were willing to serve in the various Services. A national service register was compiled from which dental surgeons could be called upon as and when required. In Scotland a Scottish dental emergency committee was formed to undertake similar functions. These volunteers helped to bridge the gap until the passing of the National Service (Armed Forces) Act of 1939, which empowered the Dental Emergency Committee (re-named the 'Dental War Committee' on September 29, 1939) to call up dental surgeons who could be spared from civil practice for service with the Armed Forces.

Other Ranks. With the help of a wireless broadcast appeal, volunteers were obtained by direct enlistment into the A.D.Corps. After the passing of the Armed Forces Act, men were obtained by conscription.

THE EVOLUTION OF THE DENTAL DIRECTORATE DURING THE WAR

Additional staff for A.M.D.6 was authorised early in September, 1939. This additional staff comprised the following:

Deputy assistant director (major)
Two temporary clerks, grade III (civilians)
One soldier clerk (corporal—dental clerk-orderly)

In March 1940, a second D.A.D.D.S. was authorised, who assumed responsibility for the general arrangements for dental treatment, while the other D.A.D.D.S. dealt with equipment, supplies and apparatus.

Further reorganisation of A.M.D.6 took place between September and November 1942. The appointment of a staff-captain to assist the

A.D.D.S. was approved and the new post of civilian officer was created. The senior military clerk then became the chief clerk and was promoted warrant officer class I.

The final war-time organisation of the Dental Directorate was as follows:

War Office:
Director, Army Dental Service (major general)

A.M.D.6:
A.D.D.S. (lieut. colonel)
D.A.D.D.S.(A) (major)
D.A.D.D.S.(B) (major)
Senior civilian officer (civilian)
Chief clerk (warrant officer class I—dental clerk-orderly)
Soldier clerk (corporal—dental clerk-orderly)
12 temporary clerks (civilians)

WAR-TIME CHANGES IN COMMANDS AT HOME

The administration of the A.D.S. in home commands was carried out by four administrative dental officers at the headquarters of commands. Aldershot, Southern and Eastern Commands were each administered by an A.D.D.S., but for the group Northern, Scottish and Western Commands and Northern Ireland District there was but one A.D.D.S. Revision of the establishments for the A.D. Corps had been under consideration for some months past, but it became essential for the establishments of the headquarters for services at commands, districts and areas to be amended to include dental representatives in order to meet war conditions and consequent expansion.

An A.D.D.S. was appointed to Western Command on September 21, 1939, but the remaining appointments were not effected until November 22, 1939. These proposals provided for an A.D.D.S. in the rank of full colonel and a D.A.D.D.S. in the rank of major, together with a staff of one warrant officer class II, one sergeant and one corporal at each of the following command H.Q.: Eastern, Northern, Southern and Western. The A.D.D.S. Southern Command also acted for the Salisbury Plain Area. Although Aldershot Command became a second class command on mobilisation, an A.D.D.S. (in the rank of colonel) and a warrant officer class I were retained in view of the additional duties performed by A.D.D.S. Aldershot Command in his capacity as training officer. A D.A.D.D.S. (major), one staff-sergeant, one corporal and one private were also appointed. An A.D.D.S. (lieut. colonel), a D.A.D.D.S. (major) and one staff-sergeant and one corporal were appointed to H.Q. Scottish Command, but the D.A.D.D.S. also acted for Edinburgh and Glasgow Area. The establishments for

London Area and Northern Ireland District each carried an A.D.D.S. (lieut. colonel), one sergeant and one private. Provision was also made for the appointment of an A.D.D.S. (lieut. colonel) and one sergeant to H.Q., A.A. Command, but this vacancy was never filled. D.A.Ds.D.S. (majors), each with a clerical staff of one sergeant, were appointed to the headquarters of each of ten areas; in some cases they were responsible for other areas as well.

D.A.Ds.D.S. were not authorised to countersign indents for supplies or approve the supply, renewal or repair of artificial dentures until July 17, 1940, when this power was delegated to them. This authority was extended on August 1, 1940, to the S.D.Os. of sub-areas and garrisons in Aldershot Command because there were no D.A.Ds.D.S. except at headquarters in that command.

Following the withdrawal of the B.E.F. from France, the military reorganisation in the United Kingdom had its repercussions on the organisation of the Army Dental Service. A number of corps headquarters were established in the United Kingdom, including those which had returned from France; they were to be mobilised to war establishment so that they could be moved from one command to another according to operational requirements.

With the expansion of the Army and alterations in the dispositions of the troops, additional administrative areas and sub-areas were formed in other commands which necessitated the appointment of additional dental representatives. They were not at this time carried on a specific war establishment but were made available from command resources, nominated for administrative duties and styled 'administrative dental officer'. Ten additional dental administrative appointments were effected in this manner up to February 1941, when further reorganisation in home commands took place.

A dental officer was attached for liaison purposes to the Polish troops stationed in Scottish Command in September 1940. He was later appointed as D.A.D.D.S. to No. 4 Liaison H.Q., Polish Forces. In December 1942 the appointment was amended to that of a staff-captain (non-dental).

On February 15, 1941, Eastern Command was divided into two commands, Eastern and South Eastern. Aldershot Command ceased to exist and became Aldershot Area within the structure of the newly formed South Eastern Command. The recognised dental administrative staff was attached to each of the new command H.Qs. An A.D.D.S.(lieut. colonel) was appointed to H.Q. Aldershot Area, who also became Training Officer, A.D. Corps, and in view of this additional duty the original other rank personnel of the old Aldershot Command H.Q. were retained, namely one warrant officer class I, one staff-sergeant, one corporal and one private.

On the same date reorganisation in other commands began and a number of 'county divisions' were formed in the place of certain areas. As a temporary measure, pending consideration of revised war establishment, an administrative dental officer and a dental clerk-orderly were attached to the headquarters of each area and county division as they were formed to ensure continuity of administration. D.A.Ds.D.S. (majors) were appointed to the H.Q. of seven county divisions on February 28, 1941. As a result of the reorganisation the A.D.D.S., Scottish Command, was up-graded to full colonel with corresponding increases in the other rank personnel.

Following the recommendations of the Gale Committee, a further reorganisation of commands in the United Kingdom began on December 1, 1941. Important improvements in the dental administration were effected, and in this respect it was appreciated that in assessing the requirements for administrative dental officers the personnel of the A.D. Corps were not only responsible for static elements in a command but were also responsible for all units of A.A. Command and for all units of the field force. No administrative dental officers were allotted to these formations; the responsibility for their dental care therefore devolved upon the commands in which they were located. In brief, the new organisation established in the United Kingdom consisted of commands, corps districts or districts, areas or divisional areas, and sub-areas or garrisons. At each headquarters of a corps district and of certain divisions a static element was included on the war establishments which would remain, in order to provide continuity of administration, if either formations had to move.

Thirteen district headquarters were established; to four of these A.Ds.D.S. in the rank of lieut. colonel were appointed, and to the remaining nine D.A.Ds.D.S. (majors). Clerical staff at each included one staff-sergeant and one private. Eleven area H.Q. were set up, but to three only were D.A.Ds.D.S. and sergeant dental clerk-orderlies appointed. The war establishment of a headquarters of a corps district provided for an A.D.D.S. (lieut. colonel), one staff-sergeant and one corporal. In all, seven such corps districts were established. A special static element was authorised for the Canadian Corps District; this included one D.A.D.D.S. and one sergeant clerk. The county divisions were disbanded and new divisions were organised on either a higher or a lower establishment; administrative dental officers were included with the latter. Nine divisions on the lower establishment were raised and a D.A.D.D.S. and one sergeant were appointed to each. There were no medical or dental representatives at the headquarters of sub-areas.

It was originally proposed that, with the exception of Aldershot District, the administrative dental officer at all the headquarters of

districts should be D.A.Ds.D.S. (majors), but that at eight of these the dental administration should be strengthened by the additional appointment of staff-captains (dental). This was not approved by the War Establishments Committee, but the appointment for three of the districts, namely West Riding, North Midland and Salisbury Plain, was up-graded to that of A.D.D.S. (lieut. colonel). A staff-captain (non-dental) was, however, added to the headquarters staff in Northern Ireland. On January 21, 1942, London District was separated from Eastern Command to become an independent district.

The total number of executive dental officers serving in home commands at this time, including those attached to medical units, was 1,473; dental administration was carried out by 48 administrative dental officers (6 colonels, 13 lieut. colonels and 29 majors), an approximate overall ratio of one administrative D.O. to thirty executive D.Os.

There was little change in the organisation in the United Kingdom until the end of 1942, when certain corps districts were reorganised and divested of their static commitments. It was then decided that there would be three types of administrative district—corps district. All areas became second class districts, and sub-areas became sub-districts. The war establishment of the H.Q. of a first class district provided for an A.D.D.S. (lieut. colonel), one staff-sergeant and one private; that for a second class district included a D.A.D.D.S. (major) and one sergeant-clerk. The change-over was gradually implemented during the early part of 1943. Corps districts were converted to first class districts. All districts, areas and sub-areas which had not already been transformed adopted the new standard war establishments with effect from May 15, 1943. All existing districts became first class districts with the exception of II Corps District (the only remaining corps district), which remained in its original establishment, and the following four which became second class districts: Lothians and Border, South Highland, North Riding, North Kent and Surrey. H.Q., Northern Ireland, was reorganised at this time and H.Q. British Troops in Northern Ireland, was disbanded; dental administration was carried out by an A.D.D.S. (lieut. colonel) with a clerical staff of one staff-sergeant and one lance-corporal (a sergeant was added to the establishment in August 1943). As there had been a reduction in the allocation of man-power to the army which necessitated a reduction in the reserve organisation (responsible for the training of drafts for overseas) only three divisions were retained on the lower establishment. In September 1943, the remaining corps district headquarters was reorganised as a corps headquarters and was replaced by a first class district H.Q. (Essex and Suffolk District).

The effect of this reorganisation on the administration of the A.D. Corps was the up-grading of ten administrative dental officers to be

On the same date reorganisation in other commands began and a number of 'county divisions' were formed in the place of certain areas. As a temporary measure, pending consideration of revised war establishment, an administrative dental officer and a dental clerk-orderly were attached to the headquarters of each area and county division as they were formed to ensure continuity of administration. D.A.Ds.D.S. (majors) were appointed to the H.Q. of seven county divisions on February 28, 1941. As a result of the reorganisation the A.D.D.S., Scottish Command, was up-graded to full colonel with corresponding increases in the other rank personnel.

Following the recommendations of the Gale Committee, a further reorganisation of commands in the United Kingdom began on December 1, 1941. Important improvements in the dental administration were effected, and in this respect it was appreciated that in assessing the requirements for administrative dental officers the personnel of the A.D. Corps were not only responsible for static elements in a command but were also responsible for all units of A.A. Command and for all units of the field force. No administrative dental officers were allotted to these formations; the responsibility for their dental care therefore devolved upon the commands in which they were located. In brief, the new organisation established in the United Kingdom consisted of commands, corps districts or districts, areas or divisional areas, and sub-areas or garrisons. At each headquarters of a corps district and of certain divisions a static element was included on the war establishments which would remain, in order to provide continuity of administration, if either formations had to move.

Thirteen district headquarters were established; to four of these A.Ds.D.S. in the rank of lieut. colonel were appointed, and to the remaining nine D.A.Ds.D.S. (majors). Clerical staff at each included one staff-sergeant and one private. Eleven area H.Q. were set up, but to three only were D.A.Ds.D.S. and sergeant dental clerk-orderlies appointed. The war establishment of a headquarters of a corps district provided for an A.D.D.S. (lieut. colonel), one staff-sergeant and one corporal. In all, seven such corps districts were established. A special static element was authorised for the Canadian Corps District; this included one D.A.D.D.S. and one sergeant clerk. The county divisions were disbanded and new divisions were organised on either a higher or a lower establishment; administrative dental officers were included with the latter. Nine divisions on the lower establishment were raised and a D.A.D.D.S. and one sergeant were appointed to each. There were no medical or dental representatives at the headquarters of sub-areas.

It was originally proposed that, with the exception of Aldershot District, the administrative dental officer at all the headquarters of

districts should be D.A.Ds.D.S. (majors), but that at eight of these the dental administration should be strengthened by the additional appointment of staff-captains (dental). This was not approved by the War Establishments Committee, but the appointment for three of the districts, namely West Riding, North Midland and Salisbury Plain, was up-graded to that of A.D.D.S. (lieut. colonel). A staff-captain (non-dental) was, however, added to the headquarters staff in Northern Ireland. On January 21, 1942, London District was separated from Eastern Command to become an independent district.

The total number of executive dental officers serving in home commands at this time, including those attached to medical units, was 1,473; dental administration was carried out by 48 administrative dental officers (6 colonels, 13 lieut. colonels and 29 majors), an approximate overall ratio of one administrative D.O. to thirty executive D.Os.

There was little change in the organisation in the United Kingdom until the end of 1942, when certain corps districts were reorganised and divested of their static commitments. It was then decided that there would be three types of administrative district—corps district. All areas became second class districts, and sub-areas became sub-districts. The war establishment of the H.Q. of a first class district provided for an A.D.D.S. (lieut. colonel), one staff-sergeant and one private; that for a second class district included a D.A.D.D.S. (major) and one sergeant-clerk. The change-over was gradually implemented during the early part of 1943. Corps districts were converted to first class districts. All districts, areas and sub-areas which had not already been transformed adopted the new standard war establishments with effect from May 15, 1943. All existing districts became first class districts with the exception of II Corps District (the only remaining corps district), which remained in its original establishment, and the following four which became second class districts: Lothians and Border, South Highland, North Riding, North Kent and Surrey. H.Q., Northern Ireland, was reorganised at this time and H.Q. British Troops in Northern Ireland, was disbanded; dental administration was carried out by an A.D.D.S. (lieut. colonel) with a clerical staff of one staff-sergeant and one lance-corporal (a sergeant was added to the establishment in August 1943). As there had been a reduction in the allocation of man-power to the army which necessitated a reduction in the reserve organisation (responsible for the training of drafts for overseas) only three divisions were retained on the lower establishment. In September 1943, the remaining corps district headquarters was reorganised as a corps headquarters and was replaced by a first class district H.Q. (Essex and Suffolk District).

The effect of this reorganisation on the administration of the A.D. Corps was the up-grading of ten administrative dental officers to be

A.Ds.D.S. (lieut. colonels), but the loss of more than a corresponding number of junior administrative appointments was a definite disadvantage to the administration which was later improved by the appointment of staff-captains to selected headquarters.

In order to facilitate the nomenclature of administrative appointments in the A.D.S. and to bring this into line with the corresponding medical appointments, the A.Ds.D.S. at command headquarters were re-designated D.Ds.D.S. in January 1944; D.Ds.D.S. held the rank of colonel, A.Ds.D.S. that of lieut. colonel, while D.A.Ds.D.S. were majors.

Beginning in April 1944, before the departure of 21 Army Group for the invasion of Europe, a gradual reduction in the number of districts began by the combination of their commitments. This process continued until December 1, 1944, when South Eastern Command, with the exception of Aldershot District, was merged into Eastern Command. Aldershot District was absorbed into Southern Command. Thereafter the gradual reduction in the number of district headquarters continued.

The dental clerical staff attached to a command headquarters at the time of greatest expansion consisted of the following:

Home Command

Warrant officer class II, Sergeant } dental clerk-orderlies

Corporal, A.T.S.

Lance-corporal, A.T.S., Private, A.T.S. } subject to variation

while at H.Q. London District the dental clerical staff was:

Staff-sergeant, Corporal } dental clerk-orderlies

Two privates, A.T.S.

Auxiliaries of the A.T.S. had been employed at H.Q. commands on duties in connexion with the Army Dental Service since April 1942, but none were employed for dental duties at H.Q. Northern Ireland District.

DENTAL ADMINISTRATION IN THEATRES OF WAR

FRANCE 1939–40

At the outbreak of the War of 1939–45 one administrative dental officer was appointed to the G.H.Q. of the B.E.F. This appointment in the rank of full colonel was styled 'Deputy Director of Dental Service' and was included with the establishment for the Medical Branch of the G.H.Q. staff. No other dental administrative appointments to armies or areas were authorised by war establishments. The number of dental

officers was never sufficient to provide an adequate dental service. The D.D.D.S. had no independent dental units under his control; all dental officers who accompanied the force were attached to field and base medical units. It was generally found that the retention of dental officers with their parent medical units did not always serve the best interests of the troops; moreover, many medical units were held in reserve or were unsatisfactorily located in so far as the Army Dental Service was concerned; the services of the dental officers so affected would have been wasted if they had not been otherwise employed on detached duties. The problems of the Army Dental Service were different from those of the Army Medical Services; the latter were largely concerned with the sick and the wounded who had become militarily ineffective, whereas the former was called upon to deal in the main with effectives. In order to meet the urgent requirements of the troops, independent dental units were at first created at the expense of medical units. Later, dental officers were sent to France to reinforce the dental units so improvised and to fill the depleted establishments of the medical units. The arrangements adopted in France made it necessary to nominate certain executive dental officers for administrative duties, and eventually administrative dental officers were appointed to H.Q., L. of C., and to certain areas and medical sub-areas.

By the time of the fall of France, war establishments had been amended to provide A.Ds.D.S. (lieut. colonels) at the headquarters of armies and of L. of C. and at the medical base sub-areas; and D.A.Ds.D.S. (majors) could also be appointed to the headquarters of selected L. of C. areas and base areas.

MIDDLE EAST

Unlike the B.E.F. the British Forces in the Middle East grew out of a peace-time establishment held in Egypt and Palestine for garrison duties. The operational administration thus developed from a peace-time administration, but the peace-time commitments remained. The development of the dental administration was satisfactory in so far as the base areas were concerned—a D.D.D.S. appointed to G.H.Q., Middle East, and A.Ds.D.S. or D.A.Ds.D.S. were placed in charge of base areas. The appointment of an administrative dental officer to H.Q., Eighth Army was never made despite repeated requests for approval, with the result that the dental service of forward units remained unsatisfactory. The difficulties experienced in France arising out of the inadequate number of dental officers available for independent dental units not attached to and under the control of medical units were again encountered. Mobile dental units (M.D.Us.) limited in numbers and raised in the Middle East were later placed at the disposal of D.D.M.S., Eighth Army, for allocation to lower formations.

NORTH AFRICA

For the invasion of North Africa a D.D.D.S. was appointed to G.H.Q. of the force, an A.D.D.S. was appointed to H.Q., First Army, and D.A.Ds.D.S. were attached to the headquarters of base and L. of C. sub-areas. The majority of executive dental officers were, however, still attached to medical units. Only eight mobile dental units as independent units of the A.D. Corps, were raised in the United Kingdom for the original force. Four were allotted to First Army and all were at the disposal of the administrative dental officers concerned. This was the first time dental units were included in the order of battle of an expeditionary force. The number of independent dental units, however, was still too small to permit the provision of an adequate dental service (particularly for the forward troops). Moreover, the relationship of the R.A.M.C. and A.D. Corps was such that the senior administrative dental officer was not free to move a dental officer from a parent medical unit to a location where his services could be better utilised. Later in the campaign, field dental laboratories (F.D. Labs.) and field dental centres (F.D.Cs.) were raised and despatched to North Africa.

ITALY

The development of the Army Dental Service followed the same general lines as in North Africa.

N.W. EUROPE

The experience gained during the earlier campaigns was embodied in the planning for the invasion of Europe and was incorporated to a large extent in the order of battle of 21 Army Group. The need for dental administrative representation at the various formation headquarters was now accepted. The developing hope for administrative independence and the desire that the dental service should be permitted to manage its own affairs had, with the years, grown in strength and now began to mould policy.

Dental administrative control within 21 Army Group was similar to the organisation provided for the earlier invasion of North Africa, but the administration had at its disposal many more executive dental officers attached to independent dental units and could now hope to provide an efficient service. For the first time in its history the A.D. Corps entered the field with an allotment of dental officers, administrative and executive, that was sufficient to carry out its tasks, but the order of battle even yet did not provide the number of mobile dental units that was desirable. Three mobile dental teams (M.D.Ts.) were allotted to each corps for employment on the basis of one for each division, four

were allotted to army troops and one to each L. of C. area and base sub-area.

Later in the campaign, it was possible to implement the schemes proposed earlier in the year to provide additional mobile dental units. The dental personnel mobilised with the field dressing stations were re-allotted to newly formed M.D.Ts. In this way the original number of sixteen M.D.Ts. raised for employment with 21 Army Group was increased to forty-four; in this way too there was created a pool of dental officers who were free from the requirements of the Army Medical Services. M.D.Ts. were available for distribution, subject to the discretion of the administrative dental officer concerned, on the basis of three per corps, two per infantry division and one per armoured division, plus an increment of one for every division or its equivalent within each corps. Many more M.D.Ts. could have been usefully employed on the L. of C. visiting isolated units.

Besides M.D.Ts., which were the original independent dental units formed for a field force, field dental laboratories and centres were raised for 21 Army Group as units of the A.D.Corps. The number of executive dental officers attached to independent dental units and therefore under an Army Dental Service and not under the Army Medical Services control came to exceed those attached to medical units. In all, 15 F.D.Labs. were mobilised for 21 Army Group and 93 F.D.Cs.—27 Class 'A' (one D.O.), 34 Class 'B' (two D.Os.) and 32 Class 'D' (four D.Os.). As the overall strength of troops did not reach the total number that was originally planned, some of the F.D.Cs. were not called forward and were eventually disbanded or otherwise employed.

SOUTH EAST ASIA

Dental administration in South East Asia followed the same plan as in other theatres of war, but a new departure, necessitated by the independent rôle played by units in that theatre, brought dental administration down to corps level, and a D.A.D.D.S. (major) was included in the headquarters staff of an independent corps.

OVERSEAS THEATRES, FORCES, GARRISONS AND DEFENDED PORTS ABROAD

Administration of the Army Dental Service varied according to the requirements. In areas where large forces were employed, administration was by a D.D.D.S. (colonel) with a subordinate staff on lower formations on a similar basis to that in any army group. Small theatres had a correspondingly reduced administrative staff and administration was carried out by A.Ds.D.S., D.A.Ds.D.S., S.D.Os., and D.Os.

Briefly, the organisation in September 1944, was as under:

Middle East	D.D.D.S.	(colonel)
East Africa	A.D.D.S.	(lieut. colonel)
West Africa	A.D.D.S.	(lieut. colonel)
Persia and Iraq	A.D.D.S.	(lieut. colonel)
Gibraltar	D.A.D.D.S.	(major)
Malta	S.D.O.	(major)
North Caribbean Area	S.D.O.	(captain)
South Caribbean Area	S.D.O.	(major)
Bermuda	D.O.	(captain)
Falkland Islands	D.O.	(captain)

RECRUITMENT

OFFICERS

On August 24, 1939, the Dental Emergency Committee was asked to supply the War Office with the names and addresses of a hundred dental surgeons, not over 35 years of age, who, in the event of a national emergency, were prepared to offer whole-time service at home or abroad as officers of the A.D. Corps. The day after the outbreak of war, a further hundred names were requested. Soon afterwards, the Dental War Committee (D.W.C.), at the request of the Committee of Imperial Defence and with the agreement of the Ministry of Health, was instituted and became responsible for the supply of dental personnel for the Armed Services.

It took over the organisation and records already prepared by the Dental Emergency Committee. D.A.D.S., was a member of both these committees.

An initial increase in the establishment of the A.D. Corps had been approved on mobilisation, and the immediate requirement communicated to the D.W.C. on its formation was for 350 civilian dental surgeons.

During September 1939, 22 officers of the R.A.R.O. were recalled and 68 officers of the T.A.R.O. were embodied.

By the close of 1939, 23 officers of the R.A.R.O. had been embodied, 75 officers of the Officers Emergency Reserve had been called-up and 135 dental surgeons nominated by the D.W.C. had been appointed to emergency commissions from civil life, which, together with a small number from the Officers Cadet Reserve and from the dental schools and transfers from combatant units and other branches of the Army made the total officer strength 581.

In 1940 civilian dental surgeons were allotted to the Army at the rate of sixty to seventy each month, and the pool of volunteers readily met the urgent demands of the Services until May, when it became evident that the limit of recruitment by the voluntary method had been reached and that resort to conscription would have to be made. It was then

represented to the Minister of Health and the Minister of Labour and National Service that dental practitioners, hitherto included on the *Schedule of Reserved Occupations*, who were within the age limits of the proclamations of the National Service (Armed Forces) Act, 1939, should be made liable for compulsory dental service with the Armed Forces and that the compulsion should be applied through the D.W.C.

In June 1940, after three months of discussion, recruitment of dental officers into the A.D. Corps up to a total establishment of 1,233 for an army of one and a half million men was approved. The requirement communicated to the D.W.C. at this date was for 300 to 400 dental surgeons in the near future and a subsequent intake at the rate of 100 each quarter. Ninety-three civilian dental surgeons joined in June 1940, 120 in July and 148 in August; this was the greatest influx during the whole period of the war. In October 1940, as the supply of dental surgeons offering voluntary service had been exhausted, the first quota demand was made on the D.W.C. The intake of dental surgeons dropped during the latter part of the year to an average of thirty-two each month. The officer strength of the A.D. Corps at the end of 1940 was 1,368.

At the beginning of 1941, the number of dental surgeons registered for national service and recommended for service in the A.D. Corps who had appealed successfully to the Ministry of Labour for postponement of service on the grounds of personal hardship, increased to an extent embarrassing to the planned expansion of the Army Dental Service. Arrangements were accordingly made whereby appeals of this nature were settled before the names were submitted to the Service departments.

By the end of June 1941, the officer strength of the A.D. Corps had increased to 1,647—the estimated requirement by October 1941 being 2,000. The upper age limit for dental officers in the Army was raised to 40 in April 1941. The constitution and resources of the dental profession as a whole were then surveyed by a sub-committee of the Dental War Committee and a report was submitted to the Minister of Health in July 1941, which included the following recommendations: (1) that a greater use should be made of civilian dental practitioners in part-time service and that arrangements should be made for the treatment of men between the date of their medical examination and the date on which they were called up for service. On this point the War Office informed the Minister that experience, even in peace-time, had shown that the employment of civilian dental surgeons was, in general, most unsatisfactory and uneconomical and led to many complications and undesirable friction. Under war conditions the constant movement of troops, the need for security and, in many cases, the isolated situation of camps, units and detachments rendered the routine employment of civilians impracticable. Under the existing Army class intake procedure, it was

impossible to arrange for men to be treated between the date of medical examination and that of calling up for service, and, moreover, all would not necessarily be required for the Fighting Services and no documents would be available. (2) That the normal age limit for entry should be raised. As dental officers were required to work for long hours at high pressure, it had been found that older men were not generally capable of standing the strain; the Minister was informed, however, that if the Army were faced with a severe shortage, it was prepared to accept dental surgeons up to 50 years of age. (3) That women dental officers be employed for the treatment of personnel of the Women's Services. In this connexion it was pointed out by the War Office that intakes to the A.T.S. were variable in number and that the period of basic training was too short to enable all treatment to be completed at the depots; treatment, therefore, had to be continued at other A.D. centres. In view of these difficulties, it was considered that dental treatment could be provided better by male dental officers, but that, in the event of an expansion of the A.T.S., the employment of women dental surgeons might be possible later. (4) That unqualified dental practitioners should be accepted for service as dental officers. The Army did not favour this suggestion. In November 1943, however, it was ruled that 'Dentists, 1921' were to be considered for dental service in commissioned rank, but by this time the Army had an adequate number of dental officers, and replacements for all wastages were met by newly qualified dental surgeons. (5) That there should be modification in the amount of conservative dental treatment performed for non-regular personnel in the Services. On this point the Minister was informed that the amount of dental work done for the soldier was the minimum necessary to maintain his health and physical efficiency and that instructions to this effect had been embodied in a directive issued to all commands in January 1940. (6) That in the existing circumstances D.Os. should not be employed on non-dental duties during normal dental duty hours. The War Office pointed out that every serving officer must have some knowledge of military duties and it was not practicable to issue rigid orders precluding such employment; instructions were, however, in force that necessary dental duties would invariably take precedence over all other duties.

In July 1942, the War Office, informed the D.W.C. that a number of women dental surgeons would soon be required for service with the A.D. Corps for the treatment of personnel of the A.T.S. Approval was received in December 1942, and the first appointment was made on February 16, 1943. A total of seventeen women dental surgeons were eventually commissioned in the Army.

Civilian dental surgeons were taken into the Army at a rate of approximately 24 each month from June 1941, until June 1943; thereafter the rate dropped appreciably to an average of four each month.

The maximum number of D.Os. serving with the A.D.Corps was reached in November 1943, when the officer strength was 2,143. This number varied but little until the conclusion of the war in Europe, when, with the introduction of the scheme for the re-allocation of man-power, release to civil life began on the basis of age and length of service. The officer strength of the A.D. Corps at the end of the war in the Far East had fallen to 2,050.

OTHER RANKS

On the outbreak of war, recruitment of other ranks for the A.D. Corps was by special enlistment. Numbers sufficient to complete the 1st Contingent of the B.E.F. and the existing peace establishments were obtained together with an additional intake of 150 dental mechanics and 200 clerk-orderlies. Recruiting was temporarily suspended at the end of September 1939, pending consideration of future commitments and requirements. With the passing of the National Service (Armed Forces) Act, other ranks for the A.D. Corps, both dental mechanics and clerk-orderlies, were obtained through the channels established for the normal Army class intake. As dental mechanics were included in the *schedule of reserved occupations*, demands for those below the age of reservation were made on the D.W.C., which body arranged with the Ministry of Labour and National Service for their transference to the Armed Forces.

By March 1940, 1,138 dental clerk-orderlies and 324 mechanics were serving in the A.D.Corps. The number of dental mechanics was necessarily increased as men of the higher age-groups were called-up and as the change in the status of the personnel of the A.T.S. made these personnel entitled to the provision of artificial dentures. A gradual increase in the number of other ranks occurred; the maximum, 3,833, was reached in March 1945 (1,753 dental mechanics, 2,033 clerk-orderlies and 47 prisoners-of-war); in addition, 267 auxiliaries, A.T.S., were serving in home commands on dental clerk-orderly duties. The strength of other ranks at the conclusion of hostilities with the Japanese was 3,538 (1,591 dental mechanics, 1,914 dental clerk-orderlies and 33 soldiers still classified as prisoners-of-war); 179 auxiliaries of the A.T.S. remained on duty with the A.D. Corps.

The employment of auxiliaries of the A.T.S. with the A.D.Corps was first proposed in July 1941, when discussions were commenced on the means whereby economies in man-power could be effected by replacing men by women in suitable occupations. The opinion of A.M.D.6 at this time was that women could not be employed as dental clerk-orderlies without difficulty. It was impossible to employ them with field units, and the majority of static units were small and widely dispersed with no suitable facilities for the accommodation and welfare of women

personnel. In April 1942, approval was given for the employment of women clerks of the A.T.S. on duties in connexion with the A.D. Corps at the headquarters of commands. By October 1942, however, there was a definite shortage of male dental clerk-orderlies, and at some dental centres unauthorised attachments of auxiliaries had been made in order to alleviate the situation. The position had changed considerably since the earlier tentative proposals; more male dental clerk-orderlies were being mobilised for field units, and the A.T.S. had, with the introduction of compulsory service for women, expanded enormously. It was now possible for a limited number of auxiliaries to be employed with advantage at the A.D. Centres primarily responsible for the dental treatment of personnel of the A.T.S. The trade of dental orderly was accordingly added to the list of trades authorised for the A.T.S. There were, moreover, a number of auxiliaries, mostly dentists' receptionists in civil life, who were anxious to become dental orderlies.

Some difficulty was at first experienced in making the transfers to duty with the A.D. Corps as the Deputy Director of Organisation (A.T.S.) would not issue posting instructions for the personnel unless there were vacancies for them in war establishments, and at this date no war establishment had yet been introduced for A.D. Centres at home. Arrangements were satisfactorily completed by March 1943, and a series of special courses for potential women dental clerk-orderlies commenced at the A.D. Corps School of Instruction. By October 1943, 87 auxiliaries had been classified as dental clerk-orderlies, class III, and had been allotted to A.D. Centres for duty. An allotment of 250 auxiliaries of the A.T.S. was agreed to, and as the number of auxiliaries with previous experience of dental duties was small, the Army Dental Corps accepted untrained personnel of the more intelligent general duty type.

ALLOTMENT OF A.D. CORPS PERSONNEL

With the rapid expansion of the Army, the allotment of D.Os. to troops on the peace-time ratios (1 dental officer to every 500 recruits per annum, 1 to 3,000 trained soldiers serving at home and 1 to 2,000 men serving overseas) could not be maintained. For example, the ratio of D.Os. to men with the B.E.F. in France in 1939–40 was approximately 1 to 6,000 men.

Revised ratios were considered in 1940 during the discussions on the establishment for the A.D. Corps. In its endeavour to increase the output of dental work per officer, A.M.D.6. proposed the following scales when assessing the number of dental officers required to provide an adequate service:—1 D.O. to 1,000 recruits per annum, 1 D.O. to 2,000 trained soldiers at home and 1 D.O. to 1,500 men serving abroad; dental clerk-orderlies were to be obtained on the basis of 1 to each D.O.

These scales were not approved and the following were finally accepted and formed the basis for further recruitments: 1 D.O. to 1,200 recruits or untrained soldiers per annum for initial treatment, 1 D.O. to 3,000 men for maintenance treatment at home, and 1 D.O. to 2,000 men for maintenance treatment in all stations abroad, which provided for an approximate overall ratio of 1 D.O. to 1,216 men.

Experience quickly proved that this allocation was inadequate and not sufficiently flexible, and towards the end of the war the following scales were adopted:

1. Within the United Kingdom—an overall scale of approximately 1 D.O. to 1,000 men, irrespective of whether the officer was executive or administrative. The concentration of D.Os. treating intakes was heavier than that for trained soldiers.
2. To an army group—an approximate overall scale of 1 D.O. to 1,500 troops. Dental mechanics were allotted in the proportion of 1 to 2,000 troops.
3. With overseas theatres and forces—as far as possible D.Os. and dental mechanics were allotted on the same scales as for army groups.
4. Garrisons and defended ports abroad—each garrison and defended port abroad had a war establishment in accordance with its requirements.
5. Indian divisions—two Indian dental units (British Troops), three Indian dental units (Indian Troops) and two Indian dental mechanics units were allotted to each Indian division (calculated at 30,000 Indian troops and 4,000 British troops). War establishments thus provided five D.Os. and two mechanics to each Indian division.

Dental clerk-orderlies were provided according to the vacancies in war establishments.

EMPLOYMENT OF DENTAL PERSONNEL

The dental duties of dental officers attached to static or temporarily static medical units took precedence over all other duties, but, by virtue of their attachment to a unit, they were allotted special additional duties, such as president of the mess committee, in order to assist with the general working and welfare of the unit. In active operations or on the move, when it was obviously impossible to carry out dental treatment other than for cases of emergency, the dental officer was given such duties as the commanding officer directed. Among different duties, dental officers attached to medical units were called upon to perform were the following: unit liaison officer, first-aid wound dressing, emergency anaesthetist, casualty sorting, control of the evacuation of casualties, billeting, unit security, and embarkation and dis-embarkation duties. Other ranks of the A.D. Corps attached to medical units carried out certain barrack and regimental duties, but they were on no account

to be detailed for hospital duties or as batmen. During active operations they were called upon to act as emergency stretcher bearers or medical orderlies.

During the early part of the war, representations were made that, in certain instances, dental officers attached to field medical units stationed at home were being employed on non-dental duties to the detriment of their professional work; and further, it was not clear what supervision of their dental duties could be exercised since administrative dental officers were not available in field force formations in the United Kingdom, other than at the headquarters of the county divisions. To prevent this misuse of professional skill, instructions were issued that unless and until active operations occurred in the United Kingdom, routine dental duties would continue; and further, that the technical supervision of the dental officers attached to field medical units rested with the administrative dental officer of the command, area or county division in which they were serving. Arrangements were made later for dental officers serving at home to receive additional instruction in the administration of general anaesthetics with a view to their employment as emergency anaesthetists in the event of there being active operations in the United Kingdom.

Dental officers were not permitted to engage in private practice save in exceptional circumstances and then only with the express permission of the War Office. Executive D.Os. were attached to the following dental units: A.D. Centres (static), F.D.Cs., M.D.Ts. (operational and non-operational), dental laboratories and F. D. Labs.; and to the following medical units: general hospitals, C.C.Ss., field ambulances, light field ambulances, parachute and airlanding field ambulances, field dressing stations (not at the end of the war); convalescent depots, maxillo-facial units, hospitals, hospital ships, military hospitals, and a variety of medical units raised on special war establishments (i.e. Indian, West African, etc.).

A number of senior warrant officers of the A.D. Corps were appointed to commissions, in the first instance, as lieutenant quartermasters, to fill the vacancies in certain headquarters establishments created by the approval of the employment in administrative posts of officers who were not dental surgeons but who possessed a wide knowledge of the organisation, particularly in connexion with the technical aspects of the dental service.

THE APPOINTMENT OF A CONSULTING DENTAL SURGEON

The expansion of the Army implied an increase in the number of patients suffering from unusual dental conditions and general systemic diseases, attributable to or aggravated by dental sepsis. The increasing magnitude of the war meant that there were to be expected large numbers of casualties with injuries to the face and jaws both from the

battle zones and as a result of air raids, all of whom would require the expert opinion of a dental specialist to ensure their successful treatment. These considerations led to the creation of the post of consulting dental surgeon carrying the rank of colonel (later brigadier), on February 1, 1940

THE CREATION OF DENTAL SPECIALISTS

The introduction of war establishments for special surgical teams for chest surgery and maxillo-facial surgery afforded the opportunity to give recognition to the dental officers attached to such teams. One such team had already been formed in the Middle East from M.E.Cs. own resources. The work involved required special experience and close co-operation between dental surgeon and surgeon; together they examined the cases and decided the treatment to be followed. In the new establishment the surgeon was classified as a specialist, and in view of the special qualifications required by the dental surgeon for this work, it was considered that he should similarly be of specialist status. The importance of the specialist status of the dental surgeon appointed to the maxillo-facial teams established by the Emergency Medical Services had already been recognised. The appointment of specialists in the A.D. Corps was a new departure, but the needs of modern warfare and the progress of dental surgery made recognition of the special position of the maxillo-facial dental surgeon necessary. It was agreed that the dental officer attached to such a team should be classified as a 'specialist maxillo-facial dental surgeon', with the rank of major and should receive additional pay—the conditions were the same as were applicable to specialist medical officers. The war establishment for the maxillo-facial surgical unit was approved on March 13, 1941, and incorporated the first specialist classification for officers of the A.D. Corps.

The natural sequel to this precedent for the appointment of specialist dental officers was the recognition of dental specialists in other spheres of dental surgery. At a meeting of Army Medical Directorate's Consultants Committee held on August 13, 1942, it was agreed that there was an urgent need for the appointment of a certain number of dental officers with exceptional experience, as 'dental surgical specialists' on the basis of one to each command at home and to certain commands abroad. The recommendations were accepted by the War Establishments Committee on November 20, 1942, and Treasury approval for granting specialist status and pay was received on January 27, 1943. The officers selected were to act in a consultative as well as in an executive capacity in the same way as specialists in medicine or surgery in the R.A.M.C.; they would advise on, or undertake the treatment of difficult or complicated cases of maxillo-facial injury and minor oral surgery for the dental officers within the command. They were attached to convenient military hospitals in the commands or districts at the discretion of the D.Ds.M.S.

concerned, and they maintained close liaison with the medical and surgical specialists. Besides the treatment of dental cases referred to them, their executive duties included the care of hospital patients in whom oral infection might be either an aetiological or an aggravating factor in systemic disease, and also the maintenance of oral hygiene as a pre-operative measure in all surgical cases.

Command dental surgical specialists were, in the first instance, appointed to the six home commands and Northern District, and all were held on the war establishment for command medical pools. Subsequent reports indicated that London District was inadequately served in this respect—the dental specialists in neighbouring commands were fully occupied and could not cover London District—accordingly, a dental surgical specialist was appointed on February 10, 1944. A dental surgical specialist was added to the war establishment for the consultants (medical), Middle East, on June 21, 1943; the appointment was applied to a dental surgeon in one of the general hospitals in that theatre.

As there was little change in the commitments of the A.D.S. on the disbandment of South Eastern Command, two dental surgical specialists were allowed for Southern Command to provide the necessary specialist facilities.

From experience gained during the campaigns in the Middle East and North Africa, it became necessary to split the maxillo-facial surgical unit into forward and rear sections; and the amended war establishment approved in December 1943, provided for two dental officers and introduced the new classification of a 'graded' officer. The dental officers attached to the unit were to be specialist maxillo-facial dental surgeons or graded maxillo-facial dental surgeons.

Further progress in the classification of dental officers with special responsibilities and experience occurred in July 1944, when the war establishments for 1,200- and 600-bedded general hospitals were amended. These provided for the appointment of 'specialist dental surgeons' and 'graded dental surgeons'.

The specialist appointments thus open to officers of the A.D.Corps were as follows:

1. Dental surgical specialist — one appointed to each command and independent district at home.
2. Specialist dental surgeon or
3. Graded dental surgeon

} Appointed to 1,200- and 600-bedded general hospitals

4. Specialist maxillo-facial dental surgeon or
5. Graded maxillo-facial dental surgeon

} Appointed to maxillo-facial surgical units and to the Military Hospital (Head Injuries), Oxford.

Specialists were defined as officers who by virtue of their qualifications and experience were recognised as experts to whom patients suffering from conditions beyond the scope of general dental practice could be sent for diagnosis and treatment, and to whom cases requiring specialist knowledge and technique could be referred. Graded dental surgeons were officers who had special knowledge of oral or maxillo-facial surgery but who had not been in the practice of their speciality sufficiently long to gain the wider experience necessary for classification as specialists. Graded surgeons were not granted the rank of major but were entitled to additional pay.

THE TRAINING OF ARMY DENTAL CORPS PERSONNEL

At the beginning of the war, owing to the extreme urgency of providing dental care for the B.E.F., the majority of newly commissioned officers and newly enlisted men had perforce to be sent direct to units without previous military training. Later the A.D. Corps School of Instruction was expanded and undertook this essential training. Separate courses of instruction were arranged for D.Os., clerk-orderlies and mechanics. The course for dental officers included instruction in the treatment of jaw injuries. Many members of the R.A.F. Dental Branch and of the dental services of the Canadian and U.S. Armies and of the Allied Nations also attended this course.

Advanced courses of instruction in the treatment of maxillo-facial injuries were arranged through the courtesy of the Ministry of Health and the Department of Health for Scotland at the special plastic surgery and jaw injury centres established at the E.M.S. hospitals at East Grinstead and Ballochmyle.

Special courses were also arranged for dental officers in the following subjects: general anaesthetics, military hygiene, administrative duties, dental prosthetics and field training. Selected other ranks of the A.D. Corps attended special courses in field training, advanced prosthetics and dental radiography.

In October 1939 a course of instruction for dental officers in the treatment of jaw fractures and maxillo-facial injuries was arranged and combined with a course on military dental organisation, administration and duties and training in anti-gas measures.

During the War of 1914–18, special courses of instruction in the treatment of maxillo-facial wounds were given at the Norbury War Hospital. Similar training for all officers of the A.D. Corps had been recommended by the Warren Fisher Committee, but before the War of 1939–45 shortages in the peace establishment rendered this impossible. Events made it essential for such training to be provided, and, moreover, it could be undertaken from the corps' own resources.

A war establishment was approved for the school of instruction which took effect from November 16, 1939. The staff now consisted of:

Commandant and chief instructor (lieut. colonel)
Instructor, trained in anti-gas duties (major)
Instructor and quartermaster (lieut. quartermaster)
Five assistant instructors:
Warrant officer class I (dental mechanic)
Warrant officer class I (dental clerk-orderly)
Warrant officer class II (dental mechanic)
Warrant officer class II (dental clerk-orderly)
Staff-sergeant or sergeant from the dental clerk-orderly section and trained in anti-gas duties.
Four clerks (one staff-sergeant or sergeant and three rank and file) all from the dental clerk-orderly section.

The courses were held fortnightly and were of an intensive nature. The average numbers attending each course were twenty-five dental officers and forty other ranks. Accommodation for the school was found in the vacant premises of the Maida Junior Mixed School, Middle Hill, Aldershot.

The syllabus of the course for dental officers was as follows:

Subject 'A'—Jaw injuries

(i) Non-Battle—Anatomy. Causation. Displacements. Clinical diagnosis. Bone repair. Field dental equipment. First aid. X-rays. Teeth in the fracture line. Wire and arch wire techniques. Design, construction and application of appliances. Advanced operative techniques. Study of case histories.

(ii) Battle—Historical review. War projectiles. Impact effects on maxillo-facial tissues. Glancing, penetrating and wrenching-off wounds. Immediate and early, local and general effects. Study of stereoscopic photographs. First aid—preliminary operative measures. Nursing and feeding problems. Complications. Design, construction and application of appliances. 'Maxillo-facial' techniques. Study of case histories.

(iii) Study of any jaw injury case undergoing treatment at the Army Dental Centre, Cambridge Hospital, Aldershot.

Subject 'B'—Military subjects

Systems of evacuation of casualties in the field. Functions of the regimental aid post, field ambulance and field dressing station. Map reading. Operation orders. Field messages. Gas training, respirator drill and gas chamber. Pistol training. Squad drill. Stretcher drill. Discipline. Customs of the Service. History of the Army Dental Corps.

Subject 'C'—Administration

Organisation of an army dental centre. Accounting for medical equipment. Correspondence and office routine. Military law.

The materials available for instructional purposes for the treatment of maxillo-facial injuries at the commencement of the courses for officers were:

> Photographs, lantern slides models, splints, X-rays and case histories of actual cases treated during the War of 1914–18, which were lent or given to the Army Advisory Committee on Maxillo-facial Injuries.

These were augmented as the war progressed by the addition of fresh material from the theatres of war and reports from specialist dental officers. The lines of treatment recommended were constantly revised as new information was collected and correlated.

In August 1944, a special photographic section was formed in order to ensure that adequate and expertly executed clinical photographs were taken to accompany the records of the more important cases treated in the United Kingdom by the dental specialists.

Two military training films were produced. The first, entitled 'Our Teeth', was for general circulation to intake centres and training units. This described in clear precise dialogue and with ingenious picture comparisons and animated drawings the function of the natural dentition and its use to the individual, the dental condition of a typical group of recruits, the importance of preserving sound teeth and healthy gums, the manner in which dental disease spreads in the oral cavity and how the resultant poisons can affect the well-being of the whole body, the method of restoring a carious tooth to full function, the removal of a tooth that was beyond repair using a general anaesthetic; it concluded by suggesting a simple, practical and efficient routine for the maintenance of oral hygiene.

The second film was produced for a limited audience, being for the instruction of dental officers in the preliminary treatment of casualties in the field suffering from maxillo-facial injuries. Special photographic stands and equipment were designed and constructed to obtain unobstructed and shadowless intra-oral photography under the most difficult conditions. A photographic team spent several months with 21 Army Group collecting suitable clinical material and many of the casualties portrayed in the film received their injuries during the crossing of the Rhine.

In addition to the officers' initial training course and the routine preliminary training, trade testing and classification of newly enlisted dental mechanics and potential clerk-orderlies, special courses were arranged by the school's staff in dental prosthetics for dental officers in field training for officers and other ranks and in advanced prosthetics for selected dental mechanics.

Up to August 31, 1945, the following numbers of dental officers of the various dental services had attended the officers' initial training course at the A.D. Corps School of Instruction:

The Army Dental Corps	2,179
Royal Air Force Dental Branch	340
United States Army Dental Corps	60
Canadian Dental Corps	16
New Zealand Army Dental Corps	4
Polish Dental Service	4
Indian Army Dental Corps	2
Netherlands Dental Service	1
Total	2,606

There were 996 potential dental clerk-orderlies trained at the school up to the end of August 1945; 964 were classified as tradesmen and 32 failed in their examinations and were subsequently transferred to other arms of the Service. Up to the same date 1,684 dental mechanics were trade tested, 502 were classified as class III tradesmen, 949 were recommended for further training before classification and 233 failed to reach the necessary standard of technical skill for employment as dental mechanics in the A.D. Corps and were transferred either to the clerk-orderly section or to other arms of the Service. During the war, 321 auxiliaries of the A.T.S. were trained for dental clerk-orderly duties, 307 passed the trade test and were classified and 14 were returned to their units having failed to reach the necessary standard at the examinations.

It was impossible for all of the potential dental clerk-orderlies enlisted at the periods of greatest expansion to receive their preliminary training at the A.D. Corps School of Instruction. Initial training was accordingly decentralised to commands, and arrangements made for intakes to be posted to the larger A.D. Centres where a satisfactory programme of training could be undertaken.

The subsequent training of other ranks of the A.D. Corps was the responsibility of the dental officers under whom they were serving. Dental mechanics were trade-tested at their laboratories and dental clerk-orderlies were examined at their units by the responsible administrative dental officers. Advancement in their trade to class II and class I tradesmen was dependent also on length of service. It was the responsibility of the Training Officer, A.D. Corps, to co-ordinate and advise upon the training and classification of other ranks of the corps, to check examination papers and to attain a uniform and high standard of efficiency throughout all commands.

Special courses of instruction for dental officers in maxillo-facial injuries were arranged at the special plastic surgery and jaw injury centres established by the E.M.S. at their hospitals at East Grinstead, Ballochmyle, Park Prewett and Hill End. Two types of course were instituted—short and prolonged. The short courses were intended to

give adequate instruction to those dental officers required for service with field medical and dental units and usually lasted about a fortnight. Candidates for the prolonged courses were selected from those who attended the short courses and were given advanced instruction and extensive practical experience to fit them for duties with maxillo-facial surgical and other specialist units. The duration of the extended course varied from one to four months and in certain circumstances was for a much longer period. Occasionally 'refresher' courses were arranged for those officers who had attended the advanced course of study and who were obliged to return for some time to general dental duties pending a vacancy for appointment in their particular speciality in a suitable dental unit.

Advanced instruction in the treatment of maxillo-facial injuries was given at the four special centres already named, but officers selected for the short courses attended only at East Grinstead and at Ballochmyle.

On January 19, 1942, D.A.D.S., addressed all home commands on the subject of the employment of officers of the A.D. Corps during active operations, and proposed that they should act as emergency anaesthetists.

Additional instruction in the administration of general anaesthetics was arranged at a number of military hospitals, general hospitals and C.C.Ss. located in the United Kingdom. The duration of the course was to be fourteen days and not more than two D.Os. were to be detailed to attend any one course; where possible, priority of instruction was to be given to those dental officers attached to field medical units.

The courses were suspended in August 1942, but were resumed a year later for dental officers belonging to units of 21 Army Group. Regular courses ceased in April 1944, but a certain number of officers continued to receive instruction under local arrangements. Up to the end of the war, 434 dental officers had attended courses of instruction in general anaesthesia.

Arrangements were made in January 1945, for ten vacancies at each of a number of courses on military hygiene held at the Army School of Hygiene, to be allotted to officers of the A.D. Corps expected to serve in the Far East. Fourteen courses were attended and 137 dental officers were trained.

In February 1941, instructions were issued by the War Office for commands at home to arrange for all officers of the A.D. Corps holding permanent or short-service commissions to receive tuition in administrative duties. For this purpose, majors were attached to the headquarters of commands and captains to area headquarters, in both cases for a period of fourteen days.

Some dissatisfaction having been expressed concerning the standard of work in the construction of dentures, a conference was held in June

1944, at the War Office to inquire into the causes of faulty denture work and to discover means whereby this could be remedied.

It was reported that the main causes of unsatisfactory denture work were:

(i) Lack of interest on the part of the dental officer which resulted in:
  (*a*) insufficient consideration of individual cases, and
  (*b*) carelessness in execution.
(ii) Lack of skill displayed by the dental officer, the dental clerk-orderly or the dental mechanic.
(iii) Faulty laboratory technique.

This information was obtained in answer to questions asked during the various courses of instruction. Many dental officers stated that they spent little time on denture work because to spend more time reduced the number of conservations shown on the monthly returns, and certain administrative dental officers would not accept time spent on denture work in lieu of a required number of fillings. At multiple dental centres some junior officers reported that they could have little interest in prosthetics because they were denied the opportunity of completing the dentures for a man for whom they had initiated treatment; more often than not another officer at the dental centre continued with the work. At other dental centres it was found that the officer in charge, or a particular officer detailed by him, undertook most of, if not all, the denture work of the centre, thus preventing junior officers from gaining experience. A few dental officers lacked the basic knowledge of the properties and correct uses of denture materials and also of elementary techniques.

Although the officers in charge of the dental laboratories denied that the techniques used by them were at fault, the percentage of 'raised bites' was sufficiently high to suggest some common errors, such as:

(i) Using thinly mixed plaster-of-paris in order to flask a number of cases with the same mix, resulting in a weak and easily compressible investment which would not withstand the stress of flask closure.
(ii) Mixing too much acrylic resin in order to pack a large number of cases at one time.

In order to overcome these difficulties, it was proposed to adopt, as far as was practicable, a uniform technique in processing all denture work in all commands.

Officers in charge of A.D. Labs. were informed of the procedure to be universally adopted at a special conference held at the War Office and courses of instruction were instituted for dental officers at the A.D. Corps School of Instruction.

Ten dental officers were detailed for each course which lasted for one whole week. Between July 4, 1944, when the first course began and August 31, 1945, 49 courses were held, and 497 D.Os., including 17 women, underwent instruction.

The syllabus followed was as under:

1. The pre-extraction stage
2. The extraction stage
3. The impression stage
4. The work-room stage
5. The bite stage
6. The try-in stage
7. The finish stage
8. Repairs and re-basing
9. The 'flat' lower
10. The cleft palate.

The importance of the continuation training of dental mechanics and clerk-orderlies by the officers in charge of dental units was stressed.

With the issue of dental X-ray apparatus to selected A.D. Centres in home commands, the training of personnel of the A.D. Corps as dental radiographers became necessary. It was expected that the immediate requirements would be met by training fifty other ranks, and a course for this number was arranged at the Army X-ray School and Stores, R.A.M. College. This started on April 8, 1942, and lasted until May 6, 1942. The men were then classified as 'war emergency dental radiographers' but they held no special rank. Owing to delays in the issues of X-ray sets, all those trained could not be immediately employed and in some cases employment in their capacity could not be found for them for over two years.

A second course was arranged in June 1944, when twenty-four male other ranks and four auxiliaries of the A.T.S. successfully passed the examination. Four more men completed the course in March 1945.

A series of courses for selected dental mechanics commenced at the A.D. Corps School of Instruction in August 1943, to give theoretical and practical instruction in:

(*a*) the design and construction of appliances used in the treatment of the more complicated types of maxillo-facial injury, and
(*b*) the technique of acrylic resin denture construction.

As the number of potential dental mechanics called-up with the Army class intakes was diminishing, this was an opportune time to elevate the general level of technical ability throughout the dental mechanic section of the A.D. Corps and to develop individual specialised knowledge and skill. There was a probability, moreover, that a large number of highly-skilled dental technicians would be required for medical and dental units at home and abroad who had practical experience of the construction of the specialised appliances used in the treatment of maxillo-facial injuries.

Four dental mechanics were detailed to attend each of the first four courses and, thereafter, the number was increased to six. The duration

of each course was four weeks, and there was an interval of one week between them. Twenty courses had been held up to the end of August 1945, and 112 dental mechanics had received advanced instruction.

Five special courses, each lasting for two weeks, were arranged at the A.D. Corps School of Instruction for dental officers and other ranks who had been nominated for service with the field dental units allotted to the field force for the invasion of Europe.

The courses started on February 16, 1944, and 110 dental officers, 120 dental clerk-orderlies and 80 mechanics attended them.

The syllabus included the following subjects:

Organisation in the field
Administration in the field
Field dental equipment
Squad drill
Stretcher drill
Physical training
First aid—general
Jaw wounds—first-aid measures
Military law
Pay duties and welfare
Small arms training
Motor bicycle tuition
Field hygiene and sanitation
Camouflage
Passive air defence
Field messages and signals
Map reading
Mess tin cookery
Gas training
Tent pitching and bivouacking
Army training films

Similar courses were to be arranged for personnel of the A.D. Corps selected for service in the Far East, but these did not materialise.

THE FACILITIES FOR THE PROVISION OF DENTAL TREATMENT IN HOME COMMANDS

Dental treatment in home commands was provided chiefly by dental officers attached to static A.D. Centres. The mechanical side of denture work was undertaken by the A.D. Labs. that were eventually established in all commands. The supply of mobile dental units (trailer-caravans fitted as dental surgeries) which was approved in July 1940, greatly facilitated the activities of the A.D.S. and filled a long-felt want for greater flexibility in the organisation of temporary and urgent arrangements for the many units which were constantly changing their locations, and for the provision of dental treatment to small and isolated units and detachments for which the establishment of a permanent dental centre would have been uneconomical. At all times there were dental officers and dental mechanics attached to field and other medical units who were available to supplement the facilities for dental treatment in a command.

ARMY DENTAL CENTRES

At the end of August 1939, there were 77 full-time A.D. Centres and 38 part-time visited centres in operation in the United Kingdom. The recall of the reservists and the embodiment of the T.A., for whom no

dental treatment was provided in peace-time, made an immediate and extensive expansion of the Army Dental Service essential. New centres were opened as soon as possible at all training centres and wherever there were large concentrations of troops. Requisitioned buildings were extensively used, but satisfactory accommodation was difficult to acquire and invariably required much alteration and adaptation; considerable plumbing and electrical wiring were needed in establishing a dental surgery, all of which had to be undertaken by the R.E. who were hard pressed by the demands for their services from all arms. Small depots developed into large training centres, but since at this time there was no establishment for a definite ratio of dental officers to men at a training centre, dental centres could not be provided.

Expansion was impeded by the difficulties of providing accommodation but still more so by the delays in the delivery of dental outfits. As additional dental personnel were available and in order not to lose valuable time and service in the gigantic task of rendering the Army dentally fit, the staffs at many centres were multiplied and officers and other ranks worked in shifts pending the arrival of equipment. Another difficulty was that the dental outfits were seldom delivered complete to scale, many items of essential equipment being omitted for the reason that they were not immediately obtainable by the contractors. The opening of a new dental centre was thus often delayed for several months. To add to the confusion, many enthusiastic war emergency dental officers placed in charge of new dental centres, communicated, on their own initiative and with the best of intentions, direct with the manufacturers to report deficiencies instead of through the official channels. Others purchased supplies and materials from local agents and subsequently put in claims for repayment. New centres were sometimes opened by A.Ds.D.S. without prior reference to the War Office. Incomplete dental outfits were despatched direct from the contractors to newly-formed centres, and when for operational reasons, such as the sudden departure of troops from the area, a newly opened centre was unexpectedly closed, the deficiencies ultimately despatched to the original address went astray. Detachments of permanent centres were sometimes opened with a few items of essential equipment and this splitting of complete outfits led to difficulties.

By the end of 1939, 47 additional A.D. Centres had been opened in home commands, bringing the total in operation to 162, only one of which continued to be a part-time visited centre (Channel Islands). Up to this time the officer commanding the nearest military hospital, reception station or other army medical unit acted as accounting officer for the A.D. Centre. With the expansion of the Army Dental Corps and the continual changes in the disposition of both troops and medical units it was impracticable for this arrangement to continue, and in order to

facilitate procedure and to ensure the proper care of dental equipment and stores by those who used them and should, therefore, be responsible for them, all A.D. Centres in home commands became separate accounting units on April 1, 1940. At this date, 244 centres were affected. Several others had been formed but they remained open for short periods only and are not included in this total. This change was important in that it established the independence of the dental unit and was an acknowledgement that A.D. Corps personnel were capable of managing an efficient and separate unit. The formation of new A.D. Centres remained in the hands of commands for some time longer, but with the constant changes and the expansion that was effected central control became inadequate. Accordingly, when expansion had reached a certain stage and when conditions at home became more settled, the freedom hitherto enjoyed by local administrative dental officers and employed with considerable success, had perforce to be restricted, and centres were re-organised on a more permanent basis. On March 1, 1941, soon after the re-organisation in home commands began and when South Eastern Command was formed, A.D. Centres and A.D. Labs. in home commands assumed a numerical identity, and from this date no new centres could be formed without first obtaining the authority of the War Office. All existing centres were thus allotted serial numbers, the total number at this time being 486. It will be noted that in eleven months the total number of centres in the United Kingdom had been almost doubled.

There was as yet no war establishment for army dental centres. This omission gave rise to much dissatisfaction. It seemed to A.D. Corps personnel that a legitimate avenue towards promotion was being blocked. Moreover, the question of discipline was presenting serious difficulties, especially at the large centres where the senior dental clerk-orderly was seldom above the rank of private. Local acting unpaid rank could, of course, be granted, but this offered little encouragement; more often than not, the rank was refused on principle by the men most suitable for appointment; moreover, it was widely felt that the responsibilities fully justified additional pay and merited appropriate rank.

It was not until December 9, 1942, that A.D. Centres at home were placed on a war establishment. Conditions for both officers and other ranks were greatly improved. The establishment was based upon the number of equipped dental chairs at a particular centre, and ranks were assessed according to the degree of responsibility at each. Thus at centres with five or more equipped chairs a major was appointed officer in charge, while a centre with twenty equipped chairs had an officer in the rank of lieut. colonel. The dental clerk-orderly at three- or four-chair centres was a corporal, at centres with five or more equipped chairs he was a sergeant and at a twenty-chair centre he was a staff-sergeant. At the

larger A.D. Centres certain additional ranks were allowed according to the following scale:

Number of equipped dental chairs	1	2	3	4	5	6	7	8	9	10	11	20
Officers:												
Lieut. Colonel	—	—	—	—	—	—	—	—	—	—	—	1
Major	—	—	—	—	1	1	1	1	1	1	1	2
Capt. or Lieut.	1	2	3	4	4	5	6	7	8	9	10	17
Clerk-orderlies:												
S/Sergt.	—	—	—	—	—	—	—	—	—	—	—	1
Sergeant	—	—	—	—	1	1	1	1	1	1	1	1
Corporal	—	—	1	1	—	—	1	1	1	1	2	3
L/cpl.	1	1	—	—	—	1	—	—	1	1	—	—
Private	—	1	2	3	4	4	5	6	6	7	8	15

This establishment was later known as an 'Army Dental Centre (Home) Type "A", A.D. Corps'. The Army Dental Centre Type 'B' was introduced to differentiate it from a centre where the personnel were all men, when the employment of auxiliaries of the A.T.S. in dental clerk-orderly duties was authorised; this establishment, approved in the autumn of 1943, allowed approximately half the number of dental clerk-orderlies to be other ranks of the A.D.Corps, and the remainder to be auxiliaries of the A.T.S. The allocation of ranks was the same as for the Type 'A' centre and the establishment gave proportional distribution of them between male and female personnel. At those centres solely engaged on the treatment of personnel of the A.T.S., auxiliaries of that Service replaced all other ranks of the A.D. Corps included on the establishment.

The peak in the number of A.D. Centres in operation at any one time during the war was reached in August 1942, when there were 548 in the United Kingdom. It was not the policy of the War Office to allot the serial number already given to a defunct centre to a newly formed one in case it proved necessary to re-open the original centre at a later date. The highest number allotted to an A.D. Centre during the war was 679, which indicates that from the time centres were serially numbered, 679 different locations were provided with them.

A.D. Centres were established in many different types of building and each required individual conversion. The accommodation at the large hutted camps set up all over the country provided either a wooden hut or a Nissen hut, its size being dependent upon the commitments. (*See* Plates VII and VIII.) No standard plan was evolved during the war for a centre at a hutted camp, but many useful conversions were designed.

To illustrate the extent to which requisitioned buildings were being used as accommodation for centres in the United Kingdom, the following gives the position as it was in August 1944:

Number of A.D. Centres established in the following types of requisitioned building:

Private houses (including shops)	225
Hotels	12
Schools	6
Municipal property	6
Church halls	5
Places of public entertainment	3
Holiday camps	2
University premises	2
Cotton mills	2
Total	264

ARMY DENTAL LABORATORIES

During the early months of the war, the processing of all denture work in home commands continued to be centralised, as in peace-time, at the Army Dental Laboratory, Aldershot. Additional dental mechanics were employed at the laboratory as the demand for denture work grew.

By the end of 1939, it became essential to decentralise the production of mechanical work to commands, and during December each command, Northern Ireland District and London Area established army dental laboratories. A home war establishment was authorised with an effective date from December 12, 1939, for three sizes of command dental laboratory. That in Aldershot Command remained the principal and largest laboratory and acted as a pool for dental mechanics from which mechanics could be posted for temporary duty to augment the resources in other commands according to variations in the pressure of work.

The new authorised establishment for the Command Dental Laboratory, Aldershot Command, was as follows:

Officer-in-charge	Lieut. colonel
52 Dental mechanics	1 Warrant officer class I
	1 Warrant officer class II
	3 Sergeants
	3 Corporals
	44 Privates
2 Dental clerk-orderlies	1 Corporal
	1 Private

The A.D. Labs. in the other home commands were all raised on the same establishment; this carried only half the number of dental mechanics allowed for Aldershot Command, and the allotment of ranks was as follows:

Officer-in-charge . . .	Lieut. colonel
26 Dental mechanics . .	1 S/sergeant
	1 Sergeant
	1 Corporal
	23 Privates
2 Dental clerk-orderlies . .	1 Corporal
	1 Private

Northern Ireland District and London Area were each authorised a small dental laboratory with a major as officer-in-charge, one dental clerk-orderly (private) and 4 dental mechanics, one of whom was a staff-sergeant and the remainder privates. The laboratory formed in London Area was a development from the small peace-time laboratory at Millbank.

The authorised establishment of these command dental laboratories was soon found to be inadequate and each of them was gradually increased in size, in some cases necessitating a move to larger premises, by the attachment of additional dental mechanics, until many employed the unwieldy total of eighty or more. Smaller laboratories, not on any authorised establishment, were also formed at many different locations, usually as an attachment to a large dental centre, to meet the needs of local commitments. In March 1941, serial numbers were allotted to thirteen A.D. Labs. Since this coincided with the re-organisation of home commands and the absorption of Aldershot Command into the newly created South Eastern Command, the result was that some commands had three dental laboratories under their administration whereas others were left with only one.

In June 1941, pending the consideration of increasing the home establishment of A.D. Labs., instructions were issued to each command, with the exception of South Eastern Command (which already had two large dental laboratories) and Northern Ireland District, to form a detachment of their principal laboratory, thereby anticipating the desired organisation of two dental laboratories to serve each home command. Unfortunately official confirmation for this step was delayed for eighteen months, and in the meantime, the staffs of these detachments suffered the anomaly of performing the full duties of, and carrying responsibilities in every way similar to those of, the parent establishment without any material recognition in respect of pay and promotion which was enjoyed by the staffs of the parent units. This, as was the case with the clerk-orderlies at the A.D. Centres, had an adverse effect on the morale of the mechanic section of the A.D. Corps.

On December 9, 1942, authority for the additional dental laboratories was, at long last, obtained, and a revised home war establishment was introduced which included improvements in the number of non-commissioned ranks. The new standard laboratory carried fifty

dental mechanics on its establishment, three dental clerk-orderlies, and a lieut. colonel as officer commanding. The distribution of ranks was as follows:

Dental mechanics . . .	1 Warrant officer class I
	1 S/sergeant
	1 Sergeant
	3 Corporals
	8 L/corporals
	36 Privates
Dental Clerk-orderlies . .	1 Sergeant
	2 Privates

In consequence the laboratories at home were re-organised, the existing serial numbers were cancelled, the small laboratories disbanded and the original parent units and their detachments, thirteen in all, were allotted new numbers.

MOBILE DENTAL UNITS (HOME)

That some means whereby dental treatment should be made available at short notice, for units and formations in the United Kingdom in isolated or temporary locations, or to reinforce the dental arrangements at a permanent station when the necessity arose, such as on the receipt of urgent orders by the unit undergoing treatment to move overseas, was soon realised at the beginning of the war.

Various suggestions were put forward by administrative dental officers, such as the issue of a certain number of field dental outfits to each command to enable temporary dental centres to be established, or the transportation of the home dental outfit, with the exception of the heavy fixtures, packed in suitable containers, a dental chair being improvised. These methods were successfully tried on several occasions but shortage of dental outfits and transport prevented their general adoption. It was decided that a two-wheel trailer caravan fitted as a dental surgery and supplied with a modified scale of equipment, similar in design to those which had been employed with considerable success by various local authorities for their school dental service in country districts, would fulfil the necessary conditions dictated by the limitations of supplies and would, at the same time, solve the different problem of adequate accommodation. Moreover, the cost of such mobile dental units would be offset by eliminating the requisitioning, adaptation and upkeep of buildings necessary for the establishment of static dental centres.

Negotiations were begun in March 1940, with a firm which had just completed a large contract for mobile dental clinics for the Rumanian Government and was in a position to undertake the work at short notice. Plans were discussed and the modified scale of equipment drawn up. Authority for the provision of sixty trailers was given by the

PLATE VII: An Army Dental Centre at Home established in Nissen Hutting. Exterior

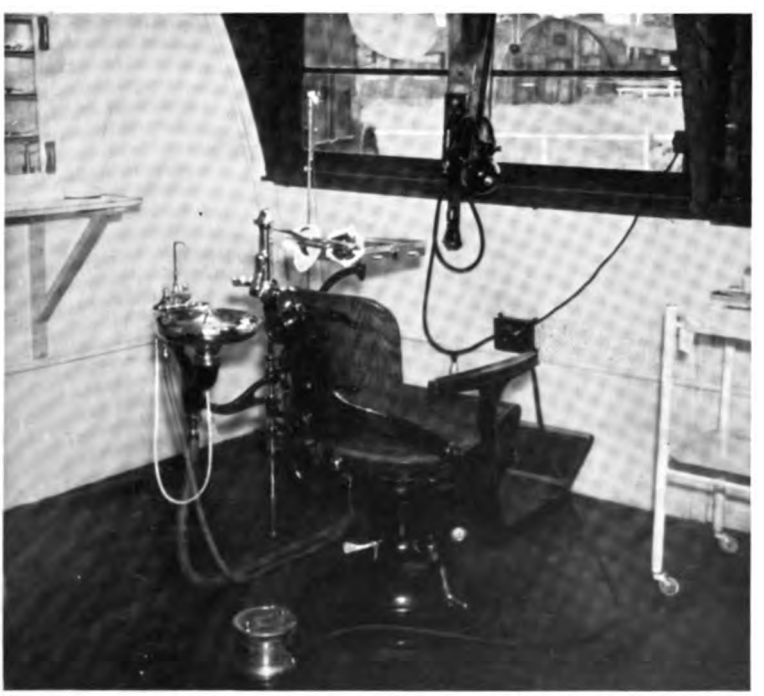


PLATE VIII: An Army Dental Centre at Home established in Nissen Hutting. Interior

[*facing page* 328

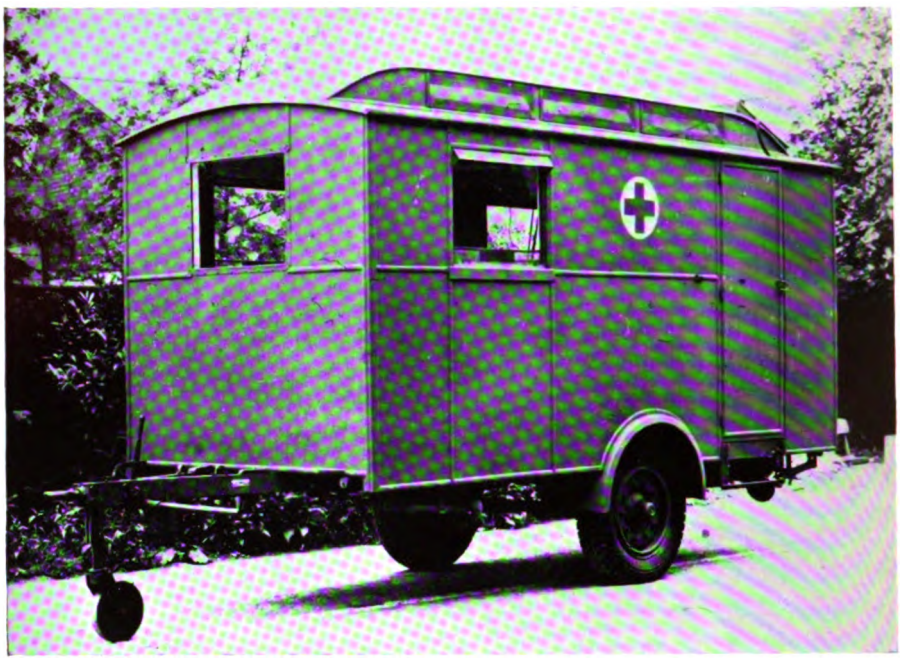


PLATE IX. A Mobile Dental Unit (2nd Type). Exterior

PLATE X: A Mobile Dental Unit (2nd Type). Interior, forward end

PLATE XI: A Mobile Dental Unit (2nd Type). Interior, rear end

PLATE XII: No. 1 Mobile Dental Prosthetics Unit. (The Canadian Gift Unit.) Exterior

PLATE XIII: No. 1 Mobile Dental Prosthetics Unit. (The Canadian Gift Unit.) Interior

PLATE XIV: The B.R.C.S. and O.St.J. Mobile Dental Unit. Exterior

PLATE XV: The B.R.C.S. and O.St.J. Mobile Dental Unit. Interior

Ministry of Supply in July 1940. Delivery of the first trailers was promised for the end of August, but the production was seriously delayed by the bomb damage and disruption suffered by sub-contractors, during the enemy air attacks in the autumn of 1940.

The basis for the allotment of M.D.Us. was at the rate of two to each division located in a command. The estimated allocation of units was as follows:

Eastern Command	16
Northern Command	12
Scottish Command	8
Southern Command	14
Western Command	8
Northern Ireland District	2
Total	60

An order of priority for delivery was agreed upon, and commands informed the War Office of the locations where the M.D.Us. were to be sent in the first instance. Despatch of the first four units to a command was effected on January 24, 1941. All were sent to Eastern Command. Fifty M.D.Us. had been delivered by the middle of April, but the sixtieth was not supplied until October 20, 1941.

The M.D.U. was a two-wheel stream-lined caravan with a curved roof, the height of which precluded the employment on the unit of dental personnel over 5 ft. 9 in. tall. It was divided into three compartments—surgery, entrance and office; a small plaster-bench was fitted inside the entrance. The surgery was provided with a dental foot-engine and a dental chair of modified home pattern with adjustable bracket-table, cuspidor holder and anglepoise lamp attached. There was a small dental cabinet with drawers for instruments and cupboards below. Additional cupboards were fitted for holding stores and garments. Natural lighting was good. Sliding panels covered the windows in the roof and at the sides during blackout hours. A 12-volt battery provided the artificial lighting. The steriliser was housed in a special cabinet built on the fume-box principle. Water was carried in special containers, and a small metal wash-basin was conveniently placed on one side with a waste pipe emptying into a bucket outside the caravan. At each corner of the caravan there were adjustable parking jacks to allow the floor of the unit to be levelled to suit the contour of the ground and to take the weight off the tyres when the vehicles were stationary. Various items of ordnance stores and equipment were supplied including camouflage netting and a bell-tent (which could be used as a waiting-room when required). The trailers were fitted with a tow-bar for towing by motor transport to the different sites, and were suitably balanced to allow of man-handling into positions inaccessible to trucks.

M.D.Us. were attached to a station maintenance company (later absorbed into command (mixed) transport companies) of the R.A.S.C. for vehicle maintenance and to a 'parent dental centre' for administration and supplies; they functioned under the general direction of command headquarters. The personnel comprised one dental officer and one dental clerk-orderly—the home war establishment authorised in December 1942, provided for one dental officer (captain or lieutenant) and one dental clerk-orderly appointed as a lance-corporal.

The introduction of these units was welcomed by all officers commanding units and formations to which they were attached. Every facility was afforded to the dental personnel attached to them, and a high degree of co-operation was achieved. Staggered appointments were generally arranged which caused as little interruption as was possible to the units' training programmes. The fact that the dental personnel lived with the officers and men of the unit undergoing treatment helped, in no small measure, the smooth working of the scheme.

The principal uses to which M.D.Us. were put can be summarised as follows:

1. To provide dental treatment for outlying units and detachments.
2. To provide quick reinforcements to static dental centres necessitated by a sudden and temporary increase in the amount of work, e.g. by an abnormally large intake.
3. To provide a concentration of treatment for one particular unit required, at short notice, for service overseas.
4. To replace, in an emergency, the dental department of a field medical unit temporarily closed for manoeuvres.
5. To reconnoitre preparatory to opening a static dental centre.

The convenience of the M.D.U. for providing facilities for dental treatment was soon appreciated by administrative officers and field commanders alike, but another aspect of its usefulness was not so obvious. It was estimated that in one year each M.D.U. saved approximately 60,000 man-miles in the conveyance of men to and from static A.D. Centres in unit transport; this also represented a considerable saving in petrol and tyres. A report from a M.D.U. which was treating the personnel of a general construction company of the R.E. engaged on erecting a Nissen hutted camp, for example, indicated that during its short tour it had saved no fewer than 2,000 working man-hours, as a result of its presence at the site. Since the construction of one Nissen hut required from 170 to 200 working man-hours, the time-saving value of the M.D.U. can be appreciated.

The success of the M.D.U. was immediate and authority was sought in September 1941, for the supply of thirty-six additional trailers. This was given the following month and the contract placed. Plans were drawn up for an entirely different type of vehicle which incorporated

the improvements and modifications suggested in the light of the practical experience gained in the operation of mobile dental units. The body of the vehicle was made rectangular in shape, which allowed ample head-room inside. The two interior doors and all partitioning were eliminated. The roof was re-designed on the clerestory principle to give improved ventilation. The entrance door was placed at the same end as the dental chair so that patients were not obliged to cross the surgery floor; in this way the amount of dirt brought into the unit was reduced to a minimum. A more stable system of jacking was used. A jockey wheel and transverse bar were fitted to the tow-bar to aid man-handling. The fume cupboard was excluded and a simple shelf with cowl and exit pipe substituted. A water storage tank of fair capacity was added. The windows were made larger. Sliding metal gauze screens, to prevent the entry of flies and insects, and louvres were fitted to each window that opened. Shelves, a zinc top to the plaster-bench, an electric plug for connecting to the mains supply and an accumulator charger were additional improvements. The furniture and cupboards were re-arranged. (*See* Plates IX, X and XI.)

Twenty of the new type trailers had been delivered by September 1942, and the contract, which now included eight additional trailers allotted to the Army from cancelled Admiralty and Air Ministry contracts, was almost completed by the end of the year. The forty-four new M.D.Us. were distributed to commands as follows:

Eastern Command	6
Northern Command . . .	10
Scottish Command	7
South Eastern Command . . .	8
Southern Command . . .	7
Western Command	6
Total . . .	44

Although eminently suitable in many respects, the type of vehicle used had certain disadvantages that were most difficult to overcome, particularly with regard to the health and comfort of the dental personnel. On account of its light construction, which, of necessity, had to conform to specifications influenced by the general shortage of materials, the unit was hot in summer and exceedingly cold in the winter; it was recorded that the floor temperature was often some 30° F. below that near the ceiling. Condensation, through inadequate insulation, caused severe difficulty at all times, and constant mopping-up and drying had to be carried out in order to prevent the rusting and deterioration of instruments, equipment and supplies.

Towards the end of the war, efforts were directed towards the replacement of those trailers which had seen long service and were beyond

economical repair, but the continued acute shortage of mechanical transport and the difficulties in connexion with the driving and maintenance of the vehicle prevented this most desirable development of the mobile dental unit.

Thirteen M.D.Us., built on self-propelled vehicles, merit special mention. In January 1941, the St. Andrew's Ambulance Association lent a fully equipped motor ambulance fitted as a dental surgery, including complete dental equipment, for use in South Highland Area. It was based on Perth. A civilian driver was provided and the unit was maintained by the association. It rendered a service of inestimable value throughout the war in carrying dental treatment to the many isolated detachments of troops located in the area of its tour. It was later generously made an outright gift to the Army Dental Service.

In September 1941, Mr. J. W. Miller of Toronto, Canada, made a generous offer to provide a M.D.U. for the use of the Army, and deposited £950 for this purpose. The 'Canadian Gift Unit', as it was called, was completed in June 1942, and was allocated for duty first to Northern Command, then Scottish Command (where it remained for eighteen months) and finally to Eastern Command. It comprised a prosthetics laboratory for four dental mechanics constructed on a lorry chassis, and a dental trailer of standard army design. The value of this type of unit was abundantly proved during the course of the war. (*See* Plates XII and XIII.)

In September 1942 the Scottish Branch of the B.R.C.S. lent a M.D.U. mounted on a Ford V8 chassis for use in West Scotland District. The Society provided a driver and also undertook to maintain the vehicle, but the dental equipment was supplied from army sources. This was the first of a series of M.D.Us. generously made available or presented to the Army by the Scottish Branch. A second unit was supplied in May 1943; a third in August 1944; a fourth in September 1944, which was given for the use of 21 Army Group in Europe; a fifth in November 1944 and two more in August 1945; a total of seven Ford V8s fitted as dental surgeries, four of which were later made outright gifts to the Army Dental Service. This was not the full extent of the generosity of the Scottish Branch which had shown such interest in the Army Dental Service, for a self-propelled vehicle fitted as a dental laboratory for two dental mechanics was presented in April 1945. This unit worked as a detachment of 4 Army Dental Laboratory, Edinburgh, and visited the outlying A.D. Centres in Scottish Command.

The War Organisation of the B.R.C.S. and the Order of St. John lent two self-propelled M.D.Us. to the Army in February 1945, both of which were presented as gifts at the end of the war. (*See* Plates XIV and XV.) These units were specially designed, generously equipped and

included many items of special apparatus which could not, for reasons of economy, be incorporated in the earlier type.

The last unit which deserves description was the conversion of a motor coach carried out in Northern Ireland District. This was a combined dental surgery and laboratory constructed on one chassis. It proved very satisfactory in use, provided ample interior space and fulfilled a very pressing need in the district.

In March 1945, a few officers and other ranks of the A.D. Corps were trained to drive army transport in order to undertake the driving of the Corps' own self-propelled vehicles which, it should be noted, with but one exception (and that because the vehicle in question had been condemned for any other purpose) had been provided not from army sources, despite repeated recommendations for their supply, but by the generosity of individuals and charitable institutions.

A war establishment for a M.D.U. of the Home Field Army was in existence; this included one dental officer, one corporal dental clerk-orderly and one corporal dental mechanic; a 3-ton 4 × 2 lorry was provided for transport and a driver-in-charge, R.A.S.C., was attached. No mobile dental units specifically for the Home Field Army were raised.

FIELD DENTAL CENTRES

Before the war A.D. Centres were established abroad according to the authorised ratio of dental officers to troops. They were located in barracks, reception stations and military hospitals. The only dental officers who accompanied a field force and were allowed by war establishments were those attached to the various medical units. Experience in France in 1939–40 proved that these dental facilities were inadequate, but the campaign came to an end before the situation could be satisfactorily rectified. In the Middle East, however, there was a number of A.D. Centres which had been established for the peace-time garrisons, but, as new medical units were raised from the resources of the Egypt and Palestine Commands, many existing centres were absorbed into the establishments of the newly formed medical units as their dental departments; the number of command centres was thereby reduced. Owing to the desire of D.M.S., Middle East, to have all units under his administration functioning on a definite war establishment, Middle East war establishments were introduced for the remaining command dental centres. Four classes of centres were authorised and these were the forerunners of those ultimately adopted for use with army groups, when they were called 'Field Dental Centres (F.D.Cs.) (Operational)'. In army groups they were utilised primarily as base and L. of C. units but could be employed in the corps areas if required. F.D.Cs. were formed from the balance of personnel available to complete the authorised scale of dental officers in any army group when the vacancies in the

establishments of medical units and other dental units had been filled. The personnel allotted to the different classes of F.D.Cs. (operational) were as follows:

Class 'A' . . .	1 major, captain or lieutenant
	1 corporal (clerk-orderly)
Class 'B' . .	2 majors, captains or lieutenants
	1 corporal (clerk-orderly)
	1 private (clerk-orderly)
Class 'C' . . .	1 major or captain (officer commanding)
	2 majors, captains or lieutenants
	1 corporal (clerk-orderly)
	2 privates (clerk-orderlies)
Class 'D' . .	1 major (officer commanding)
	3 majors, captains or lieutenants
	1 sergeant (clerk-orderly)
	3 privates (clerk-orderlies)

In theatres overseas, other than in army groups, a war establishment for a 'field dental centre (non-operational)' was introduced. These dental centres were, however, formed on the same basis as for army groups. The allotment of ranks according to the number of equipped dental chairs was the same as in the home war establishment for army dental centres. In addition, local types of dental centre were raised, such as the F.D.C. (Persia and Iraq Command) which had one dental mechanic (private) added to the establishment. Some small theatres did not use the establishment for a F.D.C. India also had its own special establishments.

A standard plan for a F.D.C. (operational) was approved, as was also a schedule of equipment.

FIELD DENTAL LABORATORIES

Dental mechanics were allotted to overseas commands in peace-time according to the local requirements. No arrangements had been made before the war for the formation of dental laboratories for a field force, but dental mechanics were included on the war establishments of general hospitals, C.C.Ss. and convalescent depots. In the Middle East dental mechanics were first attached to the M.D.Us. formed specially for operating in the desert, but by that time, in pursuance of the policy of D.M.S., a number of dental laboratories at the base had been raised on a Middle East war establishment. This establishment was utilised to frame the requirements for a 'Field Dental Laboratory' (F.D. Lab.) for use in all theatres of operations and resulted in the following being approved:

Field Dental Laboratory, The Army Dental Corps
- 1 major (officer commanding)
- 8 dental mechanics (1 staff-sergeant, 1 corporal and 6 privates)
- 2 dental clerk-orderlies (1 sergeant and 1 private)
- 1 general duty man (any arm)

A solo motor-cycle was provided in order to work an independent and quick-delivery service for denture cases. A standard plan for hutted accommodation was drawn up and a schedule of equipment approved.

F.D. Labs. were formed from the balance of dental mechanics to complete the authorised scale for an army group after the vacancies in the establishments of medical units and other dental units had been filled.

MOBILE DENTAL TEAMS

Mobile dental teams (M.D.Ts.) for use in the field were introduced first in the Middle East for the later desert campaigns. A small number was raised for the field force that took part in the invasion of North Africa, and larger numbers were used in the invasion of Europe. The ultimate basis for allotment of M.D.Ts., which had gradually developed during the war, was as follows:

(*a*) one team to each armoured division
(*b*) two teams to each infantry division
(*c*) three teams to each corps
(*d*) plus an increment of one team for each division or its equivalent within each corps.

They were provided with one 3-ton lorry for transport and certain other equipment. The teams under (*a*), (*b*), and (*c*) above were classed as army troops and those under (*d*) as G.H.Q. units but were normally placed at the disposal of the A.D.D.S. of army and usually attached to divisions. When they were employed in an 'air-portable' rôle, they were equipped with a jeep and trailer instead of the 3-ton truck. The personnel of the team comprised one dental officer (captain or lieutenant), one dental clerk-orderly (corporal), one dental mechanic (corporal) and one driver (R.A.S.C.).

DENTAL PERSONNEL ATTACHED TO MEDICAL UNITS

The number of dental officers attached to field medical units in the United Kingdom at any one time and between the different commands, varied greatly; it was entirely dependent upon the stage reached in the war and the changing operational requirements. At first the mobilisation of the B.E.F. for France resulted in a transference of dental officers from static A.D. Centres to medical units to fill vacancies in war establishments. Before they embarked for overseas their services were used to supplement the A.D.S. in the particular command in which they were for the time being located. After Dunkirk there was, of course, a greater concentration, as many were attached to medical units of the Home Field Army during the days when a German invasion was expected. With the formation and expansion of First Army their numbers increased, but fell again when the invasion of North Africa took

place. This process was repeated in connexion with the invasion of Europe.

The dental officers attached to medical units were, at all times, utilised to augment the dental service of the command in which they were stationed and were under the control of the command headquarters for this purpose. They established their own dental departments whenever possible and usually carried out dental treatment for the troops of the formations to which their medical units were allocated. Failing this, they were temporarily detached from their parent units for duty at static A.D. Centres, but were always liable for immediate recall.

There was, however, a number of medical units permanently located in the United Kingdom. The military hospitals did not carry dental personnel on their establishments, but A.D. Centres with establishments to meet the requirements were formed either in the hospital precincts or nearby. The command dental surgical specialists worked at a selected military hospital in their respective commands. The military convalescent depots, on the other hand, had dental personnel attached to them and each class of depot carried an appropriate establishment for these. These were as follows:

Military Convalescent Depot	Attached Dental Personnel
Class 'B' (501–1,000 men)	1 major, captain or lieutenant 1 private (clerk-orderly)
Class 'C' (1,001–1,500 men)	1 major, captain or lieutenant 1 l/corporal (clerk-orderly)
Class 'D' (1,501–2,250 men)	1 major, captain or lieutenant 1 corporal (clerk-orderly)
Class 'E' (2,251–3,000 men)	2 majors, captains or lieutenants 1 l/corporal (clerk-orderly) 1 private (clerk-orderly)

There was a special war establishment for the Military Hospital for Head Injuries, Oxford, which carried a specialist or graded maxillo-facial dental surgeon, a staff-sergeant dental mechanic and a corporal dental clerk-orderly. Dental personnel were also provided for on the war establishment for a 50-bed field hospital (Empire Base Installations) and a field ambulance (Home Field Army). One corporal and one private dental clerk-orderly of the A.D. Corps were included on the war establishment for a command or area medical store in order to attend to the demands for the supply of dental items of equipment and dental materials.

Dental personnel were employed with the following field and overseas medical units: the appropriate ranks of the officers and the other ranks of the A.D. Corps carried on the war establishments are given:

Light field ambulance	1 captain or lieutenant 1 corporal (clerk-orderly)
Field ambulance	1 captain or lieutenant 1 corporal (clerk-orderly)
Parachute field ambulance	1 captain or lieutenant 1 corporal (clerk-orderly)
Air-landing field ambulance	1 captain or lieutenant 1 corporal (clerk-orderly)
Casualty clearing station	1 major, captain or lieutenant 1 corporal (clerk-orderly) 1 corporal (dental mechanic) 1 private (dental mechanic)
General hospital (200 beds)	1 major, captain or lieutenant 1 corporal (dental mechanic) 1 l/corporal (clerk-orderly)
General hospital (600 beds)	1 major, captain or lieutenant (specialist or graded dental surgeon) 1 corporal (dental mechanic) 1 l/corporal (clerk-orderly)
General hospital (1,200 beds)	1 major, captain or lieutenant (specialist or graded dental surgeon) 1 sergeant (dental mechanic) 1 corporal (clerk-orderly) 3 privates (dental mechanics)
Convalescent depot (1,000 men)	2 majors, captains or lieutenants 1 corporal (dental mechanic) 1 l/corporal (clerk-orderly) 1 private (clerk-orderly)
Convalescent depot (2,000 men)	2 majors, captains or lieutenants 1 corporal (dental mechanic) 1 l/corporal (clerk-orderly) 1 private (clerk-orderly)
Light casualty hospital (1,000 beds)	1 major, captain or lieutenant 1 corporal (dental mechanic) 1 l/corporal (clerk-orderly)
Maxillo-Facial surgical unit	2 majors, captains or lieutenants (specialist or graded maxillo-facial dental surgeons) 2 corporals (clerk-orderlies) 1 staff-sergeant (dental mechanic) 1 sergeant (dental mechanic)
Field ambulance (East Africa)	1 captain or lieutenant 1 sergeant (clerk-orderly)
Casualty clearing station (East Africa)	1 captain or lieutenant 2 sergeants (dental mechanics) 1 sergeant (clerk-orderly)

An East African convalescent depot (100 Africans)	1 captain 1 sergeant (dental mechanic) 1 sergeant (clerk-orderly)
An East African general hospital lower establishment (1,000 African beds) .	1 major 2 sergeants (dental mechanics) 1 sergeant (clerk-orderly)
An East African general hospital (200 European beds)	1 major, captain or lieutenant 2 privates (dental mechanics) 1 private (clerk-orderly)
A general hospital, Mauritius	1 major, captain or lieutenant 1 sergeant (dental mechanic) 1 sergeant (clerk-orderly)
An East African general hospital higher establishment (1,000 African beds)	1 major 2 sergeants (dental mechanics) 1 sergeant (clerk-orderly)
A West African field ambulance	1 captain or lieutenant 1 sergeant (clerk-orderly)
A West African general hospital (600 African beds)	1 major 2 sergeants (dental mechanics) 1 sergeant (clerk-orderly)
A West African general hospital (200 European beds)	1 major 1 sergeant (dental mechanic) 1 sergeant (clerk-orderly)
A West African general hospital (200 African beds)	1 major 1 sergeant (dental mechanic) 1 sergeant (clerk-orderly)
A West African C.C.S. . . (100 patients)	1 captain 1 sergeant (dental mechanic) 1 sergeant (clerk-orderly)

Other ranks of the A.D. Corps were also attached to base and command depots of medical stores, a special establishment being implemented to meet the different requirements of the theatre concerned. At the G.H.Q. Medical Stores and Base Spectacles Depot, Middle East, for example, four other ranks were employed (warrant officer class II, corporal and two privates); on the other hand, one private only was attached to a base depot of medical stores in North Africa, while one corporal was included on the establishment for a corps district depot of the British Army of the Rhine.

THE SUPPLY OF DENTAL EQUIPMENT DENTAL MATERIALS AND MISCELLANEOUS STORES

THE ORGANISATION FOR SUPPLY

The supply of dental equipment and dental materials for the Army was conducted through A.M.D.3 of the Army Medical Directorate, which was advised in all matters affecting dental requirements, including the placing of contracts with manufacturers, by A.M.D.6.

No independent dental supply depots were formed during the war, but dental equipment and dental materials were held by the various depots of medical stores. All indents for dental supplies were prepared by the dental officers-in-charge of dental units and submitted to the administrative dental officer concerned for counter-signature before being passed through the organisation for the supply of medical requirements. To assist with the completion of demands for items peculiar to the Army Dental Service, dental clerk-orderlies, who had the necessary technical knowledge, were attached to depots of medical stores according to local requirements.

Demands for the issue of authorised barrack and ordnance stores and equipment were made to the appropriate depots by the dental units concerned.

DENTAL EQUIPMENT

Authorised scales of dental equipment for different purposes were in existence before the outbreak of war and were detailed in the regulations and schedules.

At the beginning of the war there was some delay in the delivery of home dental outfits. Production was eventually organised to meet the increased demands of the Services and a steady flow of dental equipment for the Army resulted.

The dental equipment used by the Army Dental Service can best be considered under the headings of the various outfits issued. The following were the dental outfits used during the war:

i. Home dental outfit
ii. Field dental outfit
iii. Field dental outfit for two dental mechanics
iv. Field dental anaesthetic outfit
v. Field dental casting outfit
vi. Dental haversack
vii. Dental haversack—airborne
viii. Additional outfit for dental surgical specialists
ix. Additional outfit for maxillo-facial dental surgeons.

The quality and performance of the dental equipment used during the war was, in general, extremely satisfactory. Some difficulty was experienced with one make of electric dental engine supplied to the Army, but the fault in the design was soon rectified. One item of equipment, however, was the cause of endless trouble—the contra-angle handpiece. This article was, of necessity, in constant use throughout the day, and despite careful maintenance the small cogs and accessory parts rapidly wore out. Inferior quality steel and poor design were

largely blamed, but the constant use to which they had to be put was probably the sole reason for the apparent excessive wear. The delay in effecting repairs to these essential items no doubt accentuated the problem. An acute position sometimes developed at dental centres mainly concerned with conservative treatment, and at times one contra-angle handpiece had to be shared by all the dental officers at the centre as the remaining handpieces were away for repair by the manufacturers or otherwise unserviceable. To overcome this difficulty, spare parts for contra-angle handpieces (hexagon nuts, cog and cylinder and head cog for short spindle) were later held at command medical stores at home and despatched to overseas theatres; this enabled such minor replacements to be undertaken locally and avoided the previous practice, with its inevitable delay, whereby the articles were returned to the manufacturers for repair. Hypodermic syringes also were the subject of occasional complaint, but the consequences were not nearly so serious nor so inconvenient as was the case with the handpieces.

Under the Lend-Lease Agreement, 100 American field dental outfits (Chests M.D. No. 60, Dental, including portable chair) were delivered in December 1942, for the use of the Army Dental Service—in 1940, 300 had been asked for. Fifty of these outfits were re-directed to the Middle East, some were used in troop transport ships and the remainder were made available to home commands for emergency use, such as for repatriated British prisoners-of-war, for Allied forces and for enemy prisoners-of-war. In December 1942, a large consignment of miscellaneous dental instruments and dental sundries was also received from America; these were used to replace items of similar design in making up the British outfits until the supply was exhausted.

The Home Dental Outfit.—The items of equipment issued with the home dental outfit remained unchanged until the end of 1941, and were according to Appendix 34 of the *Regulations for the Medical Services of the Army*, 1938. At this date the scale was amended, certain obsolete and little-used articles were deleted and various additions were made. The additions included a wider assortment of burs, carborundum points and impression trays, a different type of water syringe with a rubber bulb, and the introduction of suture needles, Coupland's osseous chisel, Winter's elevators, a balance for Zelex impression compound, a pair of narrow-beaked forceps, Spencer Wells' artery forceps, Lennox matrix outfit, a stand for burs, a bakelite waste receiver, and a kidney-shaped dressing basin.

The home dental outfit was issued to army dental centres at home and was already installed in certain peace-time dental centres abroad. After the withdrawal from France in 1940, dental officers attached to general hospitals and C.C.Ss. located in home commands were issued with home dental outfits to establish their dental departments. On the

departure of the medical unit it was often possible to allow the home dental outfit to remain, as the accommodation was taken over as a command static army dental centre. Much time and expense was in this way saved in the formation of army dental centres and the installation of the necessary dental equipment. The dental officers attached to field ambulances assisted with the routine dental treatment of the troops in the command in which they were stationed; they were not supplied with home dental outfits for the purpose but were permitted to take their field dental outfits into use. To enable them to undertake denture work they were instructed to indent for the following additional items of equipment, which were held only so long as the unit was employed in a semi-static rôle and remained in the United Kingdom: plaster bowl, plaster knife, plaster mixer, tooth shade-guide, bench pins and clamp, and plaster-of-paris as required. At a later date, field ambulances were allowed to retain these additional items.

During the early months of the war, when the Army was expanding rapidly and the delays in the delivery of dental supplies were great, many improvisations were introduced in order to tide over the difficult period, among these was the conversion of easy chairs with arm rests for use as dental chairs.

In February 1941, thirty-five dental chairs of superior quality (Sterling, double-cylinder) were made available for issue to selected army dental centres at home.

The facilities for dental radiography in the Army Dental Service were not good at the beginning of the war. One dental X-ray apparatus was installed at the Millbank dental centre and another at the dental department, Cambridge Hospital, Aldershot. Although it was possible for patients to be X-rayed at various medical units and the facilities available at the E.M.S. hospitals were extended to the Army in October 1940, the results obtained by the use of medical X-ray apparatus left much to be desired and a great deal of inconvenience and unnecessary waste of time was caused by the necessity of sending dental patients, often for long distances, to medical establishments for this purpose. Dental radiography now formed an essential part of dental diagnosis and treatment, and satisfactory results could only be obtained by the use of a specially designed dental X-ray apparatus operated by the dental surgeon, or by a technician conversant with the difficulties peculiar to the anatomy of the mouth and its pathological conditions. In March 1942, arrangements were made to issue thirty dental X-ray sets to large army dental centres in home commands, and a number of other ranks of the Army Dental Corps received special technical training to operate and maintain them. In March 1944 the supply of nineteen additional sets was authorised. They were distributed to commands according to specific requirements and not on an equal number basis.

To improve the existing facilities for denture production and to enable minor readjustments to denture cases to be carried out in army dental centres and so avoid the necessity of returning such work to the dental laboratory, articulators were issued in April 1944, to dental centres with five or more equipped dental surgeries. In July of the same year, and for the same purpose, fifty electric dental bench lathes were supplied to selected army dental centres. In December 1944 one hundred additional articulators were made available to command medical stores for issue to centres at the discretion of administrative officers.

Also in 1944, carbon dioxide sparklet dental sprays were introduced for issue to the larger army dental centres on the basis of six to each of the home commands. These were used for the treatment of gum infections and for general oral prophylaxis. In August 1945, supplies were sufficient to allow of the issue of one dental spray to every army dental centre, mobile dental unit and military convalescent depot at home.

A limited number of Rathbone dental units was made available at the beginning of 1945, and they were issued to army dental centres likely to become permanent peace-time establishments.

The home dental outfit was also supplied to some of the hospital ships and to all the home mobile dental units, but in the latter case without the heavy equipment and electrical apparatus. The mobile dental unit was provided with a dental chair of lighter construction than the standard type; the electric steriliser, aseptic instrument cabinet, aseptic table, fountain spittoon and electric engine were deleted from the scale, but a hand-operated saliva ejector and a large dressing tray were added.

The Field Dental Outfit. Arrangements were made on the outbreak of war to add to every field dental outfit the following articles for use in the preliminary treatment of maxillo-facial casualties: Kazanjian artery clamps, webbing head-bands and Kingsley splints.

Reference has already been made to the addition of items necessary for denture work when the field dental outfit was taken into use in home commands. It had already been recommended by D.D.D.S., B.E.F., that these articles should be included in the outfit, but it was not until some time later that they were generally supplied on special indent to dental officers attached to field ambulances. It was not necessary to issue them to dental officers attached to general hospitals and C.C.Ss. as the articles were available in the outfit for the dental mechanics attached to these units.

The original field dental chair was heavy and rather bulky and took a long time to assemble. This was replaced in 1941 by an all-metal tripod chair of simple design and constructed with light-weight alloys. It was carried in a canvas bag.

The outfits issued at the beginning of the war had been in store for varying lengths of time and were deficient of some items of equipment

as they had been assembled before the introduction of new scales. This necessitated the rendition of special indents to complete the outfits to the authorised scale.

Field dental outfits were supplied to field dental units on the basis of one to each dental officer and to all dental officers attached to medical units. Towards the end of the war, complete field dental outfits were issued to some of the large troop transport vessels to enable any dental officers on board to undertake emergency dental treatment for the troops during the voyage.

The field dental outfit comprised, at the end of the war, two panniers and the field dental chair with canvas bag packed in a wooden case.

The Field Dental Outfit for Two Dental Mechanics. The field dental outfit for two dental mechanics was the standard outfit issued during the war to all army dental laboratories at home, to field dental laboratories, to mobile dental units (operational), and to dental mechanics attached to medical units. No special scale of mechanical equipment was introduced for the large command dental laboratories at home and they were all formed from the nucleus of the standard field dental outfit for two dental mechanics. In the Middle East, however, a special scale of mechanical equipment was authorised for dental laboratories raised on the Middle East war establishment. A special scale of equipment was also introduced in July 1941, for issue to the single dental mechanic attached to a hospital ship.

The equipment of the static army dental laboratories was augmented from time to time by additional items; these included electrically driven grinding and polishing lathes and the Injectodent automatic rubber packing machine. The first Injectodent apparatus was supplied to the Aldershot Dental Laboratory in November 1939 and proved to be efficient in use and adaptable to mass-production methods. By May 1941, a second apparatus had been installed; and in the following September, two were supplied to each of the other five large laboratories at home and one to each of the two small laboratories. By August 1943, however, owing to the restrictions on the supply of dental rubbers, to the advent of acrylic resins for denture work and to the unsuitability of the machine for processing repairs to dentures, these apparatuses had fallen into disuse.

No special apparatus was supplied to the dental laboratories for the processing of acrylic dentures, other than camel hair brushes, mixing pots and bone spatulas; boiling pans were improvised or the vulcaniser was used. Various experimental auto-tension flask clamps were tried, but as there was much controversy on this aspect of the subject and as no simple and entirely efficient design was produced, no authorised addition to the scale of equipment was made. In March 1944 demands for one pound of waterglass (Sodii silicas) to each field dental outfit for

two dental mechanics were sanctioned; this substance was recommended for general use as a separating medium in model casting.

In June 1945 some American pattern pliers, specially designed for bending stainless steel, were made available for distribution to army dental laboratories at home.

The Field Dental Anaesthetic Outfit. The field dental anaesthetic outfit had been designed before the outbreak of war and was issued to large army dental centres at home and abroad and to those smaller centres where the demand for the use of general anaesthesia for the extraction of teeth was large.

In the original outfit the length of rubber tubing supplied was one yard only; this was increased to two yards in December 1939. The outfit included the standard type of facepiece, tongue forceps, sponge holders, mouth gag, mouth props, throat packs and apron. Towards the end of the war, an oro-nasal attachment was supplied to a number of army dental centres.

During the war, the outfit was not issued according to any particular scale of dental officers employed at an army dental centre, but it was supplied on special indent to stations both at home and abroad where the local commitments made them a definite requirement. One field dental anaesthetic outfit was issued to each field dental centre and mobile dental unit (operational) and to certain hospital ships.

The Field Dental Casting Outfit. The field dental casting outfit was designed at the beginning of the war to enable dental mechanics in the field to undertake the casting of metal splints required for the treatment of maxillo-facial injuries. It was introduced early in 1940. Seven such outfits were despatched to France in February of that year and an additional twenty-five the following May. It was intended to supply one to each general hospital and casualty clearing station.

The outfit became a normal supply to static army dental laboratories, to field dental laboratories, to mobile dental units (operational), and to those medical units where dental mechanics were included on the war establishment.

The Dental Haversack and the Dental Haversack (Airborne). The need of supplying dental officers in certain operational areas with some convenient container to enable them to carry on their person a small number of essential dental instruments and materials for such emergency dental treatment as they might be able to undertake, became evident following the evacuation from France. Many of the dental officers involved in that crisis took with them a few items of equipment, but no definite instructions were given for that purpose and much depended upon the officer's initiative. The question was raised in August 1941, and tentative proposals were made for the design of an emergency kit for dental officers in the field. Difficulties in connexion with the duplication of

instruments already available in the field dental outfit arose, and the necessity for strict economy in the supply of all equipment impeded the discussions and delayed the approval of such an issue. By October 1942, the 'Haversack, Dental' and the 'Haversack, Dental—Airborne' were approved, but their supply was restricted to dental officers serving with special-duty formations and the airborne troops.

The contents of these haversacks were identical, except that in the airborne haversack special spring-base metal containers replaced the ordinary tin containers for the local anaesthetic solution and the iodine bottle.

The Additional Outfit for Dental Surgical Specialists. It had been found that the dental surgical specialists appointed to home commands required special instruments, additional to those available in the home dental outfit and found in the operating theatre of the hospital to which they were attached, in order to carry out in an efficient manner the specialist type of dental treatment that it was their duty to perform; and that they had been obliged to provide such instruments at their own expense. In April 1943 the command dental surgical specialists were requested to submit recommendations for additional instruments for the consideration of the Consulting Dental Surgeon to the Army to enable him to prepare a uniform and generally acceptable scale. At this date the situation with regard to the supply of such articles as might be selected had not been examined. By November 1943 a provisional standard scale had been agreed upon, and discussion commenced on its implementation. There was considerable delay before supply was effected; many of the instruments selected had to be specially made by British firms as some of the patterns chosen were of German origin or foreign design. It was not until March 1945, that the first articles were delivered and supply to commands began. It was also intended to issue this additional outfit to the specialist and graded dental surgeons attached to 1,200 and 600 bedded general hospitals, but the slow rate of production did not allow this to be done.

In November 1945, additional equipment for the treatment of maxillo-facial injuries was issued to command dental surgical specialists, and at the same time, one dental laboratory in each command and independent district was provided with special items required for the latest procedures used in the construction of splints and appliances.

The Additional Outfit for Maxillo-facial Dental Surgeons. The scale of surgical and dental instruments available for the use of dental officers attached to the maxillo-facial surgical units developed during the course of the war, and was gradually augmented as experience increased and the latest techniques were successfully tried and accepted as sound surgical treatment.

The original teams (as they were then called) were supplied with the full scale of equipment and materials that were available in the field

dental outfit, the field dental mechanical outfit and the field dental casting outfit. At first, additional equipment, according to the personal choice of the dental officer concerned, was obtained either through local purchase or from army sources. With the formation of more maxillo-facial surgical units, it was desirable that a standard scale of equipment should be introduced. This included all the items contained in the standard field dental outfits together with Kelsey Fry's bone awls, the complete Clouston-Walker apparatus for the fixation of fractured jaws and the accessories—nuts, bolts, drills, dies, taps, rods, tubing, flux, etc. but the scale of issue of particular items was greater than was the case for command dental surgical specialists and the selected army dental laboratories at home.

Dental Materials. As a direct result of the war two important factors seriously influenced the conduct of dental practice. These were the control in 1940 of the supply of mercury, which was essential for the manufacture of explosives, and the restrictions placed on the use of rubber consequent upon the entry of Japan into the war and their effective and rapid seizure of the natural rubber producing areas of the world. The former affected both conservative and mechanical dental procedures, while the latter affected only the production of artificial dentures.

Mercury was essential for the amalgam used in the conservation of the teeth, and was also used for colouring certain denture base rubbers in the form of vermilion. Although various proprietary makes of dental cement were tried with some success in an attempt to find a suitable substitute for the amalgam filling, nothing adequately replaced it. In the case of the dental rubbers, the use of vermilion was restricted and the supply of rubbers containing it limited. Dental rubbers containing other colouring matters were introduced and widely used. The finished dentures compared favourably with those produced with the vermilion coloured rubbers, but greater care had to be exercised during processing in order to avoid porosity. Experiments were also conducted with the quick-vulcanising rubbers which were not coloured with vermilion and normally reserved for the urgent repair of broken dentures; these proved to be quite satisfactory. When, in 1942, the rubber plantations were threatened by the Japanese advances and the prospect of dwindling stocks became a reality, severe restrictions were placed on the allocation of natural rubber for dental purposes and the strictest economy in the use of existing stocks had to be enforced.

It was fortunate that research in dental plastics had made considerable progress. There was on the market a number of brands of denture base material which were primarily methyl methacrylate and called collectively acrylic resins. In September 1942, a Committee on Denture Base Materials was formed in order to report on the situation and to make recommendations to the Ministry of Health for the general adoption of

an alternative for dental rubber. A representative of the Army Dental Service was appointed to this committee. In February 1943, supplies of rubber for dental use were strictly limited in quantity, and such rubber as would in the future be available would be reserved for the repair of existing vulcanite dentures. Acrylic resin denture base material was placed on the market for general use and at a greatly reduced price. A memorandum was prepared for circulation to the dental profession setting out certain features of the new material, making recommendations for the processing and repair of dentures, and instituting practical demonstrations, which were to be given in all parts of the country.

The Army conducted thorough tests in its dental laboratories of all the different makes of acrylic denture base material and selected several which were taken into general use. Directions were issued to the effect that all new dentures were to be made of acrylic resin, but that in some cases, where a high degree of resilience was required, it was permissible to use vulcanite for partial dentures in order to reduce existing stocks of rubber, which were likely to deteriorate with prolonged storage.

It was found that partial lower dentures made entirely of acrylic resin lacked elasticity, a property which vulcanite dentures possessed and which was often essential for fitting such cases. To overcome this difficulty stainless steel lingual bars were introduced for partial lower dentures, especially when constructed in acrylic resin. The first lingual bars supplied proved to be unsatisfactory as they were not, nor could be, suitably tempered. It was decided, therefore, that for the time being all partial lower dentures would be made in vulcanite. In January 1945, after many tests, a suitable lingual bar was adopted for general use, and, as this overcame the flexibility problem, directions were issued in April for all new dentures to be made in acrylic resin. Successful experiments were also carried out in the use of fibre-glass for strengthening partial acrylic dentures; this substance was later added to the authorised scales.

The majority of artificial teeth used in the army during the war were made of fused porcelain and were supplied by British manufacturers. Supplementary stocks of teeth were, however, purchased in America, Palestine and Cyprus for the overseas forces. No contracts were placed for the supply of acrylic teeth, which came on the market soon after the general adoption of acrylic resin as a denture base. The question was examined in December 1944, and arrangements were made for the army dental laboratories to produce small quantities of acrylic teeth themselves from their own moulds and using acrylic dentine—these were to be used for selected cases.

In April 1940 it was considered that the number of different moulds of artificial teeth normally supplied to the Army was excessive, and

in order to aid the bulk manufacture of teeth it was essential to simplify the schedule. A census of the commonly used moulds was made; those in great demand were retained and the remainder were eliminated from the scale. Twelve different moulds for upper pin teeth were selected and each mould was supplied in three different shades. Eight moulds for lower pin teeth were chosen, also in three shades. Eleven moulds for diatoric teeth were retained, five of which were supplied in three different shades each, three in four shades each and three in five shades each.

The other materials used in dentistry presented no special problems, except that from 1942 Ames' Black Cooper Cement was in short supply and was thenceforth reserved for the fixation of splints in maxillo-facial work. 'Zelex' impression compound was first tried by the Army in September 1939, and was later made a general issue.

In 1941 information was sought in order to prepare a scale of dental supplies necessary to support one dental officer for one year. It may be useful to record some of the figures which emerged :

1 oz. of alloy produced 60 restorations
1 oz. of mercury produced 50 restorations
1 cavity bur prepared 5 cavities
1 packet of synthetic porcelain produced 45 restorations
1 2-oz. bottle of local anaesthetic solution was used for 25 extractions
1 lb. of plaster-of-paris was sufficient to cast 5 models
1 lb. of plaster-of-paris was used for 4 articulators
1 lb. of plaster-of-paris was sufficient for 3 large flasks or 4 small flasks
1 lb. of modelling wax made 20 full upper bite blocks
1 lb. of modelling wax made 26 full lower bite blocks
1 sheet of modelling wax was sufficient to set-up one full upper and lower case
1 lb. of base rubber and ½ lb. of pink rubber produced 40 full cases
20 units of acrylic denture base material produced 20 large full upper dentures, or 30 average sized full upper or lower dentures, or 40 mixed cases
1 lb. of pumice polished 50 jobs
1 lb. of whiting polished 150 jobs
1 hard lathe brush was used to polish 6 cases
1 soft lathe brush was used to polish 12 cases
1 felt polishing cone was used to polish 15 cases
1 file (bastard or smooth) lasted approximately 3 months
1 roll of glass paper (20 yards) was used for 120 cases.

STATISTICS RELATING TO THE CONTRIBUTIONS OF THE ARMY DENTAL CORPS TO THE HEALTH AND EFFICIENCY OF THE ARMY

To present a reliable appreciation of the general dental condition of the Army as a whole during the six years of war is a most difficult task. So many factors influence the onset and extent of dental disease in different mouths, in different communities and under different conditions that it remains difficult to assess the results of dental treatment.

It is impossible to demonstrate in any conclusive fashion how far the dental treatment given to the troops during the war helped to prevent the wastage of man-power and to raise the general health and the standard of efficiency of the Army. The fact that there was no serious discharge rate on account of dental disease, however, must surely be accepted as sufficient evidence of the great value of dental treatment.

Various factors influence the preparation of dental statistics, such as the interpretation given by different dental officers to the terms 'dentally fit' and 'dental treatment completed'. While the general policy laid down by the War Office was that the standard of dental treatment to be given to the Army under war conditions was to afford 'the greatest good for the greatest number', all dental officers could not be expected to agree as to the interpretation of this policy. Again, disagreement on this point leads to variations in the assessment of the number of fillings, extractions, etc., required by an individual soldier, since border-line cases upset the calculations. Comparison of the results obtained at dental inspections in the different commands tended to strengthen this assumption, though it must be borne in mind that the composition of units varied greatly; for instance, one unit could have a high proportion of young soldiers, while in another the majority of the men could come from one particular locality and at the same time could be drawn from the older age-groups. The statistical data about to be presented are useful, however, in that they give a trustworthy impression of the dental state of the Army as a whole. Total figures for the amount of dental treatment completed can be accepted as correct, and it may be assumed that the variables mentioned had a reasonably constant effect on other returns, which permits comparison of the figures submitted at different stages of the war. (*See* Table 41.)

The total number of unsaveable teeth extracted at the beginning of the war in relation to the total number of teeth conserved was very much higher than it was towards the end. This suggests that the general dental condition of the Army must have been considerably improved during the war years and, moreover, that at the beginning a great deal of dental sepsis must have been removed. The reason why the amount of dental treatment provided towards the end of the war

TABLE 41

Summary of Dental Treatment completed for Other Ranks of the British Army—Home and Overseas

Year		Attend-ances for treatment	Men whose treatment had been completed	Teeth extracted	Teeth conserved	Scalings completed	Men sup-plied with new dentures	Dentures supplied	Dentures remodelled	Dentures repaired
1939 (Sept./Dec.)	Home	176,259	46,270	181,631	128,012	16,894	1,597	2,404	598	986
	Overseas	14,413	4,375	5,904	9,978	2,344	300	400	202	200
1940	Home	2,080,449	836,327	1,794,576	1,749,262	361,586	38,932	58,354	12,591	12,590
	Overseas	122,688	33,027	76,627	74,101	14,282	3,591	5,278	1,468	1,955
1941	Home	3,551,098	1,231,346	1,966,925	2,771,441	631,148	91,872	135,508	34,057	25,741
	Overseas	318,809	91,719	154,208	155,728	34,321	12,664	18,462	5,297	6,145
1942	Home	3,657,425	1,267,133	1,462,691	2,731,365	684,193	99,154	141,990	46,455	35,316
	Overseas	595,450	447,333	208,014	324,025	76,449	23,098	31,653	14,103	12,260
1943	Home	2,550,928	1,292,735	940,095	2,916,855	816,073	79,118	114,701	50,112	47,111
	Overseas	891,465	347,347	253,042	419,013	110,535	31,375	40,902	23,085	28,297
1944	Home	2,576,140	912,964	547,439	1,968,932	572,440	67,629	82,798	56,883	49,631
	Overseas	1,086,141	381,593	342,506	496,625	167,107	37,744	49,893	33,051	44,103
Totals 1939–44	Home	14,592,299	5,586,775	6,893,357	12,265,867	3,082,334	378,302	535,755	200,696	171,375
	Overseas	3,028,966	1,305,394	1,040,301	1,479,470	405,040	108,772	146,588	77,206	92,960

continued to be so great was that once a man has been made dentally fit he requires maintenance treatment. Moreover, the Army was constantly being diluted with intakes whose dental condition was described as deplorable and for whom a vast amount of dental treatment was required.

INVESTIGATIONS INTO THE DENTAL STATE OF THE ARMY

In February 1940, because of the increasing arrears of the work, information was required by the War Office on the effect on man-power if a dental standard of fitness for entry into the Army were re-introduced. For this purpose an examination of the dental treatment cards held in home commands was arranged. They were sorted into four groups—Army class intakes, units of the T.A. (other than those belonging to A.D.G.B.), Army personnel of the organisation for the Air Defence of Great Britain, and the A.M.P.C. In all, 66,500 cards were examined and in each group the following particulars were required:

(i) Total number of cards examined.

(ii) Number of men who, on first inspection, had not *less than eight* sound or saveable teeth (including two molars) in the upper jaw functionally opposed to eight sound or saveable teeth (including two molars) in the lower jaw.

(iii) Number of men who did not attain this standard but were already in possession of well-fitting dentures.

(iv) Number of teeth marked for extraction.

(v) Number of teeth marked for conservation.

(vi) Number of men whose oral hygiene was classified as 'good'.

(vii) Number of men whose oral hygiene was classified as 'fair'.

(viii) Number of men whose oral hygiene was classified as 'neglected'.

The results of the examination were as follows: The small Roman numerals in the first column refer to the questions above:

	Army Class Intakes	*T.A. (not A.D.G.B.)*	*A.D.G.B.*	*A.M.P.C.*
(i)	29,300	29,600	6,300	1,300
(ii)	20,369	19,420	3,677	317
(iii)	2,006	3,157	658	295
(iv)	58,619	57,969	9,487	4,113
(v)	75,341	62,700	14,864	1,019
(vi)	9,005	9,987	2,343	174
(vii)	13,513	13,534	2,728	574
(viii)	6,660	5,474	1,155	552

From this statement the following information, expressed as the percentage of the total number of dental cards examined in each group, can be deduced:

	Army Class Intakes	*T.A (not A.D.G.B.)*	*A.D.G.B.*	*A.M.P.C.*
(*a*) Below standard	30·48	34·39	41·63	75·62
(*b*) Already in possession of satisfactory dentures	6·85	10·66	10·44	22·69
(*c*) Requiring new or remodelled dentures	23·29	23·72	31·19	52·92
(*d*) Oral hygiene 'good'	30·9	34·4	37·6	13·4
(*e*) Oral hygiene 'fair'	46·3	46·7	42·2	44·1
(*f*) Oral hygiene 'neglected'	22·8	20·9	20·2	42·5

The average numbers of conservations and extractions per man inspected in each group were as follows:

	Conservations	*Extractions*
Army Class Intakes	2·5	2·0
T.A. (not A.D.G.B.)	2·1	1·9
A.D.G.B.	2·3	1·5
A.M.P.C.	0·8	3·2

In July, October, November and December 1942, records were kept of the time spent in making the intakes to the G.S.C. dentally fit, in order to ensure the allocation of a sufficient number of periods in the training programme to enable the completion of all treatment during the six weeks of primary training. The records covered 10,003 men who were, on first inspection, in need of some form of dental treatment, and the total number of hours spent in the completion of their treatment was 13,054—an average of 1 hour 18 minutes per man—this included time spent in the waiting-room which, with the co-operation of all concerned, was reduced to the minimum. Due allowance had to be made for the routine inspection of all new intakes, the necessary documentation and for abnormal demands and emergencies. An average of four 45 minute periods per man was allotted for dental treatment for each intake.

In September 1943, reports were called for on a specially arranged dental inspection to be held in home commands in order to arrive at a cross-section estimate of the percentage of trained soldiers requiring dental treatment and to have details of that treatment. Inspections were carried out at A.D. Centres sited at military and general hospitals and at convalescent depots. Patients were selected at random.

The results obtained in the different commands and independent districts are shown below, and it is interesting to note how great is the variation between them:

Command or District	Total number of men inspected	Total number requiring some form of dental treatment including denture work	Number requiring denture work	Total number of conservations required	Total number of extractions required	Number requiring scaling
London . .	1,000	671	130	774	349	419
Eastern . .	1,000	659	93	662	290	244
Northern . .	1,000	573	71	874	198	262
Scottish . .	1,000	893	164	2,426	232	599
South-eastern .	1,000	777	191	1,633	246	493
Southern . .	1,000	808	176	1,710	429	555
Western . .	1,000	792	111	1,922	328	473
Northern Ireland .	1,426	1,154	157	2,472	476	764
Totals . .	8,428	6,327	1,093	12,473	2,548	3,809

From the above the following can be deduced:

(*a*) Percentage of trained soldiers requiring some form of dental treatment, including denture work 77·71 per cent.
(*b*) Percentage of trained soldiers requiring denture work . . . . . 12·97 „ „
(*c*) Percentage of trained soldiers requiring scaling . 45·91 „ „
(*d*) Average number of conservations required per man inspected . . . . . 1·48 „ „
(*e*) Average number of extractions required per man inspected . . . . . 0·302 „ „
(*f*) Average number of conservations required per man found to be in need of treatment . . 1·97 „ „
(*g*) Average number of extractions required per man found to be in need of treatment . . . 0·403 „ „

These figures should be compared with those given earlier in this section. There is a large decrease in the extraction incidence, the percentage of trained soldiers requiring denture work is lower, and the conservations rate has been reduced to a small extent.

The inspections carried out in connexion with the investigation by the Directorate of Medical Research of the requirements of dental manpower produced the results given below for Army class intakes on first inspection:

Percentage of recruits, in the following home commands, requiring, on first inspection:

	Eastern	*Northern*	*Scottish*	*Southern*	*Western*
0 visits . .	11·7	2·5	2·9	5·7	1·0
1 visit . .	34·0	16·6	21·1	26·3	8·8
2–3 visits . .	41·6	50·8	26·1	44·3	51·3
4 or more visits .	12·7	30·1	29·9	23·7	38·9

To illustrate the extent of dental treatment provided during the three and a half months of recruit training, the following figures were obtained from the inspection of soldiers after the completion of their training:

Percentage of men at the end of recruits' training requiring:

	Eastern	*Northern*	*Scottish*	*Southern*	*Western*
0 visits . .	55·5	55·0	61·2	46·0	44·9
1 visit . .	29·0	33·0	33·2	42·4	34·1
2–3 visits . .	11·0	9·0	3·6	11·6	13·1
4 or more visits .	4·5	3·0	2·0	0·0	7·9

From the examination of returns covering March to September 1945, and similar to those obtained for the Directorate of Medical Research, the data given below have been prepared. They provide a fair assessment of the dental condition of trained soldiers serving in home commands towards the end of the war. For the purpose of the returns, the men were divided into the following age-groups:

Age-group A . . . men under 20 years of age
Age-group B . . . men between 20 and 30
Age-group C . . . men between 30 and 40
Age-group D . . . men over 40

The number of trained soldiers inspected, in each of the four age-groups was as follows:

Age-group A	43,118
Age-group B	106,815
Age-group C	89,891
Age-group D	28,089
Total number inspected	267,913

From the returns, the following information was compiled:

(*a*) *Percentage of trained soldiers found to be dentally fit:*

Age-group A	*Age-group* B	*Age-group* C	*Age-group* D	*All Groups*
72·20	65·45	69·63	74·21	68·86

(*b*) *To complete dental treatment, percentage found to require:*

	Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
1 visit .	17·34	20·42	17·30	14·91	18·30
2–3 visits .	7·53	10·88	9·25	6·68	9·35
4 or more visits .	2·93	3·25	3·82	4·20	3·49

From an analysis of the different type of denture work required by these groups of men, it was found that the percentage in each category, expressed as a percentage of the total number of men inspected was as follows:

Percentage of trained soldiers requiring:

(*a*) New dentures, or replacement of dentures as a result of loss, etc.:

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
0·88	2·16	3·02	2·55	2·28

(*b*) Remake of existing dentures:

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
0·26	1·03	2·20	2·90	1·50

(*c*) Repairs to dentures:

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
0·23	0·69	1·04	1·54	0·82

(*d*) All forms of denture work:

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
1·37	3·88	6·26	6·99	4·60

It should be realised that the figures given above indicate the denture work required by the different groups of men at the time of inspection, and do not represent the percentages of men in the various age-groups who wore or should have worn artificial dentures.

Ulcerative Gingivitis. The incidence, per 1,000 men, of acute ulcerative gingivitis in the same groups of men was as follows:

Age-group A	4·01
Age-group B	9·08
Age-group C	6·51
Age-group D.	3·34
All groups	6·80

Additional information is given below on the incidence of entirely new cases and of relapses of this condition as it occurred in the United Kingdom. It is emphasised that the figures represent the incidence of fresh cases and of relapses only and do not give the total incidence of the disease in the Army. Some home commands reported that there was a slight seasonal increase in the incidence of acute ulcerative gingivitis, the spring and early summer months being chiefly blamed; but the statistics show that the differences were not very great.

TABLE 42

Incidence of Acute Ulcerative Gingivitis among British Troops (Officers and Other Ranks) serving in Home Commands (per 1,000 troops)

Date	*Fresh cases*	*Relapses*
March 1942	2·84	0·61
June 1942	2·47	0·54
September 1942	2·48	0·54
December 1942	2·38	0·62
March 1943	2·63	0·62
June 1943	2·78	0·73
September 1943	2·43	0·68
December 1943	2·05	0·53
March 1944	1·76	0·51
June 1944	2·81	0·68
September 1944	1·32	0·38
*December 1944	1·14	0·27
*March 1945	1·30	0·29
*June 1945	1·39	0·28
*September 1945	2·30	0·46

* For these months, the returns showed the number of officers and other ranks of the British Army distinct from other categories of personnel. Those for the earlier months do not make this distinction.

This disease was, during the war years, the cause of considerable anxiety. It was regarded as being synonymous with the trench mouth of 1914–18 and, since it was accepted that this was endemic under war conditions, a high prevalence was expected. To begin with all diseases of the gums, from the mild forms of gingivitis to severe cases of true Vincent's angina, were viewed with alarm and classified as instances of 'Vincent's Infection'. Thus the incidence of acute ulcerative gingivitis was greatly magnified. In fact it never got out of hand; energetic precautionary measures were taken whenever a case was diagnosed. The affected individual was instructed to use his own feeding utensils. The washing water used by him was used by none other. The water supply was chlorinated. No affected individual was allowed to be employed in the preparation of the unit's food. Oral hygiene was preached and practised. Attempts were made to determine the cause or causes of the condition but no conclusive results were secured.

THE DENTAL STATE OF THE A.T.S.

Detailed information regarding the dental condition of recruits to the A.T.S. is inadequate, but it was estimated that during the first half of 1941 more than 20 per cent. of women presenting themselves for enlistment were rejected as being below the prescribed dental standard. Accordingly, in June 1941, pending the issue of full instructions, the dental standard was relaxed and recruits were enrolled into the A.T.S.

irrespective of their dental condition; it was also arranged that they could be supplied with all forms of denture work under the same conditions that applied to soldiers. In September 1941 it was estimated, from the information then available, that the initial dental treatment required by auxiliaries was 75 per cent. of that required by soldiers on first inspection, but that the amount of continuation dental treatment required was approximately the same for male and female personnel.

Details of inspections during the period March to September 1945, covering 49,383 trained auxiliaries of the A.T.S., were prepared along the same lines as were adopted for the inspection of trained soldiers. The women were divided into similar age-groups for the purpose of the returns, and the number examined in each age-group was as follows:

Age-group A (−20)	10,293
Age-group B (20–30)	33,068
Age-group C (30–40)	5,291
Age-group D (40+)	731
Total number inspected	49,383

From a consideration of the returns, the following results emerged:

(*a*) *Percentage of trained auxiliaries found to be dentally fit:*

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
62·42	65·51	66·92	70·72	65·09

(*b*) *To complete dental treatment, percentage found to require:*

	Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
1 visit	23·92	18·52	20·34	18·47	19·84
2–3 visits	10·55	13·12	9·53	6·98	12·11
4 or more visits	3·11	2·85	3·21	3·83	2·96

(*c*) *Percentage of trained auxiliaries requiring new dentures, or replacements as a result of loss, etc.:*

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
0·42	0·64	0·87	0·14	0·61

(*d*) *Percentage requiring remake of existing dentures:*

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
0·07	0·37	0·91	3·14	0·41

(*e*) *Percentage requiring repairs to dentures:*

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
0·04	0·18	0·41	0·0	0·18

(*f*) *Percentage requiring all forms of denture work:*

Age-group A	*Age-group B*	*Age-group C*	*Age-group D*	*All Groups*
0·53	1·19	2·19	3·28	1·20

The incidence, per 1,000 women, of acute ulcerative gingivitis in the same groups of auxiliaries was as follows:

Age-group A	5·343
Age-group B	5·806
Age-group C	4·725
Age-group D	0·0
All groups	5·508

CONCLUSION

The Army Dental Corps was an outcome of the experience of the War of 1914–18. The need for an organised dental service within the Army had been displayed, and the Army Dental Corps was brought into being to satisfy this need. The Corps pursued its development during the years when financial stringency and a revulsion against all things military made healthy growth difficult, if not impossible. Under the stimulus of the War of 1939–45 the Corps reached its long-delayed maturity and when war ended, could rightly claim that its responsibilities had been faithfully discharged and that its insistent and ever-growing desire for a large measure of self-administration was justified by the record of its performance. The status of A.D. Corps personnel within the Army was considerably elevated, the number and variety of avenues leading to promotion and increased pay were multiplied and the morale of the Corps greatly raised. Service in the Corps became attractive and the work that the members did came to be professionally and emotionally satisfying. The dental service had grown under the shelter of the medical service; becoming full-grown, during the war years it sought a measure of administrative detachment from the service that had nurtured it, in order that its contributions to the well-being of the Army might be unrestrained by the difficulties which its subordinate association within the Army Medical Services necessarily entailed. Throughout the war the purely professional interest of the two services became increasingly merged. It was only in the administrative field that a certain divergence occurred.

CHAPTER 6

THE ARMY PATHOLOGY SERVICE*

THE organisation of the Pathology Service of the Army had to undergo rapid expansion to meet ever-increasing needs and to fulfil many new requirements. As in the War of 1914–18, expansion was possible only through the willing co-operation of the pathologists from civilian life, who, from the most experienced down to the youngest specialist, helped to maintain this service at a very high level throughout the war, in all commands, at home and abroad.

THE PATHOLOGY DIRECTORATE

The Pathology Directorate was first formed in 1919 with Sir William Leishman as its first director. Before that, during the War of 1914–18, he had been adviser in pathology and bacteriology to the D.M.S. of the British Expeditionary Force and to the Director-General, Army Medical Services.

In 1939, the directorate was accommodated in the Pathology Department of the Royal Army Medical College, Millbank. Before the outbreak of war, it had been decided that on mobilisation the Director of Pathology would move to the War Office and establish the Pathology Directorate (as A.M.D.7) there.

In September 1939, the move took place. To begin with the medical staff consisted only of the Director of Pathology (D. of P.) and an assistant director (A.D.P.). As the work of the directorate expanded, two more medical officers were added to the staff.

The move of the directorate from the War Office to the college some years before was, in the opinion of the Army Pathology Advisory Committee at the time, a retrograde step; they had had no alternative, however, for reasons obtaining at that time, but to accept the ruling. But from experience gained since the move to the college, the necessity of being in closer touch with the different branches of the Army Medical Directorate at the War Office had become very evident. With the Directorate of Pathology housed at a distance from the War Office, means of ready reference were not available and lack of co-ordination resulted. This was now remedied.

SCOPE OF DUTIES OF THE PATHOLOGY DIRECTORATE, 1939–45

The scope of pathology in the Army was widening rapidly owing to the rapid advance in knowledge of subjects within its purview, such as

* The substance of this account was provided by the Directorate of Pathology of the Army Medical Directorate.

chemotherapy, antibiotics, blood transfusion, defence against chemical and biological warfare, immunisation procedures—both active and passive, anti-bacterial and antiviral. New methods and new techniques requiring further study and practice were being evolved at this time. The Pathology Service was responsible not only for the supervision of hospital and mobile bacteriological laboratories and for the organisation of research into several urgent problems but also for maintaining the closest possible liaison with consultants and advisers in all branches of medicine and surgery. In addition this directorate made the necessary arrangements for the training of personnel for laboratories and blood transfusion units, and undertook the editing of A.M.D. Bulletins giving technical information for distribution to all medical officers.

PERSONNEL AND TRAINING

Before the outbreak of hostilities, a list of all civilian pathologists in the country had been prepared with the result that, when required, the difficulty of getting the right men for the appointments in the various laboratories was much reduced. Requests for pathologists were sent by the Army Medical Directorate to the Central Emergency Committee of the British Medical Association (which later became the Central Medical War Committee), and were forwarded by them to the Medical Research Council, which had compiled and maintained a register of pathologists in the country. Nomination of pathologists for allocation to the Army was undertaken by a sub-committee of the Council. The Director of Pathology was a member of this sub-committee, so that the precise requirements of the Army were represented. In this way a supply of pathologists was maintained, after the initial appointments on the outbreak of war had been filled by Regular, Reserve, Supplementary Reserve and Territorial Army officers.

Army pathologists were divided into two main groups:

(1) Fully trained and experienced pathologists who were employed as 'specialists in pathology'. Such appointments carried the rank and pay of a major, R.A.M.C., together with specialists' additional pay. Before classification as a full specialist, an officer was required to have had five years' whole-time experience of pathology since qualification, except in special circumstances.

(2) Trained but relatively inexperienced pathologists who were employed as 'graded pathologists'. These appointments did not carry any advance in rank, but entitled the officer to draw additional specialist pay, when so employed. Many of these 'graded specialists' were obtained from stations overseas where medical officers with some laboratory experience were given further training, usually in the central pathology laboratory of the command which was officered and adapted for carrying out such training. But for this subsidiary supply of pathologists it would

have been quite impossible to fill the necessary appointments. The great majority of these graded pathologists carried out extremely good work and many were later classified as 'fully qualified specialists'.

A syllabus, based on the peace-time course of instruction for pathologists at the Royal Army Medical College, which had been found by experience to meet the needs of the Army, was drawn up. Through the courtesy of the University Court, laboratory accommodation was provided in the Departments of Surgery and Bacteriology of Edinburgh University for the formation of the Command Laboratory of the Scottish Command. The course of instruction was for six months and the teaching was carried out by the A.D.P., Scottish Command, and his staff.

This internal supply of pathologists—including those trained in central laboratories overseas—added to the recruitment of fully experienced or 'graded' pathologists from the M.R.C., enabled the Army's needs to be met without interfering too drastically with the civil pathology services.

All pathologists proceeding overseas attended a short course of three weeks in tropical medicine and pathology, and this course was, in most cases, supplemented by additional instruction on arrival overseas. Other courses of instruction were held at the Army Blood Supply Depot, the Emergency Vaccine Laboratory, the R.A.M.C. Gas School, etc.

Courses of instruction in the bacteriology of anaerobic infections were made possible through the generous help of the Middlesex and University College Hospitals. As a result, a large number of pathologists were fully trained in modern anaerobic work.

The command laboratories were all officered by experienced pathologists, and junior pathologists were, as far as possible, posted to such laboratories to gain experience before being posted to take charge of a laboratory.

LABORATORY ASSISTANTS

The supply of laboratory assistants had been a serious problem at the outbreak of war and there had been direct recruitment under the misleading heading of 'laboratory assistant' without the subheading 'bacteriology and pathology'. As a result only a very small number of suitable men was obtained. Direct recruitment was stopped and a training scheme evolved whereby instructional courses were undertaken in the main laboratory in each command. Very many efficient laboratory technicians were trained in this way. Experience gained during the war indicated, however, that special staff and facilities are necessary in the principal laboratories for this to be effective.

Training cannot be carried on satisfactorily in a busy laboratory full of routine work, unless special accommodation and teaching staff are made available. As in the case of pathologist officers, so in the case of laboratory assistants, the central pathology laboratories in commands

overseas did excellent work in training. The courses were short and intensive—three to four months—and were followed by an examination. This system worked excellently until the release programme came into force after the cessation of hostilities, when experienced N.C.Os. were at a premium.

THE ORGANISATION OF PATHOLOGY IN COMMANDS AT HOME

Under the Director and Assistant Director of Pathology at the War Office the service was administered in commands by the A.D.P. of the command who had a dual function—adviser on administrative and technical pathology matters to the D.D.M.S. of the command, and officer commanding the command laboratory. In addition to the peace-time command laboratories in London, Aldershot, Edinburgh, Chester, Tidworth, York and Northern Ireland, there were also the general hospital laboratories, such as those at Shaftesbury, Drymen, Glasgow and elsewhere. The general hospital laboratory played a very important part in the general plan in commands both at home and abroad. On the L. of C. and in base areas, these laboratories, in addition to their routine hospital work, frequently served as area or district laboratories for concentrations of prisoners-of-war, labour camps and base troops, where grouping of hospitals was not practicable; this led to a considerable degree of overwork, unless temporary additions to the war establishment were made.

The statement below gives the war establishment of a general hospital laboratory:

A General Hospital (50 *to* 1,200 *Beds*)
Extract from W.E. IV/356/1

Laboratory assistants	50 beds	100 beds	150 beds	200 beds	250 beds	300 beds	400 beds	500 beds	600 beds	700 beds	800 beds	900 beds	1,000 beds	1,100 beds	1,200 beds
Staff-sergeant	–	–	–	–	–	–	–	–	–	–	–	1	1	1	1
Sergeant	–	–	–	–	–	–	–	–	1	1	1	–	–	–	–
Corporal	–	–	1	1	1	1	1	1	1	1	1	1	1	1	1
Lance-corporal	–	–	–	–	–	–	–	–	–	–	–	1	1	1	1
Private	1	1	1	1	1	1	1	1	2	2	2	3	3	3	3

Pathologists were not definitely allotted to any particular general hospital, but were posted to commands and theatres of war within the establishments of hospitals on an 'as required' basis.

The chain of laboratories established on mobilisation by the Emergency Bacteriological Service (later Emergency Public Health Laboratory Service) gave very valuable assistance to military laboratories

in many areas. This service was included among the defences against the possibility of bacterial warfare; pathologists not being required in this manner, they were able to concentrate on the bacteriological investigations of epidemics, and in this way facilities for the early laboratory diagnosis of infectious disease were afforded which would not otherwise have been available. The directorate was much indebted to the Medical Research Council for this service.

There was also close collaboration with the Emergency Medical Services (E.M.S.) Laboratory Service. The siting and equipment of the new laboratories were planned, as far as possible, with a view to their value in the organised post-war pathology service. This combination of expanded Army laboratories, Emergency Public Health and E.M.S. laboratories, provided a very efficient pathology service for the home commands.

It is of interest to note that the evacuation of the B.E.F. in 1940 involved the directorate in the loss of equipment of twenty laboratories, including that of a central biochemical laboratory and three mobile bacteriological laboratories. By the middle of August 1940, practically all these laboratories had been built up again and the pathologists of the original force were fully employed once more.

In 1940 a consultant in bacteriology to the forces at home was appointed.

MEDIA MANUFACTURING CENTRE

After initial administrative difficulties, the media manufacturing centre was established at home and combined with the L.C.C. Centre. Standardised media, ingredients for media, Kahn antigen, etc., were made in the United Kingdom at the centre and shipped abroad to the base depots of medical stores for distribution. The range of products turned out was continually increasing and the provision of reliable culture media ready-made and available to all laboratories was a great advance.

THE EMERGENCY VACCINE LABORATORY

The outbreak of war in 1939 resulted in a considerable strain on the resources of the vaccine department of the Royal Army Medical College in the early days of mobilisation owing to the sudden necessity of providing large quantities of typhoid vaccine. To ensure that the department would meet all demands likely to be made on it, arrangements were made for extra personnel and the necessary reserve of Roux bottles, vaccine bottles and caps. The mobilisation establishment of the vaccine department was two officers and the necessary laboratory assistants, but this establishment was increased as the work grew in volume in the later years of the war.

It had also been decided shortly before the outbreak of hostilities that the vaccine department should move from London to avoid the risk of bombing. The Military Hospital, Tidworth, was selected as the site and in September 1939, the staff and equipment moved there in lorries from Millbank. Accommodation was provided in two large barrack rooms and annexes. Tidworth had been selected as the site, for the reasons that the personnel of the laboratory could be attached to the R.A.M.C. company there, and, in addition to the two barrack rooms, certain smaller offices and space for animal houses were available.

Before the move, 300 l. of T.A.B. vaccine were bottled ready for issue, plus another 200 l. in bulk ready for bottling.

From this time onwards, throughout the war and afterwards, the emergency vaccine laboratory became the centre of production, for the Army and the Royal Air Force, of vaccines—particularly T.A.B. and cholera—and of diagnostic sera and suspensions. The routine weekly production of T.A.B. vaccine alone was approximately 120 l., and this quantity was increased on many occasions. In the first quarter of 1944 the peak figure was reached, with a total issue of 5,110,000 ml. of vaccine during the quarter; this amount included 1,112,500 ml. of T.A.B. vaccine and 162,500 ml. of cholera vaccine; in addition there were considerable issues of diagnostic materials which, though not so great in volume, often entailed considerably more work in production than is generally appreciated. The preparation of specific diagnostic sera in large amounts, and of sufficiently high titre to permit of 'pooling' and yet to retain an adequate titre, often requires a repeated series of immunisations in different rabbits. The issue of rabbit sera for diagnostic purposes increased fourfold during 1943 and nearly 100 rabbits were employed in serum production at one time. Work was done to ascertain the most suitable method of preserving agglutinating sera under tropical or sub-tropical conditions. The opening of the North African campaign greatly increased the overseas demand for vaccines, sera and suspensions, in addition to those already being supplied to Middle East Command.

The work of the laboratory comprised much research work in addition to the routine, and a very competent team of workers was assembled who worked in close liaison with the Medical Research Council, mainly in connexion with the investigation of typhus fever and influenza.

Other problems studied included observations on the use of propamidine and acridine dyes in the nose, with particular reference to the diphtheria carrier state, and the effect of a bacteriostatic substance upon the common cold.

In regard to typhus, work in the emergency vaccine laboratory was concentrated mainly on antigenic studies of different strains of rickettsiae,

and as a result of meetings held in London at the National Institute for Medical Research a plan of research was formulated. New strains of rickettsiae were continually being flown home from the Middle East Command for study, and much of the work was concerned with the assay of vaccines. In 1945 the manufacture of scrub typhus vaccine was started, but special arrangements were made for this at Frant, which are described elsewhere.

Research on the T.A.B. vaccine was continually being carried out. A very thorough investigation of alcoholised T.A.B. vaccine was made, and the possibility of combining T.A.B. vaccine with tetanus toxoid was also investigated but not adopted, owing to the possible deleterious effect of the toxoid component on the immunising powers of the T.A.B. antigens.

The emergency vaccine laboratory continued to be accommodated in Tidworth Military Hospital until July 1942, but on the arrival of the U.S. Army in the Salisbury Plain Area, it became necessary to vacate Tidworth. At the same time Everleigh Manor, five miles from Tidworth, on the road to Upavon and Devizes, became available and the whole unit moved there in July 1942, to join up with the subsidiary serum laboratory which had moved to Everleigh some months before. The accommodation was admirably situated for the purpose and the necessary rooms were soon provided with laboratory furnishings. The offices, detachment quarters and men's messing and recreation rooms, together with the vaccine and serum laboratories, were accommodated in the manor building; the research laboratories and the animals were housed in an annexe and hutments. The expansion of routine and research work necessitated some amendment to the war establishment which now included five officers, one of whom was a lieut. colonel and the remainder might be majors. The rest of the unit was composed of R.A.M.C. other ranks, and of civilians, many of whom were women orderlies.

An additional advantage was that mobile bacteriological laboratories for duty overseas were mobilised at Everleigh to the mutual advantage of both units.

RESEARCH TEAMS*

Research was organised and directed with the help of the Medical Research Council on many occasions to deal with urgent problems as they arose, and one method of doing so was by the formation of teams, with the co-operation of the Directorate of Medical Research. Teams to study shock, typhus, anaerobic infection and penicillin control were examples of such research, apart from the continual investigations in many other fields too numerous to mention—common cold, influenza,

* For fuller details of these activities the Medical Research Volume of this History should be consulted.

infective hepatitis, therapeutic trials, effects of immunisation, etc. Many of these teams functioned in the field in specially equipped mobile bacteriological laboratories.

Penicillin Research. The Army penicillin research teams consisted at first of a surgeon, bacteriologist and technicians working in the different theatres of war with the limited supplies at first available. Reports of both early and late treatment of infected wounds had confirmed the early promise of the value of penicillin. As supplies became more readily available, the laboratory aspects of penicillin investigations in hospitals on active service received widespread attention in hospital laboratories and specialised units. Detailed attention was given to its stability, dispensing, sensitivity and activity, alone and in combination with various sulphonamides. Its value in wounds in general, and in head wounds, chest wounds and joint injuries in particular, was a subject of continued study in collaboration with the clinician. Its value in medical treatment was controlled, and different techniques for its estimation in body fluids were tested in the laboratory. It will be seen that penicillin was the subject of intense investigation, resulting in great advances in our knowledge of its uses. Apart from well-organised, co-ordinated research for which the war provided a unique opportunity, it is little exaggeration to say that there was scarcely any laboratory at home or abroad in which the pathologist did not devote such time as he could spare at the bench to the practical study of penicillin in its various aspects.

A most outstanding and valuable report on penicillin was a preliminary report to the War Office and the Medical Research Council on *Investigations concerning the Use of Penicillin in War Wounds*, carried out under the direction of Sir H. W. Florey, F.R.S., Honorary Consultant in Pathology to the Army, Sir William Dunn School of Pathology, Oxford in collaboration with the Consulting Neuro-Surgeon to the Army.

At the time of the report, a quick answer was required to the following questions: Can penicillin be used effectively in the Army at all ? If so, how much is required, and at what place in the Army organisation can it be used to the best advantage Such was the desire for speed that the time for investigation was limited to three months. It was concluded that penicillin could make a substantial contribution to the recovery of wounded soldiers, with a corresponding saving of hospital time.

It was recommended that until penicillin became available in abundance supplies should be under the control of the Directorate of Pathology of the War Office. Useful measures for the adequate control of penicillin in the field were also formulated. The principal of these were the appointment of a 'surgical penicillin officer', 'who would be an officer with extensive experience of wounds in this war and with experience of penicillin administration', to tour commands and give instruction in the

latest methods, and of a 'pathologist penicillin officer' to be responsible for transport, distribution and assay of penicillin. Recommendations were also made on the treatment of burns and of gonorrhoea by means of penicillin.

The principles learned in this investigation were taken into practice with great benefit in the later campaigns in Europe.

Gas Gangrene (*Clostridial Myositis*). The knowledge of the pathology, bacteriology and treatment of gas gangrene gained in 1914–18 was advanced considerably during the war. The War Wounds Committee of the Medical Research Council set up in 1942 an Anaerobes Sub-Committee, of which the Director of Pathology was chairman, to inquire into the prevention and treatment of anaerobic wound infection, particularly gas gangrene. In addition to directing research, the anaerobes sub-committee was concerned very largely with the rapid propagation of knowledge. Special courses were arranged for Army pathologists in the bacteriology of anaerobes. Information on gas gangrene treated in the United Kingdom was mainly derived from analysis of case reports, but very valuable information on anaerobic infections of war wounds was obtained as a result of an investigation originating in Middle East Force and continuing in Italy and France. Apart from the excellence of the bacteriology, the centralisation of the work in one laboratory was clearly of the greatest value in obtaining the maximum information from a comparatively small number of cases. Points of particular interest which emerged from this work were the descriptions of infections with *Cl. oedematiens* and the description of streptococcal myositis; the relative importance of the soil and the clothes as sources of infection, the association of proteolytic organisms, particularly *Cl. histolyticum*, with a high mortality rate, and the beneficial effect of antitoxin in treatment. The relationship of the nature of the infecting organisms both to time of onset of the disease and to its mortality rate was traced. When only one of the pathogenic clostridia was present the average time of onset was twenty-three hours. The mortality rate tended to rise if more than one of the pathogenic clostridia or a proteolytic clostridium were present, and reached a 100 per cent. in the presence of *Cl. histolyticum*. Knowledge and understanding of this grave infection increased substantially during the war, so that better methods of prophylaxis and treatment were introduced, with improved antitoxins and new drugs to supplement early and adequate surgery, which remained the most important prophylactic measure.

Traumatic Shock, Team II (1945–6). This team carried out observations on 117 battle casualties and 164 healthy soldiers. As recent laboratory studies had shown that nucleotides might play a part as toxic metabolic factors in the response of the body to injury, it seemed important to study the effect of trauma on the distribution of nucleotide

derivatives in the blood of man. An opportunity to carry out this study occurred in the invasion of North West Europe. The findings supported the view, established in animal experiments, that trauma is associated in man with a redistribution of nucleotides within the body. Among other interesting observations the team noted that the volume of muscle damaged may be much greater than is generally realised and that the extent of the damage is probably of great importance in determining the clinical condition of the patient.

Typhus. Knowledge of typhus control differed little in 1939 from what it had been at the end of the War of 1914–18, during which millions had died of the disease in central and eastern Europe. And yet the expected holocaust did not occur, though typhus was rife in many battle areas. Africa, Burma, Iraq, Persia and Italy were all centres of infection and the menace in Europe was, if anything, intensified on the cessation of hostilities with a devitalised and undernourished people open to attack. What prevented the spread ? Undoubtedly D.D.T. and active immunisation played the major parts. Before, and during, the war, much time was devoted to antigenic analysis of the various typhus rickettsiae, upon which the principles of immunisation and diagnosis both depend. Intensive work was done in the United States and in Great Britain, and not least in the military laboratories at home, in India, Burma, Persia, Iraq and Egypt during the war. Strains of rickettsiae were flown home from the different theatres for study, and for antigenic analysis necessary for the preparation of diagnostic material and vaccines. The larva of the mite *Trombicula deliensis*, the vector of scrub typhus, which infests localities in South East Asia, can be avoided only with difficulty. A special vaccine was prepared against scrub typhus from the lungs of infected cotton rats. This vaccine had been shown to confer protection on laboratory animals, but the sudden end of hostilities prevented completion of the trial and results were inconclusive.

The work of the British Army Typhus Research Team which was formed at the emergency vaccine laboratory at Everleigh was a further example of the typhus investigations carried out between 1941 and 1946 jointly by workers from the National Institute of Medical Research, Hampstead, and the emergency vaccine laboratory.

Two substances, para-sulphonamidobenzamidine hydrochloride (V.147) and para-sulphonamidobenzamidoxine hydrochloride (V.186), had given highly promising results in laboratory tests in work at the National Medical Institute and the British Army Typhus Research Team was formed to carry out chemotherapeutic trials in typhus fever in man with these drugs.

The team began work in Algiers in July 1943, and although the number of cases available throughout the summer and autumn was small the experience gained was valuable. They formed the conclusion

that the drug V.186 did not produce any obvious clinical effect in patients in the second week of the disease. It was considered that V.186 did possibly cause a slow improvement in the condition of patients but the need for further observations on a large group of patients was obvious.

The Naples outbreak in December 1943 provided further material for further study and much of the work was transferred to that centre. A detailed analysis of the clinical course, symptomatology and physical findings in the cases treated was presented and tabulated in the Medical Research Council Special Report Series, No. 255—*Chemotherapeutic and other Studies of Typhus.*

The reason for the failure of V.186 in the treatment of typhus in man and its success in the mouse was not clear.

Infective Hepatitis. As in the War of 1914–18, so in that of 1939–45, infective hepatitis attacked the armies in the field to a degree that is not generally realised—and the Army at home did not entirely escape. The impact of attack was felt very severely in Middle East Force and Italy. The disease reached epidemic proportions in Middle East Force, and intensive investigations were made into the mode of transmission and the discovery of the responsible agent. The artificial communicability of the disease was demonstrated by injecting six human volunteers intravenously with infected blood—all attempts at animal inoculation having proved fruitless. The investigations were continued and an attempt to isolate a possible virus was made, a wide range of animals being used. These tests were also unsuccessful, but various facts emerged, such as the immunity of local inhabitants, the significance epidemiologically of subclinical attacks and the liability of officers in the Army (as distinct from the Navy) to contract infection. Following on the discovery of the infective agent in faeces, it was postulated that there existed some lack of acquired herd immunity on the part of officers, through less exposure to casual excremental infection, as an explanation of their increased susceptibility. This was not generally accepted.

Homologous serum jaundice and the possibility of syringe-transmitted infection became a serious problem in connexion with transfusion of plasma and arseno-therapy. It was suggested that hepatitis was being conveyed through venepuncture and intravenous injections. It soon became evident that this hypothesis was correct.

Diphtheria. Although diphtheria never reached serious epidemic proportions it naturally received much study and special interest, because it was always present in the Forces. Following on a really intensive immunisation of children in 1940, the subject of mass immunisation of the troops against diphtheria was continually under review, particularly in Middle East Force, where the incidence had been high in certain units. But work on the reaction in the adult resulting from the injection

of A.P.T. clearly showed that the reactions of young children and of soldiers in a force were not at all comparable, and that more harm than benefit would accrue from blind mass immunisation of an adult Army in the field and that, in any case, it was unnecessary in view of a process of natural immunisation during the preliminary years of army communal life. On the other hand, immunisation of the recruit as now practised is a well worthwhile procedure as a long-term policy.

New bacteriological methods of supplementing cultures of Loeffler slopes by culture on blood agar media containing potassium tellurite were widely practised in all laboratories and resulted in a much higher degree of accuracy. The rôle of *C. diphtheriae* in wounds received much study and led to the conclusion that it was a secondary invader only, and not a primary agent, and that it was present mainly when infection elsewhere was also present.

ORGANISATION OF THE ARMY PATHOLOGY SERVICE IN OVERSEAS COMMANDS

In most instances this is considered in connexion with each of the campaigns, but that in West Africa is best dealt with here.

WEST AFRICA COMMAND

In 1941 an A.D.P. was appointed and plans were initiated for the provision of laboratories in five military hospitals in Nigeria, three on the Gold Coast, two in Sierra Leone and one in Gambia. In most cases this entailed completely new building. A standard plan was drawn up in conjunction with the Royal Engineers and a number of laboratories built.

A team for the field investigation of trypanosomiasis was also formed, and consisted of African laboratory assistants and a N.C.O. trained in this work, who carried out gland puncture surveys of African units.

In 1943, the Consulting Physician W.A.C. put forward the recommendation that a military medical research laboratory should be constructed in Accra, the headquarters of the command. The establishment of this laboratory, which was planned with a view to extensive histological work and animal experimentation, consisted of a team comprising a pathologist, physician, biochemist and African and European technical staff, working under the joint direction of the Consulting Physician and the A.D.P., and incorporating the previously formed trypanosomiasis team.

Before the construction and occupation of its own laboratory, the team was able to commence work at the Medical Research Institute, Korle Bu, through the courtesy of the civil authorities.

The training of Africans as laboratory assistants was undertaken at all West African laboratories and the establishments of these laboratories

contained a number of these trained African technicians who were graded as laboratory assistant 'African', class I, II and III. It was found that, whereas their technical abilities often equalled or surpassed those of their European colleagues, their sense of responsibility was rarely sufficiently great to warrant their employment in lieu of a European of a similar grade.

In 1945, a course of training for pathologists, to afford local replacement of time-expired pathologists, was begun at the Military Medical Research Laboratory. A number of officers completed the course and were duly classified as graded pathologists.

CHAPTER 7

THE ARMY BLOOD TRANSFUSION SERVICE*

INTRODUCTION

THE importance of resuscitation work, in which transfusion holds a major position, was appreciated by the military authorities long before the outbreak of war. For the provision of an adequate transfusion service, the choice lay between two policies. There was, on the one hand, the policy of blood grouping the whole Army, supplemented by the issue of transfusion equipment to all medical units, so that they would be capable of obtaining blood for their needs from donors on the spot and with the minimum of delay. There was, on the other hand, the policy of establishing an Army Blood Transfusion Service (A.Tr.S.),† based on an elaborately equipped Army Blood Supply Depot (A.B.S.D.) in the home country, from which supplies would be dispatched to special transfusion units in overseas forces. In this case the medical officer in the field would be relieved of the onus of obtaining supplies himself, and a body of officers, especially trained in transfusion work, would be created. The second choice was adopted.

The British Army thus came to be the only one with a transfusion service capable of producing its own blood, fluid blood substitutes or dried blood substitutes, grouping serum and crystalloids suitable for use in any field of operations. Had the Army committed itself to the first choice, it would soon have found itself entirely dependent on civilian or commercial organisations for the supply of blood substitutes and crystalloids. Experience, in 1942, when commercial firms were asked to supplement the Army's own supplies of crystalloid solutions, showed that British manufacturing firms were not equipped to produce on the scale required.

Furthermore, experience of modern mobile warfare quickly revealed that, save in exceptional circumstances, the time required for obtaining blood during the course of a heavy battle, simply did not exist. This, indeed, was the experience of the enemy, who relied on this system,

* The substance of this account was provided by Sir Lionel Whitby, Regius Professor of Physic in the University of Cambridge and, during the war years, Brigadier and Consultant in Resuscitation and Transfusion to the Army and in charge of the Army Transfusion Service, an organisation very much his own creation. An account of the Army Blood Transfusion Service from the clinical aspect will be found in the Surgical Volume of this Series, Chapter 2.

† It is to be noted that the abbreviations used in this account, e.g., A.Tr.S., A.B.S.D., are not official. They are used in this narrative because of their convenience.

and also of the Americans, who had eventually to abandon their elaborate equipment for collecting blood 'on the hoof', and adopt the British method of a central blood bank, furnished with blood obtained from their troops in England, and later, by delivery from the U.S.A. Mass blood grouping of troops presents great difficulties; errors technical or clerical may readily reach 10 per cent. So, at least, was the American experience. Mass grouping of troops was, therefore, discouraged, however spectacular and useful it might appear to be in theory or to the lay mind. But in order to stifle criticism and to provide some measure of blood locally obtainable, it was laid down that the following personnel should be carefully blood grouped, with the result recorded in A.B.64 and on the identity disc:

1. All medical units.
2. Base troops.
3. Special troops, such as commando and airborne, who were likely to work in isolation.

The idea of an Army Blood Transfusion Service was discussed by Lieut. General Sir William MacArthur, then D.G.A.M.S., with the President of the Royal College of Surgeons, in the autumn of 1938, soon after the Munich crisis. It was agreed that the Royal College of Surgeons (R.C.S.) should design the necessary organisation and procure the basic staff and equipment. In April 1939 a potential key staff, drawn almost entirely from the laboratories of the Royal College of Surgeons and the Middlesex Hospital, was earmarked. There was a Director, Army Transfusion Service, with the rank of colonel; an officer commanding the Army Blood Supply Depot (Home), (colonel); and an overseas Blood Transfusion and Surgical Research Laboratory (B.T.S.R.Lab.) commanded by a lieut. colonel. The Service was placed under the control of the Directorate of Pathology, War Office. At the same time the South-western counties of England, with headquarters at Bristol, were selected as the site of operations, it being thought, at that time, that this would be a safe area.

In the uneasy summer of 1939 the first foundations were laid in Bristol. Through the goodwill and co-operation of the medical officer of health (M.O.H.), a voluntary donor campaign was launched. At the same time temporary premises in a corporation hospital (Southmead) were provided by the M.O.H.

All through the summer months co-operation was sought and obtained from the M.Os.H. of the five South-western counties, and through them, the help of hospitals, pathologists, doctors and voluntary workers. At the outbreak of war there was a nucleus of about 5,000 volunteers in most of the west country towns, and an organisation was in existence capable of rapid expansion.

Nevertheless, it was difficult work to attempt to inspire enthusiasm and sacrifice for a war which most people thought would never happen. Some sort of guess was made as to the requirements of this entirely new service, in respect of personnel, equipment and transport. When it is realised that this pre-war organisation was evolved entirely by civilians, it can be considered remarkable that the establishment required so little alteration when it was reviewed by Army experts after having been in operation for two months.

On Sunday, September 3, 1939, mobilisation began in earnest. In quick succession there appeared at Southmead Hospital numerous officers and numbers of V.A.Ds., these last, at all hours of the day and night, all hungry and many footsore, some having walked the five miles from the station, and all anxious to start work at once. For such an influx, neither billets nor food had been provided, neither, at the time, was there any work of the type which a V.A.D. would expect to do. Meanwhile many of the civilian laboratory staff were braving even stranger adventures. They found themselves summoned to a recruiting office in London where, after a perfunctory medical examination, they were duly enlisted and entrained for the wilds of Salisbury Plain—there to be equipped. Here they were neither expected, welcomed, nor equipped in a depot already full to overflowing with other newly recruited soldiers, all requiring the same treatment. Inevitably they were, the next day, returned to their own unit at Bristol, there to be at least welcome, but there also to raise, once again, the embarrassing questions of billets, pay and equipment, the procedures for which, at that time, were beyond the comprehension of the civilian staff.

The hospitality of Southmead Hospital at this stage exceeded all bounds of normal generosity. The nation owes a debt that can never be repaid to the medical superintendent, the steward, and all the staff of Southmead Hospital. Without their help and co-operation the Army Transfusion Service would never have reached a stage where bottles of blood were being obtained in quantity within forty-eight hours of the declaration of war.

The Service passed through its difficult initial phases and quickly became established, but from the aspect of administration and internal economy its early records constituted an auditor's nightmare.

At the outset the production of the home depot was directed towards supplying the B.E.F. with whole blood, while its research department concerned itself with methods for prolonging the storage period of blood, and, with the longer view, the development of a satisfactory and more durable blood substitute. This last work had so advanced by 1940 that the first small deliveries of filtered fluid human plasma were available for use at the time of Dunkirk and in the Norwegian campaign. The advance party of the Blood Transfusion and Surgical

Research Laboratory (Overseas) embarked at Newhaven on October 5, 1939, reaching Dieppe the next day. On October 6, 1939, the first delivery of 40 pints of blood was made by air to this overseas unit, and notification was received that some of this blood had been used on October 13, 1939. After this time drafts were dispatched during October, November and December 1939, together with all the equipment required to complete the overseas unit.

The home depot was severely tested in April and May 1940 in meeting the requirements of the N.W.E.F. and B.E.F., but was able to meet all demands until the time of the final evacuation from the Continent. For the B.E.F. dispatches of blood were made by air from Filton Aerodrome, Bristol, to Dieppe Airport, the blood being contained in special insulated boxes which maintained a low temperature during the journey. After Dunkirk the Blood Transfusion and Surgical Research Laboratory (Overseas) was disbanded, and no such ambitious unit was ever afterwards re-formed. In its place a simple base transfusion unit (B.T.U.) was provided to serve in every field of major operations.

As the war progressed the size of this unit increased greatly in order that it might efficiently fulfil its main function of distribution. These B.T.Us. were designed to be self-supporting so far as the major requirements of crystalloid fluids for a force were concerned, and to distribute efficiently to forward field transfusion units (F.T.Us.), supplies of blood or the blood substitute appropriate to the climate of the country, obtained from the home depot.

The first of the B.T.Us. left for the Middle East in August 1940; this unit, with headquarters in Cairo, was able to exploit local resources for the supply of blood, blood serum and blood plasma with which to supplement supplies of dried plasma sent from the home depot; it carried the whole burden of transfusion work from the time of General Wavell's early campaigns, through El Alamein, to the final battles in 1943. In 1942, 2 B.T.U. and 3 B.T.U. were sent to India and 4 B.T.U. to North Africa. Early in 1943, 5 B.T.U. left for Persia but was eventually diverted to the Middle East and acted as an advanced section of 1 B.T.U. in the Tripoli area; in 1943 it proceeded to Italy and operated with C.M.F. until the close of the campaign in 1945.

In 1944, 1 B.T.U. was withdrawn from Cairo, refitted in England, and proceeded overseas with the B.L.A. on June 6, 1944; it operated with this force until the close of the campaign in 1945.

With every major force there were a number of F.T.Us., appropriate to the size of the force; altogether 41 such units were mobilised and equipped. During the whole war the Army Blood Supply Depot (Home) was concerned with the supplying of these many forces with blood, when the force was operating within air supply distance, with fluid plasma, dried plasma, crystalloid solutions, grouping serum and

transfusion equipment; it acted as the parent unit and mobilisation centre for all other transfusion units and as the central school of instruction in transfusion and resuscitation for the whole British Army. At no period during the war was it ever possible to consider that the requirements of the Service reached a stable basis. Always the demand was on a mounting scale and this rendered difficult the forward provision of equipment. At the end of the European war, however, it could be said, with fair confidence, that no force was ever vitally short of transfusion supplies or equipment, and that the A.Tr.S. built for itself a fine *esprit de corps* and exercised an ingenuity for exploiting local resources which enabled it always to render the service that was expected of it.

THE REQUIREMENTS FOR AN ARMY TRANSFUSON SERVICE UNDER WAR CONDITIONS

The creation of a transfusion service which would meet all possible Army needs was no mean problem; it called for much thought, considerable ingenuity and meticulous attention to minute detail. The lessons of the War of 1914–18 and subsequent clinical and experimental research work had clearly shown the virtue of transfusion in the treatment of exsanguinated men and had indicated that the requirements of any one individual might be of a very large order. The main problems, as they appeared in 1939, were:

1. The provision of considerable but unknown quantities of stored blood for use in forward areas.
2. The devising of a simple but efficient apparatus for administration, which would be stout enough to stand up to field conditions and inexpensive enough to permit mass production, as well as justify expendability when salvage was impossible.
3. The initiation of work designed to prolong the period of safe storage of blood and to perfect apparatus which would provide proper conditions of storage during transport and in the field.
4. To develop the production of a blood substitute stable enough to stand up to tropical or arctic climates, indeed wherever the Army might have to operate.
5. To produce a grouping serum stable without refrigeration, so that any unit, or medical officer, could be self-supporting if need be.
6. The devising of standard packings, medical mobilisation equipment for medical units, equipment necessary for resuscitation in the field and special packs for airborne troops and other special forces.
7. The provision of an efficient refrigerator servicing organisation.
8. The education of R.A.M.C. personnel in the technique of transfusion work, the basic physiological principles of resuscitation and the fine art of the work in general.

The size of the problems, albeit large enough in 1939, increased greatly as the war progressed.

PROVISION OF STORED BLOOD

It was correctly assumed that blood could not be obtained without donors. Donors could not be obtained without publicity. Donors would not keep faith unless the technique of blood-taking was painless and facile, unless the organisation for the sessions was made convenient to them and involved the minimum of waiting, and unless they themselves were treated with kindness, courtesy, respect and gratitude.

The obtaining of these conditions called for the creation of a donor registration department concerned with registering and indexing the records of volunteers and with calling them to attend for donation at suitable times and places; attached was a sub-department dealing with publicity. At the same time a blood collection department required to be formed, consisting of teams drilled to a high pitch of technical efficiency and schooled to be punctilious and polite. These two departments were co-ordinated by a standing committee, which met once a month to arrange programmes of bleeding sessions and publicity, and where the two points of view could be expressed—the one by office administration and the other by those who had to endure the daily and monotonous toil of field work. The provision of blood was the basic function of the Service and the size of the problem grew to exceed all reasoned forecasts. Whereas in 1939 the original war establishment (W.E.) catered for the production of about a hundred pints of blood in a day (though leaving latitude for expansion), towards the end of the war the Service was collecting 1,200–1,300 pints a day with regularity; the record figure for day-collection was 1,657. This vast expansion called for constant review and reorganisation of the whole depot, for it naturally had an effect on all other departments. At the outset the only product catered for was stored blood, with a life of some 10–14 days. With the advance of knowledge, this storage period became prolonged, but it also became necessary to obtain vast quantities of blood for the preparation of plasma. Forecasts of requirements in preparation for battles or campaigns or for the equipment of a force such as the B.L.A., had necessarily to be complete guesswork. In these circumstances the overall figure of waste (3·2 per cent.) can be considered creditable.

Apparatus. The apparatus for the giving of blood and the taking of blood was designed and tested before the war broke out.

Consequently the raw material for assembly was ordered and delivered before September 1939. In principle, this apparatus remained stable during the whole war. It was extensively tested from every aspect in 1939–40, and the minor alterations then made were never superseded. This was a great advantage to the Army in that there were never multiple patterns or major changes in components liable to

confuse the issue. When new developments in transfusion material were evolved, the original apparatus for blood was capable of adaptation for using with, for example, dried plasma, fluid plasma, or a crystalloid solution, with no more than the addition of a standard rubber bung. Almost every report from widely scattered theatres of war paid tribute to the efficiency, simplicity and satisfactory qualities of this apparatus. Trouble arose in 1942–3 owing to the shortage of rubber for the making of high quality tubing so essential to good work, and owing to economies in the use of cellulose for the making of viscaps.

These troubles were eventually rectified after strong representation to the Ministry of Supply, but for a period, during which synthetic rubber and thin viscose caps were being supplied, the apparatus fell into disrepute. The A.B.S.D. (Home) undertook numerous experiments to investigate whether cellophane tubing or polyvinyl alcohol derivative plastic tubing could substitute for the not easily obtained good quality rubber. In brief, no substitute for the last-named was found; experiments with all other substitutes were unsuccessful.

For administration purposes two main types of set were made available. The one (giving set, hospital pattern) being easily reconditioned for repeated use and suitable for static units, such as military hospitals and base hospitals; the other (giving set, overseas pattern) being regarded as expendable or needing to be reconditioned by the A.Tr.S. The main difference between the two sets was that the former consisted entirely of glass and rubber, the filter being washable glass beads, whereas the latter was constructed with stainless steel air inlet and fluid outlet needles, with which the bung of the bottle could be pierced (in the place of the easily breakable glass tubing of the home pattern set). In the overseas pattern the filter consisted of a cotton gas mantle contained within a glass enclosure, while the air inlet was fitted with an ingenious non-return valve, made on the principle of a bicycle tyre valve, which enabled positive pressure to be applied in order to speed up the rate of administration. Both sets were furnished with drip counters. The overseas set was wrapped in cellophane, packed in a gold lacquered tin box and sterilised before being used. The only modification (or addition) required when the set was to be used for any material (dried plasma, crystalloid solutions) other than blood or liquid plasma, was to include a standard bung with the set.

The apparatus was also capable, with a little ingenuity, of being adapted for gastric suction or intramuscular penicillin administration.

The set for the taking of blood (taking set, universal pattern) was a simple combination of an air filter, appropriate lengths of rubber tubing and a glass window to prove entry into a vein.

An important feature of all types of set was that the same sized needle (gauge 18/10) was used for both giving and taking; this prevented confusion and ensured complete uniformity. The size was somewhat smaller than that ordinarily used for taking blood, and somewhat larger than that ordinarily used for administration; the latter point was no disadvantage, the former was overcome by exerting a small amount of negative pressure when collecting blood. Every needle issued was hand-sharpened. This small, but important detail, must have made the difference between success and failure in literally thousands of cases.

The production of this apparatus on the scale required called for the creation of an assembly department, with sub-departments concerned with sterilisation, needle-sharpening, glass-blowing, wrapping and packing, salvage and reconditioning, and final checking. Similar departments were likewise established in B.T.Us. (Overseas).

Storage and Transportation of Blood. Experience with small blood banks before the war, as well as the publications on the question of storage in Russia, America and Britain, had shown that the then accepted safe storage period of ten to fourteen days would probably be capable of prolongation. This was an aspect of great importance to the army in the field, to which, especially in forward areas, deliveries might be intermittent, and in which the wastage rate was liable to be high. Intensive research in the last months of 1939 enabled the storage period to be prolonged to three weeks at least, while blood up to four weeks old could be used in small quantities. Important aspects of this problem were the preparation of the blood to stand up to the racket of a journey by aeroplane, by lorry and sometimes by dispatch rider, and the provision of equipment to ensure constant and accurate refrigeration from the time the blood was collected at a centre in England, throughout its aeroplane journey, and throughout its subsequent journey in overseas transport—and finally at its last reception point with a forward F.T.U. As to the trauma of transportation, the obvious and simple procedure was adopted of filling bottles right to the top, so that the contained corpuscles could do no more than roll in their own suspending fluid. A special machine was devised for this purpose, and the method then perfected stood the test of the whole war. As an incidental and at first unknown advantage, it appeared that exclusion of air from the bottle effected a prolongation of the storage period for several days.

As to the provision of a chain of accurate refrigeration, the problem called for the devising of mobile refrigerators, suitable for use in the home country and with B.T.Us. and F.T.Us. overseas in frigid, temperate and tropical climates, as well as the designing of insulated boxes suitable for air transport, which would give a reliable performance for a known period, under the different climatic conditions.

The solution of these problems called for the creation of a laboratory and research department and the obtaining of skilled personnel for a R.E. section of both home and overseas organisations.

Blood Substitutes. In the War of 1914–18 use had been made of gum arabic saline as a substitute for blood. It was then found that this artificial substitute possessed some of the properties necessary for an efficient blood-volume restoring fluid, but that it had many disadvantages. American work had suggested that natural blood-plasma or blood serum were greatly superior and were also, under certain conditions, capable of being preserved for relatively long periods, as compared with whole blood. The main danger, when dispensed in fluid form, was the probable high frequency of contamination, unless the products were kept in the frozen state from the time of collection to the time of use. Refrigeration facilities of this type, though feasible for permanent civil hospitals, were clearly outside the bounds of practicability for field work. The obvious solution was to provide a sterile fluid *a priori* accomplishing sterility by means of bacterial filtration. The easiest method was the Seitz filter with asbestos pads. Whereas this presented little difficulty with serum, the problem with plasma was complicated by inevitable occurrence of post-filtration clotting. Much attention was paid to this matter by the home depot. Considerable research led to the evolution of the alkali-wash method of filtration and finally to the alkalinised-plasma technique. This last method held the field until the end of the war and was used by B.T.Us.; it resulted in the production of a clear orange yellow fluid remaining stable without clots of depositions in about 95 per cent. of bottles, for periods up to two years when stored under ordinary room temperature conditions. The fluid was eminently suitable for temperate climates, but was not exported in large quantities to the Tropics on account of fear of denaturation, should there be no facilities for cool storage. It formed the main equipment of the B.L.A., and was used therein in large quantity, especially by airborne and commando troops. One of the great advantages of this filtered fluid was that its clarity provided a simple criterion of fitness for use; if turbid, it was considered unfit.

The more easily prepared fluid serum was not exploited by the Army for the reason that early experimental assessments suggested that its use would be associated with a higher proportion of reactions. The disadvantage of fluid products was their liability to denature in hot climates. The production of dry material by sublimation from the frozen state had been developed before the war, and a small plant for production of dried serum in 200 c.cm. amounts was in operation at Cambridge under the aegis of the M.R.C.* This appeared to be the

* *See* the Medical Research Volume, Chapter 3.

working basis of an ideal product for Army use, in that this material promised to be stable under all climatic conditions without refrigeration, and required no more than the addition of an appropriate amount of distilled water to make it ready for use. The disadvantage of having to carry water as well as the dried product was clearly outweighed by the advantage of safety. The Army interested itself in this material and at the outset obtained gifts of it from the Cambridge plant, which were sent to M.E.F. In 1940 the 'Women of India', through the influence of the Vicereine, generously contributed the money for the presentation of a drying plant for Army use. Later, by a further contribution from the same source, the size of this plant was doubled and was able to produce 12—1,400 × 400 c.cm. bottles of dried plasma per week. A spin-freezing technique was developed which enabled plasma to be dried in × 400 c.cm. amounts in standard transfusion bottles, thus bringing this product into line with all the standard apparatus for administration. An obvious advantage was the dispensing, in × 400 c.cm. amounts, as compared with the uneconomically small amount of × 200 c.cm.

The development of this work called for the creation of a plasma filtration department linked, for the purpose of bacteriological control, with the central laboratory, as well as a plasma drying department and a crystalloid production department.

Grouping Serum. The selection of individuals suitable for the donation of high-titre grouping serum involved much labour. The problem was to produce a stable serum which would preserve its properties without refrigeration. A dried product was the only solution. The completion of this work was by no means easy, for the degree of dryness must be absolute, if the stability of the antibody is to be permanently maintained. Here again the Army had the advantage of advice from the M.R.C. unit at Cambridge, and eventually produced a dried serum dispensed in amounts the equivalent of 2 c.cm. sufficiently stable to withstand five hours' boiling, which is considered to be the equivalent of at least fifteen years in the Tropics. Throughout the war the various products that were made underwent test after storage for periods in the 115° F. climatic conditioning hut at the Chemical Defence Experimental Station, Porton. The work necessitated the creation of a blood grouping department for the purposes of testing new volunteers, checking blood groups, checking Group O blood and the preparation of dried grouping serum for export.

Packs, Packing and Dispatch. The Army demands as much uniformity as possible, but sufficient latitude to prevent uniformity defeating the main object, that of equipping a unit or a force with all essential material. Massive transfusion work was a new field so far as the Army was concerned. Much thought was given to the scale on

which transfusion fluids and transfusion equipment should be issued to the various medical units down to the regimental medical officer. Two standard packs were evolved (apparatus, transfusion and infusion, field pattern; apparatus, transfusion and infusion, hospital pattern) designed to provide enough equipment for any field unit or static hospital to perform efficient transfusion work. Likewise, packs were devised for F.T.Us. and airborne troops.

The principle was to produce a composite box which would be readily manhandled and to issue one box or more according to the size or requirements of the unit. Likewise, the maintenance supplies to a force were disposed as standard packs in standard boxes calling for the provision of huge contracts.

The evolution of this aspect of the Service proceeded apace; it called for the creation of a packing and dispatch department overseen by skilled supervisors and a special 'Q' department to deal with shipping alone.

Refrigerator Servicing. Without accurate refrigeration the use of stored blood is fraught with danger. It was necessary for the Service to seek out and enlist skilled refrigerator technicians to service and repair the multiple refrigerator apparatus with which every force was equipped. These R.E. experts became an integral part of the A.Tr.S. at home and abroad. Furthermore, with the small units, the F.T.Us., it was necessary to teach the R.A.M.C. orderlies and R.A.S.C. drivers enough of the principles and practice of refrigeration to enable them to carry out routine servicing and effect minor running repairs. This requirement was appreciated at the very outset, and was implemented.

COURSES OF INSTRUCTION

Precise knowledge concerning the art of resuscitation and skill in the practice of transfusion are not part of the equipment of the average medical man. Consequently it was necessary to educate the civilian-recruited Army in these matters. This difficulty was overcome in 1940 by the formation of a school of instruction. At this school, throughout the whole war, there were held regular short courses of instruction for officers and for other ranks which were attended not only by the British Army, but also by large numbers of Americans, Canadians and representatives from almost all the Allies. In addition, there were held long courses of instruction for potential field transfusion officers (T.Os.), as well as a course from which men could qualify for grading and mustering in the trade of transfusion orderly.

There can be little doubt that this definite educational campaign resulted in a dissemination of knowledge throughout the Army, which raised its standard of transfusion work to a very high level and which paid handsome dividends in relation to the efficient treatment of the wounded.

WAR ESTABLISHMENTS, FUNCTIONS, ORGANISATION AND ADMINISTRATION

Probable requirements called for a considerable amount of thought and much provisional speculation. The amount of blood which could be collected by an expert team in a working day was an unknown quantity. The ideal composition of such a team was likewise unknown, while the amount of blood likely to be used was clearly going to be very variable. R.E. and R.A.S.C. services had, obviously, to be provided, and a good supply of young officers experienced in transfusion work needed to be ensured. Elasticity, to meet fluctuating demands, was clearly essential. The original plans visualised an A.B.S.D. (Home), an organisation at medical base in all overseas theatres of war, and a number of F.T.Us. operating in forward areas with orthodox medical units. These units were originally allotted to a C.C.S., but in the course of time were placed under the control of D.D.M.S. corps. This last arrangement made the employment of a F.T.U. elastic, and so conformed to the varying requirements of a fast-moving mobile war. In the later campaigns the F.T.U. operated with F.S.Us., field ambulances, C.C.Ss. or general hospitals, according to the immediate requirements of any given situation.

ARMY BLOOD SUPPLY DEPOT (HOME)

As already stated, this large central organisation at Southmead Hospital, Bristol, through B.T.Us. (overseas) and F.T.Us. (home and overseas), eventually supplied the whole Army at home and abroad, with all transfusion equipment, with grouping serum and with all transfusion fluids that could not be obtained locally. Plasma and serum, fluid or dried, were, with a few exceptions, always obtained from this source. At home, blood was supplied to R.A.M.C. units within road delivery distance of Bristol, if they were unable to obtain blood by means of their own local organisations, while crystalloids were supplied to units which had no facilities for preparing their own. These home duties were mainly employed during the defence of Britain, 1940–2. The main functions of the A.B.S.D. were to ensure adequate supplies of assembled equipment, blood substitutes and crystalloid solutions to all overseas forces and to provide a service of stored blood when the theatre of operation was within air delivery distance. The depot was also the parent unit, training centre and mobilisation centre for all transfusion units proceeding overseas. In addition, it had to provide a school for training in resuscitation and transfusion for officers and other ranks, R.A.M.C.

The depot carried a staff of skilled engineers for the repair and servicing of all Army refrigeration apparatus and for the operation of its own plasma drying plant.

It was never possible to forecast a ceiling of production right up to the termination of European operations. Consequently most war establishments, which were always devised on a generous basis, were inadequate almost by the time they were promulgated. But, fortunately, the principle of permitting expansion in terms of amount of blood or other transfusion fluids (including crystalloids) demanded, enabled the depot to do its job. On mobilisation the depot mustered 9 officers and 71 other ranks, of which 39 were female. This provisional establishment contained four blood-collecting teams (each 1 officer and 7 other ranks, including A.T.S. drivers) it being thought that each team could collect 25 pints of blood *per diem*. The remainder of the establishment consisted of laboratory staff, clerical staff, administrative staff and Royal Engineers. In October this provisional establishment was consolidated and increased to 14 officers, 101 other ranks (63 female) and 19 vehicles.

Increments of 1 officer and 7 other ranks were permitted for every 25 pints of blood *per diem* in excess of the 100 pints *per diem* permitted by the basic establishment. As such, the depot functioned until 1942, though, on account of the development of plasma production, the number of collecting teams had been increased to fifteen.

In March 1942 the depot was entirely reorganised to make the maximum use of woman-power, with a basic strength for the collection of 400 pints of blood *per diem* by ten blood teams (50 pints *per diem* with two spare teams). The demands on the depot were so great that the operational strength consisted of 26 teams, and the total personnel numbered 38 officers, 353 other ranks (female) and 33 other ranks (male), a grand total of 424, with 73 vehicles. By June 1944 the operational strength had increased to 34 blood-collecting teams. At the same time, the whole of the transport of the depot (89 vehicles) was placed under the control of the local R.A.S.C. C.(M) T. Company.

In March 1945 the depot, having been visited by the War Establishments Investigation Committee, was finally recast with a basic strength for the collection of 1,200 pints of blood *per diem* and the production of 1,200 pints of crystalloid fluids. The operational strength consisted of 34 teams with a strength of 46 officers, 48 other ranks (male) and 410 other ranks (female), grand total 504, with 106 vehicles.

Criticisms were made concerning the employment of so many medical officers upon the routine work of blood collection and blood production. It was argued too that the A.Tr.S. could have been run as a civilian organisation and so saved the immobilisation of Army medical officers. This last argument failed to appreciate that an equal number of civilian practitioners would have been required. Thus the civil organisation would have been no more than a paper transaction so far as the medical man-power of the country was concerned.

It has also to be borne in mind that the finest training for field transfusion work is the vast experience in vein puncture which routine blood collection provides. The constantly changing depot staff provided officers for the field for whom neither small veins, nor invisible veins, nor collapsed veins held any terrors. It was their fundamental Bristol training which enabled them to do their field work speedily and efficiently, and which reduced the necessity for cannulation to something under 1 per cent. of cases.

BASE TRANSFUSION UNITS

The original B.T.U. for the B.E.F. was an ambitious project. It carried the impressive title of 'Blood Transfusion and Surgical Research Laboratory (Medical Base)'. It was designed not only to distribute blood and crystalloid solutions, the latter having been prepared by its own staff, but also to conduct research into the problems of wound shock, wound sepsis and gas gangrene; many of its officers (9 in all) were detached to C.C.Ss. to act as transfusion officers. The establishment of this unit consisted of 13 officers, 67 other ranks and 12 vehicles. Experience showed that the problems of research were more suitably performed either in laboratories in Britain or in areas more forward than a medical base. The unit fulfilled its functions so far as the manufacture of crystalloid solutions and the distribution of blood was concerned. After the fall of France the unit was disembodied.

In June 1940 a very much smaller 'base mobile refrigerator unit' was formed for service in the Middle East; it consisted of no more than one officer, four O.Rs. and one refrigerator truck. This totally inadequate staff was increased in December 1940 to one officer, ten O.Rs. and two refrigerator trucks, and again, in May 1941, to two officers (one of whom was Adviser in Transfusion to the Force), fourteen O.Rs. and six vehicles. This last establishment permitted small increments to be added, according to the demands for saline production. The unit was named 'A Base Transfusion Unit, R.A.M.C.'. Upon this establishment were mobilised 1 B.T.U. for M.E.F., 2 and 3 B.T.Us. for India, 4 B.T.U. for B.N.A.F., and 5. B.T.U. designed for Iraq but diverted to M.E.F. and afterwards to C.M.F. The inadequacy of this unit was soon manifest by the experience of 1 B.T.U. in the campaigns of 1941–2. Expansion to a size capable of performing the functions set out below was authorised locally, and upon the experience of the El Alamein battle and the Desert campaign of 1942–3, the final war establishment was devised and promulgated in December 1943. This contained four officers, sixty-five other ranks and sixteen vehicles, as a basic establishment for an army of two corps; it was composed of a headquarters section at base, a forward distributing section (later renamed advanced blood bank) or sections, according to the size of the

force; and, when distance from England justified the addition, a blood-collecting section (or sections) and a plasma processing section.

Upon this establishment was reformed 1 B.T.U. on its return from M.E.F. to take its place in B.L.A. In C.M.F. 4 and 5 B.T.Us. were amalgamated to provide the majority of additional personnel.

Thus, finally, one B.T.U. was provided for each overseas force with a personnel appropriate to the size of the force. According to distance, the B.T.U. was either largely self-supporting or obtained most of its supplies by air or sea from A.B.S.D. (Home). The B.T.U. had facilities for the preparation of simple intravenous fluids such as glucose-saline, and carried a staff of engineers for refrigerator-servicing and repair. The advanced blood banks were sited, when communications were long, at the most forward air transport landing-ground.

B.T.Us., particularly in the later stages of the war, found themselves required to assume numerous additional duties. Thus, penicillin was distributed through B.T.Us. (on account of the refrigerator facilities) while the officers in charge of penicillin control were attached to the H.Q., B.T.U. Sulphonamides and sulphonamide solutions were also dispensed from B.T.Us.

Experience showed that a B.T.U. was not mobile, that it needed first-class permanent buildings with good services of electricity, gas (if possible) and water, and that it usually required some three months to become well-established and running smoothly. In B.N.A.F., an attempt was made to develop a mobile B.T.U. but the experiment was a complete failure. The base headquarters section with stills, apparatus, assembly rooms, stores, etc. was finally regarded as immobile, but its advanced blood banks were freely movable, to conform with advance or retreat.

FIELD TRANSFUSION UNITS

The idea of forming small F.T.Us. for the performance of resuscitation work in forward areas was conceived before the war, and remained stable throughout the whole course of the war though the manner of attachment, the control and utilisation altered somewhat with the accumulation of experience.

In the B.E.F., 1939–40, the F.T.Us. were held on the establishment of the B.T.S.R.Lab. (Medical Base) on a scale of one per C.C.S. in the force. They were detached from the base and attached to the C.C.S., though, nominally, not under the control of the O.C., C.C.S. So far as transfusion work was concerned, the arrangement worked well, but the experience of the campaign clearly showed that the movements of a F.T.U. should be controlled by a senior administrative officer, that its disciplinary and internal economy control should be the concern of the O.C. of the unit to which it was attached, and that its

relations with a B.T.U. should be no more than technical control and supply. The original units consisted of one officer, three other ranks and one vehicle containing a refrigerator. For a short period, in the Middle East in 1940, an attempt was made to form a F.T.U. for attachment to C.C.S. without a special transfusion officer, his duties being undertaken by G.D.Os. from the C.C.S. This experiment was a complete failure, and the special transfusion officer was restored to the establishment two months later.

The establishment of a 'Field Transfusion Unit, R.A.M.C. (for Blood Transfusion and Resuscitation Duties in the Field)', was finally stabilised with one officer, four O.Rs. and one refrigerator vehicle (3-ton lorry with refrigerator mounted).

On April 25, 1944, after repeated representations extending over three years, one of the O.Rs. was authorised to be a lance-corporal. The two nursing orderlies within the unit were graded and mustered in the trade of transfusion orderly; the R.A.S.C. driver was trained in the servicing, operation and maintenance of a refrigerator, in addition to his normal duties.

The F.T.U. was the smallest self-contained unit with the Army, with its own medical mobilisation scale and war equipment table.

CANADIAN FORCES

A modification of the British system was devised for the Canadian Forces in February 1943. Authority was obtained for the mobilisation of seven F.T.Us. of similar composition to those of the British Army. These were to rely for their supplies upon the British B.T.Us. and A.B.S.D. (Home). The Canadian Forces had hitherto employed a variety of sources for the supply of glucose-saline. It was agreed that all future supplies should come from the A.B.S.D., which was equipped to meet all reasonable demands. The Canadian units were trained and equipped at the A.B.S.D., Bristol.

ORGANISATION OF SUPPLIES

The general chain of supply is shown in Fig. 1, which emphasises the key to a successful blood service, namely, the provision of constant and accurate refrigeration from the time of taking blood until the time at which it is administered. In principle, supplies of whole blood were not sent to forward units (field ambulance, etc.) unless these had a F.T.U. (with refrigerator) attached; they were, however, permitted to obtain a small supply for immediate use when a F.T.U. was conveniently close. Otherwise supplies were limited to the safe and more durable plasma.

Much experience had shown that personal supervision of blood supplies was vitally essential, otherwise insulated boxes or other

ephemeral containers were apt to be stranded at aerodromes, left in the refrigerator room of a ship or abandoned by the roadside. A safe and successful service could be assured only by entrusting supply to the personal care of the personnel of the transfusion service.

Chain of Supply

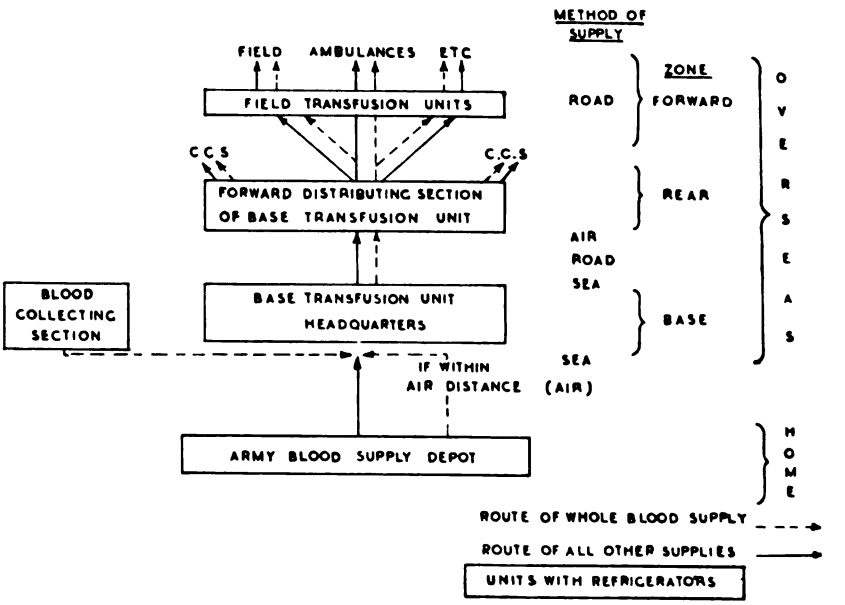


FIG. 1 : Diagram showing routes of supply of The Army Transfusion Service, according to facilities available.

STATUS OF THE TRANSFUSION SERVICE

This thorny matter was first raised in 1941, upon the appointment of a Consultant in Resuscitation and Transfusion to the Army. At this time, during the Battle of Britain, transfusion officers, with their units, were allotted to commands, and as such were responsible to the D.D.M.S. for the efficiency of transfusion arrangements and training within the command, in the event of invasion or bombing. Following upon a conference held at Bristol in August 1941, the matter of specialist status was presented to the War Office. The representation was ineffective. Experience in the Desert battles of 1942–3 led to the matter again being represented by the Consulting Surgeon, M.E.F., but likewise, with no effect. Similarly, in 1943, representation was made by the Consultant in Resuscitation, following upon a tour of Africa and the Middle East, and in 1944 representation was made from India. All these efforts were likewise ineffective. Finally, in 1945, the matter was again raised by B.L.A. and by the Consultant in Resuscitation,

following upon a tour of B.L.A. The principle was eventually accepted, but it did not become effective until after the cessation of hostilities in Europe. Thus to most of the officers who had faithfully served the A.Tr.S. for the four years required to qualify as a full specialist, this recognition came too late.

By the end of European hostilities the volume of work performed by a transfusion officer during a busy period had become overwhelming. This was because of the full exploitation of this life-saving measure, as well as the practice which surgeons had come to follow, namely, the leaving of pre-operative selection and post-operative care completely in the hands of the non-specialist but highly skilled transfusion officer. Yet, during quiet times, the transfusion officer was relatively unemployed, and worked at the general duties of the hospital.

It was the custom to equip a main forward surgical centre with two F.S.Us. which could work in relays, and one F.T.U. to serve the two. Consequent upon this experience, representations were made for an increase of the war establishment of a F.T.U. from two transfusion orderlies to four, and for the B.T.U. to hold a pool of trained transfusion officers who could be attached temporarily, at any busy point, to relieve the overworked officer commanding the unit. These recommendations were never considered owing to the cessation of hostilities.

It may be finally concluded that efficient transfusion work can only be performed with skilled and trained personnel generously allotted. To overwhelm the staff with work, even for short periods, leads to inefficiency. Any future establishment of an A.B.S.D., a B.T.U. and a F.T.U. should be amply staffed to permit of relays of work.

THE ARMY BLOOD SUPPLY DEPOT

Accommodation. The premises originally occupied at Southmead Hospital consisted of two maternity wards. Here the staff worked under difficult and crowded conditions, expanding by means of small wooden huts acquired from a number of unofficial sources. In January 1941 four brick buildings, to meet the special requirements of the work, were completed in the grounds of Southmead Hospital. On account of the repeated air attacks on Bristol and the damage caused to essential services such as gas and water, it was considered advisable, in December 1940, to provide a 'shadow depot' in another district. A country house—West House, Chilton Polden, near Bridgwater, Somerset—was selected and adapted for immediate use. In March 1941 the plasma drying plant was installed in the stable premises at West House, and from that time onwards the growth of the depot called for expansion, both in Bristol and at Chilton Polden.

At Bristol, expansion occurred bit by bit. No forecast was ever possible as to the ceiling of requirements. Delays in the execution of

work invariably meant that more was required by the time additions were completed. To the four original brick buildings at Bristol were eventually added two large huts and three small ones, as well as accommodation for some 80–90 A.T.S.

At Chilton Polden, which developed finally into a drying plant section, a crystalloid production section and the complete store department, with facilities for packing and dispatch, the increase in accommodation included three requisitioned houses, a hutted camp, seven large Nissen huts and numerous store sheds, an administration hut and several additional buildings to house cold rooms, etc. Finally, a large store department was requisitioned at Street, Somerset, to accommodate the excess stores previously kept in the open or in marquees.

DONOR REGISTRATION DEPARTMENT

The donor registration department was operated by a civilian organising secretary, later supplemented by a general list officer, known as donor registrar, and still later by a full-time publicity officer, A.T.S. The department itself contained a clerical section and a publicity section. The whole organisation was co-ordinated with the A.B.S.D. by a standing committee, meeting once a month (or more often, if necessary) for the purposes of forecasting programmes, arranging publicity campaigns and discussing matters of policy. There was obviously a close integration with the blood-collecting section and indirectly with the plasma preparation departments. It must be emphasised that the work of the donor registration department called for the most meticulous attention to detail.

Area of Operations. At the outbreak of war the area chosen for the operations of the Army Transfusion Service consisted of the five south-western counties of Gloucestershire, Wiltshire, Somerset, Dorset, Devon and Cornwall. This area was selected because it was thought, at that time, that it would be relatively immune from enemy air attack. With the fall of France, and the proximity of Cherbourg, the area, Bristol in particular, received intensive attention. Until June 1940 the A.Tr.S. overlapped with nothing more than the very small local transfusion organisations in the big cities of Bristol, Bath, Exeter and Salisbury. Before the outbreak of war the Government had divided the country into regions for administrative purposes for dealing with threatened air raids and invasion, and in these areas the Ministry of Health had organised the Emergency Medical Services and were establishing blood transfusion services.* The five counties used by the A.Tr.S. fell into Region 7. In view of this, in June 1940 an agreement

* *See* E.M.S. Volume 1, Part II, Chapter 11.

was made with the Ministry of Health that the A.Tr.S. should be responsible for all transfusion work in Region 7. This arrangement lasted until March 1942, at which time the area was found to be too small for the ever-growing requirements of the Army.

Consequently, by agreement with the Ministry of Health, the A.Tr.S. was then given access to the donor panel in Region 6—the counties of Oxfordshire, Hampshire and Berkshire—making use of such donors as the civilian service did not require. There the Army acquired a considerable number of additional donors, but was not loaded with the responsibility for maintaining the A.Tr.S. in Region 6. This arrangement continued until the end of the war.

Administrative Sub-areas. In the operation of blood collection, the team goes to the donors, rather than the donors to the team. This involved much travelling in an area which was largely rural, and in which the population was widely scattered. Experience soon showed that, for continuous routine work, winter and summer, the maximum daily travel for a team could not exceed 25–30 miles, if they were to maintain their efficiency.

Consequently, the whole area from Reading to Penzance, was subdivided into smaller areas, each based on a large centrally placed town. In these towns the teams were accommodated, and from them they made their daily journeys to other towns, villages or works, over a distance not exceeding 25–30 miles. These sub-areas were based on Reading, Oxford, Swindon, Gloucester, Cheltenham, Bristol, Salisbury, Winchester, Southampton, The Isle of Wight, Bournemouth, Dorchester, Taunton, Exeter, Barnstaple, Plymouth, Bodmin and Truro. They were controlled from the headquarters at Bristol.

Each of these sub-areas involved blood collection at 20–60 subcentres. In each of these there had to be arranged suitable premises in which the teams could operate, facilities for transportation of donors from outlying hamlets, as well as local comforts and contacts.

The donor registration department at Bristol contained a complete card-index of such centres—1,332 in all—containing a wealth of detail concerning availability, charges, routes, distances, names of important local people and arrangements for heating, lighting, car parking, etc. A duplicate book of information was available for study by blood-collecting officers and their teams, in order that they might arrive at their destinations properly briefed.

Donor Panels. The creation of a large general donor panel was a fundamental requirement of the service. Some 5,000 had been enrolled before war broke out. The growth of the panel can be appreciated from the following table. In this, the figures are divided into the total numbers enrolled, and what is called the 'effective' panel. This last is the number of enrolled donors whom experience has shown could be

expected to report for blood donation when called upon to do so. A donor panel is always a wasting asset, by reason of change of address, illness, death or apathy. Constant samplings and analysis were necessary for the purpose of estimating the effectiveness of any given district. From these results the forecasts were made concerning the need for publicity and propaganda in a given area in order to refresh the panel. This side of the work called for much forethought.

	Sept. 3, 1939	Dec. 31, 1940	Dec. 31, 1941	Dec. 31, 1942	Dec. 31, 1943	Dec. 31, 1944	May 8, 1945
Donors enrolled	5,000	79,000	136,911	230,187	367,313	529,529	567,764
Effective panel	—	—	98,000	95,227	141,115	153,074	155,000

This general panel needed sub-division into special sections. The vast majority were available for the supplying of plasma, and were used as such. In preparation for European operations, a segregated panel of Group O donors for supplying whole blood had to be created. At all times there was a special panel of high titre agglutinin donors of Group A and Group B, for the supplying of potent grouping serum. In later years it was necessary to segregate a panel of Rhesus-negative donors.

The state of these panels at the end of the war was as follows:

General panel (effective) . .	155,000
Group O donor panel . .	30,000
High titre serum panel . .	560 (458 Group A; 102 Group B)
Rhesus-negative panel . .	79

Method of Call-up. The calling-up of donors demands a highly organised system and a considerable knowledge of local conditions. Times of sessions differ in agricultural, industrial or urban communities, and programmes must be made to fit the convenience of the donor.

Sufficient notice must be given, yet not too much, otherwise many forget their call. In addition, there is always the problem as to whether it is worth while calling a second time someone who has failed to keep his first appointment. The main system of call-up was by postcard, designed to arrive four to five days before the session. These printed postcards contained spaces for five 'calls-up'; they were brought to the session by the donor, collected and used again.

In certain small communities and in factories it was often convenient to leave the call-up to a local agent, who was asked to supply a given number of donors between certain hours. This method, in factories especially, also supplied donors at short notice for emergencies. In general, a blood-collecting team was expected to deal with 100–120 donors in a day's session, and 'call-ups' were designed to produce this number in relation to the degree of co-operation in the district. This

last was estimated according to previous responses—to wit, the effective panel as described above.

In busy times the donor registration department would regularly send 2,000 postcards a day, and deal with 100–150 letters.

Publicity Section. No blood or blood products can be supplied without donors. The obtaining of an adequate number of voluntary blood donors requires much advertising, publicity and hard work, such as house-to-house canvassing and street or works enrolment. Yet, from 1939 to February 1943, for the prosecution of this basic work, the A.B.S.D. had to rely entirely on such financial resources as it could raise privately, upon the generosity of the press (given in full measure) and upon such posters and leaflets as the War Office Printing Department would consent to produce. No official support, other than the last-named, was forthcoming, despite annual representation. Funds were raised by local entertainments and dances and by private donations from public-spirited civilians. In February 1943 the War Office obtained authority for a grant of money for local printing and an entertainment allowance, while authority was granted to the Ministry of Information through the War Office for display advertising in the press, manufacture of special window displays, printing of standard posters, production of display photographs and lantern slides for cinema display. In addition, the service had the more or less continuous help of Army mobile information units equipped with loud-speaker vans, as well as the mobile information vans and mobile cinema unit of the Ministry of Information.

In 1943 a large number of official photographs of the A.B.S.D. were taken, while a film entitled *Of One Blood* was made of the work of the depot. These, together with a number of official brochures, more particularly one which was handed to each donor, the last page of which contained a detachable prepaid postcard for the enrolment of friends, completed a formidable armamentarium of propaganda. In this year also an A.T.S. publicity officer was added to the war establishment. This officer took charge of a publicity team, composed of four V.A.Ds., which had been established for some years during which it had been controlled by a medical officer.

Publicity was conducted by four main methods. Firstly, major campaigns, occupying six to eight weeks, conducted mainly in large towns or cities. Secondly, minor campaigns, occupying two to four weeks, in small towns and urban districts. Thirdly, advance publicity by loud-speaker vans, heralding the visit of a blood-collecting team. Fourthly, general publicity by advertisement and poster. Of all these methods the major campaigns were the most productive. With them the whole field was personally canvassed by house-to-house calling, with assistance of local volunteers from the W.V.S., the B.R.C.S., the Order of St. John, and the local A.R.P. organisation. The campaign usually opened with

a public meeting with the mayor in the chair, addressed by the commanding officer and usually some well-known public figure. Other fruitful sources of donors were R.A.F. stations and military camps visited by the publicity team.

In principle, publicity was closely co-ordinated with blood collection. The best results were obtained when the latter followed quickly on the former. The final act of a publicity team was often the staging of a bleed, at which a number of local celebrities (e.g. the mayor, the M.P.) gave their blood, and these ceremonies were written up in the local press.

The Response of the Public. Before the war, with the exception of an enlightened and public-spirited few, the public in general regarded this act of blood donation as a major operation worthy of some considerable expression of gratitude and demanding some appreciable period of rest in order to allow of recovery. Yet even at the outset of war there were thousands who volunteered for what they thought would be an ordeal. With the spread of knowledge, with appropriate propaganda and with proper handling by experienced blood-collecting teams, the public soon learned that blood donation held neither terrors nor unpleasant sequelae. Many looked forward to the visits of the teams as providing a pleasant social event and a relief to the monotony of war-time routine.

Industrial workers learned that they could donate and return to their work within three-quarters of an hour. Works managers learned to have confidence that their man-power would not be decimated or their production interfered with. To many, particularly the old, the maimed, the halt and the blind, the act of donation was a psychological satisfaction, being one of the few positive contributions to the war effort which they could make. Hundreds of thousands donated once, tens of thousands twice or thrice, thousands four or five times and hundreds achieved double figures.

The regions operated by the A.Tr.S. were undoubtedly those most heavily bled in the whole country. Nor must it be forgotten that Service personnel in Southern Command provided a generous quota, particularly in times of emergency. The loyalty of the big industrial concerns was invaluable, and served to tide over many a crisis. Nor should it be forgotten that all industrial concerns, including shopkeepers, allowed free time off for blood donation without deduction from wages. The following statement shows the number of blood donations made to the A.Tr.S. throughout the period 1939–45:

Year	1939–40	1941	1942	1943	1944	1945 to May 8	Grand total
Donations .	33,845	77,694	124,241	172,074	267,595	80,597	756,046

The following table shows the distribution of these donors by counties, as well as the contributions of Service personnel during the whole war period:

TABLE 43

Distribution of Donors by Counties

Bristol	155,460
Gloucestershire	54,829
Wiltshire	58,845
Somerset	99,300
Devon	93,526
Cornwall	22,150
Oxfordshire	21,627
Berkshire	26,252
Hampshire (including Isle of Wight: 9,122)	96,874
Dorset	32,764
	661,627
H.M. Forces	94,419
	756,046

The figures given refer to actual donations. The number of persons called to donate was, however, very much greater. Of those called, some did not report (ineffective panel), while others reported and were adjudged unfit to donate. The statistics of this last class gives some indication of the general state of nutrition of the country. The number reporting for donation indicated the interestedness of the population; it was greatly influenced by the war news. In times of battle, for example, the Normandy landings, the response was invariably better than when the war fronts were inactive.

The following records relate to the years 1943 and 1944:

	Donors called	Donors reporting	Response per cent.	Donors rejected	Per cent. rejected	Donors bled	Per cent. bled in relation to call-up
1943	288,677	186,109	64·4	14,035	8·0	172,074	59·0
1944	391,933	287,154	73·3	19,559	6·8	267,595	68·2

These figures suggest that, in the sixth year of the war, there was no deterioration in the fitness of the average donor. During the period of European operations, the response of the public improved.

Blood Collecting Section. Blood was collected by a varying number of mobile teams, the intake being gauged to meet the fluctuating demands of the depot, as forecast by the standing co-ordinating committee. The original depot strength contained six such teams, estimated to be capable of collecting 25 pints of blood each per day. Experience soon

showed that a team could readily collect 50 pints *per diem*, and all subsequent war establishments were based on this figure. In actual practice, the teams were accustomed to collect from 100 to 150 pints in a day, and the record figure for a team working unusually long hours was 303 pints in a day. The depot finished the war entitled to 35 blood teams on the basis that 10 teams could collect 400 pints of blood in a day, and additional teams could add 50 pints each. The maximum demand on the depot was 1,657 pints of blood in one day (= 35 teams). In actual fact, the depot was never supplied with 35 teams, but was able to fulfil its commitments by reason of the efficiency of a lesser number who, as stated above, were able to ensure an intake of 100–150 pints per day each. In practice, no more than 13 teams were ever in operation at one time. Spare teams were necessary to cover sickness, leave, rest days, transfusion duties, propaganda work and emergencies, such as sudden demands for blood or assembled equipment.

A blood-collecting team consisted of a medical officer (usually a woman), four V.A.Ds., two A.T.S. (M.T.) drivers, and either one male nursing orderly, R.A.M.C., or two A.T.S. transfusion orderlies. The team travelled in a large six-seater car (when obtainable) and a lorry fitted with a refrigerator into which the blood could be placed. The lorry carried all the equipment to enable the team to convert any room of reasonable size into a miniature hospital ward, suitable for their work. The teams were equipped with stretchers, trestles, trolleys and team boxes containing essential medical stores and facilities for the social side, such as the making of tea; suitable literature of a propaganda type was carried for use in the waiting room. The team required a large room for the operation of blood collection, a waiting room, a rest room, in which donors could lie down, and facilities for making hot drinks and washing-up, as well as lavatory accommodation. For normal working, four couches were used, each attended by a V.A.D. The two A.T.S. transfusion orderlies acted as receptionists and general-duty assistants, while the A.T.S. (M.T.) drivers were responsible for the rest room and the dispensing of hospitality. The medical officer carried out the operation of bleeding, supervised the general care of donors, and himself (or herself) inspected the arm of the donor before dismissal, at the same time expressing the thanks of the Service for the donation. The M.T. drivers were allotted an hour in the day in which to maintain their vehicles. It will be noted that they were afterwards employed on non-transport duties with the team. This practice was frowned upon by the R.A.S.C. Yet, had the practice not been upheld, the team drivers, having reached their destination, would have spent their days in idleness, while the duties which they performed would have called for the addition of two extra

A.T.S. transfusion orderlies to each team, together with extra transport to carry them.

The operation of blood collection was reduced to a drill in order to ensure smooth working of the sessions. At the outset the teams were trained in slow motion, so that each and everyone had their allotted work in unloading, setting up the site, carrying out the operations, loading, and returning to depot and preparing for the following day's work. At the same time, the humane and personal element was insisted upon. Each donor had to be made to feel that his or her appearance was the event of the day; politeness and courtesy were implicit; donors were always addressed by name and properly introduced to the medical officer or visiting officers; light conversation was positively practised and thanks meticulously given. Complaints or accidents were noted and dealt with, as far as possible on the spot, and afterwards recorded in the appropriate record books at the depot. The principle was that the donor was always right, and the same applied to local agents and other helpers. The high standard of efficiency which the teams achieved is reflected in the small number of accidents, complaints and compensation claims which arose out of their tremendous work in handling over three-quarters of a million donors.

An integral part of the team work was their proper servicing with clean linen, fresh equipment and expendable stores. This was done by a complete team stores department, which made daily issues of such materials and dealt with laundry, mending and general reconditioning. With teams detached at distant points it was customary to return the day's takings to Bristol in a ferry lorry and to send back the clean materials required.

The endurance and patience required for day-in day-out blood-collection work was very great. After a time, boredom was inevitable, yet this had to be hidden from the donors. Furthermore, the fatigue and discomfort of working under all conditions of weather and season required much courage. Neither fog, nor icy roads, nor a torrential downpour could ever be allowed to interfere with a pre-arranged programme which was quite incapable of cancellation. Blackout driving added to the hardships, and at the end of a long day's work, there were always the vehicles and equipment to prepare for the next day.

As a routine, the teams worked for four days in succession, followed by one complete rest day; this routine would continue for weeks on end. Teams were instructed not to sacrifice efficiency in favour of speed or spectacular figures, for though a team containing one medical officer did, in times of emergency, bleed 250 or 300 or more donors, it was clear that they could never do so as a daily routine, otherwise the standard of work would suffer, particularly the few seconds of personal

attention given to every donor, which was an oft-complimented characteristic of the A.Tr.S. In the course of the war years, two women medical officers, who faithfully served during the whole period are estimated to have bled between 35,000 and 40,000 donors each.

The incidence of minor contamination of the blood at the time of collection was reduced by a meticulous attention to technique and by skill on the part of the operator. From 1942 onwards the A.B.S.D. adopted a special and scrupulous routine in the preparation of rubber tubing, bottles, and all apparatus used for the collection of blood which was to be used as such; special precautions were taken to exclude dust. Rapid cooling and quick delivery to the depot was ensured by attaching an additional large size Type A mobile refrigerator to the blood-collecting team. By these means the incidence of contamination was reduced to a commendably low level. In ordinary times Group O blood was collected only by highly experienced officers. In times of great pressure, Group O blood had also to be 'picked out' from a bleed of mixed donors. For this purpose, an extra V.A.D. was attached to the team, who carried out grouping tests on the spot and segregated the Group O bottles.

Accidents to Donors and Claims for Compensation. All complaints and accidents were immediately recorded in the depot books, together with a statement from the medical officer concerned. Most of these were of a trivial nature, as can be gauged from the small number of compensation claims paid.

The following is a classified summary of the accidents and complaints recorded:

Period	Number of donors bled	Haematoma	Cellulitis	Thrombosis	Accidents due to fainting	Dermatitis	Hysteria and debility	Unclassified	Total	Incidence
1939–45 .	756,046	57	10	6	32	20	41	31	197	1 in 3,838

As to accidents sufficiently serious to merit claims for compensation, the incidence and detail were as follows:

Period	Donors bled	Settled without submission to War Office (F.3a)	Submitted to War Office (F.3a)	Sum involved	Incidence of Claims
1939–45 .	756,046	9	23	£165 3s. 2d.	1 in 23,626

Most people were prepared to accept a minor complication, such as haematoma, without comment or complaint. The figures given above record only those cases in which a complaint was made.

With regard to compensation claims, almost all were of a very minor character, being payments of a doctor's small bill, or for new spectacles or dentures broken when falling during a faint.

It is possible that two deaths were attributable to blood donation to the A.Tr.S., while in one other case, the donation was probably not the fundamental cause. The two deaths were due to coronary thrombosis soon after donation. One occurred in a soldier in the Middle East, the other in a middle-aged civilian in England. No claims were submitted. The third case, for which compensation was claimed, occurred in a donor in whom a post-mortem revealed a tumour of the brain.

The low incidence of all types of accident reflected great credit on the judgment of medical officers in the rejection of unsuitable volunteers.

The whole work of the A.Tr.S. revolved around efficient blood collection. Too high praise could not be given to the steadfastness of the permanent M.Os. who carried out this skilled, onerous, fatiguing and boring work without complaint and without question; these officers had also the difficult task, when medical man-power was short in the later war years, of training other medical officers hurriedly to perform work which usually took many weeks before the necessary skill was acquired. Likewise, the teams themselves, the V.A.Ds., the A.T.S. and, perhaps, especially the drivers who, under all conditions of weather, blackout and long hours, never faltered. The following figures are but a bare record of the 'sweat and tears' that went into blood collection:

Total number of donors bled .	756,046
Total number of sorties . .	10,081 (77 pints per team day)
Approximate mileage covered .	1,750,000
Maximum bled by one team in one day . . .	303 donors
Maximum blood obtained in one day	(13 teams) 1,657 pints
Maximum bled in one week .	10,072 donors

BLOOD BANK DEPARTMENT

The function of a blood bank was to provide adequate supplies of blood, in good condition, of guaranteed group and free from transmissible disease or contamination. So far as the fighting fronts and emergency air-raid or accident work were concerned, the only blood supplied by the A.Tr.S. was Group O (universal donor).

To achieve an ideal bank demanded the most scrupulous care in blood collection, in administration, in supervision and transportation. A permanent blood bank officer was essential, who would daily inspect the contents of the bank and pass them as fit for use; he had to be personally responsible for issues from the bank. Accurate records of every bottle had to be kept, so that each might be traced back to the donor, in case of query, and so that the checks as to group could be verified. A constant chain of accurate refrigeration (4°–6° C.) was essential from the time of collection of the blood to the time of administration; this, under active service conditions, with long lines of communication and many changes of craft or vehicle, presented one of the major problems of the service.

As to transportation, it was early appreciated that it was important to reduce movement of the corpuscles to the minimum, and so avoid damage and rupture from the stresses of shaking. A special sub-department of the blood bank was concerned with 'topping' the bottles of blood, by means of a special machine. With this the cooled bottles were filled right to the top, under strict sterile conditions, so that the contents of the bottle could do no more than roll, however much they were shaken. The results were excellent. Not only did the blood travel well, but also the fact that air was excluded from the bottle added an appreciable time to the possible storage period.

Other functions of the blood bank officer were to initiate salvage of the plasma of out-of-date blood, and to give an expert opinion on difficult grouping problems, particularly those involving the Rhesus factor.

Within a few days of mobilisation, the staff of the A.B.S.D. was actively engaged in research, designed to prolong the storage period of blood and ensure its proper transportation. The investigations provided a policy stable almost for the remainder of the war.

At the time when Group O blood was collected, a small pilot tube was filled, at the same time, from the blood contained in the tubing, which was milked back into the tube. This numbered pilot tube served to provide a sample for a Kahn test, and for a re-check of the blood group. In re-checking the group the routine was to check not only the agglutinogen content of the corpuscles, but also the agglutinin content of the serum. So far as is known, no single bottle of incorrect group was ever issued from A.B.S.D.

The incidence of syphilis in the area of operations was remarkably low. Malaria and infective hepatitis could only be excluded by history.

For control of sterility and efficiency of technique, aerobic and anaerobic cultures were made of every bottle discarded from or salvaged (for plasma) from the blood bank.

So far as Army supply was concerned, there were two periods of great activity in the supply of whole blood—for the B.E.F. and for

B.L.A. The latter called for extreme exertion on the part of the whole staff, so that frequently the topping or checking teams were working far into the night or even early morning. Indeed, the task eventually became larger than the depot could handle by reason of exhaustion of its Group O panel, so that supplementary supplies had to be obtained from civilian sources—the M.R.C. London depots and the E.M.S. regional centres. This assistance was most willingly and fully given.

So far as civilian supply was concerned there was one period of great activity during the defence of Britain, when the cities and towns of the south-west were subjected to intensive air attack. Thereafter, from 1942–5, transfusion came to be practised with increasing frequency, particularly as an appreciation of the importance of transfusion in maternity work expanded, until the consumption approached forty times the pre-war figure.

Statistics

Incidence of Positive Kahn Tests. The following gives the incidence of positive Kahn reactions in the unselected population of South-west England:

Number tested	Number negative	Number positive	Incidence of positive reactions
106,150	105,791	359	0·33 per cent.

Incidence of Contamination. The following is a record of the incidence of contamination over the years 1941–5, together with a detailed analysis of the contaminants:

Number of bottles cultured	Number sterile	Number contaminated	Incidence of contamination
6,442	6,338	104	1·6 per cent.

Detail: Aerial coliform bacilli of various types, 59; *Pseudomonas pyocyaneus*, 3; Diphtheroid bacilli, 9; *Staphylococcus albus*, 10; *B. subtilis*, 15; *Sarcinae*, 8; Total, 104.

The examination for contamination showed only chance contamination; there was never any evidence of mass contamination, with one exception where it would appear that a crate of bottles escaped being autoclaved. The admitted incidence of contamination in most blood banks at this time exceeded 5 per cent. The low incidence was therefore a remarkable tribute to the skill of collecting teams, the efficiency of the special technique and the methods of the 'topping' teams who, in busy times, had to work at very high speed. It must be remembered

also that most of the samples tested had travelled to the Continent and back, and had been in store a month or more before the tests were made.

It will be noted that the most frequent contaminant was an aerial coliform bacillus.

Exports of Group O Blood. The following figures show the volume of whole blood handled by the bank in relation to the various phases of the war. The formidable requirements of the B.L.A. should be noted, as well as the generous contribution towards these requirements made by civilian and Royal Naval services:

TABLE 44

Distribution of Group O Blood

	1939–40	1939–45	1944–45	*Totals*
	(*Battle of France*)		(*B.L.A.*)	
Pints exported to Armies Overseas .	2,580		98,127	100,707
,, ,, to Home Forces . .		1,557		1,557
,, ,, to R.A.F. and R.N. at Home		2,764		2,764
,, ,, to U.S. Forces in Britain		127		127
	1940–1	1942–3	1944–5	
	(*Battle of Britain*)			
,, ,, to E.M.S. Hospitals in Ministry of Health, Region 7	1,658	7,349	6,897	15,904
Grand total				121,059

Contributions from the M.R.C., E.M.S. and Royal Navy during 1944–5, for assistance with B.L.A., and included in the above totals, amounted to 51,833 pints (N.W. London Depot, 18,163; Leeds Regional Service, 21,381; Cardiff Regional Service, 5,874; Nottingham Regional Service, 2,480; Royal Naval Blood Transfusion Service, 3,935).

TRANSFUSION DEPARTMENT

The A.B.S.D. acted as transfusion adviser and supplier to all the E.M.S. hospitals in the Ministry of Health Region 7. In the early years, during 1939–41, the whole area was not very practised or proficient in the art of transfusion, consequently there were heavy calls on the depot staff to perform this work. This was of immense advantage to the Army, for it provided material with which to train the depot staff,

as well as newcomers and officers who attended for courses of instruction. Furthermore, the fact that the depot staff performed almost all the transfusion work in relation to air-raid casualties in Bristol and in the surrounding towns of Bath, Weston-super-Mare, Burnham-on-Sea, and other places, provided the depot staff with practical experience of casualty work, enabling them to make a close study of the problem of wound shock and to make one of the first publications on the subject; their views were accepted authoritatively by Britain and by America; they were afterwards confirmed by research teams in the field.* In the later years of the war the medical profession of the South-west became educated to the art and technique of transfusion, and there was relatively less call on the depot staff for practical work, but this retained pre-eminence in a consultative capacity and was consulted in all difficult cases, and especially as an authority on the Rhesus factor.

The careful observation of transfusions provided valuable statistics concerning the reaction rate, together with the incidence of the different types of reaction. The facts available from the Army records concerned blood used at home and blood transported to the Continent. Each bottle of blood issued from the bank was accompanied by a report card and the figures given below are a summary of the reports received.

The classification of febrile reactions was as follows. Mild reaction: temperature attaining 100° F.; moderate reaction: temperature exceeding 100° F., but no rigor; severe reaction: temperature exceeding 100° F. with definite rigor.

Incidence of reactions reported with bottles of blood used in England:

TABLE 45

Incidence of Untoward Reactions with Blood used in England

Year	Number of bottles	Febrile reactions			Pain	Nausea	Jaundice	Urticaria	Total reactions
		Mild	Moderate	Severe					
1942 .	188	10	24	12	–	–	–	–	46
1943 .	473	31	28	28	–	–	–	–	87
1944 .	1,609	56	34	47	2	2	8	5	154
1945 .	1,903	80	43	47	6	2	35	3	216
Totals	4,173	177	129	134	8	4	43	8	503
Incidence per cent. . .		4	3	3	0·2	0·1	1	0·2	12
Incidence febrile reactions		10 per cent.							

* For an account of the work performed by the Army Transfusion Service on behalf of the Emergency Medical Services, *see* E.M.S., Vol. I, Part II, Chapter 11.

Incidence of reactions reported with bottles of blood used in B.L.A.:

TABLE 46

Incidence of Untoward Reactions with Blood used in B.L.A.

Number of bottles	Mild	Moderate	Severe	Pain	Nausea	Jaundice	Urticaria	Total reactions
370	9	6	8	1	–	2	–	26
Incidence per cent. . .	2·5	2	2·2	0·27	–	0·5	–	7
Incidence febrile reactions	6·7 per cent.							

The lower incidence of reactions in blood overseas was probably accounted for by lack of opportunity for full observation, though it must be borne in mind that the transfusion in a medical illness is always more likely to provoke reaction than the mere restoration of blood volume in an exsanguinated but otherwise healthy man.

Nevertheless, the low incidence of reaction with blood used overseas led to the comfortable conclusion that the methods of collection, topping, transportation and distribution were satisfactory.

FLUID PLASMA DEPARTMENT

Attempts to prepare fluid plasma in a stable filtered state were begun early in 1939. The first efforts were extremely laborious, for it was soon found that no more than a few pints could be filtered through a 14 cm. Seitz asbestos pad without the occurrence of post-filtration clotting. Nevertheless, the idea was pursued, and a small-scale method devised which was employed to supply small quantities to the B.E.F. and N.W.E.F. Further work showed that intermittent washing of the filter pads with weak alkali greatly extended the scale of production. Finally, a method of alkalinising plasma, filtering in the alkaline state and afterwards neutralising with carbon-dioxide was perfected and adopted for large-scale use. This process, with certain precautions and improvements, served throughout the war. For large-scale work it was necessary to create a number of filtration teams, trained to an exact technique and strict routine drill, to avoid contamination. These teams, composed (after 1942) entirely of A.T.S., worked in especially conditioned sterile rooms. Multiple teams enabled the work to continue into the night hours, should the intake of blood be large and require disposal while still fresh. At the end of the war, the staff of the separating, clarifying, filtration and control sections numbered about forty. There were two

complete sets of rooms and teams for this work, the one at Bristol and the other at Chilton Polden. The fluid product was found to be relatively unstable under tropical conditions, and very little of it was sent to tropical climates. The material was, nevertheless, most popular on account of its efficiency, convenience for use, low reaction rate and small bulk, relative to dried plasma. Vast quantities were demanded for the equipment of B.L.A.; this period, January to May 1944, was the busiest time in this department.

This department not only filtered and bottled fluid plasma, but also filtered all plasma, which was afterwards dried. The volume of plasma handled by this department furnished statistics for calculating the yield of plasma from whole blood when separated by an Alfa-Laval centrifuge and filtered by the alkaline method. The following are the records for 1943–4:

Amount of blood centrifugalised (Alfa-Laval)	323,755 pints
Yield of Plasma	175,744 pints = 54 per cent.
Yield after filtration	171,206 pints
Loss by filtration	4,538 pints

Thus 323,775 pints of blood yielded 171,206 pints of filtered plasma (53 per cent.), or one pint of plasma was the equivalent of 1·86 pints of blood.

The following are some of the statistics of manufacture and export of fluid plasma as well as the amount of plasma processed and filtered for the purpose of drying:

TABLE 47

Quantities of Fluid Plasma manufactured

	1939–40	1941	1942	1943	1944	1945 (May 8)	Totals
Bottles, fluid plasma, manufactured .	8,732	15,118	32,452	9,504	47,074	3,924	116,804
Bottles, plasma, filtered for drying .	2,249	17,090	23,100	89,960	71,730	121,447	325,576
Total bottles processed and filtered .	10,981	32,208	55,552	99,464	118,804	125,371	442,380

During the same period the following gifts of fluid plasma were received and filtered by this department:

TABLE 48

Gifts of Fluid Plasma (bottles)

	1939–40	1941	1942	1943	1944	1945 (May 8)	Totals
E.M.S. and M.R.C.	—	—	5,300	1,419	18,000	9,905	34,624
Grand totals . .	10,981	32,208	60,852	100,883	136,804	135,276	477,004

The following table shows the distribution of the material to the various Forces:

TABLE 49

Distribution of Fluid Plasma (bottles)

M.E.F.	5,274	C.M.F.	13,100
P.A.I.C.	3,000	B.L.A.	57,448
India	3,500	Sundry Stations	2,334
Gibraltar	500	Home Forces	34,889
West Africa	1,400	E.M.S.	9,541
B.N.A.F.	8,000	Canadian Forces	4,904
			143,890

The very large demands of B.L.A. for fluid plasma should be noted.

DRIED PLASMA DEPARTMENT

In 1940 and the early part of 1941 the Army had no drying plant of its own and had received small supplies of dried serum from the M.R.C. drying plant at Cambridge. The serum was collected by the A.Tr.S., filtered, sent to Cambridge, disposed in amounts of 220 c.cm., in 12-oz. medical flats. At that time, since drying was carried out with serum frozen in the static position, 220 c.cm. was the maximum amount that could be dried in any one container. Early in 1941 the A.Tr.S. was presented with its own low-temperature, low-pressure process drying plant, similar to the Cambridge model, by a generous gift from the Silver Thimble Fund of the Women of India.

In 1942 the plant was doubled in size, as the result of further generosity from the same source. The first installation was completed in June 1941, and the double installation in November 1942.

Largely owing to the ingenuity and persistence of the A.Tr.S. R.E. officer, a method for spin-freezing 400 c.cm. amounts in standard transfusion bottles was evolved, and this was the only product prepared by the service itself.

The Army plant operated continuously from July 1941 without breakdown. The output of the original plant was a steady 400–500 bottles per week; the output of this double plant was from 1,200 to 1,400 per week. The plant was also used to prepare dried grouping serum, dried convalescent vaccinial serum and certain dried equine products for the use of the R.A.V.C.

Plasma dried by the spin-freeze method exists as a fine crystal and reconstitutes when water is added; it has no detectable moisture content, which is an essential feature of a product stable enough to keep under any climatic conditions. During 1942–4 excellent reports on the value of the product were received from M.E.F., C.M.F. and India. In 1945, however, certain batches, particularly in West Africa, were found to have deteriorated owing to an imperfect seal on the bottle having

admitted moisture, which was rapidly taken up by the very hygroscopic plasma. Denaturation was then inevitable.

Sterility controls were maintained for all plasma filtered before drying. Furthermore, a number of bottles were stored in the 115° F. climatic conditioning hut at the Chemical Defence Experimental Station, Porton, and examined at intervals of three months for a period of a year. Careful observations were also made on human subjects transfused with the product at Bristol by officers of the A.B.S.D.

The operation of the drying plant was undertaken by an officer and 4–6 O.Rs. of the R.E. and 6–8 A.T.S. Day and night duty shifts were necessary as the plant was in continuous operation.

The following are the production figures of the Army Drying Plant:

TABLE 50

Quantities of Dried Plasma produced

	1941 (July–Dec.)	1942 (Jan.–Dec.)	1943	1944	1945 (Jan.–May)	Totals
Bottles (400 c.cm.) .	9,062	34,299	67,289	63,331	22,800	196,781
Average per week .	348	659	1,294	1,218	1,200	

The output of the Army drying plant was insufficient to meet all the demands made upon the Service. Generous gifts were made by the E.M.S., the M.R.C. drying plant at Cambridge, and by the Scottish National Transfusion Service, while very large amounts of dried serum were presented by the Dominion of Canada. At one phase the A.Tr.S. sent plasma to Cambridge for drying, but later the gifts from this plant were derived from blood collected by the E.M.S. regional centres and M.R.C. blood supply depots. The following is a record of those supplementary gifts which went to swell the resources of the Army:

TABLE 51

Gifts of Dried Plasma (bottles)

	1940–1	1942	1943	1944	1945	Totals
Blood supplied by Army Transfusion Service and dried at Cambridge . . .	10,315	—	22,671	—	—	32,986
Presented by M.R.C. and Regions . .	—	1,600	16,689	18,631	9,562	46,482
Scottish National Service	—	—	—	3,150	—	3,150
Dominion of Canada .	—	—	8,580	72,597	28,170	109,347
Totals	10,315	1,600	47,940	94,378	37,732	191,965

Statistics of Export. From these two resources, own manufacture and supplementary gifts, the following major exports were made to various fronts. Each bottle issued was accompanied by a bottle of fluid (distilled water or saline) for reconstitution. At the end of European hostilities the A.Tr.S. had a good stock of bottles of dried plasma in readiness for the war against Japan.

TABLE 52

Distribution of Dried Plasma (bottles)

M.E.F.	35,772
P.A.I.C.	5,190
India	82,322
Gibraltar	2,291
West Africa	2,156
B.N.A.F. / C.M.F.	100,903
B.L.A.	45,755
Sundry Stations	15,574
Home Forces	46,617
E.M.S.	5,186
Canadian Forces	1,082
	342,848

GROUPING SERUM DEPARTMENT

The grouping department was responsible for determining the blood group of all voluntary donors, for the re-checking of all Group O blood exported as such, for the titration and selection of donors of high-titre grouping sera and for the preparation of grouping serum for export. Supervision of the department was exercised in part by the main laboratory officer, and in part by the blood bank officer, who was especially concerned with the responsibility for Group O blood and for such refinements as Rhesus testing.

The main staff consisted of a sergeant laboratory attendant and an especially trained team of four V.A.Ds., with from two to four A.T.S. engaged in the less responsible work. This basic staff was expanded to meet week-to-week requirements, and was often supplemented by additional trained V.A.Ds., particularly when it was necessary to send grouping teams to outlying districts to carry out tests during a publicity campaign, during visits of a blood-collecting team to an A.Tr.S. unit or when Group O blood was being abstracted from a mixed group bleed. The plasma drying department was also concerned in the preparation of grouping serum for export.

Before the war, grouping serum obtained from high-titre donors was distributed in fluid form, either in bulk or in capillary tubes containing sufficient for one test. As such, the serum had to be preserved in the frozen-solid state, otherwise its potency was soon lost. Such a method of storage was impracticable under Service conditions, and resource was, therefore, devoted to the production of a potent dried grouping serum which would

(*Sport and General*)

PLATE XVI. The Distribution of Donor Groups

[*facing page* 408

(*Sport and General*)

PLATE XVII: The Enrolment of Blood Donors

(*Sport and General*)

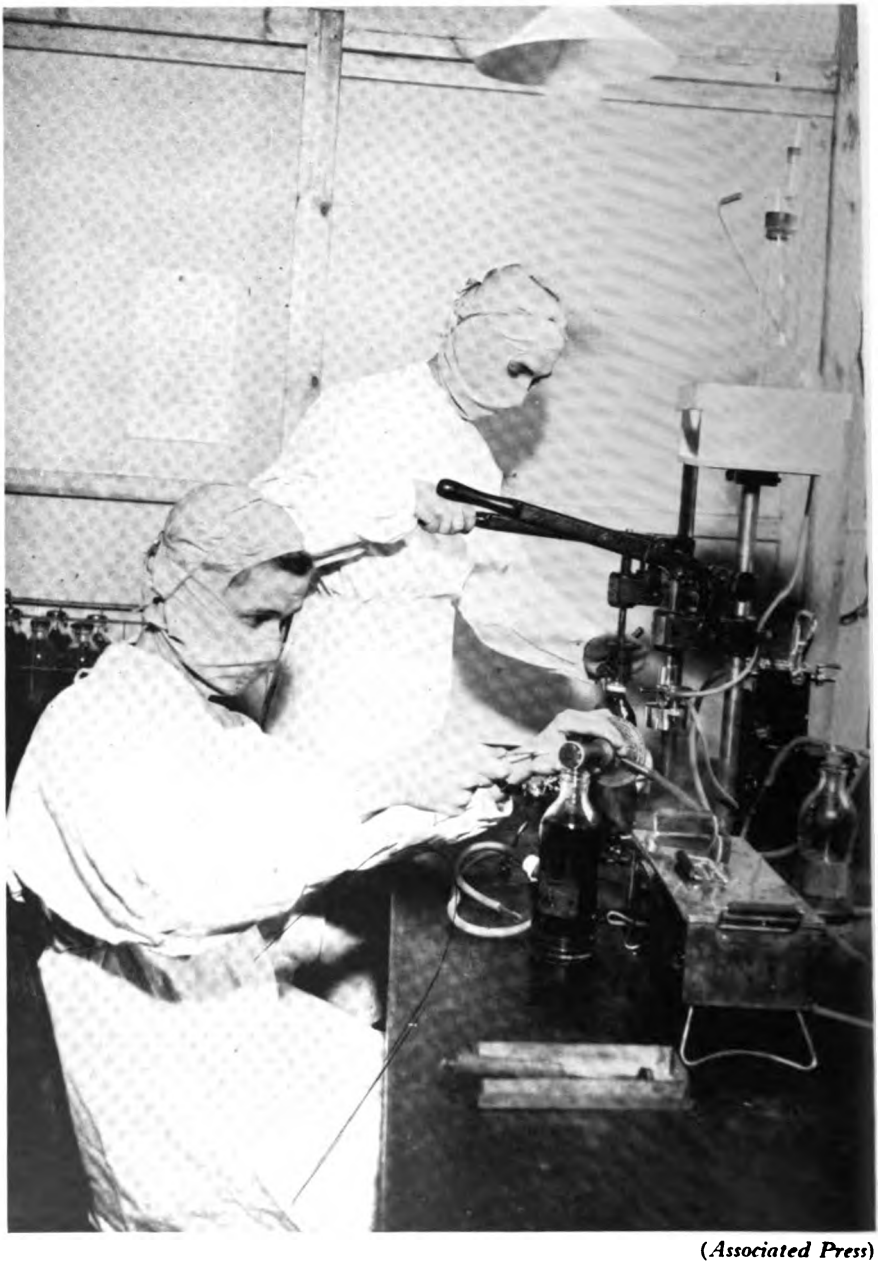
PLATE XVIII: A Blood Collecting Team at work

(*Sport and General*)

PLATE XIX: A Donor at the Army Blood Supply Depot, Bristol

(*Fox Photos Ltd.*)

PLATE XX: The Preparation of Transfusion Fluids. Plasma separated from Blood



(*Associated Press*)

PLATE XXI: The Preparation of Transfusion Fluids. Topping and Capping bottles of Blood and Plasma

(*Fox Photos Ltd.*)

PLATE XXII: Assembling Equipment

(*Associated Press*)

PLATE XXIII: Packing Transfusion Fluids for despatch by Air

remain stable without refrigeration. The problem was no easy one and, indeed, defied complete solution until quite late in the war. Complete and absolute dryness was essential for reliable preservation in tropical climates. This involved the perfection of the drying process, the perfection of the seal of the container and, what was not discovered until quite late, the removal of even such traces of moisture as reside in certain types of glass.

Time was required to test the various devices. Judgement had to be made either on reports received from overseas or from tests on material stored for lengthy periods in the 115° F. climatic conditioning hut at the Chemical Defence Experimental Station, Porton. Curiously enough, the first samples prepared by the lyophile process (in 1940) on a home-made manifold with Hyvac pump extraction and in the high-quality glass obtainable at that time, were very much more satisfactory than material prepared in 1942–3. This early product was known to have retained its potency in West Africa for a period of at least four years. In 1941, with the installation of the plasma drying plant, the serum was dried in the plant in tubes containing the equivalent of 2 c.cm. and sealed with a cork and sealing solution; this method was very unsatisfactory. From 1942 onwards the serum was dried in tubes (in amounts of 1 or 2 c.cm.) which were glass-sealed, and which contained a small amount of indicator-silica-gel; this compound was thought to remove any residual moisture from the tube, and had the advantage of being blue in colour when dry and pink when moist; it therefore indicated whether a tube was fit for use. Group A (anti-B) serum was coloured amber (with acriflavine) and Group B (anti-A) was coloured blue (with methyline-blue). The serum was disposed in amounts equivalent to 1 c.cm., and it was necessary only to reconstitute with 1 c.cm. of water to carry out tests. This pack showed almost negligible deterioration after storage for nine months in the 115° F. climatic hut, but its stability did not appear to be indefinite. Later a vacuum pack was instituted which appeared to permit stability even on boiling. The standard product of the Army was especially selected for its potency in order that the relatively inexperienced G.D.O. might have no difficulty in performing tests.

Statistics. The amount of high-titre grouping serum prepared and exported by A.B.S.D. is shown below, as well as the very large amount used by the depot itself, period 1939 to May 8, 1945:

TABLE 53

Distribution of High-titre Grouping Serum

Overseas Forces	47·6 pints
Home Forces	37·7 ,,
R.A.F. and R.N.	1·5 ,,
E.M.S.	13·4 ,,
Canadian and U.S. Forces	3·0 ,,
Army Blood Supply Depot	99·8 ,,
	203·0 pints

The resources of the A.B.S.D. were supplemented, as necessary, by generous gifts from the Galton Serum Laboratories, Cambridge. These gifts amounted to:

1939–42	1·75 pints	Total 8·95 pints
1943	2·0 pints	
1944	5·2 pints	

CRYSTALLOID DEPARTMENT

This department was responsible for the production of all crystalloid solutions used by the depot itself (for example, sodium citrate solution for the collection of blood) as well as for all solutions exported, including the reconstituting fluid which accompanied every bottle of dried plasma.

From 1939 to early in 1942 the department was relatively small, being concerned mainly with home requirements, but with the entry of the United States into the war, the depot was loaded with very large American requirements in order to save shipping space. Furthermore, with the increased production of dried plasma, the demand for reconstituting fluid increased. At the same time, the whole Army Medical Services, partly as the result of American influence and partly from their own experience, began to appreciate the necessity for considerable amounts of crystalloid fluids for intravenous administration, especially in hot climates. The statistical figures given below show clearly the expansion that was required.

The whole department was supervised from the main laboratory. It consisted of several divisions, beginning with a staff of six men in charge of the Manesty Stills, which operated day and night from 1942–5. A bulk preparation section consisted of an A.T.S. sergeant and a staff of four A.T.S.; its work was consistently checked by the R.A.M.C. W.O.II laboratory attendant. After bulk preparation, the fluids were diluted and distributed into standard transfusion bottles by a team of four to eight A.T.S. They were then autoclaved by a team of eight men and one N.C.O., who operated the autoclaves day and night. The bottles were then capped, sealed and labelled by a team of six to eight A.T.S. After inspection they were passed to stores for issue; issues were not made, except under pressure, until bottles had incubated for at least three weeks in a warm hut. Each bottle was inspected for moulds or deposits before issue.

Control was exercised by the W.O.II in charge of laboratories by means of a Zeiss dipping refractometer, with which a sample from every bulk bottle was tested for accurate strength. The strictest rules were observed concerning the use of absolutely fresh distilled water and concerning the autoclaving of solutions on the day on which they were made up. Furthermore, all solutions were filtered into their final containers through Seitz 14 cm. filters. There can be little doubt that

this refinement was an effective prophylactic for reducing pyrogenic reactions. Of these last there were very few complaints.

Nevertheless, the production of fluids suitable for export was extremely difficult, mainly owing to trouble experienced in devising a seal which would withstand tropical climates, and also to the quality of the glass supplied in the later stages of the war, which tended to give rise to silica deposits in the bottles. There can be no doubt that the British glass was greatly inferior to the American fine flint glass. The rejection rate of A.B.S.D. saline was highest after travel to India. The faults lay not with the method of manufacture, but with the quality of the materials supplied.

The policy of the Service was, so far as possible, to supply an all-purpose fluid for intravenous use. The standard solution originally adopted was isotonic glucose-saline (0·425 per cent. NaCl and 2·5 per cent. glucose). This fluid met all requirements from 1939–44. In 1944 a few cases of oedema were reported from C.M.F., and the standard fluid was then changed, under protest, to isotonic glucose-saline (0·3 per cent. NaCl, 3·3 per cent. glucose). This was issued to B.L.A.

Representations, however, from India as to the low content of chloride in this solution, as well as the realisation by those who had studied the subject that the oedema reported from C.M.F. was not due to excess chloride, led to the adoption, once again, for India, of the solution with higher chloride content.

There was little doubt that, for a patient being subjected to hydration by the intravenous route, and, at the same time, being submitted to gastric suction, the higher content of chloride was required.

The following solutions formed the great bulk of those issued by the A.B.S.D.:

1. Distilled water. Pyrogen-free for reconstitution of dried plasma (1940–42)
2. Isotonic glucose-saline (NaCl: 0·425 per cent. Glucose: 2·5 per cent.). (1939–44).
   Isotonic glucose-saline (NaCl: 0·3 per cent. Glucose: 3·3 per cent.) (1944–45).
4. Trisodium citrate: 3 per cent.—for blood taking.

The following solutions were supplied on demand:

1. Physiological saline (NaCl 0·85 per cent.).
2. Isotonic Glucose (5 per cent.).
3. Hypertonic Glucose (10 per cent.).
4. Hypertonic Glucose (5 per cent.) in physiological saline (0·85 per cent.).
5. Hypertonic Glucose (50 per cent.).
6. Acid citrate glucose solution (2 per cent. disodium citrate 100 c.cm.; 15 per cent. glucose: 20 c.cm.) for blood taking.

Statistics. The following figures show the main exports of this department:

TABLE 54

Distribution of Isotonic Glucose-Saline, etc.

		1939–43	1944	1945 (May 8)	Totals
Isotonic glucose-saline or other solutions for intravenous use (Pints)	Overseas Forces .	40,294	176,880	48,779	265,953
	Home Forces .	29,538	10,175	4,194	41,401
	U.S. Forces .	161,064	—	2,506	163,570
	Canadian Forces .	—	34,288	840	35,128
	E.M.S. . .	—	—	758	758
	In Stock . .	—	49,515	88,019	137,534
Reconstituting fluid for dried plasma	Overseas Forces .	184,266 (water)	188,832 (saline)	24,041 (saline)	397,139
	In Stock . .	—	32,271	74,205	106,476
		415,162	491,161	240,836	1,150,465

This department, therefore, produced more than a million bottles of crystalloid fluids. The work involved merely in the production of distilled water and in autoclaving was tremendous.

The following were the main receivers of the exports of isotonic glucose-saline (pints):

TABLE 55

Main Receivers of Isotonic Glucose-Saline

India	28,144 pints
B.N.A.F. and C.M.F. . . .	87,951
B.L.A.	133,752
Home Forces and Mobilising Units	89,675

In addition, the depot prepared, approximately, 40,000 pints of sodium citrate solution for its own use and about 1,000 pints for export.

ASSEMBLY (EQUIPMENT) DEPARTMENT

This department was concerned with the assembly of the standard equipment of the depot for the giving and taking of blood. Each bottle of blood or plasma (fluid or dried) sent overseas was accompanied by a complete set of sterile equipment for administration in the proportion of one set to two bottles. Salines were equipped on a scale of one set to four bottles. In addition, there was the equipment to be assembled for use each day by the blood-collecting teams. The pattern of the sets

was stabilised early in the war after satisfactory models had been devised.

This department employed from 60 to 100 hands, including voluntary workers, under the control of a staff-sergeant.

It was organised on mass-production lines, with sections engaged in making particular parts, which were fed into the assembly lines. All equipment was closely inspected for faults after assembly and again after autoclaving. The main sub-departments included a needle-sharpening department, a non-return valve department, a glass-blowing department, a rubber cleaning and washing department, and a packing and wrapping department.

Four main standard patterns of equipment were produced. In addition, the department was continually called upon to produce special pieces of apparatus, such as for penicillin drip administration or consignments of apparatus for the Ministry of Supply.

The apparatus finally devised in 1939 remained stable throughout the war, to the great advantage of the Army. Local modifications were strenuously resisted, as these were never found, on trial, to have any advantage, and had usually been previously tried. Great trouble was experienced at one period of the war, owing to the quality of rubber tubing, rubber dam and viscose caps supplied. After a period of continuous complaint, the original quality of tubing, etc. was restored. Apparent economies of this nature proved, in the end, to be far more expensive than the better quality material.

Statistics. The following figures show the work accomplished by this department:

TABLE 56

Distribution of Taking and Giving Sets

	Giving sets (Hospital pattern)	Taking sets (Universal pattern)	Giving sets (Saline)	Giving sets (Overseas pattern)	Totals
Exports: 1939–43 . .	52,720	36,967	22,488	143,572	255,747
„ 1944 . . .	5,888	11,349	40,554	168,232	266,023
„ 1945 (May 8) .	1,773	1,410	10,369	47,507	61,059
Total exports . . .	60,381	49,726	73,411	359,311	542,829
Used by Army Blood Supply Depot:—					
1939–43 . . .	—	409,000	—	—	—
1944	—	270,000	—	—	—
1945 (May 8) . .	—	90,000	—	—	—
Stock, May 8, 1945 . .	41,653	5,139	23,271	17,297	87,260
Totals	102,034	823,865	96,682	376,508	1,399,089

STORES, PACKING AND DISPATCH DEPARTMENT

The store department of the A.B.S.D. in 1939–40 occupied one hut at Southmead Hospital, Bristol. During 1940 the stores were evacuated to Chilton Polden in order to avoid destruction by air attack. There, from small beginnings, the store, by gradual additions, came to occupy 13,224 cu. ft. of covered space, 4,448 cu. ft. of tented accommodation and 2½ acres of open space. In 1945 it was also necessary to take over a large covered store camp at Street, Somerset.

The stores contained the basic requirements of the depot for one year, together with all the products of the depot before their packing and dispatch. In addition, the stores held the medical mobilisation equipment for all projected B.T.Us. and F.T.Us. Separate departments were necessary for medical stores, clothing stores, crystalloid stores, fluid plasma stores, dried plasma stores, transfusion equipment stores, medical mobilisation stores and shipment stores. The administration of these required a staff of 10–15 A.T.S. clerks and 20–30 men (for lifting).

In addition, an organised packing department was developed, with a sub-section concerned with stencilling in readiness for shipment. This department, which required meticulous supervision, occupied some 30–40 A.T.S., who would frequently work day and night shifts in order to complete a shipment. All packings were standardised, but the detail of certain packs, particularly airborne equipment, was intricate and complicated. During 1944 this department packed and dispatched 1,101 tons of stores to overseas and home forces.

Mobilisation and Overseas Units. During the course of the war the stores department equipped units which were mobilised at A.B.S.D. for overseas service. These units included the B.T.S.R.Lab. of the B.E.F., five B.T.Us. (of which one was re-equipped for service with B.L.A.) and 31 F.T.Us. (of which 8 were re-equipped for service in two theatres of war).

SCHOOL OF INSTRUCTION DEPARTMENT

It was appreciated early in 1940 that apart from giving specialised training and instruction to officers and men who were to serve with the A.Tr.S. itself, it was necessary to increase the knowledge and skill of the whole of the R.A.M.C., in the principles and practice of transfusion and resuscitation. Courses of modest size, containing about a dozen officers, and lasting a fortnight, were begun in January 1940. The courses rapidly became popular, and it was found necessary to limit the time to a week. At the same time there was a demand for a similar but lower standard course for other ranks which began in September 1941. The officers' courses were open to civilian medical officers of the E.M.S., and to officers of the Royal Navy, the Royal Air Force, Dominion Forces and U.S. Forces. The last-named attended in ever-increasing numbers until the beginning of European operations in 1944.

The school of instruction reached its peak in 1944, and the depot was forced to requisition the science block of Clifton College in order to accommodate the large number of 21 Army Group and U.S. officers who sought to attend. A special full-time staff of three officers and four other ranks had to be set aside for teaching work alone, partly by reason of the seven-day courses and partly by reason of a three months' course of instruction which was instituted in order to qualify men, V.A.Ds. and A.T.S. for the trade of transfusion orderly. In 1945, on the return of Clifton College, even more commodious hutted premises were taken on a hutted site and, at this later phase, the teaching responsibilities of the school were recognised by the inclusion in the war establishment of one major (training officer) and two staff-sergeants (instructors).

Statistics. The following is a record of the officers and of other ranks who attended courses of instruction:

TABLE 57

Courses of Instruction. Army Blood Supply Depot

Course		1940–3	1944	1945 (May)	Totals
Seven-day course for officers	Number of courses .	61	10	2	73
	R.A.M.C. . .	744	271	25	1,040
	R.N. and R.A.F. .	14	22	2	38
	Canadian . .	26	19	—	45
	U.S. . . .	40	58	—	98
	Allied Forces . .	5	6	2	13
	Civilians . . .	117	2	—	119
	Totals . . .	946	378	29	1,353
Seven-day course for other ranks	Number of courses .	29	16	5	50
	Number attending .	737	417	148	1,302
Three months' course for trade of transfusion orderly	Number of courses .	—	4	2	6
	Number attending .	—	196	20	216

It can be confidently stated that these courses of instruction, which, for long, were offered by depot officers, in addition to their routine duties, were one of the most valuable contributions to the education of the medical profession for war. The subject of traumatic shock was not one which was well understood by the average doctor, while skill in transfusion work was rarely found. The officers' courses were purposely kept small in order that individual attention might be given. The intimate nature of the instruction made the courses very popular, so that vacancies were eagerly sought for, not only by the R.A.M.C., but

also by all the other British Services, as well as U.S., Canadian and Allied Forces. The inclusion of U.S. officers added greatly to the zest of the instruction on account of the stimulus to discussion, while a most friendly atmosphere of goodwill and co-operation was developed.

Royal Engineer Section. The depot began its career with one officer and a number of O.Rs. of the Royal Engineers, who were attached for the purpose of servicing and maintaining all refrigerator equipment and for instructing R.A.M.C. orderlies in the elements of maintenance and simple repairs. It was also necessary to collect and train staff to perform similar duties for all B.T.Us. sent overseas. As the war progressed, there arose numerous problems concerning refrigeration in the field in order to ensure the safe carriage of blood in all climates and under all conditions. Consequently, the ingenuity of the staff was taxed to provide special equipment to meet the varying requirements. Furthermore, from 1940 onwards, the R.E. Section undertook the operation of the plasma drying plant. In 1944, in addition to the drying plant responsibility, the R.E. Section maintained six large-capacity cold rooms (one at a distant aerodrome), fourteen large Type A refrigerators, six Type B refrigerators and two Type E refrigerators. During 1944 the staff maintained and tested no less than fifty-one refrigerators for use in various operational areas.

The R.E. Section was responsible for the design of the Types A, B, C and D refrigerators and gave practical advice and suggestions in the design of the Type E. Numerous insulated boxes were designed by the depot staff and submitted to test, firstly, at the Experimental Station, Porton, and later in a hot (115° F.) room, which was constructed at the depot itself. The following designs were used:

1. Large capacity 20-bottle box for temperate climate.
2. Medium capacity 10-bottle box for temperate climate.
3. Small capacity 3-bottle box for temperate climate.
4. Parachute supply 5-bottle box for airborne forces, adaptable for use in temperate or tropical climates.
5. Medium capacity 8-bottle box for tropical climates.

The following special refrigerators were also designed:

1. Refrigerator suitable for mounting on jeep trailer for use by airborne forces.
2. Special refrigerator for use on 3-ton lorry in Tropics.

TRANSPORT SECTION

The main transport work of A.B.S.D. was always performed by A.T.S. Establishments to 1945 also contained a number of R.A.S.C. fitters on the strength of the depot itself. Indeed, until 1943, the whole transport of the depot was under the control of O.C. Depot, which, fortunately, permitted him to develop the work to the best advantage

without the restraining influence of the R.A.S.C. When in 1943 the transport was placed under the control of a C (M) T. Coy., R.A.S.C., the routine work and special duties had been so developed that no modifications were permissible without disruption of the whole organisation.

A.T.S. drivers were employed in taking blood-collecting teams to their destinations. On arrival, the drivers, having been given directions for vehicle maintenance, were employed on duties in the organised work of the team. A.T.S. drivers drove the special Type A refrigerator vans which carried blood from the depot to aerodromes or ports. In this work their pluck and endurance was unparalleled from the point of view both of fatigue and of overcoming appalling conditions of road and weather. There was never a failure to reach a destination in time.

A.T.S. drivers drove all the heavy vehicles carrying loads to station or port. In addition, they learned the mechanism of the refrigerator vehicles, and were capable of servicing and maintaining a refrigerator as well as a vehicle.

Statistics. The mileage driven by the transport totalled, approximately, 693,000 miles in 1944—the peak year—including 21,000 miles by the awkward Type A refrigerators. During the same period there were sixty-nine accidents, of which only ten involved damage exceeding £5. None involved injury to personnel or third party, and in 34 of the accidents, the drivers were held not to blame. An incidence of one accident per 10,043 miles, with damage exceeding £5 at one per 69,300 miles, reflects the greatest credit on a skilled and plucky band of young women.

THE BATTLE OF BRITAIN

CO-OPERATION WITH OTHER SERVICES

Following the fall of France, all of the A.Tr.S. personnel who escaped capture were concentrated at Bristol. The B.T.S.R. Lab. was disbanded, but the surviving F.T.Us. were distributed throughout England, and later Northern Ireland, as 'command transfusion units'. As such, they were responsible to the D.D.M.S. of the command for the efficiency of the transfusion arrangements in the command and for the dissemination of knowledge concerning the treatment of wound shock throughout all medical units in their area. These command transfusion officers maintained the closest touch with the A.B.S.D. for the obtaining of supplies and advice.

The field transfusion units concerned were posted as follows:

N. Ireland District . .	21 F.T.U. St. Helen's Bay
	22 F.T.U. Kilrea
	31 F.T.U. Hollywood
Southern Command . .	23 F.T.U. Tidworth
	24 F.T.U. Shaftesbury

Aldershot Command	25 F.T.U. Cambridge Hospital
Eastern Command	26 F.T.U. Bury St. Edmunds
	27 F.T.U. Maidstone
Northern Command	28 F.T.U. York
Western Command	29 F.T.U. Llandilo, S. Wales
	30 F.T.U. Ormskirk, Lancs.

The units were attached either to a C.C.S., or more usually, to a military hospital. They set about this work with vigour, and soon had transfusion fluids and equipment distributed to all medical units. At the same time, especially in the potential invasion areas on the East, South-east and South coasts, a number of dumps were formed to provide a source of supply in case certain areas should become isolated. The work was difficult to perform. Much depended upon the co-operation and encouragement of the D.D.M.S. This was not always forthcoming. Some areas, such as the huge and vulnerable Eastern Command, demanded much travelling and much forethought. Usually the only transport available was the unwieldy Type A refrigerator of the unit itself. It was no easy matter to cover a large command with a regular cycle of inspections of unstable fluids such as plasma, coupling with the inspections, a lecture-demonstration to the medical unit. The work was efficiently done and no medical unit in the country was caught unprepared for an air raid. All were ready for invasion. This was particularly so in Eastern Command, where there was not only a first-class organisation to deal with casualties, but also an organisation for obtaining blood which was forwarded to Bristol for processing. There was the closest co-operation in all areas with E.M.S. Transfusion Service, which had not come into being until after the fall of France.

Relatively little of this widespread and thorough organisation ever came into active use. There were small air raids in Southern Command (Tidworth), and more extensive ones in Lancashire, Yorkshire and Northern Ireland, but these last three involved the civil population more than military units. The two services, military and E.M.S., gave each other mutual assistance on such occasions.

In 1941 a conference of command transfusion officers was held at Bristol, where the whole scheme was considered. At this conference it was clearly shown that the services of these command officers were sometimes not fully appreciated, nor was the work that they had done given the recognition it deserved. At this time strong representations were made for the granting of specialist status to officers who were acting as advisers on a difficult and important subject. The representations were rejected. Following this conference, the command organisation was brought under closer control of the A.D.P. Command, rather than of the D.D.M.S. himself.

Late in 1941 the command organisation began to break down because, with the preparation for offensive work in the Middle East and North Africa, certain of the units were withdrawn from commands and mobilised at Bristol. By October 1942 all such units had been withdrawn. The old scheme was, nevertheless, preserved on a less ambitious basis by means of periodic visits of inspection and lecture tours by officers operating from the A.B.S.D., Bristol. It was, therefore, necessary to create a Command Transfusion Department at Bristol, in charge of a full-time officer. He was assisted by two others who, in regular 3–4 monthly cycles, visited all commands in the country. All arrangements for these tours were made by A.Ds.P. commands. This scheme continued until the end of 1943, by which time all available officers had been mobilised for service overseas.

The depot itself had, after the fall of France, more active experience of air-raid casualties than any of the satellite F.T.Us. dispersed in the commands. In that the depot was responsible for civil transfusion work in its region, its experience in the cities of Bristol and Bath and the towns of Burnham-on-Sea, Weston-super-Mare, Warminster, and other places was extensive. Two mobile transfusion teams were on duty by day and by night, who were immediately available to deal with incidents. The teams consisted of a medical officer, two nurses (V.A.D.) and an A.T.S. driver.* These had often to make excursions in the night when bombs were still dropping or fires raging. Nevertheless, this experience, which was survived without casualty, had its advantages. It gave the staff of the depot first-hand experience in the transfusion of the wounded, provided experience for newcomers and those attending courses of instruction and provided material for the study of wound shock, which was published in one of the first communications on the subject. During this period, 155 casualties were transfused, involving the use of 336 pints of plasma and 155 pints of blood, or an average of 3·1 pints of protein fluid per casualty. From this experience there emerged the general dictum, afterwards confirmed in many civilian and Service quarters, that approximately ten per cent. of casualties needed to be transfused, and that between three and four pints of protein fluid per case was a reasonable provision.

The quality of the work of the Army Transfusion Service is best assessed by reference to the volume of respectful admiration that it evoked from Army Medical Services generally. Its quantity is revealed in Table 58, which presents the balance sheet of the service for the period of the war in Europe. Plates XVI–XXIII illustrate various phases of the work of the Army Transfusion Service.

---

* For schedules of standard equipment *see Resuscitation*, 1944, H.M.S.O.

TABLE 58

Plasma and Blood Bank Balance Sheet
Period: The European War, September 3, 1939 to May 8, 1945

IN

Number of Donors bled (one pint)

1939–40	33,845
1941	77,694
1942	124,241
1943	172,074
1944	267,595
1945 (May 8)	80,597
	756,046

Marginal Notes

Gifts of blood (pints) during 1944–5 from:

North-west London Depot	18,163
Leeds Region	21,381
Cardiff Region	5,874
Nottingham Region	2,480
Royal Navy	3,935
	51,833

Gifts of Fluid Plasma (pints) from:

E.M.S. and M.R.C.:	
1939–42	5,300
1943	1,419
1944	*18,000
1945 (May 8)	*9,905
	34,624

* Kaolin plasma for drying received from Leeds and Oxford.

OUT

	1939–40	1941	1942	1943	1944	1945 to May 8	Grand totals	Correction factor for plasma yield	Equivalent in donors
Blood (pints)									
Overseas	2,580	—	—	—	59,827	38,300	100,707		
Home Forces	212	63	427	—	688	167	1,557		
R.A.F. and R.N.	189	36	136	520	1,229	654	2,764		
U.S. Hospitals	—	—	—	—	69	58	127		
E.M.S. Hospitals	971	687	3,472	3,877	4,911	1,986	15,904		
Unexported stock	—	—	18	69	321	1,456	1,864		
	3,952	786	4,053	4,466	67,045	42,621	122,923		
Less gifts	—	—	—	—	28,152	23,681	51,833		
Totals	3,952	786	4,053	4,466	38,893	18,940	71,090	× 1	71,090
Fluid plasma (pints)									
Overseas and Home Forces	6,980	11,459	25,325	9,105	55,496	19,695	128,060		
R.A.F., R.N., and Troop Ships	325	581	218	152	60	24	1,360		
E.M.S. Hospitals	1,427	2,998	4,537	975	12	—	9,949		
U.S. Forces	—	—	1,273	338	—	—	1,611		
Canadian Forces	—	—	256	914	3,734	—	4,904		
Other Allied Forces	—	80	—	—	—	—	80		
Stock, and awaiting shipment	—	—	6,143	5,582	11,354	5,464	28,543		
	8,732	15,118	37,752	17,066	70,656	25,183	174,507		
Less stock 1942–4	—	—	—	6,143	5,582	11,354	23,079		
	8,732	15,118	37,752	10,923	65,074	13,829	151,428		
Less gifts	—	—	5,300	1,419	18,000	9,905	34,624		
Totals	8,732	15,118	32,452	9,504	47,074	3,924	116,804	× 1·9	221,928

Gifts of Dried Plasma (x 400 c.cm.) from :

M.R.C. and E.M.S. 1939–42	11,915
M.R.C. and Regions 1943	16,689
M.R.C. 1944	18,631
M.R.C. 1945	9,562
Scottish Service 1944	3,150
Canada 1943	8,580
Canada 1944–5	100,767
	169,294

Gifts of Grouping Serum from Galton Laboratories :

1939–42	1·75 pints
1943	2·0 ,,
1944	5·2 ,,
	8·95 ,,

Accidents and Complaints September 3, 1939 to May 8, 1945:

Number	197
Incidence	1 in 3,838
Compensation claims	32
Incidence	1 in 23,626

Percentage waste . 3·27

Dried plasma (x 400 c.cm.)

Overseas and Home Forces	2,249	17,052	28,412	85,196	169,155	25,261	327,325		
R.A.F., R.N., and Troop Ships	—	—	—	—	4,540	275	4,815		
E.M.S. Hospitals	—	—	—	1,174	3,216	790	5,180		
U.S. Forces	—	—	1,110	—	—	—	1,110		
Canadian Forces	—	—	—	353	669	—	1,022		
Sundries	—	38	47	53	267	378	783		
Awaiting shipment	—	—	—	8,992	11,245	6,319	26,556		
Stock	—	—	5,446	24,907	39,085	148,316	217,754		
	2,249	17,090	35,015	120,675	228,177	181,339	584,545		
Less stock 1942–4	—	—	—	546	33,899	50,330	89,675		
	2,249	17,090	35,015	115,229	194,278	131,009	494,870		
Less gifts	—	—	11,915	25,269	122,548	9,562	169,294		
Totals	2,249	17,090	23,100	89,960	71,730	121,447	325,576	× 1·9	437,942

Adjustment to convert x 400 c.cm. bottles to pints: 325,576 x 400 c.cm. = 230,496 pints.

Grouping Serum (pints)

Overseas	1·50	3·80	3·95	16·80	10·25	11·30	47·60		
Home Forces	5·45	5·75	5·05	9·60	10·50	1·35	37·70		
Used by A.B.S.D.	8·30	6·20	9·20	12·30	17·50	9·10	62·60		
R.A.F. and R.N.	0·30	0·20	—	—	1·00	—	1·50		
E.M.S.	4·50	2·10	0·30	—	6·00	0·50	13·40		
Canadian and U.S.	—	—	—	—	3·00	—	3·00		
Stock	—	—	14·25	5·10	7·73	10·15	37·23		
	20·05	18·05	32·75	43·80	55·98	32·40	203·03		
Less stock 1942–44	—	—	—	14·25	5·10	7·73	27·08		
	20·05	18·05	32·75	29·55	50·88	24·67	175·95		
Less gifts	—	—	1·75	2·00	5·20	—	8·95		
Totals	20·05	18·05	31·00	27·55	45·68	24·67	167·00	× 1·9	317
Unaccounted for (Technical faults, contaminations, breakages and other discards):									24,769
									756,046

756,046

CHAPTER 8

MEDICAL PROVISION FOR THE AUXILIARY TERRITORIAL SERVICE*

INTRODUCTION

ALTHOUGH there had been a Women's Service (W.A.A.C.) associated with the Army during the War of 1914–18, the official medical history of that war devotes but two pages to its affairs and offers no detailed information which might have been used for the guidance of those who in the War of 1939–45 became responsible for the medical care of the Auxiliary Territorial Service.

The War Office letter issued on August 25, 1939, dealing with terms and conditions of service, laid it down that medical and dental treatment would be provided for A.T.S. officers and other ranks under the same conditions as for serving male personnel of equivalent rank. No further instructions appear to have been issued and for some time after the outbreak of war medical officers were quite uncertain (and in some cases unaware) of their new responsibilities. In October 1939 the Director, Auxiliary Territorial Service, decided to clarify the situation and requested information as to the rights of her Service and also asked for the appointment of women medical officers to deal with the examination of recruits, to take medical charge of large concentrations of A.T.S. personnel and of A.T.S. wards in hospitals. To this D.G.A.M.S. replied that medical treatment would be as for men, as also dental treatment, but that the provision of spectacles, dentures and surgical appliances was not yet authorised, though it was under discussion. He also agreed to arrange for women doctors to attend reception depots and the Ordnance Depot, Chilwell, and promised to consider the question of special advisers later. But he refused to consider any special arrangements for the medical examination of recruits.

The Army from the very beginning accepted the principle that the women serving it had the right to some forms of medical attention—to exactly how much was a source of argument for several years after 1939. There seems to have been astonishingly little consideration given to the medical aspect when the new Service was being planned. When, early in 1939, the Medical Women's Federation (M.W.F.) sent a representative to see D.G.A.M.S. and point out how important were the special medical requirements of a Women's Service, they were answered categorically that no specialised advice regarding women personnel was needed and that it was not intended to employ women doctors.

* The substance of this account was provided by Lieut. Colonel Letitia Fairfield, C.B.E., and Lieut. Colonel Albertine Winner, O.B.E., who served successively as W.M.A. and A.D.G., A.M.D.9.

Experience soon showed, however, that certain problems, especially of feminine hygiene, were beyond the experience of the Army-trained administrator and also that the needs of the A.T.S. tended to be forgotten in planning because it was no one's duty to remember them. When the A.T.S. Council was formed in the autumn of 1940, it was decided to include a woman doctor with the rank of lieut. colonel. She was at first given the title of Woman Medical Adviser (W.M.A.) and rather loosely attached to A.M.D.1. It soon became clear that she needed greater executive authority than that of an adviser, so in October 1941 a new A.M.D. Branch was created (A.M.D.9) to deal with all problems of the medical administration of women; the branch at first had one medical staff captain and later two, one medical and one A.T.S., only to lose both in 1945 during the run-down; it was later absorbed into A.M.D.10 and finally abolished. The right location of the senior woman medical officer at the War Office was never really decided; the separate branch had many advantages but was too small to be really efficient and in practice action was nearly always taken through one of the other branches. Activities overlapped nearly every branch—A.M.D.1 dealt with nursing orderlies and posting of medical officers, A.M.D.2 with hospital provision for A.T.S., A.M.D.3 with equipment and drugs, while A.M.D.4 provided the nursing staff for various special activities. Probably the largest overlap was with A.M.D.5, whose D. of H. was finally responsible to D.G.A.M.S. for the care of the health of women, but who delegated much of this function to the A.D.G. who was head of A.M.D.9. A.M.D.6 dealt entirely with dental provision for A.T.S. (and with women dentists when these appeared), A.M.D.7 with various special pathological services, including pregnancy tests, A.M.D.8 with all medical establishments and A.M.D.10 with regulations, medico-legal problems and medical boards; the psychiatrists in A.M.D.11 were keenly interested in many specifically feminine problems that arose, while A.M.D.12 transported all medical invalids back to the United Kingdom and the Directorate of Medical Research gradually assumed responsibility for all female statistics and sponsored several interesting investigations. Thus the head of A.M.D.9 came to be largely a co-ordinator whose function was to interpret to the Army Medical Directorate the requirements and organisation of the Auxiliary Territorial Service and to keep the A.T.S. Directorate informed of the medical aspects of the problems with which they were dealing. A possible place for the senior woman medical officer might have been A.M.D.5, with which she had most to do, but this would have limited her value as a general co-ordinator. The final outcome of experience would seem to be that, in war-time at any rate, a medical officer of standing is absolutely necessary to watch all aspects of medical provision for women, that there is every advantage in putting a woman doctor in this position and that

the best place for her is in whatever co-ordinating branch there is in the Army Medical Directorate, with free access to the D.A.T.S. and her staff.

WOMEN MEDICAL STAFF OFFICERS IN HOME COMMANDS AND OVERSEAS

In commands there were at first no women medical officers occupying administrative posts. In June 1940 a woman D.A.D.M.S. at one command headquarters proved unsuccessful and the attachment, a little later, of a woman medical officer to a district H.Q. to undertake routine medical examination and general medical oversight of A.T.S. was found to conflict with the duties of regimental medical officers. When, however, the great expansion of the A.T.S. was announced, it was decided in June 1941 to attach a woman medical officer to the staff of the D.D.M.S. in four commands, with the rank of major, to advise on all matters concerning the A.T.S. Their functions took different forms in different commands, some D.Ds.M.S. kept them entirely on A.T.S. work, while others, referring all A.T.S. problems to them, used them also for general medical staff duties, an arrangement which made it much easier for them to see their job in perspective. Later, in 1941, they became D.A.Ds.M.S.(W) (their previous position had been uncertain) and during 1942 D.A.Ds.M.S.(W) were appointed to all the remaining commands. By 1944 the A.T.S. had begun to shrink and most problems had been tackled and solved; in spite of the diminution in their work it was decided that the women staff officers should stay and be absorbed into the general staff of D.Ds.M.S. dropping the (W) from their title. Gradually they were released and not replaced. A few women were appointed A.Ds.H. and one (in B.A.O.R.) became D.A.D.M.S. to a base sub-area and one D.A.D.M.S. at Rhine Army H.Q.; all, however, without special duties *vis-à-vis* the A.T.S.

MEDICAL ARRANGEMENTS FOR THE A.T.S.

From the earliest stages of the war it was realised that it was more economical and efficient to assimilate medical arrangements for A.T.S. to those of the Army generally, than to create an entirely separate organisation for them. Thus D.Ds.M.S. within their commands and A.Ds.M.S. in their areas assumed medical responsibility for the A.T.S. In units, large concentrations of A.T.S. usually had their own woman medical officer, as the latter became more plentiful, who also looked after any male troops in the vicinity, but where the A.T.S. were attached in smaller numbers to a male unit, the R.M.O. of that unit looked after them. A curious feature was the reluctance of some R.M.Os. to undertake the care of Service women, an attitude strongly supported by one A.D.M.S. who finally announced that his medical officers could not possibly examine women 'below the chest'.

A great deal of public attention became focused on the A.T.S. and complaints that the women were not getting proper medical attention were soon forthcoming. In January 1940 the Adjutant General sent emphatic personal telegrams to all commands instructing them to make sure that everyone was fully aware of the Army's medical responsibility for the A.T.S. and urging the adequate provision of camp reception stations (C.R.Ss.) and hospital accommodation. Finally, in April, the situation was made absolutely clear by the issue of an A.C.I.

A great deal of adverse criticism had been levelled at the Service, much of it undeserved, and the widespread outbreak of influenza and german measles in the early part of 1940 did not help, necessitating as it inevitably did much improvisation of accommodation for the sick and straining the medical and A.T.S. resources to provide for the large numbers involved. Fortunately the outbreak was mild and little or no real harm was done (indeed, much was learnt which was valuable in the future), but the conditions gave rise to a good deal of unhelpful gossip and probably as the aftermath of this, inadequacy of camp reception stations and hospital accommodation was adversely commented on by the Select Committee on National Expenditure reporting in the summer of 1940.

Spectacles, Dentures and Surgical Appliances. By April 1940 it was established that the A.T.S. had full medical rights except for dentures, spectacles and surgical appliances. The chief ground for refusing these was the lack of any power to hold auxiliaries for service, with the consequent possibility that a woman would come in, get her dentures or spectacles and promptly depart. As to glasses, the need for Mark III spectacles (i.e. special flat-sided spectacles that could be worn under a respirator) was raised as early as April 1939 and turned down on the ground that women, not being front-line troops, would not have to wear respirators; after much discussion A.T.S. personnel employed with the Air Defence of Great Britain were allowed one pair. After the outbreak of war requests came up from commands that women should have all necessary appliances, but it was not until January 1941 that the first concession was made. One pair of Mark III spectacles was then granted to all who needed them, a decision promulgated in an A.C.I. (1084 of 1941). A second pair was secured in July 1941, and surgical appliances in July 1942. The supply of dentures was not conceded until June 1942 (after the A.T.S. had been brought under military law). After this, the entitlement to medical and dental attendance, treatment and appliances became the same for women as for men.

Special Leave for Private Medical Treatment. The Army in peacetime had very clear-cut rules concerning medical treatment from outside its own resources; other ranks, who were entitled to free treatment, could not make their own arrangements at their own expense, whereas

officers, who were eligible for free treatment if available but were not entitled to it, were free to make private arrangements at any time so long as they paid for it. This ruling appears not to have been questioned in peace-time, but with the influx of vast numbers of non-regulars, many of whom were desirous of having treatment from their own peace-time doctors and able to pay for it, there arose a demand that the instructions be altered. The matter was first raised in April 1940 when the proposal to give other ranks the same option as officers was turned down, mainly on the ground of the loss of administrative control. It was raised again in September 1941 and again turned down. Then in July 1942 it was represented that in actual fact soldiers and auxiliaries were constantly making their own arrangements. The matter was finally referred to the Army Council, and, after much consideration, it was decided to grant other ranks the right to 'special leave for private medical treatment' subject to certain safeguards. The most important of these were:

1. The treatment must be necessary and approved and must be from a registered medical practitioner.
2. Skin, psychiatric and venereal diseases were excepted.
3. The soldier or auxiliary undertook not to hold the Army responsible either for the cost of treatment or for any risk or injury incurred thereby.
4. A medical report had to be forwarded weekly to the man's commanding officer who transmitted it to the senior administrative medical officer of the area or district; and
5. The Army reserved to itself the right to have the other rank examined by a military medical officer or to remove him to a military or E.M.S. hospital at any time, should there be reason to consider his progress unsatisfactory.

These decisions were promulgated in an Army Council letter in February 1943, and the many administrative queries that arose were elucidated in a further letter in August 1943.

After the initial difficulties had been surmounted, the scheme worked fairly well and certainly regularised a practice that it would probably have been impossible to stop. From the Army's point of view, the practice was unsatisfactory, since it was exceedingly difficult to exercise any kind of control over such as were being treated by their own doctors, and in a few cases much trouble was experienced in getting them back to duty. It is of interest that although both the Royal Navy and Royal Air Force allowed a similar option, the United States and Canadian Armies had no such freedom and neither officers nor other ranks were permitted to have any medical treatment from other than military sources.

Camp Reception Stations. In the early stages of the war there was a great lack of accommodation for the minor sick, who were cared for mainly in so-called sick bays, i.e. rooms provided by the units in their own billets, nursing being done by interested members of the unit, local immobile V.A.Ds. or anyone else who could help. This system was strongly criticised in 1940 by the Select Committee on National Expenditure, and in January 1941 proper provision of C.R.Ss. was authorised on a basis of 2 per cent. of strength (the men's rate was 1 per cent.) wherever the numbers of A.T.S. in the locality exceeded 500. Most of these large groups were entirely A.T.S. units with a special establishment, which included V.A.Ds. and A.T.S. G.D.Os., with a nursing officer of the Q.A.I.M.N.S. wherever the D.D.M.S. considered it necessary. In some cases an A.T.S. wing or ward was attached to a male C.R.S. and in Anti-aircraft Command mixed C.R.Ss., accommodating male and female patients in separate wards with a mixed staff, proved very successful. The original war establishment provided too many V.A.D. nursing members and insufficient cooking, clerical and domestic staff. *Ad hoc* attempts were made to remedy this, but a comprehensive revision of the war establishment, bringing the men's, women's and mixed C.R.Ss. into line and remedying the observed defects, was held up for so long that it never took place.

Sick Bays. For smaller units (less than 500) a similar scale of beds was allowed in what were called sick bays, provided under unit auspices and staffed by A.T.S. medical orderlies instead of the nursing orderlies V.A.D. (or later, A.T.S.) of the C.R.Ss. The larger R.A.M.C. units were more satisfactory and more efficient and were used whenever the numbers within a ten mile radius justified it, but the sick bays were surprisingly successful in smaller and more isolated units, though they were more difficult to supervise. There was also a tendency for units, officially served by a C.R.S., to set aside their own, unauthorised, sick bay for sick too trivial even for the C.R.S. Much care was lavished on these irregular sick bays, but the medical authorities were always nervous lest serious illness in its earlier stage should get missed in these unsupervised places and did all they could to discourage them. An instruction was issued in 1944 ordering units not to keep auxiliaries in bed for more than a few hours without informing the M.O.

HOSPITAL PROVISION

The hospital provision was simple. The care of sick women was nothing new to the Army, which had long provided for its families and its nurses. In all the peace-time garrisons was a military families hospital and into these A.T.S. personnel requiring hospital treatment were at once accepted. Many of the larger military hospitals also set

aside women's wards, while A.T.S. officers were warded with nursing officers. Out-patient and casualty treatment was provided automatically for the women, side by side with men, only a few special clinics (e.g. V.D.) being kept separate, but there was a brief tussle in the early days with some of the older hospitals without female beds before they would allow women to attend their out-patient clinics.

There was one abortive attempt to set up a purely A.T.S. hospital. Early in 1940 it was found that the isolation block of the new Queen Charlotte Hospital was lying nearly completed and empty and the hospital authorities offered it to the Army. A scheme was formulated to complete it, equip it and open it as a 200-bedded hospital for the Women's Services and for its staff, and female specialists in medicine, surgery and gynaecology were nominated (these were the first women specialists to join the Service as such, in December 1940). It was found, however, that the cost of completing the hospital would be much greater than had been expected. Then on September 7, 1940, the London 'blitz' started and it rapidly became clear that the London area was not an appropriate place in which to establish a new military hospital. Finally the project was entirely abandoned; a proportion of the required beds were opened in the Military Hospital, Shenley, to the establishment of which the specialists were nominally added, though in fact the original three, when they came in, were employed in other parts of the country on ordinary specialist work.

The great bulk of the hospital provision was, however, with the E.M.S., and most of the A.T.S. sick were cared for in civil hospitals. The E.M.S. served the A.T.S. well. Its especial advantages for them were first its ubiquity—no unit was so isolated that it had not an E.M.S. hospital within reach—and second its availability for women; as the hospitals had been planned for the civilian population they had women's wards as a matter of course. The Women's Services were fully entitled personnel where the E.M.S. was concerned and had access to all the special units, clinics and hospitals of that service.

One of the most valuable E.M.S. units to the A.T.S. was the neurosis centre at Mill Hill. This started in the early days of the war for the expected psychoneurotic casualties of air raids, but gradually became more and more filled with military personnel. By 1942 it had 50 beds for Service women under a civilian woman psychiatrist and these beds were afterwards increased to 100 and later to 150. Here, too, misfits were re-mustered and re-posted with the help of the Annexure Scheme. The success of Mill Hill was very great and it saved for the Service large numbers of men and women who otherwise might have drifted unhappily back to civil life. Mill Hill closed in 1945 and its A.T.S. work was taken over by the Queen Alexandra Military Hospital, first at Shenley and later at Horley.

The problem of the psychotics was entirely different. At the beginning of the war psychotic auxiliaries were all dealt with as civilians and removed at once to civilian mental hospitals to be dealt with by certification or voluntary treatment, whichever was appropriate. But when in 1941 the Women's Services came under military law, these arrangements were no longer legal and provision had to be made for them to be kept in a military hospital as long as they remained military personnel (V.A.D. members up to January 1944 had to be treated as civilians). The difficulty, however, was to provide trained nursing staff for such a military hospital, for the Army only had its male mental nursing orderlies and the A.T.S. could provide none. Finally a satisfactory compromise was reached, a wing of St. Andrew's Hospital, Northampton, a large private mental hospital, was taken over, the medical superintendent and his deputy both received honorary commissions in the R.A.M.C. and the rest of the staff continued to work as civilians. In this way some 90 beds were obtained for A.T.S. and W.A.A.F. personnel and for nursing officers, with a military status and all the benefits of an up-to-date civilian hospital. For the rest of the war the Military Hospital (Women), Northampton, did excellent work and relieved the Army of all anxiety in respect of its female psychotics.

CONVALESCENT ACCOMMODATION

The Army recognised the need for two types of convalescent provision for its men. On the one hand there were the convalescent hospitals run for the E.M.S. by the Joint War Organisation of the B.R.C.S. and the Order of St. John which catered for men in the early stages of recovery, who still needed rest, relaxation and continued medical supervision and treatment; on the other there were the convalescent depots, military medical units which specialised in the later stages of rehabilitation and the conversion of cured but physically soft men into trained and fit soldiers.

The need for the convalescent hospital type of provision for A.T.S. was early recognised and the A.T.S. was fortunate in finding a generous friend who lent Cornwell Manor, Kingham, Oxfordshire, as a convalescent home for auxiliaries. There was accommodation for forty-eight. But as the Service grew there soon developed a need for more accommodation, and first one and then more and more B.R.C.S. and Order of St. John convalescent hospitals were allotted to Service women, until at the peak over 500 convalescent beds were available. Officers were taken at the B.R.C.S. homes at Kildonan Castle, Ayrshire, at Corsham Court, Wiltshire, and for a time at the Officers' Convalescent Home, Osborne.

All these convalescent homes were located in large and often beautiful mansions, usually in the depths of the country and well or badly suited

to the purpose in hand. Those run by the B.R.C.S. had as a rule a commandant (often the owner of the house) who was responsible for general administration and discipline, and a matron (always a trained nurse) who looked after the medical welfare of the patients under the general supervision of a local medical practitioner who visited, sometimes regularly once or twice a week, sometimes only as required. The rest of the staff were usually mobile V.A.D. members—clerks, cooks, nursing orderlies, etc. The efficiency of these homes varied a good deal; the best were first class, but some were not so good and much depended on the harmonious relations of matron and commandant. The Service departments had no direct control over these homes and all representations, whether complaining or otherwise, had to go through the Joint War Organisation, which in turn worked through its county directors. It was therefore very difficult to get any uniformity of policy in the various homes, which seemed highly autonomous, in spite of the greatest helpfulness and goodwill at the centre. Kingham was an A.T.S. unit under the command of an A.T.S. officer with a nursing officer to deal with the medical side, a wholly A.T.S. staff except for one V.A.D., and again the local doctor superintending the treatment. Military control was here complete and there was no trouble over policy. Kingham started in 1940 and the rest opened at intervals from 1941 onwards. By the beginning of 1943 a common defect had shown itself in the lack of occupation for auxiliaries; though not at first recognised as such, another manifestation of the same failing was also causing trouble in the numerous complaints from units that girls returned from convalescence quite unfit for full duty. It was therefore decided to try and remedy this. The military establishment of a B.R.C.S. and Order of St. John convalescent hospital allowed a N.C.O. (corporal for less than 50 beds, sergeant for 50 and over) for purposes of administration and discipline, but this had never been implemented (with one unsuccessful exception) and it was decided to give carefully selected N.C.Os. an elementary training in modified physical training tables and educational and recreational pursuits suited to convalescents. The N.C.Os. were picked in February 1943 and in March and April the education and physical training courses were held; commands were warned and asked to keep an eye on the experiment and the N.C.Os. were duly posted. Unfortunately the homes themselves had been insufficiently prepared, and at a conference held in September to assess results the reports were very mixed. A few N.C.Os. had made good and were proving a great success, but some matrons were alarmed at the very idea of giving P.T. to convalescents whom they considered fit only to lie about and do nothing and some units had relegated their N.C.O. to clerical and administrative duties only, while others had refused to treat her as a member of the staff and in many cases things were difficult.

Since most of the difficulties were such as could easily be resolved, it was agreed to continue the experiment for another six months and then review policy.

Shortly after this conference a woman medical officer was appointed specialist in physical medicine for A.T.S. and her first assignment was to visit each of the homes and report both on the N.C.Os. and on the work. The next meeting in April 1944 had the benefit of her first-hand reports and as a result it was decided to remove the N.C.Os. from the most unco-operative homes and to concentrate on the ones from which results could really be expected. A certain number of unsuccessful N.C.Os. were also eliminated and it was agreed to select and train another batch, this time from among trained A.T.S. P.T. instructors. This was done in August 1944. Moreover, this specialist and the P.T. staff revised and improved the P.T. tables in the light of experience and turned them into true remedial exercises. They were further revised and improved in 1945.

After this the scheme worked fairly well, but only as the result of an immense amount of personal visiting, exhortation and tact on the part of the specialist in physical medicine and the command medical, P.T. and education staffs. There is no doubt, however, that it was worth while; the auxiliaries got well more quickly and at the end of their stay were alert and fit instead of soft and bored. But the expenditure of time and energy on the part of the Army was very great and would not have been necessary had control been more direct.

Kingham never had an establishment for an N.C.O. to carry out similar functions because after the A.T.S. Reconditioning Centre was opened it was always hoped that Kingham could be closed, its work being undertaken by the convalescent homes of the B.R.C.S. and Order of St. John. But for various reasons it did not close until after the end of the war, and for the last year or two one of the N.C.Os. held on the establishment of an unco-operative home was in fact used at Kingham. The work done here was exactly the same as that done in the other type of home and it was very successful.

THE A.T.S. RECONDITIONING CENTRE

At first there seemed no need for the type of accommodation provided in the male convalescent depot; it was considered that women did not need the hardening and toughening required by fighting soldiers, that their work did not necessitate special rehabilitation after illness; convalescent hospitals were all that was required. But as the urgent need for woman-power made the units work at higher and higher pressure, complaints began to be heard that auxiliaries fresh from hospital or convalescence were unable to undertake full duty at once, that there were no light duties in the A.T.S. and that it would

be better not to return such auxiliaries to the unit until they could undertake normal work. It was this demand that led to the opening of a new type of unit, the A.T.S. Reconditioning Centre which combined the characters of a convalescent depot, a physical development centre and a centre for remedial treatment of faulty posture and foot defects. This unit opened in the winter of 1943 with 250 beds which were gradually reduced to 100 as the A.T.S. decreased in strength. It was highly successful and was a pioneer venture in rehabilitation. A similar unit functioned in B.O.A.R. near Brussels in 1944–5.

When it was finally decided early in 1943 to open an A.T.S. equivalent of a convalescent depot much thought was expended on a title. As it was proposed to include a certain number of cases for which the men would have used a P.D.C., convalescent depot seemed inappropriate, rehabilitation centre too difficult to spell and pronounce, and finally, almost by process of exhaustion, the title 'A.T.S. Reconditioning Centre' was adopted. It was much criticised and almost universally disliked, but its critics never offered a better alternative and only in 1946, when the rôle had somewhat changed, did it become the A.T.S. Convalescent Establishment.

It was a pioneer unit; rehabilitation had been fully worked out for soldiers, miners and other male workers, but the rehabilitation of women was an untilled field, and, as far as can be ascertained, this was the first establishment in any country to be devoted entirely to it. The first task was to find premises, and after much searching, Hatchford Park, near Cobham, in Surrey, was selected; it had previously housed a male convalescent depot and much of the equipment was taken over from this unit. It was to take 250 'trainees' (they were not to be called patients) and the alterations and additions required many months' work. It opened in November 1943, however, with about thirty trainees under the command of a woman medical officer with the rank of major.

The plan laid down (from which little deviation proved necessary) was to fill the auxiliaries' day with physical and mental activities, leaving the evenings for their own recreation. The physical aspect included (1) carefully graded remedial exercises ranging from grade I, who did all their exercises sitting down, to grade V, who did full A.T.S. P.T., (2) special individual remedial classes for those with disabilities requiring them, (3) organised games (hockey, tennis, runs, etc.) and various constructive tasks in and around the house and garden, from sweeping leaves to heavy digging. The educational activities varied with the instructors available and the policy of the officer-in-charge; it included classes in English, arithmetic and elementary science, current affairs and A.B.C.A., play and poetry readings, toy-making, etc. It had been hoped originally to relate each girl's classes to her A.T.S.

job and to teach domestic science to cooks and orderlies, English and arithmetic to clerks and elementary science to signals personnel, drivers, A.A. personnel, etc., but this aspiration, though probably sound, could never be put into practice as it would have required too large a staff. It was found to be essential to divide most classes into the bright and not-so-bright; any further sub-division would have been impossible.

The unit was extravagant in staff, but many of the specialists were essential, however small the unit. In addition to the commandant there was an A.T.S. company commander in charge of welfare, A.T.S. discipline, etc., a second medical officer, two specialist junior commanders, one for P.T. and one for education, an adjutant and a junior officer as platoon officer for the staff (later a second junior officer was added for messing and Q); also a physiotherapist. The (woman) specialist in physical medicine also visited weekly. There was a C.S.M., a C.Q.M.S., administrative N.C.Os., P.T. and A.E.C. sergeants and the usual clerical and cookhouse staffs. Altogether the staff numbered between 60 and 70 for 250 trainees.

Hatchford Park was almost ideal for the purpose. It was a large modern house, near to which a number of huts had been built, together with cookhouse and dining hall. It had many large rooms, a good hall with a stage, a swimming pool (which was never used, first because of water shortage and later because of difficulties in chlorination), large and beautiful grounds and a garage which at first was used as a gymnasium; later a large gymnasium was built in the grounds.

From the point of view of medical and technical policy the unit ran smoothly from the start and very few adjustments were needed. Administratively there were many teething troubles, some arising from clashes of personality, others from sheer inexperience at all levels in managing such a unit. The control of A.T.S. personnel by administrative medical officers was a complete novelty and created certain difficulties. All its war-time commandants contributed to its success. The first laid down the technical and medical policy that lasted to the end, the second sorted out the A.T.S. and R.A.M.C. problems and put its internal administration on a firm basis and the third gave it its final welding and polishing.

The trainees fell into several groups. There were first the cases from hospital, C.R.S. and convalescent home who required toning up, exercise and general re-orientation. Then there were recruits and serving auxiliaries who were vaguely below par, weedy, undernourished and pallid; their requirements were exercise, good food and encouragement. Among the unexpected were the cases requiring intensive and long physiotherapy and remedial treatment, mainly severe foot defects and postural anomalies; these did excellently and were perhaps the

outstanding success of the unit—the halt not only walked but ran and jumped. Then there was a group of signals personnel, doing highly secret work under great strain; these mainly needed rest and freedom with a little exercise and usually came for a week only; the other cases stayed as a rule from three to five weeks. Neurotics as such were not accepted, but a certain number were there under other diagnoses. Results were good, both as regards well-being and general fitness as well as in the cure of specific disabilities, but unfortunately follow-up was incomplete and it was not possible to give statistical proof of success.

Remedial Classes. As the success of the reconditioning centre with severe foot defects became manifest, the specialist in physical medicine conceived the idea of saving time and woman-power by treating the less severe, but not the less crippling, defects in the units. She taught one of the surplus convalescent home N.C.Os. a series of simple remedial exercises designed to increase the mobility of the foot and to improve posture, persuaded London District to find her a suitable room, and in the autumn of 1943 started a series of remedial classes, each for about ten auxiliaries and lasting forty minutes. The results were remarkable; many after one or two courses of daily classes for three weeks were entirely relieved of foot troubles they had had for years and the idea seemed worth developing.

The next extension was at 7 A.T.S. Training Centre at Guildford. Here the specialist had been examining recruits and had found less than 50 per cent. with normal feet. She persuaded the commandant in November 1943 to start a similar foot class, using one of the training centre P.T. instructors and again success was remarkable; similar classes were soon after started at 11 Training Centre, Dalkeith. In January 1944 a course in remedial exercises was held at the reconditioning centre, which was attended both by B.R.C.S. N.C.Os. and by P.T.Is., especially from training centres, and with no definite establishment the number of remedial classes slowly grew.

In September 1944 it became clear that proper staff was needed and that these classes saved so much woman-power that they were worth it. A request was submitted for one specially trained P.T.I. for every 2,500 auxiliaries (80 in all) to be held in command pools and allocated to the best advantage. As a number of P.T.Is. were being thrown up by the disbandment of A.A. Command, the authorities agreed to this and regular training was started, three-weeks' courses being held at the A.T.S. P.T. School, first at Leicester and later at Denbury. In March 1945 the scheme was launched by a War Office letter; commands were told that the increased P.T. establishment was to allow the starting of remedial classes wherever numbers and needs justified it; that most, if not all, P.T.Is., would receive the necessary training so that classes would be possible nearly everywhere; that the classes would be under

general medical supervision and organisation but the P.T. staff officers would be responsible for the supervision of the standard of instruction.

The scheme was somewhat held up by delay in providing the necessary equipment but it was in operation long enough before the end of the war to prove its great value and essential soundness. Perhaps its most remarkable feature was the excellence of the results obtained with the simplest of exercises and equipment and instructors whose training had lasted three weeks (plus normal P.T.).

E.M.S. NEUROSIS CENTRE

The Women's Service Wing at the Mill Hill Neurosis Centre started in 1943 with 50 beds for psychoneurotics. The results of psychotherapy and careful rehabilitation were excellent, but if cases were to be returned to duty, some form of intra-service rehabilitation was also required. For men there had already been evolved what was called the 'Annexure Scheme' for the resettlement and follow-up of doubtful cases. In May 1943 this was appropriately modified for the A.T.S. Cases in which it was thought there was only a 50 : 50 chance of recovery were interviewed by a selection officer who, in consultation with the psychiatrist in charge of the case, made certain recommendations concerning employment and posting. In this way an attempt was made to place such as had been misfits in the most favourable environments to prevent further breakdown. These recommendations were sent to the War Office and if at all possible a suitable posting was arranged. When this was settled a special letter was sent to the group commander asking her to keep a special eye on the auxiliary and explaining the position in non-technical terms. After three months and six months follow-up forms were sent to the unit asking for a report from the A.T.S. or medical officer on her progress.

The follow-up showed that considerably over three-quarters of these cases were still in the Service after six months and were rated by their units as very good, good or fair workers. As most of them would probably have been discharged in the absence of the scheme, it must be regarded as most successful.

Of course many cases from Mill Hill recovered so completely that they did not require this special posting and the hospital's own follow-up statistics showed a remarkable recovery rate.

A.T.S. MEDICAL PERSONNEL

When the A.T.S. was originally recruited it seems to have been thought that the B.R.C.S. and Order of St. John would provide all the auxiliary female staff required by the medical services, and the A.T.S. was only called on to supply ambulance drivers. In 1941, when the need for replacing every potential fighting man by a woman was

urgently realised, a list of priorities was laid down to govern the order in which the various arms of the Service should be allotted A.T.S. In that list the R.A.M.C. occupied the lowest place, so that the medical services never employed more than a relatively small number of A.T.S. It must be admitted that many of the men who might have been replaced were of low category, but since much of the work of the corps is so obviously suited to women, psychologically and physically, it is to be regretted that more use could not be made of them. It was not until after 1944 that the trade of nursing orderly became available for A.T.S. personnel, the female ranks being entirely filled previously by numbers of V.A.Ds. It was only the realisation that the latter's ceiling had been based on the Army's male strength and that the A.T.S. when sick were being provided for out of the Army's share, that produced in 1944 a small allotment of A.T.S. nursing orderlies who were intended to replace V.A.Ds. in A.T.S. C.R.Ss. and hospital wards. They were trained at the R.A.M.C. Depot, Crookham, and at selected military hospitals. A few were selected and trained in B.A.O.R. and there were also some Palestinian A.T.S. nursing orderlies in the Middle East.

A certain number of A.T.S. personnel worked in military hospitals and C.R.Ss. as clerks, storewomen, general-duty orderlies, cooks (both hospital and ordinary), telephonists, etc.

There was also a small number of masseuses, radiographers, almoners, etc., who, having entered the A.T.S. in the ordinary way, were subsequently employed in their own profession by special War Office authority.

The medical orderly was an employment peculiar to the A.T.S., for the Army knew only the medical officer's orderly, found from within the unit and rather erratically trained. With the development of unit sick bays and the appreciation of the importance of welfare in a Women's Service, there came the realisation of the need for female personnel, with rudimentary but none the less organised training, to care for the cases of trivial sickness within the unit, to look after the M.I. Room and its equipment and to help the medical officer at sick parade. A scheme for the production of these medical orderlies was launched in 1941; at first units were asked to nominate suitable auxiliaries and send them for training, under command arrangements, at selected military hospitals, military families hospitals and C.R.Ss. which had nursing sisters in charge. The syllabus included simple nursing duties such as the taking of temperatures, the preparation and serving of invalid food, the giving of medicines, blanket bathing and bed-making, etc. They were also supposed to learn how to examine and treat infested heads, but those trained in military and families hospitals had less opportunity to learn this—indeed, in many ways the type of training they received in C.R.Ss. was better adapted to their needs than that in

hospitals. Criteria of selection was an early problem—units were found to have an unwise tendency to unload unwanted auxiliaries and an instruction was soon issued to the effect that all potential medical orderlies must be passed as suitable by a medical officer before being sent for training. A certain amount of difficulty was experienced by A.A. Command, which controlled no hospitals and few large C.R.Ss., in getting their potential medical orderlies trained, but a scheme was worked out whereby certain training hospitals, etc., in home commands, were allotted to them for their personnel; also nursing officers were posted to the C.R.Ss. of all A.A. mixed training regiments, so that the medical orderlies of a battery in training could receive their training simultaneously. This scheme, with certain administrative modifications, persisted unchanged until May 1945, when training in military hospitals ceased and the syllabus was rather more closely defined. It was also suggested that the certificate of proficiency should, if possible, be awarded on the result of an examination by a medical and nursing officer, other than those who had carried out the training; and an attempt was made to discourage the practice of using medical orderlies in training to relieve unit personnel, to the detriment of their training.

On the whole the medical orderly system worked well, but the lack of promotion and non-recognition as tradeswomen tended to discourage the best type of auxiliary. Several attempts were made to get the employment upgraded to a trade, preferably that of nursing orderly, so that personnel of units, C.R.Ss. and hospitals could have been interchangeable, with consequent increased variety of work and improved promotion prospects, but agreement could not be obtained. A partial answer was found in an improved scale of ranks for M.I. rooms serving large bodies of A.T.S. which allowed a small number of ranks up to sergeant, but the problem was never really solved.

The only other important category of medical personnel was that of chiropodists.* This category was introduced in 1941 and authorised at first for basic training centres, M.T. training centres and the Chilwell Ordnance Depot. Later establishments were approved for mixed heavy A.A. regiments and training regiments. All chiropodists were to be on the Register of Medical Auxiliaries, were given the rank of corporal and classed as a Group D trade (as were male Army chiropodists). A certain number were found already in the Service and persuaded to return to their own job and the Chiropody Group Council did their best to obtain recruits from the profession outside. Unfortunately the shortage of chiropodists in the civilian world had considerably increased their earnings and the Army's terms were not good enough to attract more than a few of the most patriotic. The established posts were never

* *See* Chapter 2, The Army Hygiene Service.

completely filled and even the Chiropody Group Council's gesture in January 1943 of forming an auxiliary register, the standards for which were less rigid, did little to relieve the shortage. Finally the chiropodists available were collected in command pools, so that they could be used to the best advantage and, to supplement them, from 1944 onwards, a number of foot orderlies were trained. These were selected from the ranks of the medical orderlies, given 26 days' training at a military hospital to enable them to deal with the simple foot troubles and granted 1d. or 2d. a day extra pay according to the size of the unit. They were certainly not as satisfactory as fully-trained chiropodists would have been, but were much better than nothing and certainly rendered good service.

The chiropodists proved to be an essential element in the Service and must have saved many working days and much discomfort. At training centres they were especially valuable, in many cases helping in the fitting of shoes and always assisting in the acclimatisation of the auxiliary's foot to the excellent but unaccustomed and sometimes unyielding A.T.S. shoe. Later, when the physical medicine specialists inaugurated foot clinics, they attended these and proved invaluable members of the team. Their scarcity was a real disadvantage to the Service which could, with advantage, have used double the number it secured.

MEDICAL EXAMINATION OF A.T.S. PERSONNEL

Before the outbreak of war recruits were examined under T.A. auspices, either by civilian practitioners or by R.A.M.C. officers, and passed as fit or otherwise to enter the Service. There is general agreement that in most cases this examination was sketchy in the extreme. This casualness in recruiting examination was probably the cause of the high wastage rate in the A.T.S. in the first year or so of the war. Soon after the outbreak of war D.A.T.S., supported by the Finance and Recruiting directorates, asked for recruiting medical boards with a detailed examination. This the medical authorities stoutly resisted, holding that such elaborate arrangements were unnecessary in view of the rôle the A.T.S. was to play. They were induced to agree that the examination might be recorded on the same form as for men (A.F.B.178) and that a R.A.M.C. officer or C.M.P. should carry out the examination, but that was all. It was agreed that A.Ds.M.S. should provide one or other at stated recruiting centres and a rough standard of fitness was agreed. Even then the Director of Hygiene refused to allow any grading and all had to be declared 'Fit' or 'Unfit'. These instructions were issued in December 1939.

Further representations in January 1940 evoked the same response.

As 1940 wore on more and more complaints came in from recruiting officers and reception depots concerning the variations in standards,

and the examining medical officers themselves complained of the lack of guidance as to how 'fit' a woman needed to be for service. Finally D. of H. yielded to pressure and in December 1940 an excellent set of *Instructions for the Physical Examination of Recruits* was issued, though the grading was still restricted to 'Fit' and 'Unfit'.

These arrangements did not last long; the rapid expansion of the A.T.S. made more extensive arrangements necessary and in April 1941 the Ministry of Labour, which had employed recruiting medical boards for men since the beginning of the war, agreed to take over women too. The boards consisted of three civilian doctors (as against five for men), of whom one, where possible, was to be a woman; the chairman, in spite of protests, was always to be a man. The same form (A.F.B.178A) was to be used for recording the examination (in 1942 it was modified and a female edition (A.F.B.178W) was issued), similar grading and standards were to be adopted and an addendum to the Ministry's *Instruction for the Guidance of Medical Boards* was issued to deal with female problems. These arrangements were very successful and continued, practically unaltered, until the end of the war.

One exception to the Ministry of Labour boards persisted to the end—the Central London Recruiting Board. The civilian personnel were superseded in 1941 by two women R.A.M.C. officers who examined all the volunteers who presented themselves besides making a number of incidental examinations of overseas and intelligence personnel. The Army medical authorities, very short of officers, twice tried to get this board handed over to the Ministry of Labour, but each time it was ruled on a high level that it was essential and would continue. It was certainly very useful to all concerned, but wasteful of R.A.M.C. officers.

Certain lessons were learned from the experience of these recruiting medical examinations. Firstly, fairly explicit standards and instructions were essential. Secondly, in dealing with women some female help was desirable—a V.A.D. was found very suitable—to obtain specimens and to control dressing, undressing, etc.; these auxiliaries could be entrusted with the testing of urines and vision, weighing and measuring, etc. Thirdly, cubicles or some form of privacy for dressing and undressing was very important, as was also reasonable privacy in examination. Fourthly, unless the recruit herself objected, there was no reason to refuse examination during menstruation except that the urine test, if abnormal, had to be repeated when clear. Finally, adequate specialist opinion had to be made readily available.

Routine Health Inspections. No definite instructions concerning routine medical inspections seem to have been considered before 1941, but various units certainly did persuade their medical officers to give their auxiliaries a regular check-over, probably a version of what the Army calls a F.F.I. (freedom from infection) Inspection, held usually on

posting, proceeding on a course, returning from leave, etc. In June 1941, however, one command reported through medical channels that its A.T.S. officers had asked for routine medical inspection and requested guidance as to its legality and extent. The result of this was an instruction issued in July allowing a limited inspection which was not very efficacious, so that in November 1941 the matter was again raised and a more comprehensive instruction drafted. This laid it down that inspections should be carried out monthly by the medical officer, assisted by a female V.A.D. or medical orderly, that the woman should remove outer garments, retaining brassiere and knickers and that due privacy should be ensured, and that a modified examination should be carried out on returning from leave, before proceeding on courses, etc. There was some high-level discussion as to the advisability of insisting that a sister of the Q.A.I.M.N.S. should be present where the examination was carried out by a male medical officer and the first instruction, issued on December 24, 1941, contained this provision. It was found to be quite impracticable, however, owing to shortage of sisters, and was withdrawn on January 21, 1942. It was hoped that the inspection would identify cases of *Pediculosis capitis* and scabies, as well as early pregnancy and any serious deterioration of general health. *Pediculosis capitis* and *Phthirus pubis* infestations were thought to be so rare in women as to need no routine search and later experience confirmed this. The first two objectives were certainly achieved; the scabies rate fell markedly about this time, though whether due to the inspection or to other causes cannot be determined, and *P. capitis* was always low among serving personnel. The hope of detecting early pregnancy was sadly disappointed, partly because auxiliaries who wished to conceal it avoided presenting themselves, partly because brassiere and knickers could conceal quite advanced pregnancy if the auxiliary was not examined on a couch. The number of full-time pregnancies which were missed at routine medical inspection was a constant source of embarrassment to the Army Medical Directorate. No attempt was ever made to find venereal disease at such routine inspections, nor could this ever be successful in women.

These inspections continued practically unchanged until 1943. In August 1942 the title 'Routine Medical Examination' was changed to 'Health Inspections' in an attempt to get away from the atmosphere of the F.F.I., but the procedure itself was unchanged. The standard of the inspections varied enormously with the conscientiousness of the medical officer, the organisation of the parade (this depended largely on the co-operation of the A.T.S. officers) and the time available. In spite of the shortcomings of the inspections they were greatly valued by many A.T.S. officers and there was much complaining when in 1943 the shortage of medical officers necessitated the abolition of the regular

monthly inspection. It must be admitted, however, that their abolition made no appreciable difference to the health statistics, nor did the subsequent abolition in 1944 of the inspection on returning from leave.

Certain commands repeatedly suggested that the unit officers were perfectly competent to do the F.F.I. type of inspection if every skin blemish was at once reported, but the suggestion was never accepted. It was, however, agreed that it was part of a unit officer's responsibility to do a weekly head and foot inspection, but again this inspection was carried out with very varying regularity and efficiency, yet it is probable that it did contribute to the lowness of the head infestation rate in serving auxiliaries.

*Medical Classification.** As already described, it was not thought in the early days that any system of medical classification was needed for the A.T.S. Volunteers were enrolled to carry out specific duties, and the examining doctor was merely expected to say whether an auxiliary was fit or unfit for that duty. At an early stage, however, the question was raised whether any medical approval was required for an auxiliary to change her employment after enrolment. After some discussion it was agreed that employments approved till then fell into two broad categories in their medical demands and that whereas an auxiliary could change her employment within the same class without medical examination, the approval of a medical officer was required for re-mustering from one class to another. This was the germ of the later system.

In May 1941 the taking over of recruiting medical examinations by the Ministry of Labour provided the stimulus for devising a more adequate system of classification based on the four grades used by the Boards. It was agreed that the male grades were not suitable and a parallel system was worked out. As with the men, there were five basic categories denoted by letters, further details of vision and hearing being shown by numbers. The categories were distinguished from those of the men by the letter W.

Women of category B.W.4 and C.W. were not recruited but were retained in the Service if downgraded to one of these categories and employable. All the sub-divisions of category A.W. were considered fit for service in any part of the world, but the B.Ws. were for service in a temperate climate and the C.Ws. for home service only. At the same time the permissible medical categories for all the authorised employments were laid down and auxiliaries employed on duties for which their medical category did not qualify them, or who were later downgraded to a category too low for their employment, were to be reclassified. As with the men, one medical officer could upgrade an auxiliary, but only a medical board could downgrade.

---

* *See* Army Medical Services, Volume I, Chapter 11.

These categories remained with only slight modification to the end of the war. They were originally issued to recruiting offices in August 1941 and a little later as a War Office letter to commands. They were embodied in a pamphlet, together with instructions on sick leave and the 'Y' list, which was issued in January 1942. In November 1943 it was decided to split categories A.W.3 and B.W.3 into two: visual standard 5, which implied poor vision in both eyes, was called A.W.5, B.W.5, while visual standard 6, which meant good vision in one eye and little or none in the other, but which was much more useful to the Service than V.S.5, was termed A.W.3, B.W.3; employments were re-arranged accordingly and a new edition of the pamphlet (now separate from 'Y' list and sick leave) was issued in February 1944.

About this time a further difficulty began to present itself. Hitherto the number of volunteers for overseas had greatly exceeded the requirements and as a matter of administrative convenience, overseas drafts were selected solely from those who were category A.W. The demand now began to increase greatly and auxiliaries were required for North-West Europe and Italy, as well as the Middle East, and the medical standards clearly would have to be reduced. But the A.W., B.W., C.W. categories, though originally intended to correspond with overseas service anywhere, temperate climate only and home service only, had become irretrieveably linked with capacity for employment, and the anomaly arose of a perfectly fit category A.W. girl, with for instance, light-sensitisation dermatitis or a mild otitis media, being downgraded to B.W. or even C.W. to keep her in the United Kingdom or N.W. Europe, which might necessitate re-classification if her employment was not permitted for these categories. In other words, the same categories were being used for two different purposes, and the confusion was considerable. Finally, later in 1944, a new system was introduced whereby the A.W., B.W., C.W. system was reserved for suitability for employment and a new suffix (O.S.), (O.S.N.T.) or (H.S.) denoted fitness for overseas service anywhere, overseas service in a non-tropical climate or home service only, and this worked very well.

One other difficulty came to light. The original classification only made provision for the two degrees of foot defects, 'severe' which were automatically category C.W. and 'slight' which were ignored. There was no category corresponding to the men's A.2, which meant moderate defects. One answer would have been to add another numeral so that sight, constitution and locomotion could all be denoted, but this was thought confusing and finally, in 1943, certain employments were marked in the pamphlet to indicate that they could not be performed by auxiliaries with more than 'slight' defects of locomotion, all the others being allowed to have 'moderate' defects.

The women officers' system of classification was introduced at the same time as the O.Rs. and followed similar lines. It was, however, simpler and merely included A.W., B.W., C.W., D.W. and E.W. When, however, the (O.S.), (O.S.N.T.) and (H.S.) categories were introduced for other ranks in 1944 the women's categories were brought more closely in line with those for male officers.

The general procedure for upgrading and downgrading officers and other ranks, as also for medical boards and discharge on medical grounds, was identical for male and female troops. The same applied to release medical examinations.

Examination for Pregnancy. From the very beginning it was accepted that a medical certificate was required before a woman could be discharged on grounds of pregnancy, but at first any doctor's certificate in almost any form was accepted. The discharge was at first carried out on compassionate grounds, and, as a number of different causes were lumped together under this head, there is no real information available as to the pregnancy rates for the first two years of war. During 1941 the whole problem was reconsidered and in September 1941 new instructions were issued which were subsequently embodied in A.T.S. Regulations. These created a new ground for discharge, 'for family reasons'; as this was paragraph 11 of the relevant appendix, pregnancy became familiarly known as a 'para 11 discharge'. A *pro forma* for the medical certificate was set out in which the doctor was asked to state, in addition to identifying particulars, the auxiliary's age, marital state, length of service, duration of pregnancy, expected date of delivery and whether a laboratory pregnancy diagnosis test had been carried out or not; the certificate had to be signed, in the case of an other rank, by an R.A.M.C. officer, a C.M.P. in charge of troops or a gynæcologist, military or civilian. It was to be completed in duplicate, one copy being used to support the discharge (which was usually carried out at three months) while the other was sent, through medical channels, to the War Office (A.M.D.9) who kept the detailed medical statistics relating to pregnancy. It was also stated that the auxiliary's examination must be carried out discreetly and with due privacy, that, if performed on suspicion only, the auxiliary should not be informed of the reason, that an internal examination could not be carried out without her consent and that she could demand a woman doctor if she so wished. The gynæcological centres, to be described later, provided the necessary staff and equipment for this.

As early as December 1940 arrangements had been made for tests to be carried out at the Pregnancy Diagnosis Laboratory, Edinburgh University, and the policy was to discharge auxiliaries as early as possible; an instruction was issued in January 1942 to the effect that a test must be used to support certificates of pregnancy given at less than

ten weeks. Unfortunately the *Ascheim-Zondek* test required for its performance large supplies of mice, and the fact that one of the largest breeders in the country had most of his stock destroyed, combined with shortage of feeding stuffs, made it necessary drastically to curtail its use, and later in 1942 it was decided that it could only be carried out when requested by a specialist in gynæcology, the unit medical officers not being able to order it. A certain amount of disquiet was therefore caused when a number of certificates were received notifying pregnancies of six to eight weeks, a disquiet which was confirmed when one or two cases came to notice from civilian sources of auxiliaries discharged on family grounds who proved not to have been pregnant at all. After consultation with the Royal College of Obstetricians and Gynaecologists it was decided that non-specialists could not reasonably be expected to be 100 per cent. certain of the diagnosis before twelve weeks, and an amendment to A.T.S. Regulations was issued in February 1943 saying that medical officers' certificates would not be accepted before twelve weeks unless supported by a gynaecologist's opinion. Some medical officers interpreted this to mean that auxiliaries could not be discharged before twelve weeks, and in December 1943 a letter was issued pointing out the desirability in certain cases, on administrative as well as on medical grounds, of earlier discharge and encouraging recourse to a specialist in these cases, though pointing out that in most cases the unit M.O. should be able to do it himself at twelve weeks without specialist help.

In January 1944 the pregnancy *pro forma* was replaced by a new Army Form (I.3214). The first version had already been modified by the addition of a space for the selection group (which was, however, rarely filled in—it had been hoped to obtain interesting information from it). The new Army form closely followed the *pro forma* and included all the previous information; it was decided that the expected date of delivery was not really necessary and involved the medical officer in much arithmetic. This was therefore omitted; by an oversight the length of service was also left out.

The pregnancy certificate, as finally evolved, gave all the information necessary to compile accurate statistics except for one difficulty: a certain number apparently got lost on their way up through medical channels and those received in A.M.D.9 were always deficient as compared with figures furnished by A.T.S. Records. It was finally decided to accept the latter as the basis for calculation of married, single and total pregnancy rates and to use the A.M.D.9 certificates as a random sample on which to base other statistics.

It was agreed that for medical and welfare reasons the Army was no place for a pregnant woman. The difficulty in finding light duties for her, the question of night duty, the problem, especially in war-time, of

booking in for her confinement and, if unmarried, of finding accommodation, all made early discharge desirable. There was also the problem, political rather than medical, of early miscarriage. The first four months is of course the most likely time for this to occur and such evidence as is available indicates that Army service, even in A.A. Command or in M.T. companies, did not predispose to miscarriage, rather the reverse. But though the medical authorities might be quite satisfied, it was not so easy to convince an unhappy husband that the much desired baby had not been lost because of lifting a heavy article or through the hurry and alarm of the air raid; on the other hand, diagnosis must be reasonably certain or alleged pregnancy would be too easy a way out (there is some evidence that with certain rather casual medical officers it did indeed prove so). It was therefore a great misfortune that the use of the laboratory tests had to be so restricted. Looking back, it seems important that in any future emergency of the same kind the Women's Services should take early steps to ensure that facilities for the laboratory diagnosis of pregnancy should be provided. In 1939–45 the Canadian W.A.C. did so and were fortunate in being able to make use of the *Xenopus* test, denied to the A.T.S. for the reason that these animals could not be imported in sufficient numbers from South Africa. This test was used for the W.R.N.S. by the medical services of the R.N. It should not have been impossible for the A.M.S. to have secured permission to import these animals in war-time.

The problem of concealed pregnancy was never successfully solved, and, as stated above, routine medical examinations proved useless. Most of the advanced pregnancies reported were, of course, in unmarried women, and the statistics show that, whereas the average time of discharge in married women was the fourteenth week, that of the unmarried was nearer the twentieth. The A.T.S. service tunic tended to hide the condition and though battledress should have been more revealing, those entitled to wear it were also apt to wear the leather jerkin which again covered everything. A surprising number of confinements occurred and in a few remarkable cases even these were successfully (if only temporarily) concealed. There seems no way of detecting the really determined woman who wishes to conceal a pregnancy.

A development of this problem was the detection of pregnancy in overseas drafts. This was a problem of some importance, especially when the Mediterranean was closed as, even if she was only six to eight weeks pregnant when she left the United Kingdom (and therefore undetectable by ordinary examination), by the time an auxiliary reached M.E. she might be twenty-four to twenty-six weeks and too far advanced to be returned to United Kingdom before confinement—a serious problem for the authorities overseas. The Canadian authorities solved

the problem to a great extent by insisting that all female personnel proceeding overseas must have a pregnancy test before embarkation. But all their women were volunteers and had to agree to this procedure before being accepted for overseas. The possibility was explored for British Army female personnel, but there were real legal and practical difficulties where non-volunteers were concerned, and the obstacles had not been surmounted before the need came to an end.

Since pregnant auxiliaries were neither sick nor wounded (at any rate if the pregnancy was normal), they were not covered by the Geneva Convention and therefore could not properly be carried on hospital ships, and yet a troopship is far from ideal even if its passengers include nursing officers.

In practice, whenever at all conscientiously possible, a pregnancy was regarded as abnormal and therefore justifying transport in a hospital ship. An instruction issued in 1942 (when the Mediterranean was closed) stated that a pregnant auxiliary must not embark if the pregnancy was more than twenty-four weeks advanced; this was relaxed in June 1944 to 'within five months of approaching confinement' for ports East of Suez and to 'within three months' for nearer ones; in June 1945 it was further relaxed to up to five months pregnant for India only, and in January 1946 the normal peace-time provisions of *King's Regulations* 1940, para. 1170, i.e. 'within three months of confinement' for all voyages. The question of air transport was considered, especially for India, but was rejected on the grounds of the great discomforts, uncertainties and possible landings at airfields far from medical aid which were inevitable accompaniments of war-time flights, as well as because of the possible danger to the foetus of anoxaemia due to high altitude flying. One or two women medical officers who were pregnant got themselves returned to the United Kingdom by air and their reports of the flight appeared to justify the rejection of this as a normal method of transport of pregnant women, at any rate in war-time.

Statistical data relating to pregnancy were presented in the *Statistical Report on the Health of the Army*. Figures are only available from October 1941, divided into pregnancies occurring in married and unmarried auxiliaries (the former constituted a proportion of the total Service which varied from 8 to 15 per cent. but contributed anything from 66 per cent. to 75 per cent. of the pregnancies). The unmarried pregnancy rate was about $1\frac{1}{2}$ to $1\frac{3}{4}$ per cent. of the unmarried strength between 1941 and 1943; it then rose to $2\frac{1}{2}$ per cent. and stayed round about this level to the end. No very clear cause for this rise was found but it was paralleled in the other Women's Services and there was a similar, but steadier and more dramatic, rise in the illegitimate birth rate for the civil population. It was always very difficult to compare the

latter with the Army's illegitimate pregnancy rate, partly because allowance could not be made for the cases that miscarried before term but chiefly because in civil life a large number of pre-marital conceptions are legitimated before birth, whereas in the Army the mothers were discharged before marriage. However, calculations based on what information was available seemed to show that when due allowance was made for these factors the Army's rate was well below the civilian figure—a corrective to the unfair scandal and gossip to which the A.T.S. was subjected in 1941 and 1942.

The married pregnancy rate rose steadily as the war progressed. In 1942 it was about a quarter of the married strength, in 1943 about a third and in 1944 nearly half—a remarkable figure. The 1945 figures were completely vitiated by demobilisation.

The well-being of pregnant auxiliaries was the responsibility of the A.T.S. authorities, chiefly A.G.19 at the War Office, and the administrative and staff officers in commands. A.M.D.9 was of course in constant touch and gave advice and help as required. The medical hazards (which are primarily social hazards) of illegitimacy to the mother and child were recognised and the welfare aspect therefore claimed the interest of the medical staff. They played a considerable part at every stage in the evolution of a social policy, in the enlistment of the help of the various voluntary social organisations, in the disposal of cases, in the drafting of the memorandum '*The Well-being of A.T.S. discharged for "Family Reasons"*' (which in its 1944 edition had a medical appendix on the care of the pregnant woman before discharge and possible emergencies and first aid), and later in the planning of the Ministry of Health scheme for pregnant women. This close co-operation between medical and lay interests within the Army was of great value in ensuring that the girls had the best medical and social care.

One of the most interesting joint schemes was the Special Discharge Depot at Whittington Hall, near Worcester, which was opened early in 1942. This was a fair-sized house to which pregnant auxiliaries could be sent before discharge, and where those cases who for various reasons were encompassed with difficulties could be sent for thorough social investigation and help. Its thirty beds proved invaluable and the medical needs were covered by a liaison with the county maternity and child welfare staff (at one time ante-natal examinations were done on the premises but this had to be stopped owing to staff shortage) and by the presence on the staff of a nursing officer with a C.M.B. qualification. The officer commanding was an A.T.S. junior commander. The unit was also used for pregnancy cases returned from overseas—again it provided a resting place pending satisfactory disposal. No case was supposed to be admitted after twenty-eight weeks, but in spite of all

efforts a few babies were born in the depot before appropriate arrangements could be made.

Towards the end of 1941 the question arose of women discharged from the Service on account of pregnancy who wished to re-enrol after confinement. It was felt strongly that such re-enrolment was to be discouraged for the sake of the child, and that the woman must be encouraged to breast-feed it herself and care for it; there was also the question of how soon a woman was physically fit for Army life after a confinement. The advice of the Royal College of Obstetricians and Gynaecologists was sought and in December 1941 its council recommended that no woman should be enrolled until at least six months after the birth of her child. This ruling was incorporated in Recruiting Instructions. A year later the further query was raised as to whether this ruling applied to women who had had still-births or had had their children adopted. In the second case the ruling was held to apply as it was not desired to encourage adoption, but in the case of still-births the advice of the college was again sought, and they advised that the time could in such cases be shortened to three months, subject to a satisfactory gynaecological examination.

Abortions were dealt with on similar lines. Cases of miscarriage before the twenty-eighth week were treated as gynaecological cases; if they had not been discharged they were retained in the Service if pronounced fit; if they had been discharged they could be re-enrolled after gynaecological examination. After twenty-eight weeks the rules applying to full-time confinement applied. Women who had recently had a confinement or miscarriage and were seeking enrolment for the first time were treated in the same way as those seeking re-enrolment.

Internal Examination. Digital or instrumental examination *per rectum* or *per vaginam* is classed legally as a surgical operation, and, like all surgical operations, is regarded by the courts as assault if the subject's consent is not obtained. Thus a real administrative problem presented itself in the diagnosis of pregnancy and venereal disease as well as of ordinary gynaecological disorders. The first instruction on the subject was issued in September 1941 in connexion with pregnancy, and merely stated that internal examination could not be carried out without the auxiliary's consent; this was subsequently embodied in the second edition of *A.T.S. Regulations.* The same problem arose next in connexion with the examination of auxiliaries alleged by soldiers to be the source of venereal disease. Here, too, it was stated that examination must be voluntary and the importance was stressed of approaching the auxiliary in such a way that she realised its importance to herself; if she refused and there was real reason to suspect her of venereal infection she was to be discharged 'services no longer required'; this instruction was issued in September 1942. A little later the question of rectal

examination and vaginal examination for conditions other than pregnancy was raised, and in November 1942 a further instruction was put out giving a set of rules; the auxiliary's verbal consent was to be obtained in the presence of a witness, a record was to be kept of the date, nature and purpose of examination, also of the name of examiner and signature of witness, and it was further laid down that internal examination should only be carried out in the presence of a nursing officer, nursing orderly V.A.D., or medical orderly A.T.S. These rules did not apply to military or E.M.S. hospitals. No further alterations were made and there was no further trouble.

Gynaecological Arrangements. Initially no special gynaecological provision was made and reliance was placed entirely on the Army gynaecological specialists at the military families hospitals and on the civilian specialists in E.M.S. hospitals. This type of provision was always perfectly adequate for the major gynaecological conditions requiring operative treatment; such cases were relatively few as they tend to occur in older women, and the age groups 18–25, in which fell the great mass of the A.T.S., are commonly free from such conditions. They were never a problem except overseas, where central provision had to be made in the absence of civil hospitals, but here the difficulty was the smallness of numbers and great distance involved, which made the appointment of a gynaecologist a necessary but very uneconomic proposition.

The main problem was four-fold. There were first a large number of menstrual upsets, mostly amenorrhoea of varying duration, but taking many forms. Secondly, there was the diagnosis of pregnancy where this was outside the competence of a unit medical officer or where the auxiliary demanded a woman doctor. Thirdly, there was the diagnosis of venereal disease, both syphilis and gonorrhoea, together with tests of cure and continuation treatment. And finally, there was the diagnosis and treatment of the non-venereal vaginal discharges, mainly trichomonas vaginitis.

These needs became apparent during 1941 and, as a start, financial authority was obtained for the appointment of an honorary consultant in gynaecology to each command. These were nominated by the Royal College of Obstetricians and Gynaecologists, and by October 1941 they had all been invited and accepted. Commands were then instructed to prepare schemes for dealing primarily with V.D. and pregnancy diagnosis, and in most cases these were prepared by the woman D.A.D.M.S. at command H.Q. in consultation with the honorary consultant concerned. A flaw in the arrangements, which only gradually showed itself, was the lack of liaison in some cases with the command specialists in venereal diseases. It was not at first realised how much skill was required in obtaining specimens for venereological and gynaecological diagnosis,

nor was the fact appreciated that the venereologist may know more about trichomonas infections and their treatment than the gynaecologist.

However, this sorted itself out, and in England and Wales with some local variants, a scheme emerged of a series of 'gynaecological centres' staffed (in theory) by experienced woman general duty officers, based on camp reception stations or M.I. rooms which were allotted a certain amount of special gynaecological equipment (*see Regulations for Medical Services of the Army*, 1938, Appendix 25(E)). These were supposed to diagnose the pregnancies, sift the venereal from the non-venereal discharges and send the latter to a gynaecologist and the former to the appropriate military hospital. At first there was a considerable number of these centres, but it soon began to become clear that the number of woman medical officers who could be trusted to take smears or cultures and diagnose pregnancy was lamentably small, and so the number of centres was reduced to those which could be properly staffed. A further difficulty was that frequent postings prevented the experienced medical officers remaining at the centres chosen. On the whole this scheme worked reasonably well for pregnancy diagnosis but the venereologists complained with justification that their gonococcal and trichomonas cases were being missed and that the latter were not being properly treated.

There had been a certain amount of difficulty in ascertaining which E.M.S. hospitals were staffed with recognised gynaecologists, and in March 1943 a list of these was issued, which was of great help, as the inequality of the peace-time distribution of civilian gynaecologists had not been generally recognised. The military specialists till then were at the military families hospitals, Catterick, Tidworth, Bovington and Devonport (until the 'blitz' of 1941) and at the Louise Margaret Hospital, Aldershot. There was also a C.M.P. at the M.F.H., Rumwood Court, near Maidstone. At that time the need became acute for a specialist in London District to supplement the special clinic already held by the Honorary Consultant, and a military gynaecologist was appointed to the Military Hospital (later Queen Alexandra Military Hospital), Shenley; she had beds and operated here and had a twice-weekly clinic at a large C.R.S. in central London and also at the C.R.S., Woolwich. This proved an essential appointment and she was fully used; the partnership of a gynaecologist and a venereologist at Shenley also proved very useful.

In July 1943 the problem of trichomonas infections was causing difficulty and it was suggested that the appointment of a consulting gynaecologist to the Army might be useful. It was thought, however, that such an appointment could only be very part-time and was hardly justifiable; there was an Honorary Consultant to Millbank and he, with the command consultants, was considered to be enough. One way out

might have been to have a gynaecologist in charge of A.M.D.9, but it is possible that so specialised a training might prove a handicap in dealing with more general health problems; certainly a gynaecological background would have been a help, for a certain amount of embarrassment was caused by having no single authoritative opinion to which to turn.

Trichomonas infestations were thought to be causing much trouble both in military and civilian circles, and in October 1943 a conference was called of all the honorary consultants and all the available military specialists, together with the past president of the R.C.O.G., representatives of the Navy and Air Force and of various interested War Office branches, to discuss the problem. As a result of this it was decided to confine all diagnosis of venereal and non-venereal discharges to military and civil gynaecologists and to treat the latter according to a standard schedule worked out for each command by its consultant at certain selected C.R.Ss., each provided with a specially instructed medical officer and nursing officer and linked with a gynaecologist; follow-up and tests of cure were again to be confined to the specialist. This scheme seems to have worked well in practice, but like so many bogies, when seriously tackled, the trichomonas problem rather melted away and caused little or no further trouble.

In Scotland, all gynaecological diagnosis and treatment (as well as V.D.) were localised in a small number of first-class civil hospitals. The scheme worked excellently in practice—at any rate very little was heard of it at the War Office.

Medico-legal Problems. The question of the legality of internal examinations has already been discussed, but certain other problems presented themselves.

There was first the general question of disclosure of medical information. As far as the A.T.S. were concerned, the chief importance of this was its bearing on the welfare of unmarried mothers, especially the very young ones. The legal and medical advisers agreed in stating unequivocally that all medical information, whatever its social repercussions, was confidential and must not be disclosed to any third person, even a girl's parents, without her consent. It was represented that in the case of a girl under twenty-one, the parents might be told if, for instance, she had become pregnant or contracted venereal disease, but the legal branches were adamant that a girl of military age was old enough to know what she was doing and to refuse permission for disclosure if she so wished.

A similar problem arose over the question of consent to operation (which in law includes such trivial procedures as blood tests, inoculation and vaccination and dental extraction). In civil life a hospital usually demands signature of a form of consent by the patient or, if he or she is under twenty-one, by a parent or guardian. As in law the

Army stands *in loco parentis* to personnel under military law, A.T.S. officers were frequently asked to sign such forms on behalf of their younger auxiliaries and thus arose the question whether the hospitals were obliged to ask their consent. Here too the legal authorities ruled that an auxiliary could usually be regarded as old enough to appreciate what she was doing, but as a matter of administrative (and political) convenience it was finally agreed:

1. That auxiliaries over 21 should sign their own consent forms.
2. That auxiliaries of 18 to 21 could sign their own consent forms but if the hospital wanted an officer's signature she should give it, provided that she was satisfied that the auxiliary was agreeable, but not otherwise. Of course in an emergency (e.g. if the auxiliary was unconscious) the officer must give consent on her own responsibility.
3. That in the case of auxiliaries under 18 the parents should be informed and their consent obtained whenever practicable, the officer taking responsibility where time or distance did not permit this. This ruling was a concession to public opinion which refused to accept for young girls the same rigorous standards it willingly accepted for boys.

In every case the officer was urged to inform the parents at once of the fact of an auxiliary's illness or operation but to use great discretion in giving details where the auxiliary might object. As in the case of male personnel, if operation was advised and refused, the auxiliary was made to sign a statement saying in effect that she did this with her eyes open.

The question of ordinary examinations was the same for women as for men. An auxiliary could be ordered to allow herself to be examined (except, of course, in the case of internal examination) and could be ordered to undergo ordinary treatment (i.e. treatment other than 'surgical operations'). She could also be ordered into hospital, and failure to obey in all these cases was failure to obey a lawful order, with its normal consequences. In practice common sense was used and disciplinary measures were only exercised when failure to obey endangered other members of the unit, e.g. infectious or mental diseases.

In reality the chief source of trouble was refusal to undergo psychiatric examination; as far as the women were concerned, the legality of enforcement in this case was never verified, as obviously an unwilling subject cannot be successfully interviewed, and persuasion was always used on these patients. The legal position of officers was similar except that there remained some doubt whether they could be ordered into hospital.

A side-effect of the disciplinary aspect of medicine was the question of hospital stoppages. It had long been the Army's practice, in cases of

illness due to the man's own fault, to exact from his pay certain stoppages for his hospital treatment; this, though not nominally a punishment, did in fact amount to it and as far as the men were concerned, was applied chiefly in cases of self-inflicted injury and venereal disease. In women it was further applied to cases of pregnancy who for some reason found themselves in hospital. The medical authorities had long sought to get these stoppages removed, mainly on the ground of their deterrent effect on reporting V.D. and the arguments used for men applied with much greater force to women, in whom V.D. diagnosis is so much more difficult; there was the harmful effect on the expectant mother of further depletion of her resources, and the A.T.S. supported strongly the medical effort to get the stoppages removed. After long discussions it was agreed, and promulgated in A.C.Is. of 1944, that in future there would be no stoppages for pregnant women and that in the case of V.D., etc., there would be none for the first thirty days of treatment. This was the best that could be obtained, but it covered the great majority of cases.

One other disciplinary matter deserves mention. Very properly the A.T.S. demanded a high standard of conduct in their officers (and cadets) and it was early laid down that an unmarried officer who became pregnant should be called on to resign her commission; it was also laid down that an adverse report (A.F.B.194E) should automatically be rendered and the propriety of basing such disciplinary action on a confidential medical document, the pregnancy certificate, was raised. Similar considerations arose in cases of V.D. or miscarriage, where again a single medical certificate might provide the sole evidence of misconduct. After much discussion it was agreed that each case should be considered on its merits and that confidential medical documents should not be used as the sole grounds for disciplinary action.

A medico-legal problem which was very small but serious out of all proportion to its size, was that of rape and criminal assault. The matter does not seem to have arisen until the end of 1941, but one or two cases reported then caused action to be taken and D.A.T.S. to send a confidential letter to all group commanders pointing out the need in such cases for medical evidence to be obtained as soon as possible and instructing them to get help from the medical officer and the Judge Advocate General's (J.A.G.) department. This letter necessitated parallel instructions to medical officers through medical channels, and in January 1942 a further letter was issued from the Army Medical Directorate instructing the medical officer to confine the auxiliary to bed in a C.R.S. or M.F.H., inform the senior A.T.S. officer and report to D.D.M.S. requesting the services of a gynaecologist, who might be a civilian; it was emphasised that the auxiliary's consent must be obtained. Scottish Command replied to this letter pointing out that in Scotland

a medical jurist was a more appropriate expert than a gynaecologist, and authority for this alternative was given.

In October 1942, partly owing to the great increase of foreign troops in the United Kingdom, the number of cases showed an increase and some discussions took place with the Home Office and New Scotland Yard. As a result of this it was agreed that, even where the assailant was under military law, the offence in the United Kingdom was a civil one and that it should be dealt with by the civil police. New instructions were worked out which laid it down that, on learning of an alleged case, the A.T.S. officer on the spot should at once inform the civil police and find out whether or not they wished the police surgeon to examine the girl. If so, she was to be made comfortable with as little damage as possible to any evidence provided by her clothing or person; if they requested the Army medical authorities to deal with the case, the unit medical officer, being informed, was to take the necessary action. In addition, the senior A.T.S. authorities and J.A.G.'s department were to be informed. This letter was finally issued in January 1943 and reissued, with small amendments in April 1945. The arrangements on the whole seem to have worked satisfactorily.

Lesbianism is not, of course, a criminal offence in English law, but the problem has definite disciplinary aspects as it is bound to present itself in any large body of women. It is pleasant to record that the number of cases reported in the A.T.S. was exceedingly small and that only one or two were at all serious. In 1941 an admirable memorandum was prepared by the W.M.A., War Office, under the title *A Special Problem*, which set the issues out with great wisdom and balance. She differentiated clearly between the adolescent infatuation, normal friendships between women, unhealthy friendships and true promiscuity. She gave wise advice against listening to gossip and jumping to wrong conclusions and the dangers of incurring the risk of an action for slander, and also gave sensible help in dealing with suspected cases. This memorandum was not issued to all officers, but was kept for those asking help, as it was felt that there was real danger of creating the problem by drawing attention to it.

The A.T.S. authorities also took a very wise and sensible line in dealing with cases when they arose. Many were satisfactorily dealt with by reposting and only a very few promiscuous lesbians had to be discharged from the Service.

SPECIAL FEMININE PROBLEMS

It has already been stated that major gynaecology raised very few problems and indeed discharges for gynaecological reasons varied only from 2 to 4 per cent. of all medical discharges. Of these a disproportionate number were for various manifestations of the menopausal syndrome,

which was probably blamed for a number of failures and misfits actually due to other causes. The other feminine problems were those associated with menstruation, sterility, pregnancy and abortion. The last two have already been considered.

Menstruation. From an early date, medical officers at basic and post-basic training units found a considerable number of recruits who complained of disturbances in the rhythm or duration of their menstrual periods. This phenomenon had long been recognised as occurring in association with any drastic alteration in the way of life or with emotional upset and had been documented in connexion with nurses and schoolgirls, but no information had hitherto been recorded as to its extent and seriousness in large bodies of ordinary women. The unit medical officers reported that it was very common and did not appear serious, but considerable difference of opinion existed concerning the need for treatment. In 1945 the Directorate of Medical Research carried out a survey on a large sample of women and found that roughly a quarter had had some menstrual disturbance on entry, mostly amenorrhoea, but that some 95 per cent. of these had righted themselves within six months without treatment; the small remainder had continued without menstruating in some cases up to 15 months and had required endocrine treatment to restore them to normality. It is therefore evident that in any similar undertaking hormone treatment need not be started until about six months' amenorrhoea has occurred. A surprising discrepancy was also found between women who remained in the ranks and those who afterwards became officers: the latter had only about 2 per cent. amenorrhoea on entry, a fact for which no explanation was forthcoming.

Dysmenorrhoea was not a problem. Recruits were asked before entry if they had suffered from it and were excluded if a history of incapacitating pain was obtained. It was suggested that the conscripts might find out that this was an easy way of avoiding service and careful watch was kept on the comparative rejection rates for this cause in volunteer and army class recruits, but no significant difference ever appeared. There was a widespread impression that the healthy life of the Army improved women who had had moderate dysmenorrhoea before entry but the survey mentioned above produced no support for this. The somewhat disconcerting fact was revealed that about a quarter of all the women had some symptoms of dysmenorrhoea, that almost all of them took some form of medicine to relieve their pain and that very few had ever sought medical advice.

Every auxiliary received a free issue of a packet of a dozen of the pad type of sanitary towel every month, a great advantage during times when they were almost unobtainable in the shops. A major problem proved to be their disposal; incinerators were everywhere provided and

the usual procedure was to provide bins and wrapping paper in the lavatories, the contents being removed and burnt by orderlies. Electric incinerators, destroying individual towels, were tried, but in large units proved inadequate to the numbers involved, breaking down frequently; in small units they were fairly satisfactory. The unexpected difficulty lay in training auxiliaries to wrap the towels and put them in the bin. There was a strong tendency to put them down the lavatory (which blocked the drains as the towels were of the non-soluble type), or to stuff them, wrapped or unwrapped, in all sorts of odd corners—behind pipes, in drawers, at the back of cupboards, etc. This was a real hygienic problem, throwing much light on the habits of certain sections of the population, and it required constant exhortation and watchfulness on the part of A.T.S. officers and N.C.Os.

Several requests were received to provide information about the extent to which internal tampons were used and whether there were any deleterious effects; also strong representations were received from interested bodies to discourage their use, but the necessary information was lacking and it was felt that in war-time conditions a free issue of the pads was probably all the encouragement justified or required.

Menorrhagia was not a problem, but since it was credibly reported that it was produced by the vibration of tracked vehicles such as Bren gun carriers, A.T.S. personnel were in consequence forbidden to drive these.

Sterility. During 1941 and 1942 cases arose where married auxiliaries presented themselves at gynaecological centres complaining of sterility, and the question was raised whether this could be legitimately held to be covered by the regulations relating to medical entitlement. It was finally ruled that if anxiety concerning sterility was such as to interfere with the auxiliary's efficiency, it was so covered. In 1943 the further point was raised whether such entitlement covered sperm activity tests on the behalf of the husband. After some discussion financial approval was obtained where the husband was a member of H.M. Forces, but not if he was a civilian, and instructions were accordingly issued in July 1943.

MEDICAL PROBLEMS NOT ESPECIALLY FEMININE

Venereal Disease. All intensive treatment for A.T.S. personnel in England and Wales was concentrated in three hospitals: the Military Hospital (later Queen Alexandra Hospital), Shenley, from 1941; the Royal Victoria Hospital, Netley, from 1942; and the Military Hospital, Liverpool Road, Chester, from 1943. In each case wards were allotted in a general hospital which also took other A.T.S. patients, the intention being to avoid the stigma of a V.D. hospital. The hope was vain but the therapeutic results were excellent.

There were two official methods of notification; unit M.Os. were supposed to notify all cases with their weekly return of infections and the hospitals notified the Consulting Venereologist rather more fully of the cases they treated. The first return was found to be very incomplete and in fact the second was accepted as a reasonable figure, though it too was subject to certain limitations. It can, however, be regarded as giving a fair index of the incidence of recognised cases of V.D. in the Service and an accurate picture of the trend of infection. It must, however, be remembered that V.D. in women is notoriously difficult to diagnose; the symptoms may be slight or hidden and the woman herself be quite unaware of her condition, and there are usually no overt signs, as there often are in the man, to facilitate rapid recognition of cases at ordinary sick parade. A considerable proportion of A.T.S. cases were found as a result of a male patient reporting the girl as his source of infection, and it will never be known how many went entirely unrecognised.

Having regard to all these sources of inaccuracy it can still be said with confidence that the incidence of venereal disease in the A.T.S. was extraordinarily low. The highest reported incidence was 5·3 per 1,000 per annum at the beginning of 1942, and after that it fell steadily to a level of less than 1·0 in 1943, where it remained throughout 1944 and 1945. It is gratifying to record that overseas service, which in the male is almost always associated with an increased V.D. rate, had no such effect on the A.T.S. and in every overseas theatre the incidence was negligible. The proportion of syphilis to gonorrhoea was much higher than in the male and much higher than in peace-time, reaching a ratio of nearly 1 : 2, but this finding was exactly paralleled in civil life and is perhaps partly due to the higher proportion of gonorrhoea cases that are missed so that when both rise syphilis appears to increase the more.

Pediculosis Capitis and Scabies. The extent of infestation with *Pediculosis capitis* came as a great shock to public health authorities, as it was revealed, first in children, by the evacuation, and later in the condition of recruits to the Women's Services. There is not a great deal of information as to the proportion found to be infested in the early part of the war, but a Scottish depot in 1940 was finding about 10–20 per cent., with a maximum of 25 per cent. In October 1941 the training centres were asked to furnish a detailed monthly return and the problem stood revealed in its full magnitude. At that time some 26–28 per cent. of the total recruit intake was found to be infested, and this varied with intakes from different parts of the country, London and the South rarely exceeding 5–10 per cent., the Midlands and North having 30–50 per cent., the industrial towns of Scotland being rather higher and Northern Ireland (which included a considerable proportion from

Eire) being highest of all (60–90 per cent.). These relative proportions remained largely unaltered throughout the war, but there were various fluctuations in the overall rate.

TABLE 59

Pediculosis Capitis and Scabies among Intakes to A.T.S. Training Centres by Quarters; Percentage of Recruits Infested; January 1942 to June 1945

	Pediculosis Capitis				Scabies			
	1942	1943	1944	1945	1942	1943	1944	1945
1st quarter .	19·4	21·2	17·6	26·6	2·2	2·1	1·6	2·9
2nd quarter .	20·2	19·7	32·2	27·8	2·4	1·7	1·8	2·3
3rd quarter .	21·3	20·4	28·8	—	2·5	1·5	2·7	—
4th quarter .	20·3	13·7	28·4	—	2·4	0·9	4·0	—
Annual average	20·2	20·2	25·8	—	2·3	1·8	2·5	—
Size of intake	107,646	46,228	19,145	—	107,646	46,228	19,145	—

TABLE 60

Pediculosis Capitis and Scabies among Intakes to A.T.S. Training Centres by Commands; Percentage of Recruits Infested; January 1942 to June 1945

	Pediculosis Capitis				Scabies			
	1942	1943	1944	1945 Jan.–June	1942	1943	1944	1945 Jan.–June
Eastern .	12·3	10·9	—	13·9	2·7	2·6	—	2·1
Southern .	7·6	—	—	11·8	1·9	—	—	0·7
South-eastern	10·6	10·1	16·1	—	1·9	0·5	1·2	—
Western .	23·0	23·3	—	29·3	2·1	2·1	—	1·8
Northern .	16·8	18·0	22·1	25·8	2·1	1·4	3·7	3·3
Scottish .	33·8	29·5	32·8	34·2	3·1	2·6	2·5	2·4
N. Ireland .	49·7	61·1	64·8	60·7	3·4	2·5	4·3	1·9
Average— United Kingdom	20·2	20·2	25·8	27·3	2·3	1·8	2·5	2·5

The Directorate of Medical Research made use of the figures collected by A.M.D.9. Contrasting them with incomplete ones for 1941, it seemed probable that the exclusion of the lowest intelligence groups (S.G.5) from the A.T.S. had been associated with a sharp drop of the infestation rate. Since during 1944 the proportion of volunteers among total A.T.S. intakes had risen from 50 to 100 per cent., and since these volunteers included a high proportion of girls under 19 years, at which

age conscription started, the sharp rise of infestation in the first half of 1944 possibly was due to the high incidence of *Pediculosis* among the younger age-groups.

Scabies rates were approximately one-tenth of those of *Pediculosis capitis*, being of the order of 2 per cent. of total intakes. Differences between commands were less consistent and less striking than those which related to *Pediculosis capitis*.

At first there was no uniformity of treatment of *Pediculosis* and most of the generally accepted methods were in use, e.g. sassafras, vinegar, paraffin and cotton-seed oil. Later a tar-oil compound was adopted, followed by shampooing and combing with a square-toothed metal comb (Sacker comb). Where supplies ran short an alternative to the tar-oil was suggested in 1:40 carbolic acid solution. This method gave excellent results, which in retrospect appear to have been largely due to the careful combing of the V.A.Ds. and medical orderlies.

The comparative value of insecticides in these infestations had not been much studied before the war, but in 1940 and 1941 it was reported that most of the older remedies were relatively harmless to the nit (including the tar-oil compound) even when they killed the louse, and it was established that certain other preparations, notably some organic thiocyanates and derris powders were much more active. Some not very satisfactory trials of these substances took place in the Army in 1941, but in 1942 the Ministry of Health took a hand, and as a result various civilian bodies together with the Army and the R.A.F. took part in a large scale trial of derris powder, cubé root and a thiocyanate known as Lethane special 384. This last proved the most satisfactory and in 1943 it was finally adopted as the only treatment authorised for the A.T.S. Lethane had the admirable property, in addition to its lethal effect, of persisting on the hair for a week or more, so that any nits not killed and hatching during the time would be at once destroyed. This treatment was used exclusively up to the end of 1945 and was very satisfactory indeed. At the end of 1945 experiments were initiated with the new universal insecticide, D.D.T.

It has already been stated that most of the examination and cleansing was done by V.A.Ds. and medical orderlies, who became very expert. Special accommodation became necessary for this and in 1941 authority was obtained for a special 'cleansing hut' (or the equivalent) per training centre. This contained six shampooing basins and a room for combing and examination with adequate lighting arrangements.

Fortunately this very high rate was in recruits only. After cleansing, the teaching and discipline of the Service, combined with careful examination kept the rate in serving auxiliaries very low indeed. In fact at a time when the recruit intakes had a rate of 23–30 per cent. the Service rate was only about 0·5 per cent. and it varied very little from this.

The problem of dealing with these very large numbers of recruits was extremely serious, for they could not be passed into the depot uncleansed. Many were found to be infested at recruiting medical examinations, but the board was not able to inform the auxiliary and give her instructions for cleansing owing to objections raised by one of the other Services. The A.T.S. recruiting officers did tactfully tell them and give them a sheet of instructions, and attempts were also made to enlist the help of local public health authorities but with very little success. The main burden fell on the training centre medical and nursing staffs, and nobly they coped with it.

*General Sickness and Discharge Rates.** The most notable feature about the sickness rates was the extremely high rate of minor sickness and low rate of major sickness, relative to the men. The C.R.S. admission rate was consistently double, the hospital admission rate approximately two-thirds. The low hospital rates may be partly accounted for by the younger age of the women as compared with the men, and the high C.R.S. rate certainly reflects a different attitude—the auxiliary was encouraged to report sick early and was put to bed for complaints which a soldier might well have ignored.

There were no serious epidemics and the other sickness rates call for no special comment. The discharge rates on medical grounds appeared to be lower for the women than the men until they were age-standardised when the reverse was found to be the case. There was a striking excess of medical discharges among married women as compared with single, but details of this could not be obtained. The most striking difference in the causes of discharge was the very high proportion of female discharges on psychiatric grounds (50 per cent. roughly as compared with about 30 per cent. for the males) and the low incidence of peptic ulcer (4 as compared with 12 per cent). All the above figures are of course exclusive of pregnancy discharges which were about four times as numerous as the ordinary discharges on medical grounds.

Medical Problems of A.A. Command. From the very start of the war women were serving with A.A. Command, at first with the regimental and divisional headquarters of the Territorial Army units with which they were mobilised. These auxiliaries presented no special problems except that their units were often in very isolated locations and they were living sometimes under fairly rigorous conditions, but medically their only difficulty was the problem of sick parades and C.R.S. accommodation, which was usually met by mobile medical officers and sick bays within the units where possible.

In 1941, however, the decision was reached to form mixed H.A.A. batteries and a number of medical problems arose. That of morale

* The statistical data on which these statements rest are presented in the Statistical Volume of this series.

solved itself—the fact of serving side by side with men, doing work whose relation to the war effort was obvious; the A.T.S. personnel of the mixed batteries considered themselves élite troops and as was to be expected this reacted very favourably on their health which throughout was excellent. But there were other problems. The A.T.S. ration had been carefully worked out and was thought to be adequate for a woman doing moderately heavy work. It was thought that if the mixed batteries drew the necessary number of men's and women's rations and pooled them, the result would approximate to the respective needs and appetites of the personnel. It did not, however, work out like this; whether it was the hard work or the open-air life or the stimulating environment cannot be determined, but the women developed huge appetites and complaints began to be heard from the men that men and women doing similar work should have similar food, and the A.T.S. personnel on the sites from the middle of 1942 got the full male ration.

Clothing was also a problem and a special sub-committee of the Medical Research Council was formed to consider it; conditions on many sites were extremely exposed and the auxiliaries might be out all night, often on top of a hill, in all weathers in the depth of winter. The committee made a number of recommendations; the most important were woollen stockings and long woollen pants (which were not popular with the auxiliaries), Shearling gloves which had a sort of hood which provided extra protection for the fingers when digital dexterity was not being used (these were most successful), and a very thick woollen smock, wind-proof, with a hood which was very warm and excellent for auxiliaries on guard duty, but about which the complaint was that it hampered movement and was difficult to get into in a hurry. The auxiliaries also had battledress blouse and slacks, excellent boots and gaiters and the ever-popular leather jerkin, praised by all auxiliaries who had to work out of doors. Certainly the climatic rigours to which these auxiliaries were exposed never seemed to harm them and the wise clothing provision certainly contributed to their excellent health.

Quite soon after the mixed batteries started to train, a rumour started that the radar equipment used for gun-laying had a harmful effect on the female sexual functions and could cause stoppage of the periods and sterility. This rumour had some plausibility (it was said to have been started by a physics graduate) in that the cathode ray tube used in radar has some features in common with the tubes used for generating X-rays which notoriously have harmful effects. The matter was at once referred to the Medical Research Council who, after careful investigations, reported in September 1941 that no harmful rays were emitted and that none of the G.L. sets (radar equipment) then in use could cause any ill-effects. The rumour, however, was never completely killed. It cropped

up again in November 1941, in May 1942, in August 1942 and again in August 1943. Each time steps were taken to spread the true facts but it always turned up somewhere else. It is of interest that no case of even alleged sterility or menstrual disturbance due to radar was ever reported, and it was learned that both the Admiralty and the Air Ministry had encountered the same rumour.

A similar false scare, which was nearly as difficult to kill, was the 'arc eye', which was dreaded by cinematograph operators working in a training device known as a 'dome teacher'. These operators used carbon-arc lamps and if they were incautious and, contrary to instructions, looked into the arc without its glass shield, they were liable to get a mild conjunctivitis due to the ultra-violet radiations. This always recovered rapidly on removing them from the exposure, but a story started about a certain bombardier who was alleged to have become blind in consequence. When this man's papers were obtained and checked it was found that his blindness was due to an entirely different cause and was indeed the result of disease contracted in infancy, but again the story was extraordinarily difficult to kill.

In 1943, as the man-power shortage worsened, it was decided to form A.T.S. searchlight units. From the medical point of view this was an entirely different proposition from mixed batteries; here the auxiliaries were to be on their own in detachments of fifteen with no male support at all except at battery H.Q. Their sites were often very lonely indeed, far from any village or even farm, and morale here was a different problem. The A.T.S. regiments were mostly kept in the neighbourhood of London but even here individual sites could be very remote. The 'searchlight experiment' was watched very carefully from A.M.D., especially by the psychiatrists, and advice was given in connexion with clothing, accommodation and selection of personnel, and there is no evidence that this work was in any way detrimental to the auxiliaries' health, but medically they were not such a dramatic success as the mixed batteries.

*Accommodation.** The single-bunked A.T.S. scale of living accommodation was maintained at 45 sq. ft. throughout the war, though the double-bunked scale was the same as the men's with 345 cu. ft. No serious epidemics due to droplet infection developed and there is no evidence that these scales were not adequate. The scale of ancillaries was generous—indeed the 15 per cent. of lavatories allowed at first was reduced to 12 per cent. without harm and 12 per cent. wash basins also proved adequate. The scale of baths was 3 per cent. showers and 1 per cent. baths and it proved very difficult indeed to teach the women to use the showers. It was partly that they were unaccustomed to them and

* *See* Chapter 2, The Army Hygiene Service.

partly fear of wetting their hair; attempts were made to deal with this last by first attaching the rose to a length of rubber tubing and later by affixing it at the side of the cubicle at shoulder level, pointing downwards, but the showers were never really popular. Some gynaecologists thought that showers, by discouraging frequent bathing, encouraged the prevalence of trichomonas vaginitis but others held that slipper-baths were the more unhygienic of the two, so that this point cannot be regarded as settled.

An important point was the very much greater quantity of water used by women as compared with men. This was partly due to the washing of underwear and the use of W.Cs. instead of urinals. A detail, but one that mattered a good deal, was their requirement of considerably more toilet paper; in 1942 an allowance of three times the male rate was agreed to.

In the early stages sanitation was as far as possible water-borne, but when the mixed batteries were deployed this was no longer practicable and it was agreed that the alternative should be disintegrating chemical closets of the Elsan type; these were also frequently used for the night latrines which the A.T.S. were supposed to have if the nearest latrine block was not under the same roof. In practice these usually became bucket latrines with a little disinfectant in them, disposal being by contractor or male sanitary squad, and the arrangements were on the whole perfectly satisfactory, though there was some difficulty in persuading town-bred officers and other ranks that they were in fact just as good as W.Cs. Most of the searchlight and many of the mixed A.A. batteries had this type of sanitation.

After 1943 there were usually some A.T.S. under canvas in the summer, and in 1944, in preparation for D-day, there was quite a number along the south and east coasts. They were not supposed to be in tents later than the end of September but the exigencies of the 'V1' attacks kept some of them out on the 'Diver' sites until well into November of that year. They mostly had the 'Indian Pattern' tents —square 150-lb. tents—and were allotted four to a tent. Ancillaries were in camp structures, and as the year wore on dining and cooking accommodation was moved into huts as far as possible. The striking thing was the superb health of the auxiliaries under canvas, even under cold and wet conditions; their morale and physical fitness was remarkable to see.

There is little to say about the effect of other accommodation on health. Requisitioned houses, barracks, huts of all types and the 'spider' or 'cracker' type of construction all proved compatible with excellent health. From the hygienist's point of view probably the 'cracker' or 'spider' hutting was the most convenient, except of course for the ideal Sandhurst blocks where these were available.

*Clothing.** The medical authorities were consulted about all the A.T.S. clothing and from the medical standpoint it was all admirable. The only mildly controversial items medically were the shoes and the corsets.

There were three different types of A.T.S. shoe, all of them medically compromises. The earliest, issued in 1939, was a rather pointed model with a toe-cap; it suited some feet admirably, but tended to crowd the toes and there were many complaints of blisters across the dorsum of the toes caused by the toe-cap. It was superseded in 1941 by the Norwegian shoe; this had not a straight enough inner border and the heel was apt not to fit well; there were also complaints that after repair the soles leaked. It was, however, a good shoe and for certain feet, especially those with slight hammer toes or mild hallux valgus, it was extremely satisfactory, as the vertical sides provided a buttress under which the deformed toes could nestle. The final model, issued in 1944, was an admirable shoe with a fairly straight inner border, no toe-cap or apron and good fittings (originally there were only two, medium and large, but it was found that a narrow fitting was essential if blistering and the use of too short shoes was to be avoided). The final model fitted nearly all feet, but there were always a few whom the Norwegian model suited better and who without it would have had to have shoes specially made, and it was found economical in the long run, therefore, to keep the two models going simultaneously with about 25 per cent. Norwegian type available with a medical certificate. Though the last was supposed to be the same, the numerous different makes were found to have certain fairly consistent characteristics and, used intelligently, this also helped good foot fittings. Certain shoes, especially of the final model, were rather hard, and in 1945 an issue of saddle soap was authorised to soften them, thereby preventing many blisters.

The corset was perfectly satisfactory for the ordinary and not too stout woman, but the woman with a full figure was catered for by a corselette and there were many complaints that this did not give enough support. Finally, in 1945, arrangements were made to get the large women more accurately fitted with specially made corsets or corselettes. Surgical corsets were of course a medical supply and were obtainable in the same way as other medical and surgical appliances, when these were authorised for the A.T.S.

*Rations.** The home service ration scale as applied to A.T.S. contained about 2,800–2,900 Calories, which was considered enough for A.T.S. personnel employed on sedentary or moderately active duties. For those on active duties, however, (e.g. those on searchlight sites, P.T. schools, etc.) it had to be supplemented, bringing it up to about

* *See* Chapter 2, The Army Hygiene Service.

3,000 Calories. The auxiliaries with mixed H.A.A. batteries, as described above, got the male scale (3,200 Calories) and those overseas got the field force ration scale (nearly 4,000 Calories). These scales were all well balanced and were medically very satisfactory. Unfortunately no large-scale survey of weights was ever undertaken but there was a general clinical impression that a considerable proportion gained weight, especially during basic training. The girls with mixed batteries also gained a good deal of weight.

Health Education. As soon as a standard syllabus was laid down for basic training centres, medical lectures were included and consisted of three half-hours, two on general and personal hygiene and one on the use of the first field dressing. These were very simple and elementary and were given by the unit M.Os. They were found very useful and were continued throughout the war.

Much controversy raged over the need and advisability of giving lectures on V.D. In the early days a good deal of offence was given by injudicious lectures by unsuitable people and the subject remained a difficult one. Sex instruction as such was not allowed as a result of an Army Council decision and the only permitted lectures on these subjects were medical. In 1941 a policy was worked out whereby auxiliaries at post-basic training received a lecture called 'Health Building and Health Wasting' which contained, in addition to an excellent outline of general health matters, a short section on V.D., this lecture to be given by any woman medical officer. At the same time a lecture on V.D. and pregnancy was devised for officers and N.C.Os. to be given if requested by one of a selected panel of women medical officers.

This worked fairly well for a time but the units were constantly asking for more, and in 1943 another experiment was tried in the shape of small discussion groups on V.D. of 20–30 auxiliaries, on the lines of A.B.C.A. taken by a selected woman medical officer. This worked excellently as long as the groups were kept small, but proved quite impracticable on a large scale owing to the shortage of good medical discussion-leaders.

Later in 1944 it was decided to use the Ministry of Health film *Subject for Discussion* and follow it up with a question period to be taken by the unit medical officer who was provided with notes for his or her guidance. This was fairly satisfactory but the complaint was still general that the auxiliaries wanted to know more. This problem was never really solved, a project for a special A.T.S. training film being turned down, largely on the ground that the A.T.S. V.D. rate was insufficient to justify it. All auxiliaries with 21 Army Group and S.H.A.E.F. had a lecture in 1944 before they went overseas. The conflict of interest between the shy and ignorant auxiliary, who is shocked and upset, and the better informed or more intelligent auxiliary, who begs for more information, is a real one and the answer is still to seek.

First-aid lectures were at first given in rather a desultory manner but an A.C.I. of 1942 laid it down that instructions were to be given to the whole Army after recruit training. A survey of the A.T.S. carried out early in 1943 revealed that about 50 per cent. of units had implemented this A.C.I. and it seems likely that that was a fair sample of what occurred all through the war. In September 1943 ten first-aid periods were introduced into the basic training syllabus in lieu of P.A.D. training. This put a great strain on the medical officers who had to give all this instruction in addition to their other duties and it was doubtful how far auxiliaries fresh to Army life were in any fit state to absorb it. In March 1943 increased intakes made it quite impossible and the lectures were reduced to two with two simple demonstrations.

Medical lectures were given to all cadet and officer schools. Pre-O.C.T.U. as from August 1943 received three lectures, one on the care of the auxiliary in quarters, one on the prevention of disease and one demonstration on how to organise a health inspection. The O.C.T.Us. at first had a lecture on general hygiene, one on medical administration and one on V.D. and pregnancy. In March 1944 the first was discontinued and five first-aid periods were added, including a realistic test under simulated 'blitz' conditions. The junior and senior officers' schools each had two periods, given by a senior War Office staff officer, on medical administration.

In retrospect it may be wondered whether all the opportunities for health instruction were taken; certainly little was done in comparison with the American and Canadian Women's Services. But the British mind does not take so kindly to lectures and it seems likely that more than was obvious on the surface was done by example and public opinion. Certainly the only lack of which the auxiliary was conscious was instruction in sexual matters and V.D., and for this a vocal proportion (how big is quite unknown) consistently clamoured all through the war.

CHAPTER 9

THE ARMY PSYCHIATRIC SERVICE*†

INTRODUCTION

A SMALL number of Army medical officers who had acquired psychiatric qualifications and experience and who were serving in various parts of the world, represented the total specialist personnel of the R.A.M.C. in this field of medicine before the outbreak of war.

A Consulting Psychiatrist to the Army was appointed shortly before the commencement of hostilities, and later a psychiatric consultant was posted to the B.E.F. The former, working alone in the first few months of the war, could do little more than lecture to the staffs of hospitals which were mobilising and to groups of medical officers in training, begin planning and attempt to attract the necessary support which would enable these plans to be carried out. The consultant with the B.E.F. was followed to France by a small staff who were attached for duty to general hospitals. At home no other psychiatrists were appointed until April 1940. After the fall of France, psychiatric cases from Dunkirk were distributed among E.M.S. hospitals and 41 B.G.H.

Had the medical needs of the Army been limited to in-patient treatment and to the assessment of the condition of those about to be invalided, the civilian psychiatric service might have sufficed. But it rapidly became clear that the paucity of military psychiatrists was having unfortunate consequences: E.M.S. psychiatric centres, for instance, were receiving, on the one hand, many chronic cases who, in spite of prolonged therapy, would be permanently unfit for further military service, and, on the other, cases where little more was required than advice to a medical officer on the handling of the simplest psychiatric problems.

In April 1940, a psychiatrist was attached to the medical headquarters of each command at home. Military psychiatric out-patient centres were established in each command and these were able to act as a filter for the E.M.S. hospitals, separating out those cases which appeared likely to recover if retained in their own units under the supervision of their medical officers. The command psychiatrists soon found it impossible to deal by themselves with their large areas, with the large number of out-patients and with all the problems that they were asked to solve. In late 1940 it became necessary to appoint further military psychiatrists to each command; these were either full or

* The substance of this account was provided by the Directorate of Army Psychiatry of the Army Medical Directorate.

† *See* Volume on Medicine and Pathology in this series, Chapter 15, ii.

'graded' specialists. In July 1940, the establishment of the command psychiatric pools was increased from one psychiatrist in each command to three (in N. Ireland District), four (in Aldershot Command) and five (in all other commands). Further additions to the command psychiatric pools were authorised in April 1941, and thus, eventually, there came to be in each command from three to ten area psychiatrists whose work was co-ordinated by the command psychiatrist at command headquarters. The main task of area psychiatrists was to provide an out-patient service for every area where there were troops or military hospitals. They visited units to discuss with R.M.Os. the military value of men who had been referred to them and to advise both medical and administrative officers on a variety of problems arising in units. They also assisted in the selection procedure.

Simultaneously with the development of this out-patient service, facilities were provided for dealing with in-patients. With the encouragement and very great assistance of the Board of Control, military hospitals were opened for psychotic patients. In the early part of the War of 1914–18 many difficult situations had arisen from the procedure whereby serving soldiers suffering from psychosis had to be sent direct to civil mental hospitals. A military mental hospital had the advantage, compared with civilian mental hospitals, of being able to detain a patient without any need for certification. In 1940, therefore, it was decided to treat military cases of psychosis as far as possible within the Army organisation, and a procedure was developed whereby officers and other ranks suffering from a presumedly curable psychosis could be retained in a military mental hospital for a period up to nine months. This policy enabled active treatment to be given, short psychotic episodes to recover, the question of attributability to be explored very carefully in each individual case, and various disciplinary problems, which might have arisen before a patient's admission to hospital, to be solved.

Until April 1942, most of the hospital treatment of psychoneurosis in England was provided by the special neurosis centres of the E.M.S., which co-operated fully with the Army, and by 41 B.G.H. When this hospital was sent to the Middle East in December 1941, the Military Psychiatric Hospital, Bishop's Lydeard, Somerset, came into operation. This soon proved to be insufficient and special wards for such cases were, therefore, provided in military hospitals; and ultimately there were developed several special Army hospitals for psycho-neurosis. These had the advantage over E.M.S. hospitals in that, being military in their organisation, administrative procedure was facilitated.

It became increasingly obvious that administrative procedures were fully as important as clinical or purely professional questions in Army psychiatry. Eventually, in April 1942, a Directorate of Army Psychiatry

(A.M.D. 11) was established within the Army Medical Directorate with a regular R.A.M.C. officer as director and three specialists in psychiatry (majors) as D.A.Ds.A.P. working under him. The main aim of the directorate was to maintain and augment the mental health of the Army by every possible means, and, where it failed in this, to provide the means of rehabilitation or treatment for men whose military incapacity was due to psychiatric causes. The directorate was responsible for the development, control and co-ordination of the psychiatric service of the Army at home and overseas and acted in an advisory capacity within the War Office. It had three branches with the following functions:

A.M.D. 11 (A) Psychiatric aspects of morale, discipline, training and equipment.

A.M.D. 11 (B) Selection, training and allocation of Army psychiatrists. Psychiatric aspects of recruiting, selection, grading, allocation and transfer of officers and other ranks. Psychiatric liaison with the Ministry of Labour and National Service.

A.M.D. 11 (C) Clinical policy and research. Psychiatric clinics and hospitals. Psychiatric liaison with the Ministry of Pensions, Ministry of Health and Board of Control. Psychiatric aspects of discharge and medical boards.

The Consulting Psychiatrist to the Army worked with the directorate, and was the professional adviser on all psychiatric matters. In addition to the director (D.A.P.) and the three deputy assistant directors (D.A.Ds.A.P.), the original approved establishment of the directorate comprised two junior civil assistants (J.C.A.) and six clerks and typists. In October 1942, the director was given the rank of brigadier; one D.A.D.A.P. was made assistant director (A.D.A.P.) (lieut. colonel) and one staff captain was substituted for one of the J.C.As.

In March 1943, the senior psychiatrist of the War Office Selection Boards (W.O.S.Bs.) was attached to A.M.D.11 as an A.D.A.P. (lieut. colonel) and was charged with the supervision of the psychiatric aspects of officer selection. In September 1943, the establishment of the R.A.M. College was amended to include a Consulting Psychiatrist to the Army at Home, whose duties were especially concerned with supervising the hospital services, advising Army psychiatric units and maintaining liaison with E.M.S. neurosis centres.

Army psychiatrists and associated clerical staff in the United Kingdom, other than those borne on the establishments of military psychiatric hospitals, were carried on the establishment of a home psychiatric pool which was placed under the control of A.M.D.11 in December 1943. At the end of 1943, there were serving in the Army

197 specialist or graded psychiatrists of whom 67 were abroad; in addition there were 30 R.A.M.C. psychiatrists (not under War Office control) serving in India. About 70 general duty officers were also employed in psychiatric hospitals. The psychiatrists in the United Kingdom were distributed as follows:

War Office Staff	4
Royal Army Medical College (Consultants)	2
War Office Selection Boards	21
Commands	58
Military Psychiatric Hospitals	45
Total	130

The psychiatrists abroad or in field force formations were distributed as follows:

21 Army Group	18
North Africa	19
Middle East	26
Gibraltar, Palestine, W. Africa	4
	67

In considering these figures it must be borne in mind that, unlike the other two Services, the Army had a high proportion of its psychiatric man-power engaged in selection duties, and that Army psychiatric hospitals, both at home and abroad, had to deal with a considerable number of Naval and R.A.F. cases.

PSYCHIATRIC HOSPITALS

Psychotics. Before the War of 1914–18, soldiers who appeared to be suffering from psychosis were admitted to 'D' Block, Royal Victoria Hospital, Netley and invalided from the Service as soon as the diagnosis of psychosis was clearly established. This policy of immediately discharging, without treatment, to civil care all soldiers suffering from psychosis aroused public protest during the early part of the War of 1914–18, and the Cabinet, in consequence, ruled that certification of soldiers as lunatics should be avoided as far as possible. Certain civil mental hospitals were taken over from the Board of Control for the treatment of military psychotics and certification under the Lunacy Acts was reduced to a minimum. This procedure lapsed after the war, and military patients were again invalided from the Service as soon as the diagnosis was clearly established. In December 1939, it was decided to revert to the procedure adopted in the latter part of the War of 1914–18. 'D' Block, Royal Victoria Hospital, Netley, however, had

only accommodation for 72 other ranks and 2 officers, and, with the expansion of the Army at the outbreak of war, this accommodation was totally inadequate. Accommodation in certain civil mental hospitals was therefore taken over from the Board of Control and designated as military hospitals. This placed the accommodation out of the control of the Lunacy Acts, and allowed military patients to be admitted and treated without any form of certification of lunacy.

The first military mental hospital to be opened was established in a section of the L.C.C. Mental Hospital at Banstead, Surrey, in March 1940. Others were opened at later dates, and provided accommodation and treatment not only for Army patients, but also for Royal Naval and Royal Air Force cases and for certain Dominion and Allied troops. For administrative purposes the medical superintendent of the civil hospital, and in most cases his deputy, were given honorary commissions in the R.A.M.C. and acted as officer commanding (lieut. colonel) and second-in-command (major) respectively of the military hospital, while continuing their duties in respect of the civil institution. The military hospitals for psychotics were:

	Date of opening
1. Banstead Military Hospital, Surrey. 400 beds, O.R. (male)	March 1940
2. Ashurst Military Hospital, Oxford. 240 beds, O.R. (male)	May 1940
3. Clifton Military Hospital, York. 150 beds, O.R. (male)	August 1940
4. Talgarth Military Hospital, Breconshire. 315 beds, O.R. (male)	October 1940
5. Dumfries Military Hospital. 80 beds, officers (male)	December 1940
6. Bellsdyke Military Hospital, Stirlingshire. 300 beds, O.R. (male) (Taken over for neurotics, January 1942)	January 1941
7. Grahamholm Military Hospital, Belfast. 60 beds, O.R. (male)	February 1941
8. Northampton Military Hospital, 113 beds, O.R. (female), 7 beds, officers (female)	October 1941
9. Carstairs Military Hospital, Lanarkshire. 200 beds, O.R. (male)	January 1942
10. Military Hospital, Exeter. 315 beds, O.R. (male)	January 1945
11. 'D' Block Royal Victoria Hospital, Netley. 72 beds, O.R. (male), 2 beds, officers, (male)	In existence before the war

Some of these hospitals were staffed entirely with a nursing staff of male mental nursing orderlies. The nursing staff of others comprised, in addition, nursing officers of the Q.A.I.M.N.S., but there was difficulty in obtaining for this type of work the services of a sufficient number of sisters with a qualification in mental nursing. It was a source of grievance among male mental nursing orderlies, some of whom had, in civil life, occupied responsible senior posts as mental nurses in civil mental hospitals, that their rates of pay and chances of promotion showed so great a discrepancy in comparison with those of the Q.A.I.M.N.S., who held a rank equivalent to that of a commissioned officer. In spite of their considerable experience in mental nursing, such men not infrequently had to work in a position subordinate to sisters, who had had much less experience in the nursing of mental illness.

During the war, all forms of active treatment were carried out in military mental hospitals, including electrical convulsion therapy, continuous narcosis, insulin therapy and malarial therapy. In November 1940, the peace-time policy of invariably discharging from the Service all recovered psychotics was modified, and men with a good basic constitution and severe precipitating causes could, after apparently good recovery from a psychotic illness of short duration, be recommended by a medical board for retention in the Service. In 1940, it was also decided to retain cases in the Service for treatment for a period not exceeding nine months. Under an Army Order[1] normal pay for these men treated in military mental hospitals ceased after three months continuous absence from duty. Family allowances, however, continued throughout the period of treatment, and the soldier received a pocket money allowance after the three months had elapsed. This procedure was amended, in May 1945, by Army Order[2]. This laid down, in particular, that from the date on which it was recommended by a medical board that a patient suffering from psychosis should be placed in medical category E he would cease to draw normal army pay and allowances, but would receive a reduced rate of pay specified in the order.

Psychoneurotics. From the outbreak of war until April 1942, the majority of military psychoneurotics were treated in Emergency Medical Services neurosis centres. 41 General Hospital, mobilised in January 1940 for service with the B.E.F., did not have the opportunity of proceeding to France before the Dunkirk evacuation. It was first set up in Sussex, but moved in October 1940 to Bishop's Lydeard, Somerset, and was largely used for training purposes. In December 1941 it proceeded to the Middle East, but a military psychiatric hospital continued to function at Bishop's Lydeard with 300 beds for psychoneurotics. In order to provide additional accommodation, 150 beds

in the Queen Alexandra Military Hospital, Shenley, were taken over for psychoneurotics, and in January 1942 Bellsdyke Military Hospital, Larbert, Stirlingshire, which had until then dealt with military psychotics, was also taken over for psychoneurotics, and the psychotic patients were transferred to the Military Hospital, Carstairs. In December 1940 Dumfries Military Hospital was opened for the treatment of male officers suffering from psychiatric illnesses, 40 beds being available for psychoneurotic cases. In April 1942 it became necessary to provide more accommodation and the whole of Hollymoor Civil Mental Hospital, Birmingham, was therefore taken over by the Army authorities, and became Northfield Military Hospital. The Military Hospital, Bishop's Lydeard, was then closed.

Northfield Military Hospital was originally divided into a 'hospital' unit (200 beds) and a 'training wing' (600 beds) where soldiers could be rehabilitated before their return to duty. While in the 'hospital' unit, patients received active psychiatric treatment and wore hospital blue clothing. From here, convalescent patients were transferred to the adjacent 'training wing', where they wore khaki, and were given modified military training under combatant officer and N.C.O. instructors. While in the 'training wing' they remained, however, under medical supervision, and received any out-patient psychiatric treatment considered necessary by the psychiatrists in the 'hospital' unit. Patients were admitted to Northfield Military Hospital only where it appeared probable that, after a short course of treatment, they would be fit for further military service in some capacity. In December 1943 it became necessary to review the policy which at that time determined the disposal of soldiers suffering from long-standing neurotic disabilities. Experience had shown that chronic neurotics with a poor constitutional background, even after treatment in hospital and, in some cases, with the aid of special postings, did not in the large majority of instances give effective service in the Army, and had subsequently to be discharged on medical grounds. There was evidence at that time to show that the maximal number of such men who could economically be employed in the Army had been reached. It was also necessary to take into consideration shortage of medical man-power, and it was decided that admissions to military hospitals for neurosis should be restricted to cases in which there was a high probability of return, after treatment, to high grade military duties. The difficulties, however, consequent upon the shortage of Army psychiatrists and of trained nursing staff were considerable.

Closely related to the question of treatment and rehabilitation of military psychoneurotics, was that of their disposal after discharge from hospital. Many relapsed after return to their original units, and in an attempt to obviate this, while meeting the urgent need for economy

in man-power, a special scheme for the placement within the Army of some of these cases was introduced in 1941, and was known as the 'Annexure' scheme. Attempts were also made at this time to rehabilitate men by drafting them into special companies of the Pioneer Corps which were employed solely on agricultural work. Men who had been reasonably well selected for this did good work. The 'Annexure' scheme was an attempt to place men, after having received treatment in certain psychiatric hospitals, in some special occupation suitable to their particular case, should they be not fit to return to normal military duties. Each hospital concerned had direct access to the department of the War Office responsible for posting men. The experiment was successful, and a follow-up investigation showed that at least 60 per cent. gave good service in their new work and made an adequate adjustment. A total of some 10,000 cases were dealt with under this scheme.

The military hospitals for psychoneurotics were:

	Date of opening
1. 41 General Hospital, Sussex. Later moved to Bishop's Lydeard	June 1940
2. Military Hospital, Bishop's Lydeard. 300 beds, O.R. (male)	October 1940
3. Military Hospital, Dumfries. 40 beds, officers (male)	December 1940
4. Grahamholm Military Hospital, Belfast. 60 beds, O.R. (male)	February 1941
5. Bellsdyke Military Hospital, Stirlingshire. 300 beds, O.R. (male)	January 1942
6. Northfield Military Hospital, Birmingham. 800 beds, officers and O.R. (male)	April 1942

PERSONNEL SELECTION

GENERAL SELECTION

As early as 1922, following a careful appraisal of the evidence of medical witnesses and combatant officers concerning their experiences in 1914–18, the Southborough Committee reached the unequivocal conclusion that adequate selection of personnel was an essential procedure in the prevention of psychiatric illness. In spite of this, it was not until March 1939 that a fairly complete scheme was suggested for the selection of men to be called up for the militia in Britain. The scheme was submitted to the medical authorities of the Army, but was rejected. After the outbreak of war, some of the most important reasons for the accumulation within the Army, in the absence of selection, of men whose mental background was questionable were that

the distribution of man-power was so arranged that very large numbers of intelligent and able men were reserved in industry, that the Royal Navy and the Royal Air Force had priority of choice, and that the Civil Defence Services claimed great numbers. The Army came low in the list, and consequently had to deal with very considerable numbers of the dull, the neurotic and the unstable.

When the first command psychiatrists were appointed, in April 1940, they were inevitably faced with large numbers of unsuitable and inadequate men, and had to begin combing them out. Many of these men had to be invalided; some could be better placed or more usefully employed in their own or other arms of the Service. Various intelligence tests were brought into use by the different Army psychiatrists, who organised experiments in group testing. Test material had to be purchased by the psychiatrists themselves, or obtained through the generosity of others outside the Army. The experiments in group testing carried out by command psychiatrists led to the conclusion that, at that time, about four per cent. of all recruit intakes were never likely to be efficient in any combatant unit. It also became obvious that highly skilled men, capable of undertaking skilled technical jobs, were being employed in unskilled occupations, and that 50 per cent. of Pioneer Corps intakes were capable of efficient service in a more skilled arm. The psychiatrists were mainly concerned with these facts in view of their importance in the causation of neurotic illness in the Army, though it was also realised that lack of adequate selection necessarily entailed a very considerable loss and wastage of man-power.

There had been in the past a popular tradition that the dull man made a good soldier. The stresses and increased tempo of modern warfare, and the duties of the modern infantryman, which demanded a technical knowledge of a number of specialised weapons, required, however, an average degree of intelligence, and presented a difficult task to the dullard. Whereas he might have been capable of carrying out some simple job in a restricted, protected environment in civil life, the dullard, placed among men of relatively higher intelligence in the Army, often become maladjusted and developed feelings of inferiority and anxiety. Mental defect was a frequent cause of military delinquency, particularly of absenteeism, and the dullard often became a disciplinary problem in his unit through failure to understand the nature of regulations and the reason for them. Investigations also seemed to show that there was a positive correlation between mental dullness and proneness to venereal disease, and to scabies and pediculosis. It was clear, therefore, that the misplaced dullard in modern war was a general liability to the Army. The method of dealing with dullards which was available to Army psychiatrists in the spring of 1940 was to make recommendations, supported by reports by the commanding

officer and the unit medical officer, which were then dealt with at the War Office. This method was extremely unsatisfactory, as long delays elapsed before recommendations for discharge were implemented. In the early days of the war, commanding officers were allowed to transfer men to the Pioneer Corps, and men who were capable of undertaking more skilled work were so transferred. Later, in July 1941, an A.C.I.[3] ensured that dull and backward men would be transferred to the Pioneer Corps only on the recommendation of a psychiatrist. According to their level of intelligence and their fitness to bear arms, these dullards were transferred to armed or unarmed companies of the Pioneer Corps. With the introduction of adequate selection of men to be placed in the Pioneer Corps, it was found that the morale and the performance of dullards so employed showed considerable improvement. Before arrangements had been made for the transfer of dullards to the Pioneer Corps, the morale of many of them had sunk very low, and it was felt by Army psychiatrists that it would be of considerable assistance in assessing the future military usefulness of some men, if, instead of transferring them directly to the Pioneer Corps, preliminary observations could be carried out for a period of one month in special units where they could be partially trained. An experimental unit, or Pioneer Training Pool, was established in Northern Ireland, to which men, who had been recommended by a psychiatrist for transfer to the Pioneer Corps, were sent for one month. The majority of men sent to this unit showed a marked improvement. Such units were not, however, generally established.

In order to make the greatest possible use of dull men, unarmed sections of the Pioneer Corps were formed as well as armed. In the latter were men who could be trained in the use of a rifle in self-defence and were fit for base or L. of C. duties overseas. The former could not even master simple arms training, and were fit only for labouring duties in the United Kingdom. In the early stages, the authorities brought considerable pressure to bear in an attempt to employ unarmed sections on unsuitable duties. The fact that many dullards had made a good adjustment under the favourable conditions of the Pioneer Corps was often interpreted by those in authority as an indication that these soldiers were fit for routine infantry duties. Owing to the popular tradition that the dull man makes a good soldier, and that the assets of stolidness and imperturbability which derive from their mental slowness would be an asset to their units in keeping with the traditional qualities of the British soldier, there was always considerable pressure on psychiatrists to upgrade men from unarmed to armed companies of the Pioneer Corps, and from armed companies to the infantry. Psychiatrists had always to resist this, though there was opportunity for upgrading men whose maturity had increased with

military service or men in whose cases psychiatric opinion had been mistaken in the recommendation for transfer to the Pioneer Corps. Psychiatrists always had difficulty in explaining that the low intelligence, which made transfer to the Pioneer Corps expedient, was a constant factor that could not be changed by training, and that the high morale and good bearing of Pioneer units showed that the men were suitably employed and well commanded, not that they would do well in work and training demanding a higher degree of intelligence. In attempts to use men from the Pioneer Corps for more skilled work, certain experiments in training were tried. In 1944, 2,000 of the best men in the armed Pioneer Corps units in Northern Command were transferred to an infantry division for training. After ten weeks it was found that:

3 per cent. were fit for infantry duties.
7½ per cent. were fit for simple administrative and domestic duties.
38 per cent. were considered as possibly employable on garrison duties.
51½ per cent. were fit only for the Pioneer Corps.

These figures referred to the very best men in the Pioneer Corps at that time.

A combination of mental dullness with lack of stability was regarded as grounds for medical discharge and was cited in A.C.Is. as precluding transfer to the Pioneer Corps. This depended on a psychiatric assessment, but the criteria of this assessment remained a matter of discussion throughout the war.

In April 1940 psychiatrists, under the authority of an A.C.I.[4] were able to recommend a change of employment for men who had shown neurotic symptoms through employment in less skilled occupation than their innate ability and civilian attainments warranted. This A.C.I. also authorised commanding officers to recommend the transfer of men with trade qualifications which could not be utilised in the arm in which they were serving, but which could be utilised in some other arm. These arrangements did not suffice to deal with more than a small part of the problem, and some organisation was clearly necessary, which would have the task of allocating men on the basis of their abilities, from the moment they were recruited.

While psychiatrists themselves had early become convinced of the need for the selection-testing of recruits, they had been able to make but little progress against opposition in the matter of introducing group-testing on a large scale. This opposition arose from the fact that many senior officers expressed the view that dull men made the best soldiers; that intelligence tests had, in any case, no validity in the selection of men; and that the psychiatrists' opinion was wrong, and the men discharged on psychiatric grounds had merely successfully deceived the

psychiatrist in order to return to civil life. Towards the end of 1939, tests devised by the Cambridge Psychological Laboratory were used experimentally to aid in selecting the specially skilled men comprising A.A. gun-teams. In the winter of 1940–1 it was decided to extend intelligence testing to all intakes at the various training regiments. A small group of civilian psychologists devised an omnibus verbal and mechanical comprehension test. The testing was carried out by regimental officers, and arrangements were made for psychiatrists to have access to the test results.

These measures fell far short of requirements, and it was necessary to bring about a fundamental change in the methods whereby men were allocated to units. At that time, this allocation was still carried out by the Ministry of Labour, and, except in the case of tradesmen allocated to certain specialised units, was more or less haphazard.

In January 1941 the Command Psychiatrist, Northern Command, presented to the G.O.C. Northern Command, through the D.D.M.S., a memorandum which recommended that both testing and disposal of recruits should be under the control of the Adjutant-General, and that a special department should be set up at the War Office to direct and administer these activities. In this memorandum, it was stated: 'In allocating personnel, the basic principle should be that no man is to be employed on work which is definitely above, or, on the other hand, definitely below his ability. Any other method of allotment is wasteful of ability, or destructive of unit efficiency. This principle is being flouted in every training centre and every field unit of the British Army at present'.

This document aroused sufficient interest for consideration to be given to more detailed proposals, which were made by the same psychiatrist in a subsequent memorandum in March 1941, which was again sent to G.O.C. Northern Command. One of the proposals in this document was that an advisory panel of consultants should be set up to formulate the technical principles on which the scheme should be founded. Representations were then made by the Consulting Psychiatrist at the War Office with the result that, in May 1941 an advisory committee was set up, under the chairmanship of D.G.A.M.S., to investigate the problem.

The members of the advisory committee toured the commands, and made investigations at various units. Eventually, as a result of all this preliminary work, the Directorate for the Selection of Personnel (D.S.P.) was set up in June 1941. The work of the directorate was guided by industrial psychologists of experience, and a system of intelligence testing was introduced at all recruiting depots. Psychiatrists were thus able to interview all men whose poor performance in the tests placed them in the lowest grades.

In the winter of 1941–2 the Directorate of Personnel Selection carried out experiments in intake selection, in which psychiatrists co-operated. These experiments led to the introduction of the General Service Corps (G.S.C.) intake scheme in July 1942.

All recruits were now first taken into the G.S.C., where, during their period of basic training, they were subjected to a series of intelligence and aptitude tests, interviewed by specially trained personnel selection officers and subsequently, wherever possible, posted to the most appropriate duties in the Army. Certain classes of recruits were referred to the psychiatrist for advice by the medical officer or personnel selection officer: viz, men in the lowest selection group, stammerers and illiterates, and men whose placement or assessment proved difficult because of a history of psychiatric illness, of apparent psychiatric symptoms, of bizarre test results, or of apparent lack of 'combatant temperament'. Some 14 per cent. of the total intake were referred to psychiatrists. The latter were enabled in these cases to recommend various methods of disposal: viz., a specific type of employment, transfer to a primarily non-combatant arm, to an armed or unarmed company of the Pioneer Corps, or lowering of medical category or discharge by a medical board on account of psychiatric disability.

The earliest memorandum on selection prepared by psychiatrists had proposed a scheme whereby misfits already in the Army would be referred to special selection centres for disposal. Such Army Selection Centres (A.S.Cs.) were instituted early in 1943. The psychiatrists' work in these centres was similar to that in the General Service intake procedure, but, whereas less than 15 per cent. of the General Service intake required psychiatric opinion, almost 50 per cent. of men passing through A.S.Cs. were referred to the psychiatrist. The A.S.C. procedure was, however, open to criticism, and it was decided to replace these centres by a formation, based on a divisional war establishment, which would undertake selection and at the same time provide a certain amount of military training, and into which the technical staff would be absorbed. The staff of the division included an adviser in psychiatry.

In February 1943 in view of the man-power situation, it was decided to discharge, while still at primary training centres, recruits who had been placed in medical category 'C', and who were not employable on clerical duties. The wisdom of this decision was subsequently questioned on several occasions, until finally in July 1944 certain men due to be discharged in accordance with this policy, were submitted to a special investigation. Of the twelve men in the total investigated, who had been placed in category 'C' on psychiatric grounds, ten were unemployable and only two were suitable for strictly limited employment.

These and certain other investigations confirmed the view that men placed in medical category 'C' for psychiatric reasons could, in the vast majority of cases, make no useful contribution to the Army. It was felt that these untrained soldiers if retained, would prove only to be a liability, and would consume valuable general medical and specialist man-power out of all proportion to the usefulness of the men themselves.

In May 1943 an investigation was initiated by Army psychiatrists to ascertain whether psychiatric examination and selection of parachutist volunteers could reduce the wastage rate, which by the methods in use at that time was considerable during training. It was shown that psychiatric prediction gradings showed a high correlation with instructors' assessments at the training centre, and that psychiatric grades provided effective prediction of all forms of training wastage other than through accidental injuries. It was clear, therefore, that this selection was of very real value. The training staff was satisfied with the results and the consequent small training wastage.

SELECTION OF OFFICERS

One of the most important factors in influencing individual and group morale is the quality of the leadership. In the early days of the war it was not possible to select and send men for training as officers on the evidence of the qualities they had shown in actual battle. In 1941 there was a high rejection rate from officer cadet training units (O.C.T.Us.), and, because unsuitable men were being selected for training and then having to be rejected, there was a serious wastage of training time. A highly undesirable result of such rejections was that an excellent N.C.O., who had, however, reached the summit of his potentialities, would be sent to the O.C.T.U., would fail there and return to his unit as a dissatisfied man and, consequently, no longer a good N.C.O.

In 1941 Army psychiatrists were asked to undertake experiments in officer selection. At this stage of the war, Army psychiatrists had accumulated considerable knowledge of the personnel problems of the Army. They were constantly aware of the fact that psychiatric factors were often responsible for producing inefficiency in officers. A considerable number of officers had been brought back from the reserve though they were, in fact, unfit. Some had even been in receipt of disability pensions for neurosis since 1918, and many had clearly been inefficient on psychiatric interview. In addition, a fair number of men, newly commissioned from the ranks, had a history of psychiatric instability which should have excluded them, and a neurotic breakdown often occurred because a man was unable to carry a degree of responsibility commensurate with his increase in rank. With the

encouragement of the Adjutant General various preliminary experiments were started in July 1941, to discover possible techniques for the rapid selection of large numbers of candidates with a view to rejecting those who were considered unlikely to succeed.

As a first experimental trial, two Army psychiatrists studied a group of some 50 officers attending the Company Commanders' School in Edinburgh. An assessment of officer quality was made on the basis of a group intelligence test, a short questionnaire, and a psychiatric interview which lasted about one hour. The results were encouraging, and there was agreement in some 80 per cent. of the cases between the psychiatric opinions and those of the staff of the school at the end of the course. Study of a second group of officers gave even better results, and agreement between the psychiatric opinions and the school reports rose to 90 per cent. This demonstrated that psychiatrists could, on the basis of intelligence tests and a one-hour interview, reach an estimate of officer quality which had a high correlation with that made by experienced Army officers after about four or five weeks' close contact with the subjects under the working conditions of the school.

Various possible organisations to carry out a selection procedure were considered, and it was finally decided that the selection unit should take the form of a board. It was decided to set up an experimental board, and, if this proved successful, other boards would be established. In January 1942 the experimental board was formed. It became No. 1. War Office Selection Board (W.O.S.B.) and consisted of a president, a military testing officer, two psychiatrists, one psychologist and two sergeant testers. Accommodation was provided for it in the Institute of Genetics of the University of Edinburgh. From the start, the work of the psychologist and the psychiatrists was closely integrated. Various types of personality test were used experimentally. After some experimental trials, a battery of written group tests was evolved, from the results of which the sergeant testers constructed, in the case of each candidate, 'personality pointers'. The latter were in the nature of pointers to such features in the personality as would require assessment by psychiatric interview.

A technique was finally developed which rendered possible the establishment of permanent W.O.S.Bs. throughout the United Kingdom and with the forces overseas, through which all officer candidates passed. The staff of each board finally consisted, as a rule, of a president, a deputy president, three military testing officers, one or two psychiatrists, a psychologist and sergeant testers. As was to be expected, objections were raised to the presence of psychiatrists on the boards. There was a tendency on the part of external critics to assume that the psychiatrist's sole function was to give opinions on cases of mental abnormality and that he should, therefore, examine only a limited number of cases. This

misconception led to the imposition of an instruction issued in March 1943 to presidents of selection boards, that psychiatrists were not to interview more than 50 per cent. of the candidates, and that their duty was to be confined to seeing cases referred by the president. Such a regulation tended to destroy completely the value of the psychiatrist to the board, and had the detrimental effect, by encouraging the misconception that the psychiatrist only interviewed 'abnormals', of increasing the anxiety of candidates with regard to psychiatric examination. They inevitably, therefore, began to make some criticism of the psychiatric rôle. Criticism of the psychiatrist, from other sources, mainly centred round the mistaken belief that he recommended the rejection of suitable candidates. It was true that he might recommend the rejection of certain superficially well-adjusted personalities who were, however, unsuitable, but more often he drew attention to underlying potentialities in outwardly unimpressive personalities, which other members of the board might wish to reject.

Subsequently, it became necessary to adapt the W.O.S.B. techniques for other purposes. A number of officers, after treatment in psychiatric hospitals, became fit for further military duty, provided that certain modifications were effected in their employment. In order to determine the capacity in which the officer would be of greatest use to the Service, such cases were referred to a W.O.S.B. where the technique was suitably modified. Suitable modifications of the W.O.S.B. procedure were also used in selecting candidates for commission in the A.T.S. In 1943 two boards were set up for this purpose, women psychiatrists being employed on both.

PSYCHIATRIC ASPECTS OF MILITARY CRIME

As psychiatrists became available it gradually became possible to attempt a more rational method of classification of delinquents, and to consider causative factors, with a view to the prevention of further crime. The soldier referred for psychiatric examination, whether because of present or past delinquencies, presented many problems, both clinical and administrative, and there was need for some measure of co-operation of psychiatrists with the military authorities, in dealing with disciplinary cases.

A War Office letter and memorandum, issued in February 1942, set out the general position of the psychiatrist in disciplinary cases in relation to the legal processes at all stages. These instructions were intended to ensure that the fitness to plead and the criminal responsibility of a soldier awaiting trial should be the subject of full and informed consideration by the convening officer, and not raised in court for the first time by the defending officer. The form of report to be used by psychiatrists was also laid down. Misunderstandings, however, arose as to the function of Army psychiatrists in such cases, and the use which

should be made of their reports. To obviate this, a confidential memorandum was issued in June 1943. In this, it was pointed out that reports by Army psychiatrists in disciplinary cases were for the information of the commanding officer and the convening officer only, and that the accused and the defending officer had no right to demand, and would not be permitted to obtain, a report from an Army psychiatrist. It was the convening officer's responsibility, on receiving the report, to decide whether a court martial should be held. Thus the Army psychiatrist was, in every case, performing his proper function as expert adviser, briefed neither by prosecution nor defence. This memorandum was republished as an A.C.I.[6] By laying down the specific function of psychiatrists in disciplinary cases, these administrative procedures were effective in disposing of accusations that psychiatrists were interfering with the proper administration of justice.

During the early years of the war, difficulty was experienced in disposing of soldiers of habitual bad character who were psychopathic personalities with anti-social trends, gave no useful service and were a harmful influence in their units. This difficulty was caused partly by the fact that certain relevant provisions of King's Regulations had been suspended at the beginning of the war. At first, such cases were often discharged on medical grounds, there being no alternative method of disposal. For various reasons, this was not satisfactory and in January 1944 a War Office memorandum was issued on the disposal of these men. This authorised the reporting of psychopathic delinquents, who had been admitted to military psychiatric hospitals, to the War Office (A.M.D. 11). If discharge from the Army was then approved, the soldier was discharged, 'his services being no longer required'. This memorandum confined this method of disposal to psychopathic delinquents who were patients in military psychiatric hospitals, and it was clearly undesirable to have such cases admitted to hospital except in cases of clinical necessity. In January 1945 a further War Office memorandum was issued which permitted Army psychiatrists to recommend for discharge soldiers who were considered to be psychopathic delinquents and suitable for discharge, 'service no longer required'. Such a recommendation for disposal could be made without the necessity of first admitting the case to hospital. Every recommendation for this method of disposal was submitted to the War Office (A.M.D. 11) accompanied by all documents and a full report by a psychiatrist. Where it was a relevant question whether or not these soldiers should serve or complete any sentence outstanding, the decision was taken by the competent military authority.

A preliminary investigation by Army psychiatrists, completed in November 1942, showed that nearly 50 per cent. of soldiers under sentence were suffering from some form of psychiatric disorder, of

which mental deficiency constituted the largest group, and that absence without leave comprised almost two-thirds of the offences for which men were committed at that time.

In view of the critical man-power situation, it was the practice to release certain soldiers on suspended sentence from civil and military prisons, and transfer them immediately to operational theatres. It became clear, however, that, taking the long view, this procedure if unaccompanied by psychiatric screening, could be exceedingly uneconomical and that crime was merely continued overseas. Eventually, in December 1944, it was decided that all soldiers admitted to group 'C' military prisons and detention barracks, i.e. recidivists and those considered to have an undesirable influence in ordinary military prisons, should be examined by Army psychiatrists as soon as possible after admission. The first 500 psychiatric examinations carried out in accordance with this instruction showed that only 48 per cent. of these men were considered mentally fit for overseas service. It was also arranged, at this time, that Army psychiatrists should examine all soldiers detained in civil prisons, soon after their admission or immediately before review of their sentence by the War Office.

As a result of the very large number of disciplinary cases examined by Army psychiatrists, it became clear that military delinquents could conveniently be classified into five broad groups:

(*a*) Young delinquent soldiers

(*b*) Recidivists.

(*c*) Psychopathic or neurotic personalities.

(*d*) Dullards

(*e*) Psychotics.

Certain specific measures were evolved for the treatment and disposal of each particular group.

(*a*) *Young delinquent soldiers.* From the outbreak of war, the Army had an influx of volunteers under the age of 18 years. These adolescents were formed into young soldiers' battalions. Unfortunately their phantasies of army life did not coincide with harsh reality, and their subsequent disillusionment was not unconnected with the fact that the crime rate in these units was very high. It was recognised that the routine methods of military punishment were unlikely to have either deterrent or beneficial effects on these young soldiers, but in fact could be harmful. A scheme was, therefore, put into effect in 1942 for the formation of young soldiers training units (Y.S.T.Us.), to be used for delinquent youths. It soon became apparent that many unsuitable cases were being sent to these units. In order to comb out the unsuitable cases from these units, an investigation was carried out by a

personnel selection officer, a psychiatrist and a combatant officer. Dullards were transferred to suitable units, and neurotics were disposed of to hospital for treatment or by discharge from the Service. Eventually, in 1944, a more scientific method of selection of cases for these units was introduced and all cases recommended for transfer to them were first examined by selection teams at Army selection centres.

(*b*) *Recidivists*. At the outbreak of war, the normal procedure was suspended whereby persistent offenders and habitual bad characters were discharged from the Army in accordance with King's Regulations. At a time, therefore, when the shortage of man-power was acute, the Army had to retain these recognised consumers of man-power. The problem became acute in 1942, and it was decided that it was necessary to segregate them in special units. In November 1942 a War Office letter authorised the formation of command labour companies. They were not penal battalions in any sense, but it was recognised that the possibility of making efficient soldiers out of such men was remote. At the same time, it was deemed necessary that such men should not benefit by their persistent delinquency and be granted discharge from the Army, and should not be placed in units where they could contaminate and lead astray younger men.

As in the case of Y.S.T.Us., the labour companies, when they were first set up, received numerous unsuitable cases. A great many dullards and a few psychotics were posted to them on the direct recommendation of the commanding officers. This necessitated a continual sorting of intakes to those units by psychiatrists. Finally, in 1943, it was arranged that the only portal of entry to labour companies was *via* an A.S.C. where the final deciding factor was the psychiatric opinion. Apart from the function of Army psychiatrists in the selection of soldiers for the labour companies, the command psychiatrists visited the companies every six weeks, and, in conjunction with the commanding officer and personnel selection officer, decided whether men had been effectively rehabilitated and whether they could be posted to a new unit. The different types of labour companies set up were based on the classification of persistent defaulters into 'redeemables', 'doubtfuls' and 'incorrigibles'.

Summarising the work of the labour companies, the Adviser in Psychiatry to 45th Division, who was also adviser to the Director of Army Psychiatry on psychiatric problems relating to labour companies, wrote: 'The chronic absentee is frequently a military misfit who can be "redeemed", that is, give efficient service in a non-penal unit, but only if the unit is specially staffed: otherwise, the mistakes of previous units will tend to be repeated. Such companies can save commanding officers much administrative and training time: they help the morale of normal units who do not feel that the chronic A.W.O.L. gets

discharged because of his offences. Those units earn their keep and rehabilitate over a third of the men sent. . . . The experiment of running non-penal companies has been a success; it has justified the imaginative outlook of those who planned them'.

(*c*) *Psychopathic and Neurotic Personalities.* These formed about 50 per cent. of all disciplinary cases referred to Army psychiatrists, and represented the usual range of clinical material. Disposal of this group depended on the clinical findings, and almost all were considered fit to undergo trial and punishment.

(*d*) *Dullards.* The problem of the delinquent in the Army was closely related to the problem of the dullard. Many dullards made, however, a good adjustment within the favourable conditions of the Pioneer Corps. Although a full statistical investigation was not carried out, the general impression was that their transfer to the Pioneer Corps had had a remarkable effect in reducing the incidence of crime in the lower intelligence groups in the Army.

(*e*) *Psychotics.* Only three per cent. of disciplinary cases referred to Army psychiatrists were found to be psychotic, and these were disposed of in the usual way.

The question of military delinquency and particularly of desertion and absence without leave, caused very serious concern in Italy and in North-west Europe in 1944 and 1945. Quite apart from the wastage of man-power, the difficulty of providing accommodation in prisons and field punishment camps became acute. The Adviser in Psychiatry, 21 Army Group, recommended that a psychiatric examination of as many soldiers under sentence as possible should be carried out; 103 cases were examined in one military prison in France. Certain basic conclusions were then reached which were set out in a report in November 1944. After careful assessment of each man's personality and ability, of the stress to which he had been exposed at the time of the offence, and the adequacy of his training for the job he was expected to perform, the following conclusions were arrived at:

25 at the time of the offence were suffering from acute battle-neurosis or severe exhaustion

20 had been subjected to severe stress and 17 to the cumulative stress of several campaigns.

26 were technically unsuited for their jobs.

40 were in some way unidentified with their units.

5 were anti-social types who could be expected to be involved in crime.

92 seemed to have good prospects of rehabilitation for further useful employment in the Army.

It was concluded that some 90 per cent. of men undergoing long sentences for absence or desertion could be returned to duty with confidence that they would not commit further offences, provided that each man were given a full psychiatric examination which would be taken as the basis for his reallocation.

After this preliminary survey, the question was taken up by Second Army, and a special Review of Sentences Board was set up consisting of the D.A. and Q.M.G., and A.A.G. Second Army and the psychiatrist attached to Headquarters Second Army. The board interviewed each man personally three months after he had been sentenced, when his case came up for review in accordance with normal military routine. Formerly, review of sentences had always been carried out by the appropriate military authority, without personal interview, on the evidence of the prison commandant's report and documents dealing with the man's military history. The board was given authority to suspend sentences on those soldiers whom it considered were worthy and would acquit themselves well. During the period November 17, 1944–January 22, 1945, 596 men were interviewed. Those men who at the interview showed signs of nervous instability, mental dullness, etc., were subjected to a detailed psychiatric examination before a final decision was made in regard to future disposal.

Disposal recommendations were as follows:

A. Cases not referred for full psychiatric examination . . 392
   Disposals:
   (i) Sentence suspended and returned to full duties in the line 378
   (ii) Sentence suspended, downgraded in medical category because of a physical disability and given suitable employment 2
   (iii) Conscientious objectors, sentence suspended and transferred to R.A.M.C. 2
   (iv) Incorrigible type of man. To remain in prison . 10

B. Cases referred for full psychiatric examination . . . 204
   Disposals:
   (i) Sentence suspended and returned to full duties in the line 57
   (ii) Sentence suspended, downgraded in medical category, and transferred to suitable employment . . 84
   (iii) Sentence suspended and transferred to the Pioneer Corps 47
   (iv) Sentence suspended and admitted to a psychiatric hospital for treatment 12
   (v) Sentence suspended and discharged from the Service 1
   (vi) Incorrigible type. To remain in prison . . 3

435 men or 73 per cent. of the total examined were returned to full duties in the line. A follow-up of these men carried out in June 1945 showed that approximately 70 per cent. of them had given satisfactory service after release from prison. The majority, therefore, made good and the policy in Second Army was justified by the results.

Later, a questionnaire was devised to elicit all the factual information necessary for a rough personality assessment of each case, as well as any material suggesting that the man required further psychiatric investigation. This was rendered necessary by the shortage of psychiatrists, which made individual psychiatric interview possible only in selected cases. The report of the prison officer and the questionnaire completed by the latter were forwarded, with the prison commandant's routine report, to the Reviewing Board. Before the commandant's final recommendation was made, the soldier was seen by a board at the prison, consisting of the commandant, a visiting psychiatrist, and the prison officer who had interviewed the man. Cases requiring further investigation or reallocation of employment were then seen individually by the psychiatrist, whose report was also forwarded to the Second Army Review Board.

This was the situation when a Permanent Review Board was set up for 21 Army Group. At the time, application was made for the inclusion of trained personnel necessary for the use of scientific tests of ability and character on the establishment of the board, but this was, unfortunately, not granted. A psychiatrist was included in the establishment, not merely to interview and report on doubtful cases, but to sit as an executive expert member. This was done in acceptance of the principle that in every case personality and the psychological aspect of the crime should receive consideration as well as the legal and disciplinary aspects, and that personality assessment is a psychiatric matter. As the psychiatrist had to sit as a member of the board, there was not time for individual interviews and the technique of assessment had to be built up on what was at hand. The questionnaire previously devised was therefore elaborated, and was completed by prison officers. The procedure of the board was largely dictated by circumstances, and, after interview with the man and studying the objective documentary evidence, a largely intuitive conclusion was arrived at.

As a result of a study of 2,000 deserters interviewed by the board, the psychiatrist on the board was able to confirm previous findings, and, in particular, the relationship between morale and desertion. In a report on his work he wrote:

> 'If then my thesis concerning the relation of desertion to group morale is correct, the effect of prolonged detention upon a deserter will be to make a second desertion more likely. If personal morale is low, the treatment must be to place the man in a group where morale is high so that

his own may be raised. Removal to an exotic environment, where he will become integrated in an anti-social group, and denied the rehabilitative effect of companions and leaders of good morale, will have the opposite of the desired effect'.

In the War of 1914–18 deserters were subject to the death penalty. In the War of 1939–45 this procedure was abolished, and instead of the death penalty sentences of imprisonment were imposed. A large number of Regular Army officers disapproved of the change and considered that the introduction of the death penalty for desertion in the face of the enemy, and its enforcement in even only two or three cases, would have gone a very long way towards solving the problem of desertion. Psychiatric experience and research, however, failed to reveal any scientific evidence in support of this view, and psychiatrists were convinced that the only logical and effective approach to the question of desertion was a thorough scientific investigation of the factors leading to such behaviour in each individual case. The Consulting Psychiatrist to the Army made the following comments in this connexion:

'The abolition of the death penalty for desertion in face of the enemy appears to be linked with the relatively small number of self-inflicted wounds. . . .

'. . . In the few cases where there have been "mass" desertions, i.e. of quite a number of men at one time, there has practically always been some explanation to be found, usually in faulty handling by N.C.Os. or officers'.

PSYCHIATRIC SERVICES IN OVERSEAS THEATRES OF WAR AND IN FORWARD AREAS DURING BATTLE

The amount of psychiatric breakdown that occurred under battle stress depended to a large extent on the kind of war that was being fought, the state of personal and unit morale and the standard of care exercised in the selection of personnel. Fluid warfare in the desert, resulting in victory, produced very little neurotic breakdown, even though there was a good deal of physical fatigue. The figure on many occasions in the desert was as low as 2 per cent. of the total casualties. The nearer the fighting approximated to the 1914–18 trench warfare, the higher became the incidence. When men were constantly suffering from weapons they dreaded most; when they were separated from each other in fierce battle and were without sleep, the rate rose to 10 or even 20 per cent. of the total casualties. Breakdown in battle occurred in all ranks and in all units. The causes lay in the individual's own personality, in his family, in the care taken in his selection and in his military training, and in his leadership, both political and military. On the whole, chronic neurotics made poor front-line soldiers, though

many men with well marked neurotic predisposition stood up for a long time to the most trying front-line fighting. The importance of adequate selection and training could not be over emphasised. Some individuals never became combatant soldiers, however good their discipline, training and leadership might have been. Units which showed a consistently high neurotic breakdown incidence were often units with too many inadequate or mentally defective personnel. The close contact of leaders with their men was essential in the prevention of these illnesses, which in many cases were a reflection on leaders rather than the led. A high incidence indicated that there had been a failure somewhere in selection, training or leadership. Instruction of combatant and regimental medical officers in the early recognition of strain was of proven advantage. When men were sent down to a regimental aid post for a night's sleep there was a good chance of avoiding breakdown altogether. The use of the term 'exhaustion' for all psychiatric casualties in the line, on the whole, proved successful. This label had a much less serious implication of illness than the shell shock of 1914–18, and, as each man could read his own label, its advantages were obvious.

The local organisation of psychiatric services in forward areas necessarily varied to some extent with the requirements specific to a given theatre of war. Such organisation was also gradually evolved as a result of experience in dealing with psychiatric casualties. A corps psychiatrist was included in the war establishment of the headquarters of a corps in 1943. His duties as laid down by the War Office in February 1944 were (*a*) to advise on all matters pertaining to mental health; (*b*) to pick out, for elimination from the corps, individuals mentally unfit for duty with the corps; (*c*) to be available for the early treatment of individuals suffering from 'minor' correctable maladjustments to military service; (*d*) to advise on the psychiatric aspects of discipline, morale and training, and, by lectures and informal discussions with officers (staff, regimental and medical) to assist in the promotion of mental health and in preventive psychiatry; (*e*) to report on disciplinary cases as required; (*f*) to supervise the management of 'exhaustion' or psychiatric casualties during action; (*g*) to attend at medical boards and assist in reclassification procedures to promote the suitable placement of men as required. The avoidance of indiscriminate evacuation and the proper selection for treatment on the spot were his primary functions in the interests of conservation of man-power. It was not practicable for the corps psychiatrist himself to run more forward treatment centres than his own corps exhaustion centre (C.E.C.). The whole success of 'forward psychiatry' depended, however, on early treatment, and towards the end of the war a divisional psychiatrist was attached to each actively fighting division whenever this was practicable.

In many instances, owing to scarcity of psychiatrists, it was not possible to attach one to every division. Suitable general duty officers were then trained by the corps psychiatrist to run these divisional exhaustion centres.

The organisation of divisional exhaustion centres (D.E.Cs.) and of corps exhaustion centres, which took the cases the D.E.Cs. found too difficult, returned approximately 65 per cent. of psychiatric battle casualties arising in a corps to full combatant duty in their original units within a period of six or seven days. It was impossible to form any accurate estimate of relapses, but it was estimated that over 80 per cent. of those returned to full combatant duty remained with their original units for at least six weeks. It may be considered, therefore, that the contribution of even the remaining 20 per cent. outweighed any deleterious effect they might have had on their comrades when beginning to break down again. The essentials of treatment were adequate sedation by the regimental medical officer immediately after the breakdown, and continuance of this sedation at the divisional exhaustion centre. Men considered unlikely to return to duty after a few days' treatment at the D.E.C. were evacuated to a corps exhaustion centre. Here were retained such cases as were likely to return to duty within seven to ten days and the remainder were transferred to a base psychiatric centre; the majority of those transferred to base psychiatric centres were rehabilitated sufficiently in a month to return to duty on L. of C. work. These cases, however, generally had to pass through a reinforcement holding unit and remain here often for prolonged periods waiting for posting. In the best of circumstances it requires high morale to withstand boredom and inaction. Soldiers who had recently had a psychiatric breakdown were not, in many cases, fit to withstand this kind of stress, and during their prolonged period of waiting in reinforcement holding units a marked deterioration often occurred. The best results were produced when the whole progress from breakdown to final return to active effective duty was continuous.

PSYCHIATRIC RECOMMENDATIONS WITH RESPECT TO DISPOSAL OF INTAKES AND DISPOSAL AT ARMY SELECTION CENTRES*

For the preparation of Tables 61–64, based on consolidated monthly returns submitted to A.M.D.11 with respect to Army intakes, certain disposal groups were amalgamated to bring into sharper relief the salient features of the procedure adopted, more especially with due regard to the provisional nature of the judgment involved. The classification adopted for Army Selection Centres (Tables 65–67) was more detailed, because decision at this level probably had greater finality.

* From the Statistical Report on the Health of the Army, 1943–5. H.M.S.O. 1948.

Table 61 shows the distribution of intelligence grades among intakes over the two years 1943–1944. Selection grade S.G.1 represents the highest level of intelligence. Such differences as exist in the modes of the four periods may be due to different regional and/or industrial source of recruits. Table 62 draws attention to the fact that the over-

TABLE 61

Distribution of S.Gs. as Percentages of Total Intake; Male Personnel; 1943–1944

Period	S.G.1	S.G.2	S.G.3+	S.G.3−	S.G.4	S.G.5	Totals	Size of Intake
1. January–June 1943 .	10·2	23·1	23·5	21·3	17·1	4·8	100·0	147,000
2. July–December 1943	11·0	18·6	20·5	20·5	20·9	8·6	100·0	63,901
3. January–June 1944 .	7·3	12·5	19·5	25·2	26·9	8·5	100·0	92,693
4. July–December 1944	12·0	17·3	21·5	22·3	20·7	6·1	100·0	118,493

TABLE 62

Distribution of Psychiatric Recommendations as Percentages of Total Intake; Male Personnel; 1943–1944

Period	Not seen or no action recommended	Special employment and change of category			Wastage, temporary and permanent		Totals	Size of intake
		Combatant tendency (C.T.) grading without special employment	To Pioneer Corps	Special employment and reduction of category	To Hospital	Discharged from Army		
1. Jan.–June 1943	91·4	3·2	3·4	2·0	0·04	0·05	100·0	147,000
2. July–Dec. 1943	89·9	3·8	4·2	1·8	0·05	0·12	100·0	63,901
3. Jan.–June 1944	90·7	3·5	4·1	1·5	0·03	0·17	100·0	92,693
4. July–Dec. 1944	92·1	3·3	3·1	1·4	0·01	0·09	100·0	118,493

whelming majority of recruits were not referred for psychiatric interview. There was a steady level of recommendations for each category of disposal. At this level of psychiatric inspection, recommendations with respect to special employment, reduction of category and posting to Pioneers, outweighed recommendations with respect to hospitalisation or discharge from the Service.

Table 63 relates the intelligence distribution of intakes to disposal, showing the absolute proportions in these groups. Since the proportions of the selection grades among intakes as a whole (Table 61) are not identical, the corresponding proportions in Table 63 do not reflect the relative liabilities of the several selection grades to a given type of disposal. The liabilities of the different selection grades to one and the same type of disposal are proportional to the quotients of corresponding figures in Tables 63 and 61. Table 64 exhibits these quotients reduced to the same (percentage) scale. The main points which emerge therefrom are:

(*a*) recruits of low intelligence are most likely to be referred for psychiatric inspection, as indeed instructions prescribed with respect to the lowest selection grade (S.G.5);

(*b*) recommendation for special employment is more likely to occur in those of lower intelligence;

(*c*) in accordance with official policy, relative liability of S.G.5 recruits to be posted to Pioneer Corps in 1944 was twenty times greater than for any other S.G. category;

(*d*) the variation with respect to relative liability to hospitalisation and discharge from the Army is of little significance since it is based on a small number of recruits;

(*e*) the above trends persist with little modification over the four periods, and where differences show up they may well be due to differences with respect to the intake populations.

Army Selection Centres (A.S.Cs.) were instituted for the reallocation and re-employment of men found unsuitable for their existing rôles, in accordance with A.C.I. 393 of 1943. Tables 65 and 66 refer to psychiatric recommendations at such centres including recommendations with respect to cases (divisional intakes) dealt with by the 45th Division which fulfilled a similar function. Figures are computed on the same basis as Table 65 to exhibit relative liability of individuals in each S.G. to a given disposal. An analysis of data corresponding to those cited with respect to intakes in Table 63 revealed that among both 21st Army Group troops and other personnel at A.S.Cs. only approximately 50 per cent. were seen by a psychiatrist.

Tables 65 and 66 which refer to Service personnel in A.S.C. (and 45th Division) at two different periods show:

(i) no noteworthy difference with respect to liability to change of employment;

(ii) greater relative liability to recategorisation of high S.Gs. in the earlier period;

(iii) somewhat lower relative liability in the later period of middle S.Gs. to be sent to Pioneers, in accordance with instructions issued to psychiatrists.

Table 67 (21 Army Group) embraces two periods, one before and one after July 1944. Before then no battleworn soldiers appeared for inspection with a view to reallocation. The outstanding difference between disposals of 21 Army Group and other military personnel is that the relative liability of S.G.5 personnel in 21 Army Group to be placed in the Seen but No Action group was low as compared with other S.G.5 Service personnel.

REFERENCES

[1] Army Order 9 of 1942.
[2] Army Order 49 of 1945.
[3] Army Council Instruction 1136, dated July 1941.
[4] Army Council Instruction 339, dated April, 1940.
[5] Army Council Instruction 1483 of 1944.

TABLE 63

Selection Grades as Percentages of Recommendations; Male Intakes; 1943–1944

Disposal	Period	S.G.1	S.G.2	S.G.3+	S.G.3−	S.G.4	S.G.5	Totals	Crude figures
Not seen or no action recommended	1. Jan.–June 1943	10·9	24·5	24·6	21·8	16·0	2·2	100·0	134,316
	2. July–Dec. 1943	11·9	19·9	21·8	21·5	20·7	4·2	100·0	57,460
	3. Jan.–June 1944	7·7	13·3	20·7	26·8	27·3	4·2	100·0	84,046
	4. July–Dec. 1944	12·6	18·2	22·6	23·2	20·5	2·9	100·0	109,179
Combatant tendency (C.T.) grading without special employment	1. Jan.–June 1943	4·4	12·7	16·3	21·0	25·1	20·5	100·0	4,687
	2. July–Dec. 1943	6·2	9·7	11·7	16·0	25·8	30·6	100·0	2,465
	3. Jan.–June 1944	5·1	8·4	11·7	17·2	31·5	26·1	100·0	3,218
	4. July–Dec. 1944	7·6	10·1	13·7	16·4	29·7	22·5	100·0	3,936
To Pioneer Corps	1. Jan.–June 1943	0·0	0·2	1·0	5·0	35·1	58·7	100·0	4,928
	2. July–Dec. 1943	—	0·1	0·2	1·0	17·9	80·8	100·0	2,714
	3. Jan.–June 1944	—	—	0·1	0·6	14·0	85·3	100·0	3,818
	4. July–Dec. 1944	0·0	—	0·0	0·4	15·8	83·7	100·0	3,647
Special employment and reduction of category	1. Jan.–June 1943	5·9	17·1	22·6	25·1	21·8	7·5	100·0	2,940
	2. July–Dec. 1943	6·7	15·1	17·9	24·5	26·7	9·1	100·0	1,150
	3. Jan.–June 1944	5·7	10·2	18·8	21·4	31·3	12·6	100·0	1,423
	4. July–Dec. 1944	9·0	12·9	19·0	25·0	28·5	5·6	100·0	1,609
To hospital	1. Jan.–June 1943	3·3	13·3	15·0	33·3	23·4	11·7	100·0	60
	2. July–Dec. 1943	5·9	8·9	29·4	17·6	23·5	14·7	100·0	34
	3. Jan.–June 1944	10·7	14·3	7·1	21·4	28·6	17·9	100·0	28
	4. July–Dec. 1944	11·8	11·8	11·8	35·3	17·5	11·8	100·0	17
Discharged from Army	1. Jan.–June 1943	—	7·2	10·1	11·6	39·2	31·9	100·0	69
	2. July–Dec. 1943	—	10·3	10·3	10·3	17·9	51·2	100·0	78
	3. Jan.–June 1944	0·6	5·6	7·5	7·5	22·5	56·3	100·0	160
	4. July–Dec. 1944	1·9	3·8	7·6	18·1	19·1	49·5	100·0	150

TABLE 64

Relative Liability of Personnel of Different Selection Grades to Specified Disposal in Accordance with Psychiatric Recommendations; Male Personnel; 1943–1944

Disposal	Period	S.G.1	S.G.2	S.G.3+	S.G.3−	S.G.4	S.G.5	Totals
Not seen or no action recommended	1. Jan.–June 1943	19·11	18·97	18·72	18·29	16·73	8·19	100·0
	2. July–Dec. 1943	18·84	18·65	18·52	18·28	17·25	8·50	100·0
	3. Jan.–June 1944	18·34	18·50	18·47	18·49	17·65	8·60	100·0
	4. July–Dec. 1944	18·56	18·60	18·59	18·39	17·50	8·40	100·0
Combatant tendency (C.T.) grading without special employment	1. Jan.–June 1943	5·13	6·56	8·27	11·75	17·49	50·86	100·0
	2. July–Dec. 1943	7·80	7·23	7·90	10·80	17·08	49·23	100·0
	3. Jan.–June 1944	10·14	9·76	8·70	9·90	16·99	44·54	100·0
	4. July–Dec. 1944	8·21	7·58	8·27	9·54	18·60	47·84	100·0
To Pioneer Corps	1. Jan.–June 1943	0·01	0·06	0·30	1·61	14·09	83·93	100·0
	2. July–Dec. 1943	—	0·04	0·10	0·48	8·30	91·08	100·0
	3. Jan.–June 1944	—	—	0·05	0·23	4·92	94·81	100·0
	4. July–Dec. 1944	0·02	—	0·01	0·13	5·26	94·59	100·0
Special employment and reduction of category	1. Jan.–June 1943	9·81	11·75	15·28	18·71	20·25	24·83	100·0
	2. July–Dec. 1943	10·45	13·94	14·99	20·52	21·94	18·17	100·0
	3. Jan.–June 1944	12·90	13·48	15·92	14·02	19·22	24·47	100·0
	4. July–Dec. 1944	12·94	12·87	15·25	19·34	23·76	15·84	100·0
To hospital	1. Jan.–June 1943	4·69	8·34	9·24	22·63	19·81	35·30	100·0
	2. July–Dec. 1943	8·73	7·79	23·36	13·99	18·31	27·84	100·0
	3. Jan.–June 1944	20·97	16·36	5·21	12·14	15·20	30·12	100·0
	4. July–Dec. 1944	14·95	10·37	8·35	24·07	12·85	29·41	100·0
Discharged from Army	1. Jan.–June 1943	—	3·05	4·21	5·33	22·42	65·00	100·0
	2. July–Dec. 1943	—	11·35	10·29	10·29	17·89	50·20	100·0
	3. Jan.–June 1944	0·95	5·17	4·44	3·44	9·64	76·38	100·0
	4. July–Dec. 1944	1·49	2·08	3·34	7·68	8·72	76·70	100·0

TABLE 65

Relative Liability of Personnel of Different Selection Grades to Specified Disposal at Army Selection Centres; Mid-May 1943–*Mid-May* 1944

Disposal	S.G.1	S.G.2	S.G.3+	S.G.3−	S.G.4	S.G.5	Totals
Not seen	19·3	19·6	19·7	18·9	16·5	6·2	100·0
Seen but no action	19·3	17·6	15·6	14·5	13·6	19·3	100·0
To Pioneer Corps	0·4	1·4	3·2	7·1	24·2	63·7	100·0
Change of employment	19·0	18·0	16·5	16·5	15·1	14·9	100·0
Recategorisation	22·2	19·8	16·1	17·3	14·8	9·9	100·0
Boys' units	8·3	25·0	25·0	25·0	8·3	8·3	100·0
To hospital	9·1	45·5	18·2	9·1	9·1	9·1	100·0
Discharged from Army	5·0	5·5	9·1	11·8	19·4	49·3	100·0

TABLE 66

Relative Liability of Personnel of Different Selection Grades to Specified Disposal at Army Selection Centres; Mid-May to December, 1944

Disposal	S.G.1	S.G.2	S.G.3+	S.G.3−	S.G.4	S.G.5	Totals
Not seen	18·9	19·6	18·0	20·4	17·0	6·0	100·0
Seen but no action	14·2	16·6	18·2	14·0	13·5	23·7	100·0
To Pioneer Corps	—	2·8	1·4	3·7	37·6	54·5	100·0
Change of employment	19·4	17·4	14·7	17·1	15·1	16·3	100·0
Recategorisation	19·0	18·5	16·1	16·4	15·5	14·6	100·0
Boys' units	13·4	10·2	17·9	13·9	27·1	17·4	100·0
To hospital	23·1	27·2	19·7	12·7	16·2	1·3	100·0
Discharged from Army	7·8	7·8	16·2	12·3	17·8	38·0	100·0

TABLE 67

Relative Liability of Personnel of Different Selection Grades to Specified Disposal at Army Selection Centres; 21 *Army Group; May to October* 1944

Disposal	S.G.1	S.G.2	S.G.3+	S.G.3−	S.G.4	S.G.5	Totals
Not seen	20·3	20·9	19·8	17·7	14·3	6·8	100·0
Seen but no action	19·4	18·3	19·1	20·6	14·9	7·5	100·0
To Pioneer Corps	—	1·3	2·4	8·2	27·6	60·4	100·0
Change of employment	15·5	18·4	15·0	15·4	17·1	18·6	100·0
Recategorisation	10·7	13·7	19·9	20·6	20·8	14·1	100·0
Boys' units	6·2	18·7	20·3	14·1	12·5	28·1	100·0
To hospital	13·7	17·1	11·9	17·9	14·5	24·8	100·0
Discharged from Army	5·2	4·5	6·8	10·3	18·6	54·4	100·0

CHAPTER 10

THE DIRECTORATE OF MEDICAL RESEARCH

In a protracted war for which a nation is unprepared there are two phases in the encouragement of scientific research for military ends. In the first the most urgent problems facing those responsible for the making of a national army are such as arise from the production, in ever increasing quantity, of trained men and of machines and materialities of existing patterns. In the second the major problems relate not to quantity so much as to quality. The aim becomes that of producing a better army composed of better soldiers, better trained and better equipped with arms of greater ingenuity, precision and lethality. Thus it is that the longer a war lasts the greater becomes the relative importance of the Department of the Adjutant-General, which is concerned with the soldier as a human being and with his quality, his health and welfare.

During the first two years of the war the Army Medical Services, like all the rest of the Army, were concerned with their own expansion. It was only when this herculean task of ingestion and assimilation was proceeding smoothly that it became possible seriously to consider desirable developments in organisation which might permit the medical services to enhance their efficiency and expand their functions.

To the increase in the size of the Army there was an upper limit determined by the total size of the population from which the Army was drawn, by the age and sex composition of this population and by the conflict between the demands of productive industry and of the Armed Forces respectively. Quite inevitably there had to come a time when the main interest of the Army authorities came to be focused upon the task of making the best use of the human material that had been placed at their disposal. In this task the Army turned to the scientist for help.

The faith of the Army in the civilian scientist had been refreshed during the early days of the development of radar and had been strengthened by the results obtained by the small group that had become engaged in the study of siting and methods of use of A.A. guns and fire control equipment in the field. The success of this employment of scientists was such that it came to be recognised that objective studies of this kind would be of great value in other fields. The Ministry of Supply engaged further groups of scientists to study gunnery, field artillery, infantry weapons, etc. Then came the decision

to form operational research sections for despatch to overseas theatres of war. By the end of the war over 350 representatives of the different branches of science, mainly of physical science, had been employed in such operational research on behalf of the Army. Between them they produced some 350 reports and nearly 600 memoranda.

A scientific adviser to the Army Council (S.A./A.C.) was appointed, borne on the portfolio of D.C.I.G.S. and charged with the responsibility of advising on matters concerning weapons, equipment and ways of making war. To this position an eminent civilian physicist was appointed. A General Staff Directorate of Research was created, charged with the study and analysis of the lessons of war and the production from them of tactical and organisational doctrine for the immediate and future rôle of the Army and for its co-operation with the other Services. The Director of Research (D.R.), a serving combatant officer of high rank, shared a common secretariat with S.A./A.C. and submitted his recommendations to D.C.I.G.S.

The Army Council enlisted the help of the Medical Research Council in devising means 'of giving greater protection to soldiers against missiles and of increasing the biological efficiency of specialised troops'.* The M.R.C. gathered to itself a Military Personnel Research Committee (M.P.R.C.) composed of eminent civilian scientists together with representatives of the different War Office 'user' directorates concerned with the matters considered. This M.P.R.C. fragmented into a number of sub-committees, on which the Army Medical Directorate was represented, each dealing with some particular problem or special subject—e.g. body armour, helmets, armoured fighting vehicles, vision, rations, clothing, analeptics, entomology, etc. The result was that, with the multiplication of these sub-committees with their ever-widening interests, the territory officially regarded within the Army as the province of the Army Medical Services appeared to be deeply invaded. It became necessary to establish between the Army Medical Directorate on the one hand, and S.A./A.C., M.P.R.C., D.R. and the research organisation of the Ministry of Supply on the other, a harmonious relationship in order that each in its own sphere might make its maximum contribution to the welfare of the Army.

It was recognised by D.G.A.M.S. that the M.R.C. could command research facilities and tap resources of scientific knowledge far greater than those available within the Army Medical Services. Nevertheless, it was impossible for him idly to watch the slow progressive usurpation of his duties as adviser to the Secretary of State on all matters deriving from the medical sciences. Much that the M.P.R.C. had been doing was exactly that which the Directorate of Hygiene was expected to do.

---

* *See* the Medical Research Volume of this History.

It was nobody's wish to see the M.P.R.C. assume and exercise a monopoly in the field of scientific investigation relating to the biological efficiency of the soldier; yet, because no adequate mechanism for collaboration between M.P.R.C. and the Army Medical Directorate had been devised, this is what was happening.

Early in 1942, therefore, D.G.A.M.S., after conversations with the secretary of the M.R.C., decided to create within the Army Medical Directorate the post of Director of Medical Research. The duties attached to this post were to be: (*a*) to advise the D.G.A.M.S. as to the best methods of approaching problems requiring scientific investigation; (*b*) to co-ordinate all scientific activities undertaken by the Army Medical Services personnel; (*c*) to act as liaison officer in connexion with all field trials undertaken by the different arms of the Service and in which the Army Medical Services were directly or indirectly interested; (*d*) to receive and assess the scientific value of all reports of scientific investigations coming into the Army Medical Directorate from Allied and other sources; (*e*) to supervise the application of the results of such investigations to military affairs and (*f*) to act as liaison officer with the M.R.C. and other civil and military bodies concerned with scientific research of interest to the Army Medical Services.

It so happened that it was found convenient for the T.A.R.O. officer appointed to this post to hold at the same time that of editor of the Army Medical Services Official History of the War.

The immediate task of D.M.R. was to establish proper and harmonious relationships with these various bodies and individuals, all concerned with research touching directly or indirectly upon the interests of the Army Medical Services. He was invited to become a member of each of the M.P.R.C. sub-committees and was thus able to remove the misunderstandings which had tended to prevent the smooth development of desirable co-operation between the M.P.R.C. and the Army Medical Directorate. He was also invited to attend the meetings of the operational research groups of the Ministry of Supply and encouraged to contribute to such discussions as had biological aspects.

S.A./A.C. was a representative of the physical sciences. In virtue of his office D.G.A.M.S. was adviser to the Army Council in respect of the biological (including the medical) sciences. The two were complementary. Problems concerning weapons, equipment and the tactical use of troops could not be considered apart from the nature and needs of the men involved. It was necessary therefore to establish the closest liaison between the Army Medical Directorate and S.A./A.C. D.C.I.G.S. was consulted and it was agreed that the integration of the activities of S.A./A.C. and of D.M.R. was most desirable and that there should be devised a machinery by means of which biological

research could be encouraged and its results made known to the General Staff and interpolated into General Staff organisational and weapon policy. It was agreed that D.M.R., at the same War Office level as S.A./A.C., should be regarded as the representative of the biological sciences and should establish contacts with such bodies as the Ministry of Supply, the producer of the materialities of war, and the General Staff Policy Committee on Weapons and Equipment. These developments oriented D.M.R. appropriately in relation to both S.A./A.C. and D.R. So it came to pass that Army medicine became involved in matters that dealt not with the health but with the military efficiency of the soldier, even with tactics.

It soon became manifest that D.M.R. must choose between two different paths of development. He could be an adviser, representing a certain viewpoint and being referred to for advice from this viewpoint on problems propounded by others, or he could be an active director of research, selecting problems for investigation (other than those being dealt with by the M.P.R.C.), initiating and organising research upon these and presenting the results of such research to those who were most concerned. An adviser requires but a small staff; a director of research needs a very considerable establishment if anything worth while is to be done. The decision taken was to add to the Army's knowledge and not to be content merely to express unusual points of view at meetings and be the exponent of bright generalities.

In so far as the Army Medical Directorate itself was concerned, there was much research of high quality afoot in the Directorates of Hygiene and Pathology and in hospitals at home and abroad under the encouragement of the different consultants. No one man, no matter how equipped, could hope to be sufficiently omniscient as to interfere profitably in these activities. It seemed, therefore, that the best service that D.M.R. could render to his colleagues in the Army Medical Directorate was to provide a statistical machinery for their assistance and also an establishment which could carry the officers who were to be employed on such whole-time investigational activities.

The broad biological problems of immediate military importance with which D.M.R. might concern himself in the interests of the General Staff, and with the co-operation of S.A./A.C. and D.R., seemed to be those relating to (*a*) the design of the Army; (*b*) the arming and equipment of the Army; (*c*) the training of the Army and (*d*) fighting the enemy.

The design of the Army—the numbers and constitution of the various formations—is determined by major strategy. But the adequate fulfilment of the design is not only a matter of having enough men but of having enough men of certain kinds. All men are not born equal, nor do all thereafter endure the same experience or acquire the same

skills. Knowledge was needed concerning the distribution of certain human attributes within the Army. In this matter D.M.R. could hope to co-operate with the Directorates of Military Training, Selection of Personnel and of Army Psychiatry.

A weapon is an extension of the man, a tool which, handled by one set of men, produces certain effects upon another set of men. The military value of such a tool is determined by its physical and mental effects upon those who use it and upon those against whom it is used. Knowledge was needed as to which of our weapons and which of the enemy's were pleasant and convenient in use and unpleasant to those against whom they were used. Opinion surveys in collaboration with D.R. carried out among front-line troops would indicate which of the enemy's weapons were most feared, and it would then become possible to relate the reputation of this weapon, its fear-evoking properties and its lethal qualities. It would also become possible to examine the question as to whether or not our troops at their battle-schools should become used to the weapons of the enemy.

In the field of training there was much that the biologist could hope to do. By means of time and motion studies he could help to eliminate fatigue and devise standardised training methods. He could concern himself with the indoctrination of the recruit, with psychological conditioning for battle and with morale. Battles can be lost through the operation of biological factors—boredom, discomfort, disillusionment, loss of faith in leadership, lack of nourishment and cumulative physical and mental strain. D.M.R. could devise methods for the collection, collation and interpretation of information of this kind on behalf of D.R. and D.A.P.

Having decided how best to render service, and having changed his title, D.M.R. then built up his organisation. The following establishment was obtained:

Directorate of Biological Research

D.B.R.
P.A. to D.B.R.

Biological Research 1	*B.R.*2.	*B.R.*3.
A.D.B.R.	A.D.B.R.	D.A.D.B.R.
S/Capt.	S/Capt.	S/Capt.
J.C.A.	J.C.A.	Administration.
Serving 'G' interests	Serving 'M' interests	Supervision of field investigations

Secretariat
S/Capt.
Statistician
Clerks
(1 T.C. II, 4 T.C. III)

The appointments to the staff were made from among such as were equipped with knowledge of human and social biology, industrial psychology, general physiology, sociology and statistics. (D.M.R., as historian, had as a staff an assistant sub-editor and a narrator.):

D.B.R's. Research Pool

Lieut. colonels	6
Majors	12
Captains	8
S/sergeants (tradesmen)	4
Sergeants	2
Corporals (clerks)	2
Privates (clerks)	4
	38

When an investigation was about to be launched, by D. of P., D. of H., a consultant, a sub-committee of the M.P.R.C. or by D.B.R. himself, the most competent men available, either within the Army or from civil life, were taken on to the strength of this pool and thereafter administered by D.B.R., the civilians usually being given commissions in the R.A.M.C. When their particular investigation was finished they were returned whence they came—to their own units or back to civil life.

At the beginning of the war the M.R.C. had been instrumental in causing to be created a number of medical research units. The Army Council had been persuaded as to the desirability of having medical observers in the field to act as the peripheral agents of the M.P.R.C. and its sub-committees. War establishments for four medical research units (1 lieut. colonel and 2 majors) had been secured, and of these one had been attached to medical headquarters in the Middle East and another to Home Forces. The members of these sections were nominees of the M.R.C. and, if they were not already in uniform, were given commissions in the R.A.M.C. for the period of their employment. It was agreed that these M.R.C. units should be absorbed into D.B.R's. holding establishment, the research pool. In this way the hindrance of a fixed establishment and a destination label was removed. A D.B.R. research section was flexible in composition and could be sent anywhere where it would be welcomed. Before a research section could be sent out to a theatre of war the permission of G.H.Q. of the force concerned had of course to be obtained. D.M.S. (or D.D.M.S.) was informed of the research organisation that existed (M.R.C., M.P.R.C., D.B.R.), was told the reasons why it was thought desirable to send out a research section and was asked to obtain permission for its despatch and its attachment to G.H.Q. It was pointed out that to almost every

matter which G.H.Q. was called upon to examine there was a medical (=biological) aspect in which D.M.S., as adviser to the G.O.C., must necessarily interest himself and concerning which he must be prepared to proffer advice. It was emphasised that for the discovery of knowledge upon which such advice had to be based it was desirable that the investigators should be such as had been trained in science and were able to devote their whole time and energies to scientific inquiry. It was stated that for the reinforcement of D.M.S. the research section was being provided, to be used by him as his instrument for the securing of knowledge that would enable him to discharge his functions more efficiently. The task of the section was to bring to his notice suggestions concerning matters meriting investigation. It was for him to facilitate the investigational activities of the section. In connexion with the purely scientific aspects of their work the section was to be allowed to maintain close personal contact with D.B.R. Otherwise the only channel of communication with higher authority was by way of D.M.S. Such reports as the section produced were to be reports to D.M.S. It was requested that two copies of all such reports, together with the observations of D.M.S., should be sent by D.M.S. to D.G.A.M.S. One of these copies would then be sent by D.B.R. to the Secretary of the M.P.R.C.

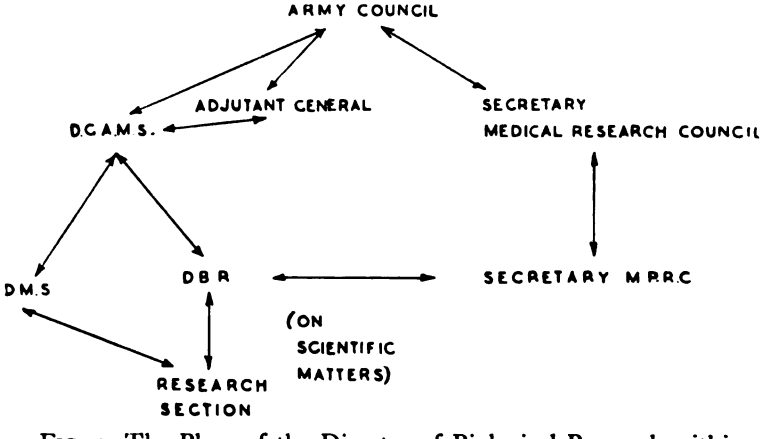


FIG. 2. The Place of the Director of Biological Research within the War Office and in relation to the Medical Research Council.

The following research projects were undertaken in 1942–3: an analysis of preventable wastage during the course of a very large-scale field exercise; an analysis of the quality of Army personnel; a study of the moral effect of weapons; time and motion studies of gun-drills; a study of the secondary effects of bombardment; methods for the collecting and assessment of information coming back from the

battle-fronts; a study of accidents during training and caused by anti-personnel weapons; character studies of German prisoners-of-war; a job analysis study of the medical officer's day; a study of the causes of wastage among air-borne troops during training; a study of the factors involved in night-fighting; a study of symptomless foot defects in a fully trained infantry brigade; penicillin trials in North Africa; investigations into the causes of infective hepatitis; investigations into the nature and causes of shock; investigations into the possible uses of plastics in bone repair.

Certain of these were completed within the year. The analysis of the preventable wastage during the exercise, which was a rehearsal for the North African invasion, showed that there was a very considerable loss during the initial stages from blistered feet among personnel of the administrative services, and particularly among the labour units. Large numbers of men had been launched into this exercise while still under dental treatment, so that men and their dentures had become separated. The standard of man-management was low and sanitary discipline was wretched.

As a result of a survey of the personnel requirements of the Army in terms of physical and mental equipment and of acquired skills, the following recommendations were made to D.G.A.M.S., D.R., D. of O. and D.S.P.: that the Army should cease to be given a sub-normal sample of the total available personnel; that steps should be taken to provide a means of absorbing some 100,000 low-grade men then in the Army, thus relieving units of these and stopping their constant drift from unit to unit; that some form of medical classification by category should be evolved which would tie up more closely with the demands of army jobs; that steps should be taken to refresh the education of men who, though highly intelligent, had come into the Army having forgotten what they had learned at school; that there should be a careful examination of all technical courses of instruction so as to ensure that what a man was called upon to learn had some reasonable bearing upon his job in the field; that in considering the design or changes in the design of weapons, equipment or establishments the implication of the proposal from the point of view of final demand and supply should be considered at the earliest possible stage in the light of the known shortage of high-grade men; that every effort should be made to reduce the misuse of men within units and to impress upon all commanding officers the seriousness of the personnel supply situation and the nature of the shortages; that in order to remove the main incentive to off-loading, commanding officers should be given some official means of disposing of completely useless men. As the result of this investigation, a committee was appointed by the Adjutant-General charged with the task of reviewing the medical category system.

The report on the study of the moral effect of weapons, which was submitted to D.G.A.M.S., D.R., and S.A./A.C., strongly suggested that there was no obvious correlation between the tendency to dislike a particular weapon and the likelihood of being wounded by it, between its moral and lethal effects; that the attitude toward a particular weapon was derived from a mixture of logical and illogical processes; that there was no indication that an irrational dislike of a weapon grew less following repeated exposure to its action and that the troops most certainly did not view enemy weapons in terms of muzzle velocities and fragmentation. As a result of this study D.R., D.S.D. and D. Air urged that it should be expanded to include the reactions of enemy troops to our own weapons.

It will be noted that most of these investigational activities were responses made to requests from 'G' quarters. The development of the directorate was being determined by the source of the demands made upon it. It had become manifest that sooner or later there would need to be discussed this question of policy, should D.B.R. as an integral part of the Army Medical Directorate swing over more and more to the General Staff side or should the General Staff be encouraged to create a biological research mechanism of its own, probably as part of the establishment of S.A./A.C. .

During 1943 this question gained in urgency. The directorate was being increasingly required to undertake investigations that were overtly concerned with matters relating to the human aspects of offensive training and tactics and with the design, development and employment of lethal weapons. The kind of information that was being sought by the General Staff could be supplied only by the physiologist and psychologist. The great majority of these possessed medical qualifications and were therefore within the Army Medical Services. These activities and interests were such as could not be pursued by the doctor in uniform who claimed the shelter of the Geneva Cross. D.B.R. placed the problem before D.G.A.M.S. who sought the opinion of the Adjutant-General. He ruled that these activities could not be retained within the Army Medical Directorate and should be transplanted to a G.S. directorate. In December 1943, therefore, B.R.1., a complete branch of the Directorate of Biological Research, together with thirteen places in the D.B.R. pool (three majors, six captains or lieutenants and four O.Rs.) were transferred to S.A./A.C. S.A./A.C. now assumed responsibility for the provision to General Staff directorates of information dealing with physiological and psychological aspects of warfare 'other than medical', fatigue and battle stress, training, weapon design, moral effect of weapons and tactics. D.B.R. withdrew from the G.S. committees of which he had been a member and the bridge between 'G' and 'M' was broken. The transference of this branch of D.B.R. to

S.A./A.C. did not retard the work that was being done. On the contrary it gave greater impetus to such activities, as the records of the performance of S.A./A.C. and his staff during 1944–5 abundantly show.

These events necessitated a complete review of the place and function of D.B.R. within the Army Medical Directorate. It had become evident that in so far as the Army Medical Directorate was concerned the chief service that D.B.R. had been rendering was in the provision of the research pool, of which very considerable use had been made by the consultants, the Directorates of Hygiene and Pathology and the M.R.C. But the maintenance and administration of this pool could not in themselves be regarded as a sufficient justification for the continuance of the directorate now that this had endured such a serious amputation. There were two possibilities, either the directorate should liquidate itself and hand its pool over to some other directorate within the Army Medical Directorate, or else it had to discover a new field of investigational activity of importance to the Army Medical Directorate and not covered by anyone else therein.

It so happened that at this time an examination of the statistical organisation within the Army Medical Directorate was proceeding and that this was disclosing a complete absence of a machinery for use for research purposes and for the provision of statistical material for the *Official Medical History of the War*. At this time too, large scale therapeutic trials were being undertaken and statistical assistance was sought for the correct interpretation of the results that were being obtained. D.B.R. therefore decided so to reorganise the directorate that it could deal with the analysis of data possessing Army Medical Directorate interest collected by the existing statistical mechanisms of the War Office, of A.M.D.2 (Stats.) and of A.G. (Stats.) in particular.

In November of 1943 a scheme for the reorganisation of D.B.R. on these lines was submitted to D.G.A.M.S., but since at this very time an investigation into the whole organisation of A.M.D. was being made by the War Office Directorate of Establishments it was decided that this reorganisation of D.B.R. should be delayed until this survey had been completed. This decision was unfortunate in so far as D.B.R. itself was concerned, for almost immediately it was announced that no vacant post on War Office staffs could be filled without the special permission of the Secretary of State. D.B.R., having lost a complete branch, was thus unable to fill a number of vacancies that had been deliberately made so that a reorganisation might proceed. However, one of the most eminent biological statisticians in the country was accommodated on the research pool (later to become deputy-director) and the initial steps were taken to build up round him a staff which under his direction would develop and utilise statistical techniques in investigational activities of interest and importance to the Army Medical Directorate and, at the same time,

produce statistics for inclusion in the *Official Medical History of the War*. The interests of the directorate were now strictly medical, and in the main statistical, in kind. It began to provide information relating to operational planning in so far as the medical services were concerned, to the construction of general administrative policies and to the assessment of the value of new therapeutic measures.

The standstill order prevented any further appointment to the staff, and so the directorate, with its pool filled almost entirely with members of teams working under the direction of the M.P.R.C., was unable for the time being to engage in any large-scale planned and organised activity. One matter of great urgency, however, demanded attention. At this time malaria was creating many and varied difficulties. Its problems were being actively studied by clinicians, pathologists and hygienists overseas and a great deal of research of a laboratory kind was being undertaken in the U.S.A., in Australia and elsewhere. It had become clear that our knowledge of the pharmacological action of atebrin was gravely deficient and, moreover, that it was desirable that we should not depend entirely upon others for investigations concerning this and related matters. It was recognised also that this drug was not always and everywhere being used to the best advantage as a suppressor of malaria.

D.B.R., after consultation with the Consulting Physician, D. of P. and D. of H., placed before D.G.A.M.S. a draft programme of research together with a suggestion that special application should be made for a war establishment for a malaria research unit. The full support of the Adjutant-General having been gained, an establishment for this unit was obtained, and by arrangement with the University of Oxford and with the military hospital in that city, laboratory and hospital facilities were made available. At the same time D.B.R. urged that all malaria work being carried out within the medical services of the Armed Forces and in civil research institutions should be co-ordinated, with the result that D.G.A.M.S. asked the secretary of the M.R.C. to set up a Malaria Committee. This was brought into being and the Malaria Unit, together with three D.B.R. research teams working overseas, were placed under the general supervision of this committee, their reports being presented not as papers issued by D.B.R. but as reports of the Malaria Committee of the M.R.C. Accounts of these investigations are therefore to be sought in that volume of the History which deals with medical research.

The creation of this malaria research unit was productive of a great deal of profitable experience. Its headquarters were in a military general hospital, one ward of which was allotted to the unit. Suites of rooms had to be hired in three different university laboratories. The volunteers that were to be used in the course of the investigations were university

undergraduates, who were of course civilians. Arrangements had to be made that such of these as required hospitalisation could be admitted to a military hospital. Arrangements had also to be made for the board and lodging for a number of these undergraduates during the vacation ; and the Army had to be protected against any possible claim for compensation from any undergraduate who developed an illness during the course of, and attributable to, experimental procedures.

The three biological research sections that were unleashed in this malaria investigation were mobilised as independent units. All the fruits of the experience of the previous years had gone into their creation. It had been discovered that it was essential that such a unit should have its own transport. A unit, as now constituted, consisted of medical officers specially selected, of other ranks with appropriate qualifications, and was supplied with a computing machine, a typewriter and motor transport. The sections were formed on No. 18 Coy. R.A.M.C.

During the course of the year the following problems had been investigated: a study of the therapeutic action of penicillin; a study of the nature of traumatic shock; a survey of medical problems of combined operations; a survey of medical problems of airborne troops; a survey of medical problems of ski-troops; a study of medical problems involved in sonic warfare; a study of rehabilitation problems among repatriates; an examination in the field of the usefulness of a new pattern motor-cycle leg guard.

No less than forty-two medical officers had been carried during the year on the research pool of D.B.R. and the majority of these were involved in investigations sponsored by a sub-committee of the M.P.R.C. or else by D. of P. or D. of H. No less than eighteen other ranks were from time to time held upon this D.B.R. pool. D.B.R. had also made all the arrangements whereby a number of volunteers required by the M.P.R.C. in connexion with investigations concerning the effects of high temperatures upon the human subject were provided.

Late in 1943 the A.F.V. sub-committee of the M.P.R.C. sought accurate information concerning the dimensions of the man for whom the tank was to be a carapace. Information concerning this man was not available and so D.B.R. undertook to secure some twenty different measurements of each of some 2,200 R.A.C. personnel. The figures obtained were submitted to the A.F.V. sub-committee.

It is to be noted that during the war the M.R.C., as is evidenced by the activities of its M.P.R.C., interpreted the term 'medical' in its title exceedingly widely and encouraged so many activities not strictly medical that there was hardly a problem in the whole field of social and human biology, and relating not only to the health but also to the military efficiency of troops, which did not come under the survey of one or other of its sub-committees. It is to be noted, moreover, that

the influence of the M.R.C. was very considerable since, being an instrument of government, it could, through the Lord President, recommend action at the highest level and thus ensure that scientific discovery was immediately and sufficiently applied.

The time came when the proposed reorganisation of D.B.R. was permitted to take place. For the second time and for the same reason—a change of function—the directorate altered its name. It now became the Directorate of Medical (Statistical) Research (D.M.S.R.). Its staff was now recruited from among those with statistical knowledge and skill and its tasks were to render statistical help to the directorates and branches of A.M.D., to undertake original statistical investigations having reference to the ultimate production of the *Official Medical History of the War* and to continue to maintain and administer the research pool. The record of its performance during the remaining years of the war is to be encountered in the *Statistical Report on the Health of the Army* 1943–5, published for the War Office by H.M.S.O. in 1948. This report was largely built out of the subject matter of the *Bulletin of Army Health Statistics* which was issued monthly during the last years of the war by the directorate. In this bulletin attempts were made to make available to all concerned such information as could be gleaned from a study of recent and current events.

Looking back it becomes clear that D.G.A.M.S. was exhibiting prevision when in 1942 he caused the post of D.M.R. to be created and assigned to D.M.R. the duties listed at the beginning of this account. At all times experience showed that there was need in the Army Medical Directorate for the presence of a scientist of standing who could bring to the aid of his colleagues a specialist knowledge concerning the techniques of medical and biological research ; and who could act as a link between the Army Medical Directorate and the many and various civilian bodies who were concerned with research of interest to the Army Medical Services. During the war years there was most certainly a place for a scientific adviser to D.G.A.M.S. Experience disclosed that the main professional qualifications demanded in one appointed to this post of D.M.R. should be (*a*) the possession of the Fellowship of the Royal Society; (*b*) the background of an academic position of distinction in one of the medical sciences, preferably not in any one of those represented by a directorate in the Army Medical Directorate and (*c*) an adequate personal knowledge of army organisation and military affairs. Whether or not it was desirable that he should have held a commission and worn a uniform remains an open question. His activities were at times undoubtedly facilitated by uniform and rank, but commonly his influence tended to be diminished outside the Army Medical Directorate since his rank was lower than that of those to whom his opinions had to be expressed. All these things being considered, it now

seems probable that a civilian status would have conferred the greater advantage.

It is equally clear that D.M.R. was correct when in the beginning he formed the opinion that the greatest service he could render would be to provide a statistical mechanism within the Army Medical Directorate and a research pool which could carry on its establishment such as were employed on investigational projects. The proper development of the directorate was deflected for a time for the reason that General Staff directorates had found in it the means whereby they might secure information of value to themselves. Because of the very considerable use they made of it the directorate became involved in activities which were not strictly medical and which could not properly remain associated with the Army Medical Directorate. This deviation, however, was corrected when the non-medical activities of the directorate were transferred, together with a whole branch, to S.A./A.C.

It is of interest to note that while D.M.R. had relinquished all activities which were in conflict with the Geneva Convention, medical officers commissioned in the R.A.M.C. and wearing the insignia of this corps were nevertheless, employed under the auspices of S.A./A.C. or of D.R. India in activities which were regarded as being inappropriate in the case of D.M.R. In retrospect it becomes quite clear that so long as physiologists, psychologists and the like are for the most part such as have pursued a medical education and possess a medical degree, it is necessary to find some place within the Army, other than in the R.A.M.C., in which they can carry on their own scientific activities not as doctors but as scientists and will not claim the protection of the Geneva Cross.

Thus the operational research section that accompanied 21 Army Group to the Continent had an establishment of twelve scientists, including a number with medical degrees, who for this purpose were commissioned and wore the insignia of the R.A.M.C. Between D-day and July 1945, this section had produced some forty reports covering a wide variety of subjects, most of them suggested by the scientists themselves. Among these investigations was one of peculiar interest which was carried out by the medical officers. This was a study of the distribution of hits and penetrations in British and the enemy's tanks, together with an account of the nature and site of the wounds inflicted upon tank personnel. The purpose of this inquiry was to determine how armour should be distributed upon tanks fighting in close country.

An operational research section was with Fourteenth Army in Burma. This also included R.A.M.C. officers, these being held on the staff of the D.R., who in India was a combination of D.R. and of S.A./A.C. These medical officers made a very comprehensive study of man-power wastage due to various causes—battle casualty, sickness,

repatriation, etc.—which was of some considerable magnitude since it involved the tracing of samples of evacuated sick and wounded in order to determine the average time of absence from the unit, together with a study of the reinforcement system, to assess the time spent in transit by reinforcements. It was hoped by these means to derive a numerical index of the amount of fighting done by a division to which the battle casualties and hence the reinforcements could be related. The results of this study were applied to the administrative planning of the assault on Malaya, but since in the event this assault was unopposed the application was limited and the value of the recommendations was not fully tested.

A review of the history of the Directorate of Medical Research shows that though it was easily possible to organise the means whereby problems of importance to the military authorities could be successfully investigated, in the very great majority of instances the solution of the problem did not materially advantage the Army. In many an instance by the time the solution had been gained the problem had lost its importance. In others the application of the knowledge gained was of necessity exceedingly tardy for the reasons that the Army was so large and complex an organisation and that medical recommendations had to be translated into action not by the medical services but by others. Thus a year or more could pass before such knowledge became transformed into routine procedure. In retrospect it is clear that (1) if problems of immediate importance to the Army Medical Services and of a practical nature are to be attacked at all hopefully by the application of science and scientific method there must exist a great reservoir of scientific knowledge of a fundamental kind awaiting application to current circumstances when once these have been defined. In the War of 1939–45 the M.R.C. and its M.P.R.C. provided the means whereby this reservoir could be tapped; (2) the nature, even the existence, of a problem of quite serious importance can remain unrecognised until trained scientists, specially selected and equipped to recognise the problem and its essence, to collect orderly, accurate data and to deduce the correct results therefrom, are sent into the field. The research pool and sections provided such scientists; (3) to a trained scientist a problem which, though unrecognised, is seriously affecting an arm or branch of the Service quite commonly turns out to be one of relative simplicity in its definition although complex in nature. For its solution a mixed team is required compounded out of representatives of a number of scientific disciplines, for example, entomologist, physiologist, psychologist, statistician, together with representatives of those whom the problem most concerns, e.g. tank commander, parachutist, etc., etc., the exact composition of the team being determined by the probable nature of the problem and the general circumstances which obtain. The composition of the M.P.R.C. and the relation of D.M.R. to the M.P.R.C.

made the provision of such mixed teams possible; (4) research of this kind can be carried out hopefully only when the group being served has itself come to appreciate the nature and the importance of the problem, to feel the need for its solution and to be willing to participate actively in its investigation. D.G.A.M.S., through the Adjutant General, was able to secure the co-operation of expeditionary force G.H.Qs. D.G.A.M.S. himself could command the interest of Ds.M.S. D.M.R., in virtue of his position in the War office, was able to enter the group and prepare the way for the research section; (5) the result of any investigation of this kind, no matter how great its potential value, can remain disregarded and unapplied unless and until its significance is thoroughly appreciated and its application encouraged by those at the topmost level of the Army. It is for this reason, among many others, that it is so important that D.G.A.M.S. should have direct access to the Secretary of State for War. In so far as the M.P.R.C. was concerned the relationship of the Secretary of the M.R.C. to the Lord President of the Council enabled the former to present any recommendation emerging from the work of the M.P.R.C. at Cabinet level.

It is not without significance that this war-time directorate was carried, in a modified form, into the post-war Army Medical Services. A consultant statistician was appointed, a statistical section and a research pool added to the establishment of the Directorate of Hygiene. It is reasonable therefore to conclude that the value of the Directorate of Medical Research to the Army Medical Directorate was recognised and that its creation was justified by its performance.

CHAPTER 11

THE ARMY OPHTHALMIC SERVICE*

INTRODUCTION

THE outbreak of war found the Army Medical Services without any organisation capable of dealing effectively with the ophthalmic problems of a national army. During the War of 1914–18 an efficient ophthalmic service had slowly evolved, but this disintegrated and by late 1919 all that remained of it were a few well equipped ophthalmic departments within the main military hospitals and a few specialists. The specially trained sisters and orderlies had disappeared and the provision of spectacles had, in 1920, become the responsibility of the Ministry of Pensions which took over the Army Spectacles Depot that had been created by the British Optical Association and managed by this Association for the War Office from 1916 onwards.

The need for the provision of an ophthalmic service within the Army Medical Services is revealed in the following observations:

1. Of the young adult population of Great Britain about 10 per cent. have sub-standard vision requiring optical correction.
2. In a national army it is to be accepted that 5 per cent. of those serving in the front line formations need spectacles if they are to be and to remain militarily effective. Among L. of C. troops the figure is 10 per cent., while among the A.M.P.C. and the like it is 15 per cent. or more. During the War of 1939–45 these figures remained remarkably constant. It is to be noted that about 0·9 per cent. of the men appearing before the civilian recruiting boards were rejected on account of gross visual defects or ophthalmic disease rendering them unfit for any form of military service.
3. It is to be expected that about 2½ per cent. of the wounded in any engagement in any theatre of war will exhibit injuries affecting the eye.
4. In respect of hospitalisation it is to be expected that some 2 per cent. of the population of military hospitals in the United Kingdom during a war will be suffering from ophthalmic lesions and that the average duration of stay in hospital for such cases will be 26 days.

Since during the inter-war years no serious consideration had been given to these matters and no policy for the creation of an adequate

* The substance of this account was supplied (in 1949) by Lieut. Colonel G. C. Dansey-Browning, then Adviser in Ophthalmology to the Army, on behalf of Sir Stewart Duke-Elder, who was Consulting Ophthalmologist to the Army during the War and responsible for the creation and utilisation of the Ophthalmic Service within the A.M.S. during the years 1940–5.

ophthalmic service, should the need arise, had been fashioned, it is not surprising to learn that there was a certain delay before the variety and magnitude of the ophthalmic problems came to be appreciated, and before steps were taken to provide an organisation which could tackle and solve them.

THE APPOINTMENT OF A CONSULTING OPHTHALMOLOGIST

A Consulting Ophthalmologist to the Army was appointed in June 1940. He at once toured the home commands to find that:

(*a*) the amount of ophthalmic work required by the Army had been grossly under-estimated;

(*b*) the visual standards and categories then in vogue were such as to permit great numbers of men needing spectacles to be enlisted;

(*c*) the establishment for ophthalmologists, opticians, clerks and orderlies was wholly inadequate. Waste and overlapping resulted from frequent postings;

(*d*) much of the work done for the Army by civilian oculists and opticians was unsatisfactory from the military point of view;

(*e*) the distribution of work between civilian and military specialists was unequal and unfair to both;

(*f*) the supply of Mark III spectacles was chaotic as organisation after organisation took on the work and was in its turn swamped by the flood of prescriptions;

(*g*) the consequent delay in providing spectacles to the recruit was disastrous because:

(i) recruits left their depots without receiving their glasses with the result that their recruit training had been gravely impaired. Even when made the spectacles might never reach the soldier during his Army career.

(ii) trained soldiers would be posted overseas without spectacles and could not obtain spectacles in overseas theatres.

The Consulting Ophthalmologist thereupon made recommendations to overcome these disabilities. He urged that:

(*a*) a sufficiency of specialists and graded ophthalmologists should be enlisted to permit the Army to deal with all its own ophthalmic problems. With an adequate staff it would be eventually possible for any soldier to be examined by a specialist within one week of an appointment being requested;

(*b*) the Army should take over completely the provision of its own spectacles and should so organise its own ophthalmic-optical service that the soldier who arrived for sight testing would leave the place of examination with his new spectacles on his face;

(*c*) the ophthalmic examination of the recruit should take priority over all other ophthalmic activities.

These recommendations were accepted and by June 1941 there had been established throughout the United Kingdom some 51 main ophthalmic centres and 138 sub-centres visited regularly from the main centres and 73 ophthalmological specialists and graded specialists were at work. The main ophthalmic centres had military optical centres (commonly described as optical sections or optical depots) as integral portions of themselves. These optical centres had their sergt. opticians working directly under the ophthalmic specialist and their own associated civilian manufacturing firms for supplies of material and the glazing of 'abnormal' prescriptions. The stock was held in optical cabinets so designed that they were easily portable and could be used to establish similar optical centres in any theatre of operations. These centres proved to be an immediate success. Whereas in 1939 only 28,000 pairs of spectacles were required by the Army, in 1940 some 282,000 pairs and in the first half of 1941 over 226,000 pairs were required.

The ophthalmologists and opticians were not borne on the establishment of any particular medical unit. They were held in command pools and so could easily be distributed within the command wherever their services could, at any time, be most useful.

OPHTHALMIC ARRANGEMENTS IN THE UNITED KINGDOM

From 1941 onwards the main emphasis was laid upon the early examination for refraction and the provision of the recruits' spectacles within a week of enlistment. This was carried out by the specialists with their portable equipment visiting primary training centres, ophthalmic sub-centres, etc.; everywhere in fact where there was a body of men in need of their services. Every spectacle-wearing recruit was supplied with two pairs (both of the gas-respirator type, Mark III) unless he was serving with R.A.C., when he was provided with three.

MAIN OPHTHALMIC CENTRES

In addition to medical beds the main centre in each command had surgical beds allotted to it. This centre was fully equipped for all operating techniques and the most skilled or senior (area) ophthalmologist was in charge with trainees under him.

Zachary Merton Convalescent Home. This was established under the aegis of the B.R.C.S. and Order of St. John. It had some 60 beds and a fully trained ophthalmic staff of all grades. Its primary functions were:

(i) to cater for ophthalmic cases who needed prolonged convalescence and special nursing;

(ii) to reduce the pressure upon ophthalmic surgical beds in military hospitals;

(iii) to undertake the diagnosis of obscure cases of ophthalmic disease;

(iv) to undertake the rehabilitation of the visually handicapped. During the war years this convalescent home dealt with 3,000 cases.

St. Dunstan's. With its many branches at home and overseas and its excellent publicity service this institution had a splendid morale-building effect on its patients in addition to its skilful training and rehabilitation of blind and near-blind patients.

It was the custom for the Army to accelerate the process of discharge of such as could profit from treatment in St. Dunstan's, so that their rehabilitation could proceed without undue delay. Altogether some 1,050 men were sent thereto during the war years.

FIELD FORCE OPHTHALMIC UNITS

In 1943 the establishment of a central Army optical store (Nottingham) and the issue of optical units to overseas forces enabled the soldier rapidly to be provided with spectacles wherever in the world he was serving. About the same time an Army spectacles depot (A.S.D.) was established in the Middle East to canalise all the demands from that command. Initially working on very limited supplies this A.S.D. eventually acted as an *entrepreneur* for the Nottingham store in the M.E. in the later years of the war.

THE MOBILE OPHTHALMIC UNIT (M.O.U.)

This unit was created in North Africa in 1941 upon a 1914–18 model and developed from one of the specialist surgical units of Eighth Army. An ophthalmologist, optician, theatre orderlies and drivers formed the personnel of a unit capable of undertaking any major ophthalmic operative procedure. However, its main military rôle lay in the treatment and retention in the forward area of cases of refractive errors and minor ophthalmic lesions. It carried an adequate supply of optical material to deal with local spectacle needs. Drugs and dressings and instruments were obtained through the usual medical channels of supply, while its optical supplies were replenished from the nearest advanced depot of medical stores, which in its turn drew from the base depot of medical stores to which bulk supplies were sent from Nottingham. In certain instances a M.O.U. had been given an ophthalmically trained nursing sister and a trainee ophthalmologist to act as anaesthetist-refractionist.

In the later stages of the war there was one M.O.U. per corps. They were usually brigaded at C.C.Ss. together with the advanced sections of neuro-surgical and maxillo-facial units. To these in combination came the 12–17 per cent. of wounded who had been injured in the head and neck region.

The functions of the M.O.U. were:

(*a*) to treat and return to their units men suffering from minor trauma to the eye or minor incidental disease;
(*b*) to operate upon and send down the line of evacuation major traumatic cases such as perforations and prolapses of the orbital contents;
(*c*) to clean up, start antibiotic treatment and to send down the line of evacuation the major traumatic cases when no immediate operative procedure was necessary;
(*d*) to provide spectacles to the troops in the forward area.

THE BASE OPHTHALMIC WING (B.O.W.)

Certain general hospitals in a field force included ophthalmic departments. Some of these were given special wards and nursing facilities for 30–50 ophthalmic beds with trained personnel attached. The number and size of these B.O.Ws. varied according to the size of the force and the theatre of operations. They acted as the main operating centres for the force for serious and long-term ophthalmic cases. They were excellently equipped and worked under the direct eye of the Adviser in Ophthalmology to the force. They returned to duty about 79 per cent. of the ophthalmic wounded cases.

Except in Burma, where there were no M.O.Us. in forward areas and where the main ophthalmic centres had to be sited well back along the L. of C. so that their work was limited, these M.O.Us. and B.O.Ws. were responsible for removing some 65 per cent. of the intra-ocular foreign bodies that enemy action had caused.

The eventual efficiency achieved by the ophthalmic service of the R.A.M.C. can be judged from the following figures: The Ministry of Pensions in 1949 was paying only 221 'Total Blindness' pensions to Army personnel and a modified pension to 357 men who had sustained some degree of loss of vision in both eyes due to wounds or trauma. Whereas in the War of 1914–18 at one period 67 per cent. of wounds to the eyes necessitated enucleation, this figure fell to 37 per cent. in the War of 1939–45.

The M.O.U. was developed to provide the immediate ophthalmic surgical treatment to the wounded man in the forward area at the level of the C.C.S. or 200-bedded hospital on the medical line of evacuation. Behind these units the ophthalmic departments of certain base general hospitals were increased in size to become B.O.Ws. Here it was possible to retain the wounded man for nursing and treatment until such time as he might be returned to duty or else evacuated to the United Kingdom as being unfit for further service in that theatre of war. On arrival in the United Kingdom the convoys of wounded men were screened at the port of disembarkation. Men who had been blinded or else were 'near

blinded' were sent direct to St. Dunstan's. The others were despatched to the E.M.S. or military hospitals nearest their own homes. Once the landings in Normandy began, with only a short cross-channel evacuation, the large civil eye hospitals and the military ophthalmic centres in each command received the wounded men practically directly from the forward medical units on the battlefield.

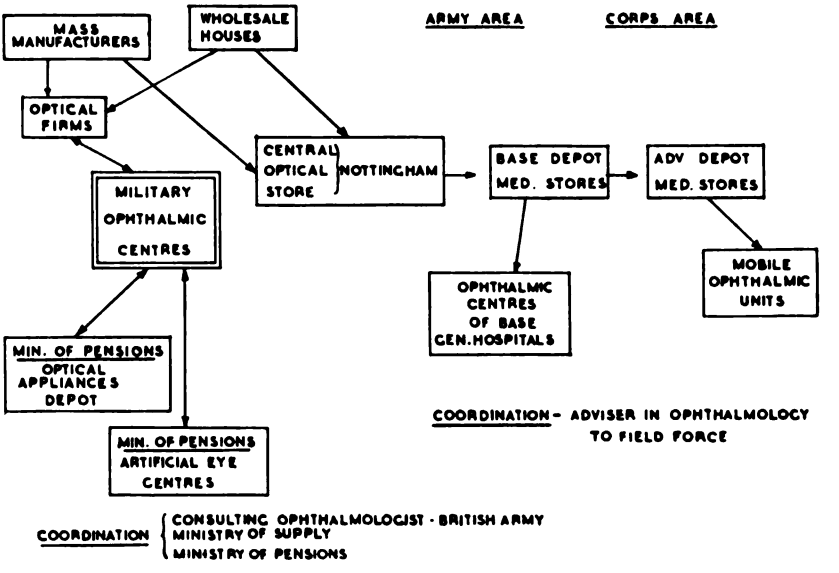


FIG. 3. System of Optical Supply

Evacuation between the various units depended upon local conditions in the different theatres of war. The wounded man had his first field dressing applied at the R.A.P. and in three to twelve hours would have been received by ambulance car at the M.O.U. There had been no further interference with his dressings *en route*. At the M.O.U. (located either at the C.C.S. or 200-bedded hospital) he was treated by an ophthalmic specialist and then evacuated by road, rail or air direct to the B.O.W. of the general hospitals at the base. This might involve a few days' travelling or only a few hours before a specialist examined him again, depending on local conditions. Thereafter, the cases deemed unfit for further service in that theatre of war would be evacuated to the United Kingdom by sea or air to a port of disembarkation or airfield and then travel by rail to their final destination.

OPHTHALMIC MORBIDITY

During the war of 1939–45 the relative ophthalmic morbidity rate for the soldier in military and E.M.S. Hospitals in the United Kingdom

was 1 per cent. of the whole. This rate overseas varied according to the country of origin of the troops concerned. Thus for Indian troops the relative morbidity rate might reach the astonishing figure of 5·6 per cent.; for British, Dominion and African personnel it could be 1·7 or 1·8 per cent.

Among returned prisoners-of-war from the Far East at the end of the War of 1939–45 some 11 per cent. displayed the stigma of nutritional amblyopia.

Comprising only a relatively small proportion of the overall morbidity rate in a theatre of war, the numbers of men suffering from ophthalmic lesions could easily be catered for in the B.O.Ws. of the general hospitals. In the field the M.O.Us. (especially if sited near a transit camp) were able to treat and prevent the evacuation of ambulant cases with only minor ophthalmic lesions.

At the base hospitals the average duration of stay in hospital of eye cases (about a month) provided some slight administrative problems because these men occupied much needed beds. The use of convalescent depots and transit camps for cases requiring only ambulant therapy relieved this pressure. In the United Kingdom an excellent example was the provision of the B.R.C.S. Zachary Merton Convalescent Home.

Not all eye diseases can be cured without some final deterioration of the patient's visual state; in certain cases this falls well below the Army's criteria of vision suitable for further service. The discharge rate in the United Kingdom for all types of ophthalmic lesion at one time was as high as 2·2 per cent. of total discharges. This fell in 1944 to 1·55 per cent. and never again was exceeded. In the Middle East, with its ever-potential source of trouble in the ophthalmias, the relative ophthalmic morbidity was fortunately only to rise to 1·86 per cent. among British, Dominion and African troops (even though acute conjunctivitis or keratitis were common lesions). It appears therefore that the ophthalmic cover was adequate and the methods of prevention of spread of infection satisfactory.

OPHTHALMIC PROBLEMS AMONG PRISONERS-OF-WAR REPATRIATED FROM THE FAR EAST

Fortunately this problem did not prove as great as was at one time expected. Once the general health of the repatriated men had been restored, irreparable damage to the sight was found in only about 50 men. These went to St. Dunstan's.

THE OPTICAL INDUSTRY

The Army Medical Services depended upon the optical industry for the supply of instruments, spectacle frames and lenses. It is necessary

therefore to consider the state of this industry in the inter-war years and to record the contribution it made to the Army's well-being during 1939–45.

The optical industry has two main types of production:

1. Optical lenses, spectacle frames, cases and all the various sundries that go to make up the finished pair of spectacles;
2. Optical instruments, ophthalmic instruments, production of the necessary equipment, machine tools and plant for the above.

The greater part of the industry is engaged in the first type of production, but the second type forms an integral portion of the whole. The retail side of the industry consists of the sight-testing and dispensing opticians who receive their supplies either from the wholesale houses or else the mass manufacturers. As is to be expected, there is no hard and fast distinction to be drawn between the retailers, the wholesalers and the mass manufacturers.

In 1895 the British Optical Association was founded to look after the interests of the retail trade, while in 1917 the Association of Wholesale and Manufacturing Opticians evolved to cover the other aspects of the optical industry.

Although strictly engaged on the retail side, the British Optical Association organised the Army Spectacles Depot and ran it for the War Office from 1916–19, supplying over a million pairs of spectacles, two million goggles, two thousand trial cases and much ophthalmic equipment. As has been related, however, in 1920 the Ministry of Pensions took over this depot.

Between 1920 and 1939 the optical industry radically changed its structure. Whereas in the early part of the inter-war period it was wholly dependent upon imports from America, France and, later, Germany, by 1939 it had become almost self-supporting from home production. The stress and strains of war were soon to prove a true test of every branch of the industry. Under the protection of the Key Industry Duties of 1931 the home production of lenses by 1939 became adequate, although this meant that the output contained a very high proportion of the obsolescent flat lenses. Both metal and plastic frames were still imported to a fair degree but most spectacle cases were home produced, as were ophthalmic instruments. But all machine tools were imported from Germany, America or Austria, as were artificial glass eyes. During 1939 and 1940 there was no acute shortage of optical goods and as yet no big government demands. During the winter of 1940–1 the government demands became appreciably greater, but the accumulation of reserve stocks was in part able to deal with these, and only in the spring of 1941 did the difficulties of man-power, blitzed factories, etc., attack the very roots of the industry. The full reckoning came in 1941–2.

Ten optical firms with an estimated capacity of five million pairs of lenses were destroyed by enemy action; all imports ceased; man-power dwindled and the output fell precipitately behind demand. Strenuous efforts on all sides resulted in peak production of all types being achieved by the end of 1944, but still the accumulated demands exceeded output, and it was not until 1946 that the industry got out of its difficulties.

Lens production reached unprecedented peaks in 1944 and again in 1946. Metal frames were manufactured in such numbers as to reach a peak in November 1944, when during the four weeks period 208,000 frames were made, 49 per cent. of these being against Government demand. Spectacle cases were in adequate supply although the metal-bodied type had practically disappeared from use. Instruments, by skilful improvisation and departure from orthodox methods of production, became sufficient by 1943, but the quality of some was none too good.

The source of machine tools for the industry dried up, and, although later some relaxation of restrictions on essential importations was permitted and home production was considerably accelerated, there were still many gaps left to be filled. At the outset of the war the imported stocks of glass eyes were rapidly exhausted, but fortunately later, after successful experimentation with plastic, the production of acrylic prostheses began and soon developed into a well established, if minor, branch of the industry.

The following abstracts from narratives written with official sanction by officials of the three supply organisations give an adequate description of the chaos in the provision of spectacles in the first three years of the war: 'Ministry of Pensions. Optical Appliances Depot. (Director of Supplies and Contracts narrative 1949)'.

> 'Our records reveal nothing of note during the period April 1922–March 1937, due no doubt to the fact that only about 15 pairs of spectacles a week were supplied. . . . In 1934 the depot was moved from Clifford's Inn to Bromyards Avenue where the whole spectacles unit was now housed. . . . There is nothing important to report at this stage, nor until February 1940 when the work of the unit started rapidly to increase, necessitating the installation of additional machinery. . . . In April 1940 there was a serious shortage of Mark III frames throughout the country, and, in order to overcome this difficulty, it was necessary to seek the co-operation of the British Metal Spectacle Manufacturers. . . . Orders for frames were outstanding to the extent of 60,000 at this period. Stock was built up, however, by July 1940. . . . By September 1940 prescriptions were again well behindhand and we were compelled to transfer 15,000 to the Joint War Emergency Committee (B.O.A.). In November 1940 the depot was transferred to Blackpool and in January 1941, due to the unsatisfactory work of the National Optical Trade, it

was decided to have all optical repair works done by the depot. In February 1941 the War Office notified the opening of its optical centres—the orders then being received by the depot were at a rate of 2,100 per week and the depot being 13,000 pairs of spectacles in arrears.'

'Joint War Emergency Committee (British Optical Association). Secretary's narrative. 1949'.

'In 1940–1 this Committee distributed thousands of Army prescriptions for Mark III spectacles to the 7,000 opticians on the list of the Ophthalmic Benefit Committee . . . later in 1941, when the organisations of Civil Defence and the Home Guard came into being, the War Office and the Ministry of Home Security asked for the help of the Committee in supplying Mark III spectacles to personnel of these services. . . . The demand was such as to restrict the issue of certain types of lenses, but even so over two million of these spectacles were supplied and fitted by the opticians'.

'Association of Wholesale and Manufacturing Opticians. (A.W.M.O. Report. 1943)'.

'The Association set up in autumn 1938 an Optical Defence Committee, so as to impress all concerned with the need for steps to be taken to maintain essential supplies, and to urge that in matters relating to the production and supply of optical goods there should be direct contact between the respective Government Departments and the trade association representing the actual producers. . . . A joint committee with the Ministry of Health was asked for and refused'.

The industry was left to itself to pursue such matters as the development of home supplies of white spectacle glass which at that time was wholly imported. In this they were successful. In the report the committee bitterly complains of the methods by which the various Service departments approached different members of the retail portion of the trade over the supply of Mark III spectacles and of the fact that no frame mass manufacturer was invited to help. In June 1940 "although without clear official guidance or estimates to work from", the Association claims to have eliminated the spectacle frame bottleneck, only to be forced to direct some considerable portion of their lens production into the manufacture of optical elements for instruments for the Services.

'In August 1940 the War Office asked for representatives to attend conferences . . . to speed up supplies of Mark III spectacles to the Army. . . . The agreed scheme resulted in the formation of the Army optical sections (48) at the various ophthalmic centres throughout the country (April 1941). . . . Then (the A.W.M.O.) organised the accumulation of depot stocks. Enemy action at the end of April 1941 destroyed substantial accumulated stocks in London'. The A.W.M.O. took over the responsibility for seeing that 'every optical wholesale or prescription house with adequate mechanical equipment did its share of the contract work necessary in equipping and servicing the Army optical centres'.

The Ministry of Supply in February 1942 became the industry's parent department, with a working liaison on production problems. The Army's optical centres had by now been equipped with stock units and the industry had organised its prescription manufacturers to give a prompt and adequate service.

In the autumn of 1942 the War Office warned the A.W.M.O. of their future increased demands. Arrangements were made by the industry to import from the U.S.A. such quantities of lenses as were available at the time to augment home production. The direct result of all this was the availability in early 1943 of large stocks of material for the overseas theatres and a central optical store (Nottingham) was established to feed overseas requirements, being serviced most satisfactorily from the industry.

CHAPTER 12

THE ARMY RADIOLOGICAL SERVICE*

THE INTER-WAR YEARS

In 1926, D.G.A.M.S. caused to be formed an Advisory Committee of Reference in Army Radiological and Electro-therapeutic Work. This consisted of the Consulting Surgeon to the Army as chairman, one Army radiologist, two civilian radiologists, two civilian physicists and an A.D.G. of A.M.D.3 as secretary. Its terms of reference were 'to advise on all matters relating to Army radiological work with due regard to economy'. To this committee a representative of the Royal Air Force was added in 1927 and in 1934 a representative of the Royal Navy, and the name of the committee was changed to become the Inter-Services X-ray Advisory Committee, its terms of reference being 'to advise on all matters relating to the efficiency of Army radiological work with due regard to economy and on such matters affecting radiology in the Royal Navy and Royal Air Force as may be referred to it by representatives of these Services'. During the next five years this committee was active in advising on the design and equipment of X-ray departments of military hospitals at home and abroad and in the field, on safety and protection measures and on the training of Army radiologists and radiographers.

In 1939 this committee, having completed its major advisory tasks, sought the opinion of D.G.A.M.S. concerning the necessity of its continuance. It was decided that the committee should be dissolved and that in its place, when mobilisation occurred, one of its members should be appointed adviser in radiology (A.I.R.). The member selected was a retired R.A.M.C. officer who during his service had specialised in radiology at home and abroad and who since his retirement had devoted himself to this branch of medicine.

He at once took steps to satisfy himself that, should war break out, the manufacturers of Army radiological equipment could supply the immediate demands of an expeditionary force and thereafter meet those of an ever-enlarging national Army. Though at the time of mobilisation the appointment of A.I.R. had not been ratified by the War Establishments Committee of the War Office, as an interim measure the A.I.R. (designate) was posted to A.M.D.3, there to become entrusted with all arrangements for supply of equipment and, through A.M.D.1., for the recruitment, training and posting of radiologists and radiographers. It

* This account was provided by Brigadier D. B. McGrigor, R.A.M.C., O.B.E., M.B., D.M.R.E., F.A.C.R., F.S.R., who, during the war years, served first as Adviser in Radiology and then as Consulting Radiologist to the Army.

was agreed by the Consulting Surgeon to the Army and A.I.R. (designate) that the requirements of an expeditionary force in respect of X-ray equipment were as follows:

(*a*) Field apparatus . . .	1. Portable apparatus. 2. Transportable apparatus 3. Power supply 4. Accessories
(*b*) Fixed installations . .	1. Base hospital sets 2. Portable apparatus 3. Power supply 4. Accessories

The Advisory Committee had already approved (under limitations) British-made field apparatus consisting of:

(1) a 77 k.v., 15 ma. mobile portable plant with suitable localiser to be carried on a 3 ton lorry (X-ray laboratory), the rear portion of which was equipped for use as a dark room when the lorry was stationary. One of these was allotted to each C.C.S.

(2) a 90 k.v., 30 ma. transportable trolley set for use with all general hospitals. These sets would also be attached to such C.C.Ss. as were static.

(3) a 4 kw. standard Army 110 v. d-c. generator with rotary converter for the supply of power, to be installed in the fore compartment of each 3 ton lorry and to be available for general hospitals (without the lorry).

The first and third of these items were in stock and the second was ordered immediately on the outbreak of war. The general hospitals and C.C.Ss. attached to the first contingent of the B.E.F. were therefore complete in respect of this equipment. Accessory apparatus and film were held in the Army Medical Store and were issued to the general hospitals and C.C.Ss. of the first contingent in accordance with the supply schedule. It was understood that such general hospitals as could obtain their electrical power from the French electricity system would do so. It will be noted that the d-c. generator had to be used because modern and suitable a-c. units were not available. It had been found impossible to get sufficient financial allotment for the purchase and storage of a-c. 230 v. generators.

MOBILISATION

At this time there was no separate organisation within the Army Medical Services for the enlargement, integration and administration of its radiological service. Radiology had been included among the responsibilities of the Consulting Surgeon to the Army. On mobilisation the Consulting Surgeon to B.E.F. consulted A.I.R. (designate)

concerning the provision of a radiological service for the B.E.F. To this conference there were also invited the radiologists on the staffs of 1 B.G.H. and 1 C.C.S. and a representative of C.R.E. at 1 M.B.S.A. It was agreed that all general hospitals and C.C.Ss. would take overseas a field service 'Rapidex' set and a 120 v. d-c. petrol-electric generator with a rotary converter so that output could be altered to a-c. at a potential of 65 to 70 volts. There were no a-c. generators available in the Army at that time. Each C.C.S. would have an X-ray lorry with its body fitted out as a developing room and a generator and rotary converter installed in a separate compartment, the X-ray set and its accessories in their special packing-cases being housed in the developing room while the unit was on the move. General hospitals would not be issued with lorries as it was intended that they should be so situated that main supply and accommodation would be available for the X-ray department. They were, however, to have a generator and rotary converter for use in emergency or as a temporary measure until the main supply became available. In addition each general hospital, as it mobilised, would be supplied with a 90/30 trolley set. These sets were already available in sufficient numbers for the medical units of the first contingent, while the special type of mobile X-ray couch, designed by A.I.R. (designate), was hurriedly being manufactured for immediate issue. Since the 90/30 trolley sets were designed to operate at 230 volts, and since it was understood that the main supply in northern France was of the order of 120 volts, the A.I.R. (designate) undertook to arrange that all apparatus should be adapted for operation at both voltages. It was agreed between the Consulting Surgeon B.E.F. and A.I.R. (designate) that the radiologist of 1 B.G.H. should act in an advisory capacity in B.E.F. It was arranged also that this radiologist should maintain a demi-official direct correspondence with A.I.R. at the War Office on urgent radiological matters. This turned out to be a most fortunate arrangement since all documents and office files relating to radiology in the B.E.F. were destroyed, so that what information concerning the radiological service in the B.E.F. exists is derived solely from this demi-official correspondence.

Radiologists and radiographers were posted by A.M.D.1. on the advice of A.I.R. to all general hospitals and C.C.Ss. In the beginning most of these postings were of regular R.A.M.C. personnel. The rest were from the Territorial Army and from among such officers possessing the appropriate qualifications as had offered their services on the declaration of war.

Although the medical units of the first contingent were complete in respect of equipment when they moved from the United Kingdom, certain of them encountered very considerable difficulty in finding their equipment when they landed in France owing to the fact that personnel and equipment travelled in different ships and often by different routes.

From the very beginning of the war, A.I.R. (designate), War Office, established a close liaison with his *vis-à-vis* in the E.M.S. Discussion between them concerned itself with the problem of the avoidance of conflict between the E.M.S. and the Army Medical Services in respect of the supply of equipment. When he became Consulting Radiologist he called conferences periodically at which the radiological problems of the Army and of the E.M.S. were freely discussed. To these conferences were invited:

(*a*) the Consulting Radiologist to the E.M.S. in order to correlate supply and demand of civil personnel and of priorities of apparatus;
(*b*) the Hon. Consultant in Radiology to the Army at Home;
(*c*) technical experts in physics, apparatus construction and repair;
(*d*) other officers (as available) who had up-to-date experience of the various X-ray departments of hospitals in operational areas;
(*e*) the officer commanding the Army X-ray School;
(*f*) from 1943, the Consulting Röntgenologist to the U.S. Army Medical Services.

THE EFFECT OF THE 1940 REORGANISATION OF FIELD MEDICAL UNITS UPON THE ARMY RADIOLOGICAL SERVICE

The Hartgill Committee's recommendations included the following:

(i) Specialist radiologists to be deleted from the establishments of C.C.Ss.
(ii) Mobile radiological units to be made available for advanced surgical centres, head-surgery units and the like.
(iii) General hospitals, including the 200-bedded, to retain their radiological specialists.

Thus it came about that the C.C.S. X-ray laboratory became transformed into the mobile X-ray unit, remaining attached to the C.C.S. but being available for temporary attachment to the advanced surgical centre or like unit. The Consulting Radiologist advised that one spare mobile X-ray unit should be attached to each C.C.S. and that others should be concentrated at the base. From 1940 onwards the mobile X-ray units were equipped with MX-2 (80/15) apparatus and 5 k.v.a., 230 v. a-c. generators and general hospitals in due course with MX-3 (90/50) and 5 k.v.a. a-c. generators.

As a result of these conferences the organisation of the radiological service gradually took shape. Fig 4 indicates its functions, advisory and executive.

THE RECRUITMENT AND TRAINING OF RADIOLOGISTS

Those who held special qualifications in radiology and who were serving in the Regular Army at the outbreak of war were very few in number. Nor were they all immediately available for service with an

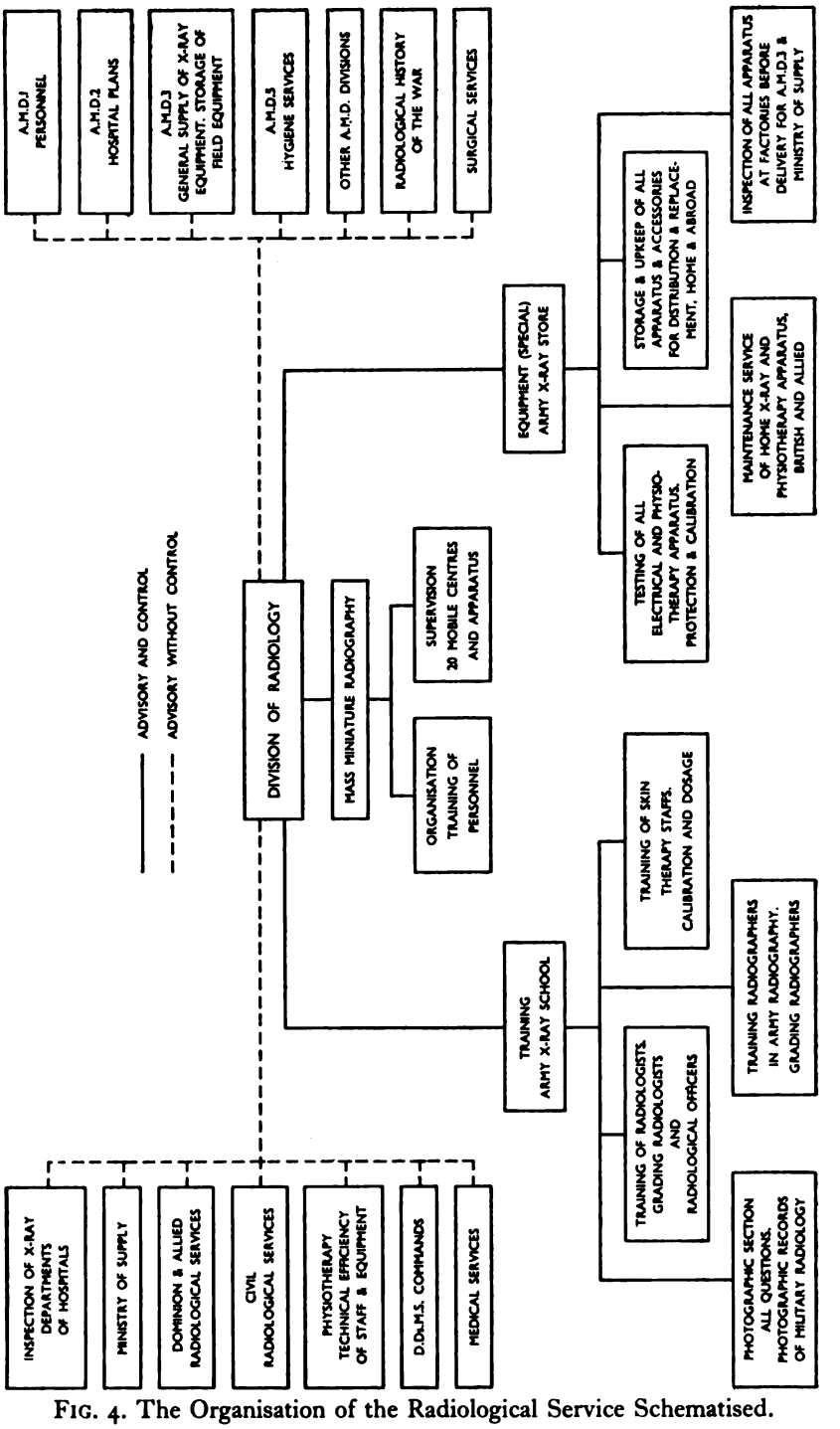


FIG. 4. The Organisation of the Radiological Service Schematised.

expeditionary force, since some of them were serving abroad while others were at once transferred to senior administrative posts. Other sources of supply were the R.A.R.O., the S.R. and the T.A. These provided but few. The names of those civilian radiologists who applied to join the R.A.M.C. were passed to the War Office by the Central Medical Emergency Committee together with a recommendation as to their suitability for employment and a suggestion as to the rank in which they might be employed—either in the rank of major with the status of specialist and in receipt of specialist allowance or as graded radiologists in their joining rank and with specialist allowance. This source of supply failed to provide anything like the number required. There were several reasons for this. One was that the E.M.S. was expanding rapidly and demanding its quota of radiologists; another was that the university diploma courses were greatly disrupted by the depletion of the teaching staffs.

It became necessary therefore for the R.A.M.C. to create its own radiologists out of its own material. Between September 1939 and June 1940 the A.I.R., soon to become the Consulting Radiologist at the War Office, conducted a series of short courses and demonstrations for the instruction of such radiologists as were then serving and could be spared from their units.. In June 1940, the Army X-ray School organised at the R.A.M. College obtained a considerably increased establishment and was headed by the officer who had been Adviser in Radiology to the B.E.F.

Home War Establishment—Army X-ray School

Personnel

R.A.M.C.	
Officer commanding (lieut. colonel) (specialist in radiology)	1
Major, captain or lieutenant (for mass radiography) (specialist or graded specialist in radiography)	1
Instructors (radiographers):	
Warrant officer, class I	1
Staff sergeant	1
Sergeants	5
Instructors (radiographers) (for mass radiography):	
Sergeant	1
Corporal	1
Total R.A.M.C.	11
A.T.S.	
Corporal	1
Private	1
Total, Army X-ray School	13

Note: All personnel of this establishment may be of low medical category.

COURSES OF INSTRUCTION

The school offered two main courses, one short, the other long. A short one, lasting for about a week, was intended for such as had been

radiologists in civilian life and who had entered the R.A.M.C. having been recommended for employment as specialists or graded radiologists.

Syllabus of Short Course

(*a*) Lectures and talks on the military aspects of radiology and the administration of an Army X-ray Department in the field by the Consulting Radiologist to the Army and by the O.C. Army X-ray School.

(*b*) Practical demonstrations in the use of A.M.D. X-ray equipment by the staff.

(*c*) Practical demonstrations on the care of apparatus by the X-ray Service Officer attached to the Army X-ray School.

This short course consisted essentially of instruction related to the differences between radiology in civilian life and in the field, the main difference being one of mobility. These radiologists were instructed also in military organisation so that when joining their units they would be able to adjust themselves to a system which was quite new to them.

The long course was a much more ambitious undertaking. G.D.Os. were selected after personal interview with the Consulting Radiologist and the Officer i/c Army X-ray School. The general requirements demanded of candidates before acceptance for training were (1) that they had been qualified for from two to four years; (2) that they had held resident appointments in medicine or surgery; (3) that they were physically fit for service anywhere; (4) that they were sincerely desirous of taking up radiology as a career. Preference was given to those who held higher medical qualifications since this might be of importance later when their promotion was being considered. The course was one of five months. It was necessarily intensive. Instruction was offered each day between 0900 and 1800 hours and the classes were deliberately kept small so that individual tuition could be offered. The first month was devoted to lectures, demonstrations and practical work in physics, anatomy, photography and radiography and the instruction was entirely technical and practical, including the setting up and dismantling of all types of equipment used in the Army. Experience showed that instruction in anatomy was quite necessary, for as a result of the early examinations it became manifest that the candidates' memories of this subject were exceedingly vague. At the end of this first month's instruction a written examination consisting of four three-hour papers was held. Any candidate who failed to obtain the necessary standard was returned to general duty. The second month's study was devoted to normal radiography, and during this time each candidate personally completed the whole series of techniques, making the exposures, positioning patients and developing the films. It was decided as a result of experience that it was essential for the military radiologist to know his radiography, since in a variety of circumstances on active service the radiologist can

find himself denuded of radiographers. The third to the fifth months were spent in military hospitals where the instruction of the candidates was continued under the personal supervision of senior radiologists. A period of six weeks was spent at each of two of the selected hospitals so that the trainees came under the influence of more than one teacher. During these periods they carried out under supervision most of the major radiological examinations. At the end of this course the candidates returned to the Army X-ray School at Millbank where they were examined by two civilian radiologists together with the Consulting Radiologist to the Army. No-one who had figured in the instruction of the candidates took part in their examination. The results were excellent, only one in five of the candidates failing to pass. The standard of the examination was that of the diploma.

As the courses succeeded each other the syllabus was reviewed and from the instruction and the examination were dropped all considerations of those radiological processes which were rare in Army hospitals, and increasing attention was paid to the radiological aspects of traumatic injuries. Those who passed the examination were posted to military hospitals as radiological officers without any promotion in rank or specialist pay. As soon as their commanding officers recommended them as being suitable for being placed in charge of the X-ray Department, they were at once raised to graded radiologists and received specialist pay. Quite a number of these general duty officers were later accepted as full specialists and were given the rank of major. Twelve of these courses were held during the war and 37 candidates passed the examinations.

In addition to these two main courses there was a large number of other courses, varying in length from a few days to a month, dealing with special aspects of the subject such as superficial therapy, mass radiography, dental radiography, clinical photography and mass statistics of blood examinations during X-ray service. The quality of the courses of instruction and the degree of skill attained by those who passed through them was such that the Examining Board in England allowed these candidates of the Army X-ray School to sit for the D.M.R.(D) without further training if they had had two years' radiological experience in the Army.

In 1944–5 the Consulting Radiologist made arrangements with the Senior Consulting Radiologist, E.T.O.U.S.A., whereby U.S. Army radiologists on their way to E.T.O. or on leave from E.T.O. could take refresher courses at the Army X-ray School. Eighty-five officers attended altogether until the deployment of the U.S.M.C. was completed.

POSTINGS

Radiologists were posted to medical units according to war establishments, but because of the continuing shortage of these specialists it

remained necessary for the Consulting Radiologist carefully to consider such matters as the size of the hospital, the class of its intake, its proximity to other hospitals, in endeavours to obviate all unnecessary postings. Only to those units the work of which demanded the presence of a whole-time radiological specialist were such posted by A.M.D.1. on the recommendation of the Consulting Radiologist.

THE RECRUITMENT AND TRAINING OF RADIOGRAPHERS

In September 1939 the available supply of radiographers was relatively in the same position as that of radiologists and the following were the sources from which they might be drawn:

(1) those already serving in the Regular Army;
(2) the R.A.R.;
(3) the T.A. Reserve;
(4) civil radiographers, male and female, who joined the Forces early.

The first three classes failed to produce the required number, mainly because promotion to higher appointments and rank in the mobilising Army claimed them early. Large numbers therefore had to be obtained in the following manner:

(*a*) Men enlisting who held the certificate of the Society of Radiographers were graded as radiographers class 1 and were given subcharge of X-ray departments in C.C.Ss. or general hospitals with the rank of corporal or sergeant as soon as they showed fitness for N.C. rank.

(*b*) Female civilian radiographers were engaged by Os.C. for service in military hospitals at home under the terms of a W.O. letter dated April 29, 1940. These might or might not be placed in charge of a department as this appointment was made by each O.C. hospital on the advice of his radiologist. A difficult situation frequently arose over this as to whether a female radiographer holding the M.S.R. should be considered senior in the X-ray department. The decision was dependent on the local circumstances as it was obviously unfair to withhold rank of sergeant and charge from a suitable N.C.O. or man merely because a female M.S.R. also worked there, to whom charge meant no extra emoluments. Each case was decided on its merits in the respective hospitals and, on the whole, this was a satisfactory solution.

The Society of Radiographers at all times provided the most helpful collaboration, both in tapping sources of supply of trained radiographers and in their correlation of the Army X-ray School syllabus of training with the Society's curriculum. Later the Army X-ray School expanded to train radiographers in large numbers.

The organised expansion of the Army X-ray School took place rapidly from July 1940. Trainees were supplied through the Training

Officer R.A.M.C. from intakes at the depot and through officers commanding companies who selected applicants of educational standard and ability for this subject. Many varied types proved suitable—artists, photographers, wireless experts and musicians—and it is noteworthy that trainees entirely new to radiography nearly always came out at the top of the examination lists.

The results of the radiographic course examinations were more than encouraging because those not likely to make the grade were returned to duty at the mid-course examinations. From hospital reports in all theatres it was noted that radiographic staffs were invariably good and interested in their work.

As the courses progressed, the members thereof were selected by the W.O.S.B. which chose a number under the age of 21, the youngest being 19. The general standard was up to normal but did not indicate that the younger men were any better than those over 21. The matter was discussed with the personnel selection board in view of the fact that in civil life the Society of Radiographers did not accept these young students for this subject. As a result it was decided to fix 20 as the minimum age for trainees.

POSTINGS

The Army X-ray School had records of the training and experience of all radiographers in the Army. These records were kept up to date from time to time by reports from radiologists and commanding officers concerned and the officers i/c Records gave the fullest possible co-operation in consulting the Officer i/c Army X-ray School with regard to postings.

All postings, most of which involved promotion, depended upon establishment, but an unofficial system was evolved, which kept the scheme together, whereby Records from time to time informed the Army X-ray School as to what radiographers were in this country and the Army X-ray School kept Records posted with regard to their qualifications and experience. It was not really a function of the Army X-ray School to take over the posting of radiographers.

Much difficulty was encountered in the matter of promotion in the radiological service. The scope for promotion in individual hospitals was small, depending on the promotion or transfer or invaliding of the senior radiographer in each. The rate of these changes, and the chances, varied in different theatres so that some juniors stepped up quickly and some, in other theatres, did not. It was quite out of the question to try to promote on a wider basis than individual theatres. Again, at home, sometimes quite junior trainees stepped up in new mobilising hospitals because there were no others available and this was unfair to men abroad who were stagnating, especially in the Middle East. It was much

regretted that no satisfactory scheme could be devised which would have overcome these difficulties and have prevented the serious discontent that emerged therefrom.

COURSES OF INSTRUCTION

The pre-war X-ray School carried on the training of small numbers up to June 1940. From that time it was decided that it was necessary to train in large numbers, up to fifty men per class. From time to time the number varied. The training staff was increased accordingly and suitable accommodation provided at the R.A.M. College for the expanding classes and new types of apparatus. The training of radiographers occupied four to five months.

Long Course for Radiographers. This four to five months course was founded on the syllabus of the Society of Radiographers (excluding therapy) slightly amended to meet Service conditions, and was specially arranged to give all candidates much practical experience. For example, the lectures on physics and apparatus construction were intermixed so that each item of apparatus was described as soon as its physical basis had been built up on the theoretical side, and the afternoon demonstrations were timed to illustrate and give practical work on the morning lectures so that their inter-relation might be more easily appreciated. Every student made a complete radiographic survey of the body and all his radiographic work was filed, inspected and noted by the O.C. School who pointed out all faults and explained difficulties. The syllabus roughly consisted of 20–30 lectures and demonstrations in each of the following subjects, with much practical work carried out by the men in small batches (2 and 3):

(*a*) Anatomy, osteology and surface markings.
(*b*) Physics: as applied to medical radiography and apparatus construction, mostly on A.M.D. and field service apparatus.
(*c*) Radiography, radiographic positioning and procedures in detail.
(*d*) Photography, clinical and radiographic, especially slides.
(*e*) Administration of an Army X-ray department.

This training, along with two years' employment in a recognised Army unit, was accepted by the Society for Part I of their schedule and close liaison was maintained with the Society.

The reasons that so much was taught so efficiently in the time were that it was a highly disciplined course, working from 10·00 to 17·00 hours daily, and that there was an ample staff of full-time expert teachers whose whole job was to see that the students got every chance. The proportion of those who passed at the end of the course was very high, because at the half-course examination those who appeared unlikely to make the grade of the final part were returned to ordinary duty.

Dental Radiography. In view of the decision to equip dental centres with X-ray apparatus to be administered by the Army Dental Corps, courses in dental radiography were arranged and attended by eighty-one dental mechanics. Each course lasted one month and these were courses modified and limited to the anatomical regions involved. The lectures on anatomy were confined to the teeth, jaw, skull, sinuses and cervical vertebrae, and the lectures and demonstrations on apparatus did not cover any apparatus other than the one standard A.M.D. dental set MX-1 (60/10) pedestal or wall. Radiography of the skull, sinuses and cervical vertebrae were taught in addition to radiography of the teeth and jaws.

It was stressed throughout that servicing of any of the dental apparatus was not a problem for the dental radiographer, but one for the Army X-ray servicing department, as the MX-1 (60/10) could only be dismantled by experts.

No examination was held as it was not considered feasible to assess a standard for qualification, and certificates issued merely stated that the trainee had undergone such a course at this school. The two courses were very successful and the Army Dental Corps made full use of their X-ray facilities.

Refresher Courses. According to schedule in Reg. A.M.S. for promotion to Class I.

Special Courses for Dominion and Allied Radiologists. At the request of the Senior Consulting Radiologist, U.S.M.C., E.T.O.U.S.A., technicians of the American Army attended the Army X-ray School from April 1943. They were temporarily placed on the strength of No. 18 Company R.A.M.C. for accommodation and subsistence and were given instruction on the construction and uses of the standard Army X-ray sets and also their own American standard 90/30 Mobile Field Set. Most of the technical demonstrations were given by the X-ray Service Officer, the general standard scope of the course by the O.C. X-ray School, practical radiography by the instructional staff and discussions on the various aspects of radiographers' duties in the field by the Consulting Radiologist. These courses were very popular with both technicians and Army X-ray School staff. In all, up to 1945, some 125 X-ray technicians attended.

Mass Radiography and Superficial Therapy. Short courses were also arranged in these subjects. In all 22 training courses, 663 candidates out of 796 passed.

Field Service Handbook of Medical Radiography. The compilation and issue of this handbook was a successful effort to record the details of all teaching at the Army X-ray school, especially the section containing a dictionary of useful radiological phrases in fourteen languages for troops in all countries.

X-RAY EQUIPMENT

At the outbreak of war the Army Medical Services possessed only a negligible quantity of X-ray equipment and few transportable models which were essential for the use of an army on the move. The equipment supplied during the first few months of the war was of necessity that which the manufacturers were holding in stock or in an advanced stage of manufacture, and, fortunately, it included a number of those units which were suitable for use under Service conditions. Some of this equipment, especially the 90/30, was delivered only four days after the commencement of hostilities and the manufacturers were able to maintain a steady flow thereafter by a supreme effort which involved the factories in continuous working, day and night. Priorities granted by the Ministry of Supply greatly helped the delivery of raw materials, while the skilled personnel involved in all stages of manufacture were, with a few exceptions, exempted from service in the Armed Forces.

General standardisation of design was immediately adopted and was maintained throughout the war with very successful results. All parts of standard apparatus were interchangeable, so that not only was it possible to maintain an efficient spare parts service, but the components of two or more damaged units could be used to make up one complete and usable unit.

Some idea of the extent of the organisation and effort involved will be seen in the list on page 538 showing the numbers of the various types of apparatus and important accessories supplied to the Army Medical Services during the war. In addition to this list, much apparatus and many accessories were commandeered or purchased locally in various theatres where they were found accessible. When different makes of apparatus had to be acquired, efforts were made to standardise within operational areas and, whenever possible, over all operational areas. Where commandeered or locally purchased sets were taken over for use in emergency, sooner or later they broke down for want of spares.

The Michaelis Mobile X-ray Unit. This was a gift to the radiological service from Miss Iris Michaelis in memory of her father. It was built to a design suitable for travelling services at home or abroad. In the autumn of 1940 it was partially destroyed when an enemy bomb fell near it. It was reconstructed and used as a mobile unit based on the Army X-ray School.

The rear section of the vehicle was equipped as a complete X-ray laboratory, the necessary electrical current being provided by a petrol-driven engine and generator. The apparatus was capable of making radiographs of, or screening any part of, the body. Practically any procedure possible in a general hospital could be performed by it. The exposed films were passed through a hatch into the forward section, which was

fitted up as a dark-room with sink, developing tanks and safety lights. Both sections of the vehicle were electrically lighted and fitted with appliances for warming and cooling the air. In its day this unit was certainly the ideal mobile X-ray unit.

	Andrews	Watson type	Solus type	Others
(*a*) Petrol electric generators 5 kw. a-c. 230 v.	—	640	—	30
(*b*) 77/15 Portable units and collapsible couch (pre-war)	31	—	—	—
(*c*) 60/10 Portable units MX-1 (1939/40)	—	28	—	—
(*d*) 60/10 Portable dental units MX-1	—	36	—	—
(*e*) 80/15 Portable units MX-2	—	530	50 (S.S. II for U.S.A. and Russia)	—
(*f*) 90/30 Mobile Units	—	300 400	32 240 (U.S.A. and Russia)	—
(*g*) 90/50 Transportable semi-fixé MX-3	—	214	—	—
(*h*) 100/150 2-valve fixed units	—	20	5	40
(*i*) Superficial therapy units	—	13	—	—
(*j*) Mass miniature radiography units	—	15	1	—
(*k*) Mobile F.S. tables and couches	—	41	265 90 (U.S.A.)	—
(*l*) Spare H.T. cables	—	Large numbers	Large numbers	—
(*m*) Spare tubes, Maclette and Eureka	—	Large numbers	Large numbers	—
(*n*) Lead aprons	—	—	575	—
(*o*) Stereo-binoculars	—	—	300+	—
(*p*) F.B. eye localisers	—	—	250	—
(*q*) Eye magnets	—	—	6 Giant 230 Portable	—
(*r*) Lucidex secondary radiation grids	—	500	—	—

Apparatus Sent to Russia, Greece and Malta. When Lord Beaverbrook went to Moscow in 1941 to discuss supplies for Russia with Premier Stalin, he undertook to send a large number of 90/30 X-ray Units by a specified date. By making a strenuous effort the factories delivered most of the units in time to catch the first convoy, while the balance was ready, complete with operating instructions printed in Russian, before the promised date. Later, in 1943, instructions were received to supply fourteen complete big valve X-ray installations for the reconstructed hospitals in Stalingrad. These also were ready on time with detailed installation and operating instructions printed in Russian. It is not known how much these were used or where.

A large consignment of complete sets was despatched to Greece but most of it was lost at sea.

After a visit to Malta by the Consulting Radiologist to the Army at the request of the Governor, the British Red Cross Society undertook to supply complete X-ray installations on his recommendations for the damaged hospitals of Malta. Mobilix (90/30) Units were despatched as a temporary measure until the hospitals could be made ready to receive the final apparatus, 4 Valve 400 ma. sets.

CHAIN OF SUPPLY

Most of the X-ray apparatus used reached a high level of efficiency. The servicing of this apparatus was greatly facilitated by rigid insistence on standardisation. The only sets not so standardised were the heavy-duty units in base hospitals and the larger general hospitals. The numbers of these were too small to permit of mass production. Shortages occurred in certain theatres from time to time due to some inexplicable hold-up at a port or to the loss of ships at sea. The X-ray tubes in use were almost all American Maclette and Eureka, but sufficient stocks were nearly always available to satisfy all demands.

Power supply was a source of very considerable difficulty as the radiological service lacked sufficient numbers of the 5 kw. generators owing to the orders for these being given a relatively low priority, and, more particularly, to their misuse as lighting sets in larger medical and other units.

The mobilisation stores for all medical units were kept at the Army Medical Stores, Ludgershall. A supplementary store of packed apparatus ready for shipment at short notice was maintained at Walton (Liverpool), while at the Army X-ray Service Store at Millbank stocks of X-ray spares were stored for urgent service and in connexion with repair work. Overseas radiological material was maintained at base and advanced depots or medical stores. In certain instances, however, X-ray equipment was congregated at a particular base depot of medical stores which happened to be near the X-ray service unit of the expeditionary force. There were two special X-ray service depots at Helmieh, Egypt.

MAINTENANCE AT HOME

In 1944 an official memorandum was issued dated July 26, which defined the respective responsibilities of the R.A.M.C. and the R.E.M.E. in respect of maintenance and repair of X-ray equipment. At home such repair of equipment used in the United Kingdom was undertaken by the Army X-ray Service Store (Home) at Millbank. Its war establishment was laid down in A.C.I. V/837/1, Section K, dated February 17, 1943.

Army X-ray Service Store—Home War Establishment

	Personnel
R.A.M.C.:	
Quartermaster	1
N.C.O. in sub-charge (staff-sergeant) (radiographer)	1
Sergeant (radiographer)	1
Nursing orderlies for duty as:	
General dutymen, Packers and storemen (includes 1 lance-corporal)	6
	9
A.T.S.	
Clerks:	
Corporal	1
Private	1
Total, Army X-ray Service Store	11

Note: All personnel of this establishment may be of low medical category.
In addition to the above, the R.E.M.E. X-ray Service Officer was attached to this establishment from the Army X-ray School as the technical expert.

This service store developed as an authorised servicing unit of the Army X-ray School after the return of the B.E.F. from France. A similar but smaller service had been organised within B.E.F. So rapidly had the activities of this section developed that the service store had to be moved to larger premises in the partially destroyed wards of the Q.A.M. Hospital, Millbank.

As faulty, broken or worn out apparatus was returned to the store it was there examined, tested and, if possible, repaired. Alternatively, an estimate for such repair was obtained from the makers and sanction for such repair applied for from the War Office through the Consulting Radiologist. Since this procedure wasted a great deal of time, there was developed an unofficial Service 'shuttle service', which very greatly increased efficiency and saved much expense. When urgent transportable apparatus or parts thereof broke down and could not be put right locally at a military hospital, notification was sent direct to the O.C. Army X-ray Store, whereupon a standard spare was despatched at once by passenger train in exchange. When the faulty apparatus was received at the store, it was there reconditioned or replaced. If necessary a trained technician was sent from the store to help in the installation of the new apparatus. The store issued a Failure Indicating Chart (Fig. 5), modelled upon the American Army X-ray Chart. This greatly helped radiographers in the location of faults in their own apparatus.

The duties of the X-ray Service Officer at the Army X-ray Store were as follows:

Duties in conjunction with the War Office

1. Technical adviser to the Consulting Radiologist to the Army on matters relative to X-ray and Electro-therapy equipment and all allied apparatus.
2. Technical adviser to A.M.D.3 on similar matters regarding estimates for cost of new apparatus and for servicing repairable apparatus and inspection of such equipment ordered through and in co-operation with the Ministry of Supply.

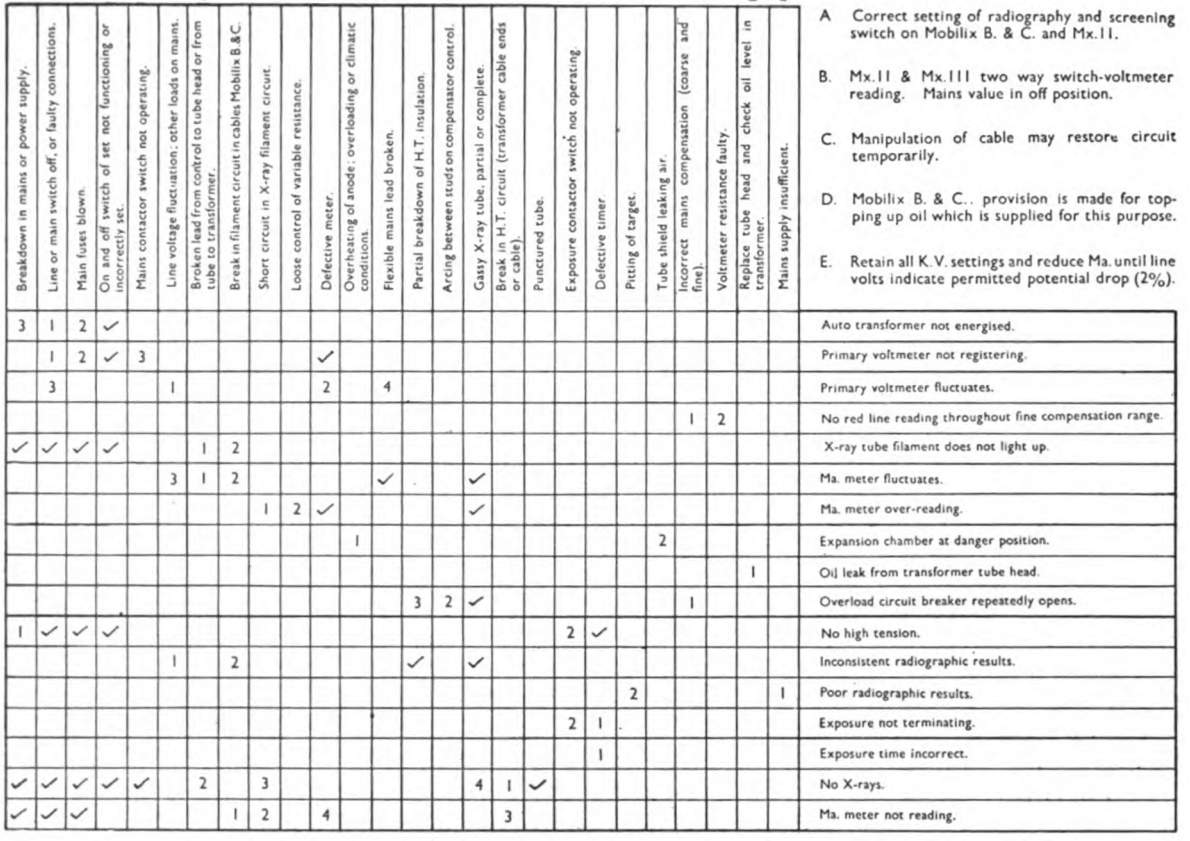


FIG. 5. X-ray Apparatus Fault Location Chart.

3. Inspection of X-ray and allied equipment in home military hospitals, either with the Consulting Radiologist or as directed by him.
4. Supervision and servicing of repairs of X-ray and allied equipment in military hospitals as in (3).

Duties in connexion with the Army X-ray School

1. Technical adviser to the O.C. X-ray School from June 1940.
2. Lectures at the school to radiologists and trainee radiologists on the physics and construction of X-ray and allied equipment and also to the staff of the school, and radiographers and technicians of the Allied Forces who came to the school for courses.
3. Assistance at all school examinations in physics and apparatus construction.

Duties in connexion with the Army X-ray Store (from February 2, 1943)

1. Technical adviser to the O.C. X-ray Service Store (originally the O.C. Army X-ray School and later the separate O.C. Army X-ray Service Store).
2. Inspection and servicing of new, repairable and unserviceable X-ray and allied equipment.
3. Organisation of training course for X-ray technicians. (Some were radiographers who took this up and some were recruited direct from R.E.M.E., etc.). These trainees finally supplied R.E.M.E. X-ray officers and staff for N. Africa, Italy, Paiforce, Egypt and B.L.A.

Trainees from the Army X-ray School in Technology afterwards took charge of X-ray service depots abroad.

X-ray service teams were trained at the Army X-ray School, being given a three months' course in Army X-ray servicing.

MAINTENANCE OVERSEAS

In overseas theatres the responsibility for maintaining and repairing was divided as follows:

Repair

(*a*) The R.A.M.C. was responsible for such first echelon repairs as were within the scope of technical personnel on the establishment of R.A.M.C. units using X-ray and electro-medical equipment.

(*b*) R.E.M.E. was responsible for all other repairs that could be satisfactorily carried out in overseas theatres. (In this connexion it is pointed out that specialist R.E.M.E. units, who were normally attached to base armament and general workshops, were found to carry out such repair work; these units, although under the control of R.E.M.E., maintained close liaison with the Adviser in Radiology in the theatre concerned.)

(*c*) Equipment beyond repair in an overseas theatre was returned to United Kingdom through R.A.M.C. channels for repair in United Kingdom under R.A.M.C. arrangements.

Provision of Spares

(*a*) Ordinary materials required for repair were provided by the service which normally provided the material concerned.

(*b*) Spares special to X-ray and electro-medical equipment were provided by the R.A.M.C. and held in a base depot of medical stores conveniently located to the base armament and general workshops, R.E.M.E.

All publications and data required by R.E.M.E. were supplied through R.A.M.C. channels and all defect reports were passed by R.E.M.E. through A.I.R. for transmission to the United Kingdom. This organisation is shown in diagrammatic form in Fig. 6, which

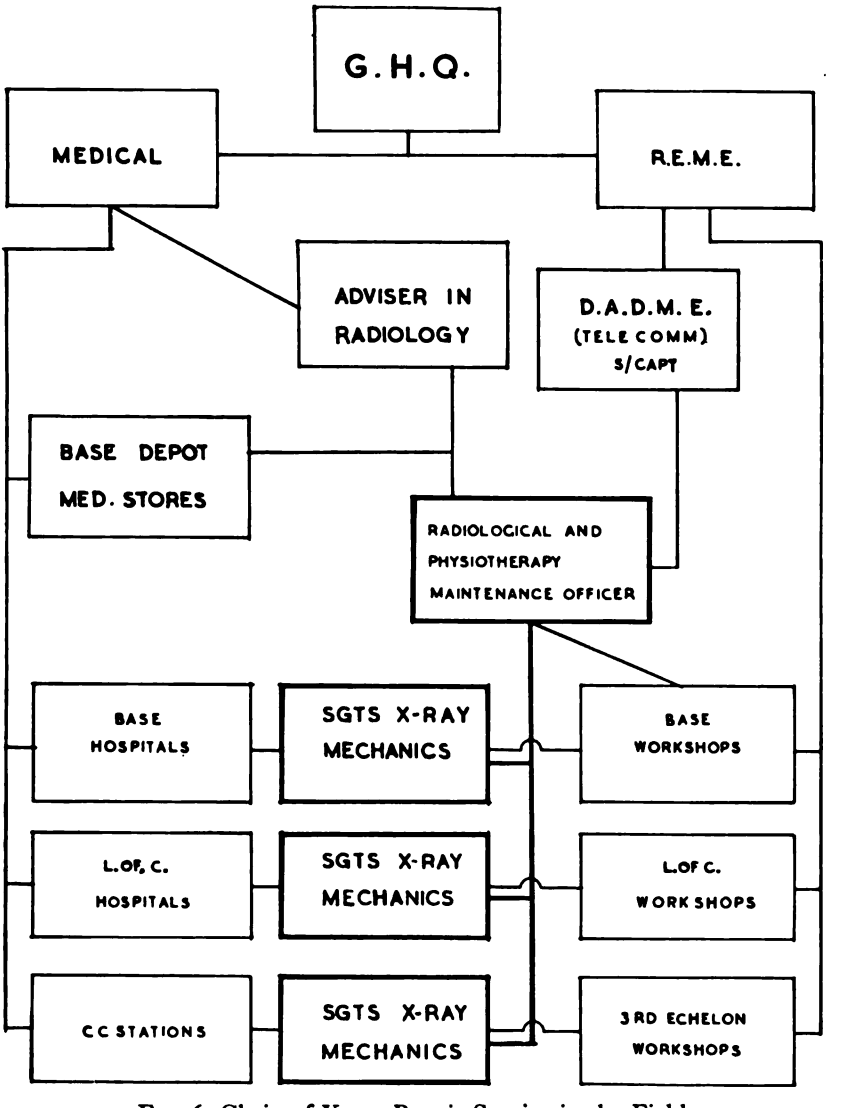


FIG. 6. Chain of X-ray Repair Service in the Field.

shows that a technical link existed between D.A.D.M.E. (Telecomns.) G.H.Q., through the Radiological and Physiotherapy Maintenance Officer.

PROCEDURE OUTLINED FOR UNFORESEEN AND EXCEPTIONAL (ADDITIONAL TO SCALE) DEMANDS FOR EQUIPMENT (OVERSEAS).

All Ds.M.S. and D.Ds.M.S. of overseas commands were circularised regarding this procedure, because reports continued to be received by the Consulting Radiologist at the War Office in the quarterly hospital X-ray reports from overseas and in quarterly reports from the advisers in radiology in forces stating that the number of X-ray sets, equipment and spare parts was insufficient to meet major unforeseen requirements as they arose, while at the same time in many cases indents emanating from the base depot of medical stores in these theatres did not contain demands to meet these reported contingencies.

During the war it was quite impossible to provide a complete range of X-ray spares at each base depot of medical stores for unexpected emergencies as this would involve uneconomical freezing of items in limited supply. The following instructions were circulated to regularise these crises:

(*a*) *Hospitals*

Officers commanding hospitals sometimes appeared to be under the impression that the quarterly X-ray reports forwarded to the War Office constituted a demand and that action would be taken without an indent being received. Such reports were considered by the Consulting Radiologist and the War Office only as advance information, and it was essential that formal demands should be submitted through the usual channels for items concerned.

(*b*) *Base Depots of Medical Stores*

It was suggested to overseas theatres that selected base depots of medical stores which were linked with R.E.M.E. X-ray Workshops should carry and maintain the bulk of the theatre X-ray spares and that reasonable stocks should be maintained by such special depots to meet emergencies as the X-ray service staff were available there and qualified to 'cannibalise' equipment, if necessary. It was not practicable or desirable to detail such ranges of spares in A.F.I.1248.

In 1944 A.C.I. IV/262/1 dated May 24, 1944 was issued finally authorising an X-ray and Physiotherapy Repair Section, R.E.M.E. This was a R.E.M.E. unit, but it was at the disposal of the A.I.R. of a Force and generally based at a suitable general hospital.

X-ray and Physiotherapy Repair Section. R.E.M.E.

(To be attached for all purposes to the base armament and general workshop R.E.M.E.)

War Establishment 79/W.E./9034 (S.D.3)

(1) *Personnel*	
Captain*	1
Total Officers	1
Electricians (sgts.)*	3
Batman-driver	1
Total O.Rs.	4
Total X-ray and physiotherapy repair section R.E.M.E.	5
(2) *Transport*	
Motor-cycles, solo	3
Car, 2-seater, 4 × 2	1

* Specially trained in the repair of X-ray and physiotherapy equipment.

In the Middle East the original X-ray Repair Services Section became gradually engulfed in a larger unit, the Surgical Repair Unit, and ceased under this regime to be as satisfactory as when it was separate. The original X-ray specialised and specially trained unit organised under A.I.R. rather lost its identity and its expert staff were merged into the bigger combine. The advantages and disadvantages of this change were carefully analysed, and although no doubt a big and overall efficient unit was built up, the intimate association of the expert X-ray technicians and the X-ray departments of hospitals was largely lost.

NOTE ON THE X-RAY MAINTENANCE SERVICE IN THE ARMY

While the Army X-ray Store was a part of the Army X-ray School it was successful up to a point. It was run on unorthodox lines, but it aimed at efficiency and speed of service and considered them more important than meticulous interpretation of regulations. This was justifiable as a temporary measure and some important results would not otherwise have been obtainable.

When the volume of work became heavier, the store, as constituted, became incapable of dealing with the situation, because it had no establishment and was administered by the officer commanding the

school, with the X-ray Service Officer and the school sergeant-major attached, in addition to their other duties. Continued expansions of the school and the work entailed by repeated alterations in accommodation made it more and more difficult for the officer commanding the school and the school sergeant-major to devote adequate time to the store work. This was to some extent offset by the unofficial placing of one or two of the best students as service men under the X-ray Service Officer, and although the usefulness of the store was limited, such work as was done was carried out in complete harmony.

The Army X-ray Service Store was later constituted as a separate unit under its own quartermaster. It was in existence long enough to show that it was not an administrative success as such. The non-success was due to the following factors:

(1) The official employment of the designation 'Store'.

This automatically turned the unit into an appendage of A.M.D.3, who looked upon it as merely another small medical store. The store side was therefore magnified, meticulous attention to regulations was intensified and the real purpose of the unit, namely, maintenance of technical equipment, was largely a secondary consideration.

(2) The posting of a lieutenant (quartermaster) as officer commanding.

This aggravated the situation noted above and brought in another difficulty, in that the lieutenant (quartermaster) commanded the unit without any technical knowledge of its real function, and the X-ray Service Officer attached, who had the all-important duties there, had no official recognition. This was a potential source of irritation to both officers concerned and tended to make co-operation difficult.

(3) Lack of servicing personnel.

When the establishment was drawn up the intention, from the radiological aspect, was that the unit would be primarily concerned in checking and servicing quickly X-ray and electro-medical apparatus and that the store side would be utilised merely to provide a more efficient and enlarged shuttle-service. Provision was made for technical assistants but these were not shown as such and the entire personnel could be, and indeed were, employed on routine store duties. The X-ray Service Officer had no authority over them and was in the invidious position of having to approach the quartermaster before he could have their services and before he could make use of material which was obviously intended for servicing purposes.

It was therefore suggested that it should cease to exist as a separate unit and should again become a branch of an X-ray unit or department, so that it would be administered by specialists and technical officers, responsible at home to the Consulting Radiologist, and abroad to the A.I.R. of the force. The unit at home, it was recommended, should be part

of the Army X-ray School, with the service branch and duties placed under the control of the X-ray Service Officer as an attached officer on the establishment and a small X-ray store branch for care of spares, with a warrant officer, class 1 or 2 in sub-charge. The servicing personnel should be designated as such, and there should be provision for a small number of trainees in addition to the members of the establishment. The X-ray Service Officer would be responsible for the technical training of those pupils and would, at the school, have definite responsibility allotted in the training of radiological officers and radiographers. The X-ray Service Officer would also be available as technical adviser to the Consulting Radiologist.

Experience had shown that in the training of radiologists, radiographers and X-ray service men, the school and the servicing unit were so closely linked that they could not be separated without detriment to both training and servicing.

It is estimated that some 8 million square feet of X-ray film was supplied and used throughout the war by the Army Medical Service.

SAFETY PRECAUTIONS IN USING X-RADIATION IN THE FIELD

Before any type of X-ray apparatus, generative or protective, was adopted for issue in the Army Medical Services it was tested by the staff of the X-ray Research Department, Woolwich, in conformity with the international standards laid down in the current official report of the British X-ray and Radium Protection Committee (1943).

Equipment issued from any medical stores was accompanied by complete instructions for its assembly and safe employment. Before impounded X-ray equipment was used, arrangements for testing had to be made locally. In the Middle East a specially constructed ionisation chamber for measuring very small doses of radiation was used to carry out tests of scattered radiation received by X-ray personnel in routine military hospital work. The results showed that the measures adopted and in use were quite adequate.

Many radiologists in the field devised extra protective screens for the operators, and, although these were not really necessary, the efforts were justified if only because they drew the attention of the inexperienced to the need for caution and ensured that the operators were at a safe distance from the source of radiation. The most important improvisation so introduced was the use of lead rubber wings added to the fluorescent screens for the wider protection of radiologist and radiographers from scattered radiation.

In 1943 'austerity types' of X-ray tube were introduced from America, and these were all passed as safe by the National Physical Laboratory at Teddington before stocks were taken into use.

Although the same international rules for protection applied, American medico-legal considerations called for extra protective measures, and this fact was taken into account when American personnel attended the Army X-ray School for instruction in the use of British X-ray equipment and when such equipment was issued to American units.

Special precautions were taken in stressing protection according to the committee's report (1943) in regard to superficial X-ray therapy.

BLOOD EXAMINATION OF RADIOLOGISTS AND RADIOGRAPHERS IN THE ARMY

From the onset of war the personnel of each Army X-ray department underwent routine blood examinations every three months and the results were embodied in the quarterly report of which one copy was rendered directly to the Consulting Radiologist at the War Office. After the reorganisation and expansion of the Army X-ray School in 1940, the blood picture of every trainee there was noted on his personal record card at the commencement of training, so that a complete check would be available in case of any suggestion of blood damage at a later date. These were added to the data derived from the quarterly reports and, as a result, it was found that there were remarkable discrepancies from the accepted normals in the blood pictures of trainees and radiographers. For example, in some individuals the white cell counts were doubled during part of the course while in others they were halved, and in most of these cases the individuals had not yet been exposed to any radiation.

TABLE 68

Blood Counts, Trainees, Radiologists and Radiographers

	Student trainees		Radiologists and radiographers			
			Home		Overseas	
	A	B	C	D	E	F
	1941–2 per cent.	1943 per cent.	1941–2 per cent.	1943 per cent.	1941–2 per cent.	1943 per cent.
R.B.C. below 4 million	2	0	2	3	2	4
R.B.C. above 6½ million	2	0·4	1·7	2	0·3	2·4
Hb. below 80 per cent.	2	0	3·5	3	1·6	2·4
W.B.C. below 4,000	1	0	0·5	2	3·3	3·2
W.B.C. below 4,500	2·3	0·4	2	6	8	7·2
W.B.C. below 5,000	9	2·7	6·5	12	15·3	9·6
W.B.C. below 6,000	25	14·2	27·2	27	24	23
W.B.C. above 10,000	5	16·5	9·75	9	4·3	6·4
Polymorphonuclears fewer than lymphocytes	3 out of 20 students	6·7	5·2	4	9·3	5
Mononuclear over 10 per cent.	0	0	3·7	4	2	3·2
Eosinophils over 5 per cent.	0	0	0·8	2	4·6	9
Numbers of examinations	300	225	400	100	300	125

Trainees (1941–2, Column A)

(1) There was quite a high proportion (25 per cent.) in which the white cells were under 6,000 (the figure noted in the X-ray Protection Committee's Report as the minimum for continued employment in X-ray work). These figures suggested that 5,000 (9 per cent.) or even 4,500 (2·3 per cent.) might be a more reasonable minimum figure to adopt under the circumstances prevailing.

(2) In the differential count, 3 out of 20 students had polymorphonuclears less than lymphocytes. (Full data on this point are not available regarding trainees as differential counts were not at first introduced in routine examinations.)

(3) Variations in the methods of estimating hæmoglobin in laboratories were in use and this made comparisons difficult, but only 2 per cent. were under 80 per cent.

Radiologists and Radiographers (Columns C and E)

Home Commands (C)

(1) There was an increase in the numbers of cases where white cells totalled over 10,000, e.g. 9·75 per cent. against 5 per cent. in trainees.

(2) In the differential count 5·2 per cent. had polymorphonuclears less than lymphocytes.

(3) In the haemoglobin estimation 5·2 per cent. had under 80 per cent.

All Overseas Commands (E)

(1) Low white cell counts increased to 15·3 per cent. below 5,000, and 8 per cent. below 4,500.
High white cell counts were 4·3 per cent., much the same as in trainees.

(2) In the differential counts 9·3 per cent. showed polymorphonuclears less than lymphocytes. (This has been stated to be a post-radiation change, but it undoubtedly occurs in many febrile diseases abroad and is really not uncommon anywhere.)
Eosinophils were 4·6 per cent. This was also stated to occur as a post radiation change but was explained by proved cases of parasitic infection.

(3) In the haemoglobin estimation 1·6 per cent. showed less than 80 per cent.

The reports of pathologists overseas were generally temperate and helpful. They frequently noted that apparent departures from normal counts were not in their opinion due to radiation, and in some cases it was pointed out that an individual with an apparently subnormal count was serving with a unit whose X-ray department was still unopened six months after its arrival. It was easy to identify the pathologist with a one-track mind, exemplified by a tendency to detect the same abstruse abnormality in multiple cases, and his reports were treated with particular care.

As a result of this analysis it can be stated that no proved case of over-exposure to radiation was found in 700 reports on the blood of actual X-ray workers and the abnormal pictures were explained by other causes.

A further analysis of 450 examinations was made in 1943 (Columns B, D and F). As abnormalities continued to appear and as the Officer Commanding the Army X-ray School stressed in Quarterly Reports the wide divergence of the blood counts in students, A.M.D.7 collaborated in carrying out a special investigation on the members of one Army X-ray course—some 60 students. The blood of each student was examined at four intervals of three weeks at the London District Laboratory, Queen Alexandra's Military Hospital, Millbank, under standard conditions. Only four students were examined each day and the investigation occupied three months. All haemoglobin and total cell counts were performed by the same trained laboratory assistant and all differential white counts were performed by the same specialist pathologist who also checked all total counts which were unusually high or low, and occasionally other counts. Every examination was made between the hours of 10.15 a.m. and 10.45 a.m. and in each case the student had had nothing to eat or drink since breakfast (7.15 a.m.) and had performed the same routine of fatigues and lectures on each day.

TABLE 69

Analysis of Blood Counts, in Course Trainees

Variations in Serial Counts

	Individual cases		Throughout the series	
	Lowest	Highest	Lowest	Highest
Hb.	86	100	86	115
R.B.C.	5,200,000	6,110,000	4,480,000	6,110,000
C.I.	0·86	1·02	0·85	1·07
W.B.C.	4,800	12,000	4,400	15,100
Polymorphonuclear	2,744	7,560	2,376	11,778
Polymorphonuclear per cent.	49	77	40	79·5
Lymphocytes per cent.	19	45	16	57·5
S.L. per cent.	4	24	4	47·5
L.L. per cent.	7·5	43	3	43
Monocytes per cent.	0	5·5	0	6·5
Eosinophils per cent.	0	6	0	6
Basophils per cent.	0·5	4	0	4

Analysis of the results of examinations bore out very closely the previous reports, namely that there was a wide divergence in the so-called normal counts, not only of different individuals but of the same individual from day to day. The most striking fact which emerged was that the red blood cell count varied within only small limits although

the white cell count was extremely variable. The total counts varied between 4,400 and 15,100 in the 225 examinations throughout the series, and between 4,800 and 12,000 in the four counts of a single individual. Similar results, some of them even more striking, were seen in the differential white cell counts. The only marked difference between this investigation and the analyses of figures received from all over the Army was that the average white cell count in the former was considerably higher—only 14·2 per cent. being below 6,000. This was more in keeping with the recommendations of the X-ray and Radium Protection Committee, but it must be remembered that this investigation was all the work of one pathologist and did not suffer the variations liable to result from estimations by a number of individuals.

MEDICAL SUPERVISION OF X-RAY STAFF WITH SPECIAL REFERENCE TO HAEMATOLOGICAL CONTROL

In 1943 A.M.D.7 issued the following direction to all commands, and it is presumed that these standards were adhered to in all the quarterly reports of X-ray personnel received up to the first quarter of 1945 (the last reports before the end of the war) after which compilation fell into abeyance :

> X-ray workers in the R.A.M.C. are employed almost exclusively in diagnostic work where exposure to rays is minimal and harmful effects most unlikely. Nevertheless, the medical profession, the laity and the workers themselves are aware of the potential dangers of X-ray work as well as the necessity for haematological control, which is an aspect that is very carefully probed whenever questions of disability and compensation arise. The haematological standards and the frequency with which they should be checked are reasonably well defined for civil work during peace-time and it is not advisable to relax the principle of regular control even though risks in R.A.M.C. personnel are minimal. The early haematological changes due to X-ray injury require a high standard of work for their detection, whilst these same fine changes are by no means specific. Furthermore, the interpretation of fine changes is now difficult because in the fourth year of the war the haematological levels of the population as a whole are somewhat below normal. It is also necessary to be aware of the more common additional factors that may intrude and thereby complicate the interpretation of results.

ASSESSMENT OF FITNESS TO TAKE UP X-RAY WORK

General. Intending candidates should have a good standard of general health and nutrition. Previous history, particularly with regard to respiratory infections acute or chronic, fleeting or of long duration, need to be recorded on account of the influence they have on the blood count. Re-examination at a later date, when such features have ceased to influence the count, may be necessary before using the blood count as evidence of unfitness.

MM

Haematological. A control count (or counts) before taking up X-ray work is essential, otherwise there is no base line to which subsequent counts can be referred. Moderately stable basic conditions are necessary both for this count and subsequent control counts. Most authorities agree that the count should be made between 1100 and 1200 hours, some two to three hours after a normal breakfast, the subject having engaged in no violent exercise during the two hours preceding and being careful to avoid such easily forgotten points as hurrying to a laboratory to get the test done. Single counts showing an unacceptable picture should not be regarded as final. Both in the preliminary assessment and in the subsequent controls it is the persistence of a feature on two or more occasions which should govern opinion. As a standard of primary assessment any one of the following results persistently obtained should be regarded as rendering a prospective candidate unsuitable for the work:

Hb. less than 80 per cent. (Haldane)
Red cells less than 4 M. per c.mm.
Leucocytes less than 4,000 per c.mm.
Polymorphonuclears less than 2,000 per c.mm.

In performing counts pathologists should appreciate that for the detection of fine changes care must be taken to ensure that the site from which the blood is taken is not cold, while the differential counts should cover at least 300 cells of an evenly distributed film. If the count is performed by a technician the film should be retained for the pathologist's inspection and his attention be drawn to the purpose of the count. Unless this rule is observed it is quite certain that a few potential candidates will be unjustifiably excluded from X-ray work while unnecessary hares will sometimes be raised with routine control counts after taking up work.

ROUTINE HAEMATOLOGICAL CONTROL AFTER TAKING UP WORK

Blood counts at regular intervals of three months should be carried out under the same moderately basic conditions as described above and with the same technical refinements. Here again a single count should not be accepted as definite, but persistent changes demand serious consideration as to whether the worker is suitable for continuing with X-ray work or whether it is no more than an indication that he requires a holiday for the recovery of his general condition of fitness.

Interpretation. In principle, reduction in haemoglobin and red cells, when due to X-ray injury, is a late phenomenon which is almost always preceded by leucopenia and neutropenia. Anaemia in a worker in the X-ray diagnostic department has almost always some other explanation than X-ray injury. Persistent leucopenia, below 4,000 per c.mm. and/or neutropenia, below 2,000 per c.mm., occurs before permanent X-ray damage has been done and may appear relatively early in persons unduly sensitive to rays. Nevertheless, similar blood changes are commonly found as the result of:

PLATE XXIV: 77/15 Portable Field X-ray Set, 1939

PLATE XXV: C.C.S. X-ray Laboratory and Generator, 1939. From 1940/41 5 k.v.a. Petro-Electric Alternators 230 v., a.c., were supplied.

[*facing page* 552

PLATE XXVI: The component parts of Watson Portable Type MX-2 (80/15). The small accessories shown are accommodated in a compartment provided for the purpose in the control unit

PLATE XXVII: MX-2 (80/15) Portable Field X-ray Set, 1940 onwards

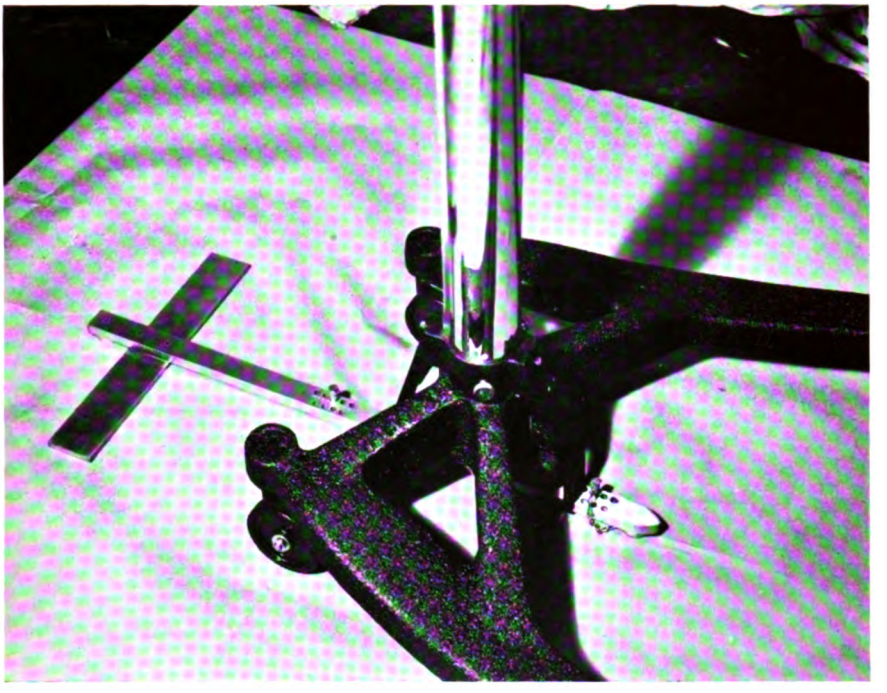


PLATE XXVIII: Stereoscopic attachment shift for MX-2 (80/15) stand

PLATE XXIX: General Hospital in the Desert, showing absolute necessity for really *portable* X-ray Sets when layout of Hospital is on sand, etc.

PLATE XXX: Watson (90/30) Transportable Field X-ray Set arranged for screening

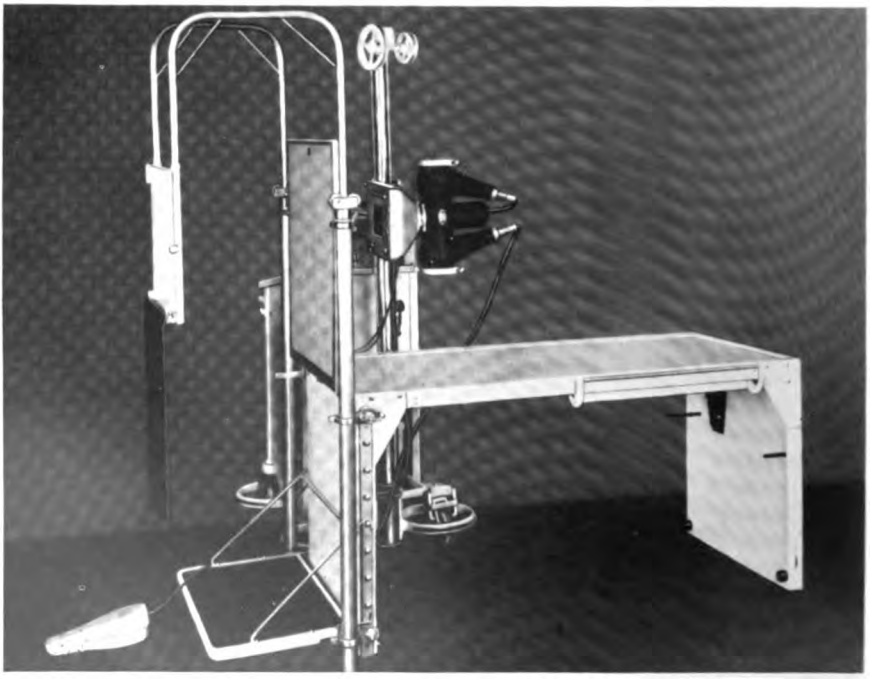


PLATE XXXI: Solus (90/30) Transportable Field X-ray Set arranged for screening

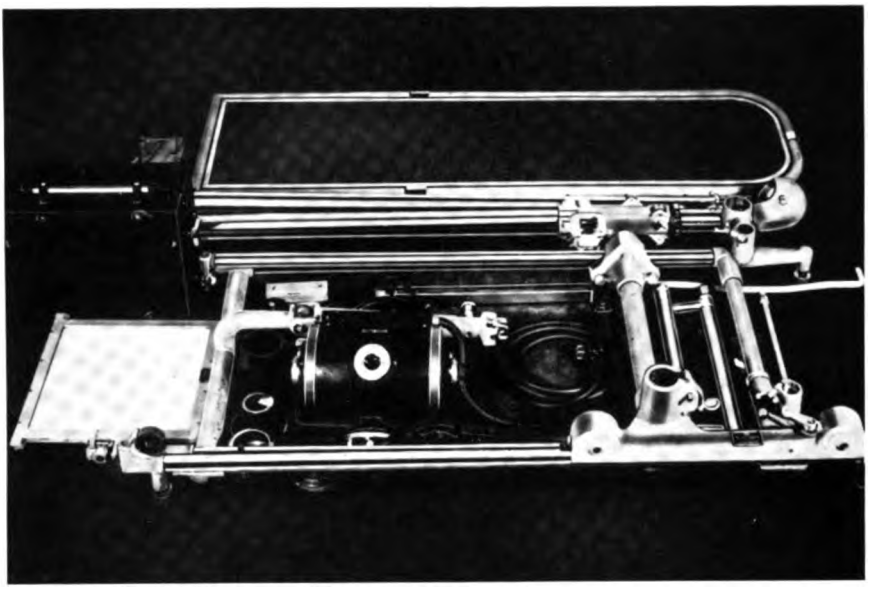


PLATE XXXII: MX-3 (90/50) 'Semi-fixé' Field X-ray Set (dismantled)

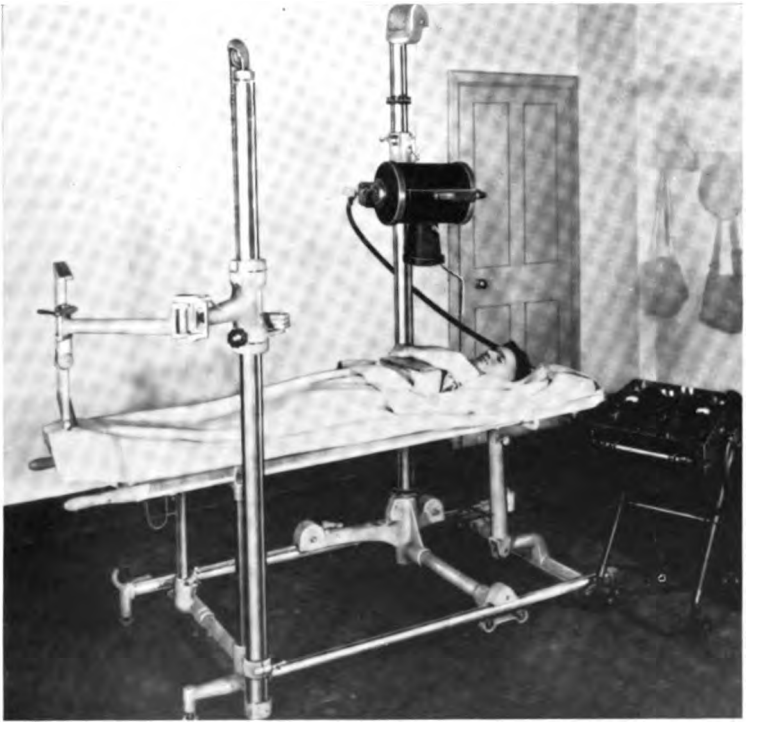


PLATE XXXIII: MX-3 (90/50) 'Semi-fixé' Field Set arranged for over-couch radiography on stretcher

PLATE XXXIV: MX-3 (90/50) X-ray Set arranged for vertical screening

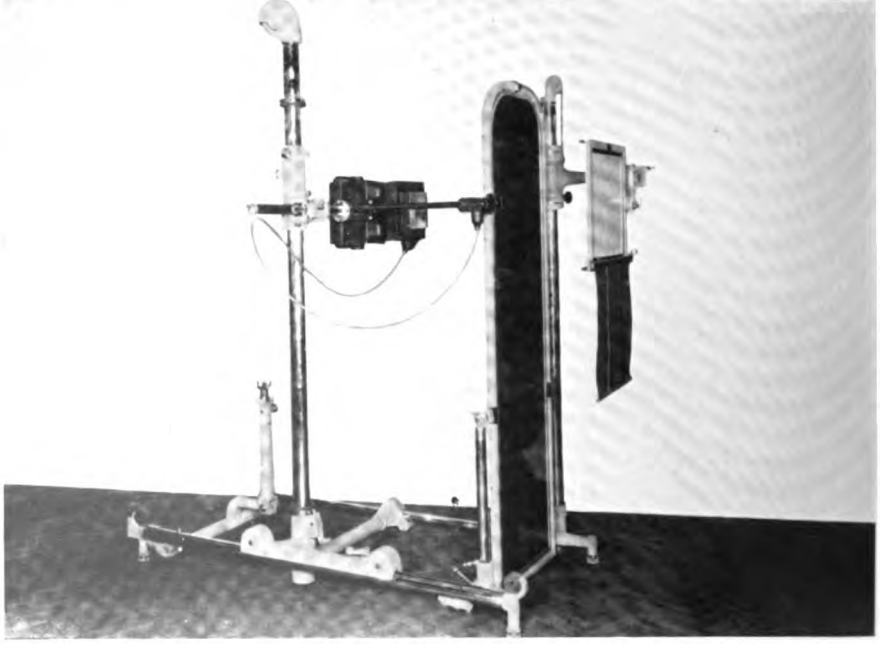


PLATE XXXV: MX-3 (90/50) X-ray set, tilting table

PLATE XXXVI: Michaelis Field Unit with generator showing tilting tube, etc., inside

PLATE XXXVII: Michaelis Field Unit after an 'Incident'

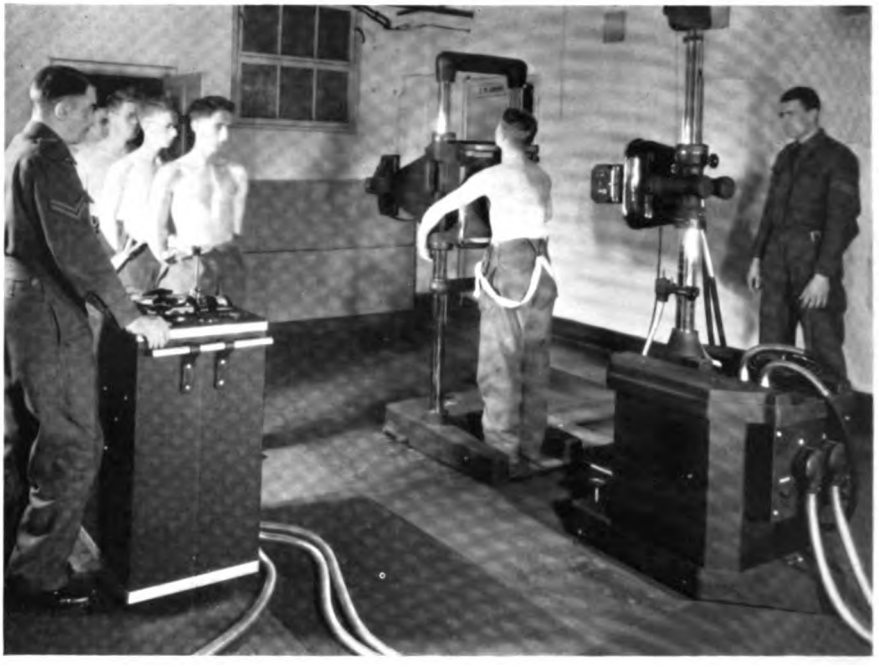


PLATE XXXVIII: Watson Apparatus for Mass Miniature Radiography in use at an Army Centre. The protective screens which are always employed by the operators in practice have been omitted in this photograph

PLATE XXXIX: Example of radiograph made with MX-2 (80/15) in a desert tent midst dust and heat. Gas Gangrene

1. General debility and under-nutrition.
2. Respiratory infections, particularly those of virus origin such as influenza in which case the changes are sometimes very persistent.
3. Glandular infections.
4. Chronic low-grade sepsis or focal sepsis.
5. The exhibition of sulphonamide drugs in susceptible subjects.

All these factors must be taken into account before accepting any blood picture as diagnostic of X-ray injury; they afford the usual explanation of suggestive properly performed blood counts in workers in diagnostic departments. A Schilling haemogram is often helpful for arriving at a decision.

Records. These should always be kept in absolute figures, preferably in chart form, with adventitious factors marked against anomalous results.

MASS MINIATURE RADIOGRAPHY

The Naval Medical Service had developed mass miniature radiography (M.M.R.), on a considerable scale before 1941 and this was closely watched by the Army Medical Services. The methods adaptable to the few naval depots were, however, quite unsuited to the 200 recruiting centres of the Army. The 'Pulmograph' used by the Naval Medical Service was well known, but it was not considered suitable and in any case it was not available in any number for extended surveys in the Army.

The Consulting Radiologist and the Officer i/c Army X-ray School examined the possibilities of applying M.M.R. to the Army intake and decided that, under the existing Army recruiting and training systems, the task was impossible on a sufficiently large scale. It is worth recording that some consulting physicians pressed continuously for this to be undertaken in the Army, but it was evident that they were ignorant of the real position regarding the manufacture of apparatus, cameras, training of personnel, Service position regarding this personnel, the dispersal of recruiting centres, the impossibility of following up cases and the considered views of the Adjutant-General's staff. The whole scheme, if it was to be tackled in the Army, was a stupendous one, especially in respect of priority of manufacture of apparatus, as every maker was already so far behind with the enormous orders already placed, including orders for Russia and other priorities. However, a start was made and as a result the preliminary work of designing a set, with the knowledge of previous failures at home and abroad, was carried out by the Army radiological staff with the important technical advice of the X-ray Service Officer attached to the Army X-ray School. These designs were accepted and developed into a practical machine and camera by the Solus Electrical Company. This all took some time

and many minor difficulties obtruded from time to time, most of which were overcome. This original experimental Army M.M.R. set was generously financed by the McMillan Company of New York. It was tested out at York, Catterick, and Leeds, where some 6,000 cases were examined and much was learned from this prototype. It was thus possible to study such difficulties and deficiencies as were evident before a really mobile and transportable unit was available.

Meanwhile much experimental work and research in 1942 had been carried out by Messrs. Watson & Sons and they had evolved a very fine M.M.R. unit which the Army accepted as a standard unit. Thirty such units were immediately ordered. The initial trials of this model had shown that it had overcome most of the difficulties experienced in the past, the design was admirable, the assembly of the components easy, the electrical output adequate and the quality of the miniature films excellent. This unit was subsequently accepted as standard by the Civil Technical Sub-Committee of the Committee of Tuberculosis in War-time.

Although the Army had already ordered the first thirty machines some time before the M.R.C. Technical Sub-Committee adopted the same model, a friendly compromise as to deliveries was agreed on between D.G.A.M.S. and the M.R.C. whereby Army and M.R.C. were to take alternate deliveries as machines became available, beginning with the Army. This collaboration worked smoothly and although deliveries were slow they fitted in, so far as the Army was concerned, for reasons that are described later.

The next difficulty was transportation, as Army M.M.R. sets had to be taken to the examinees. This was immediately solved by fitting the set into an empty mobile Army X-ray lorry complete with its 5 kw., 230 v., a-c. generator. At this point the establishment of the Army X-ray School was increased by the addition of a senior civilian specialist in radiology whose duty it was to organise the training of teams for extensive mobile work on a large scale and to exercise adequate supervision of the whole technical and professional organisation.

PERSONNEL

Courses of training for medical officers and radiographers were drawn up. It was realised that under the conditions of limited medical officer power it might not be possible to have fully trained radiologists for this duty, but efforts were made to get medical officers with experience in thoracic disease.

As the organisation developed, the mobility of the units had to be arranged so that each unit would make bi-monthly visits to six or seven primary training centres. P.T.Cs. however, were not able to allot M.M.R. a 'time place' in their schedules owing to pressure of military training and it became necessary for the M.M.R. to be made into

static units rather than mobile and to have them established at selected corps training units as a 'token'. This limited the scope of the survey of recruits as there were nearly a hundred such training units.

It quickly became obvious that for a variety of reasons—e.g., mobility of troops, military exigencies, training time schedules—M.M.R. could only provide data as to what could be done if M.M.R. had been a pre-war established organisation at recruiting centres or a really necessary and accepted priority in war-time.

TRAINING

Selected personnel underwent a course on the construction of the various components of the apparatus, its erection and maintenance and radiographic and photographic procedures. Sufficient practical training was given so that the teams were all familiar with every procedure in the M.M.R. unit. Medical officers had a course of instruction in film interpretation and in the criteria necessary to permit a classification of normal, suspicious or abnormal. In suspicious cases they also studied the miniature films in conjunction with the corresponding full-sized films and they had a short revision course in the pathology of thoracic disease.

At the annual radiological conference in 1943 the position of M.M.R. was critically reviewed and it was unanimously agreed that M.M.R. on a large scale was impracticable owing to the multiple nature of the collaboration required in the Army training scheme, the wear and tear of constantly putting up and taking down the mobile apparatus, the difficulty of co-operation at training centres and last, but very important, the fact that 'Administration' had control of training time-tables and at that time and stage of the war they were not prepared to accept M.M.R. as an urgent necessity in an army in war. These factors made it obvious that M.M.R. could not be added to the already overloaded training problem.

In 1944 there were six complete M.M.R. sets in use. The medical officers in charge of these units were all experienced in the interpretation of chest radiographs; they maintained the closest liaison with the clinicians at the hospitals to which their units were attached and two out of the three officers had also charge of wards for chest cases, thus maintaining their interest and practice in the study and treatment of diseases of the chest. These medical officers were all members of the staffs of the medical services of local authorities in civil life and would doubtless have early release from military service at the end of the war. This having been foreseen, reliefs were therefore trained from volunteers and radiological officers.

The health of the M.M.R. personnel was carefully watched and blood examinations were carried out regularly. None, however, showed any deterioration as a result of the intensive work.

The Work Done by the M.M.R. Units

Males

Unit	Totals	Abnormal	Recent T.B.	Old T.B.	
1	—	—	—	—	Training Unit at Army X-ray Store
2	19,610	222 (1·7 per cent.)	62 (0·3 per cent.)	140 (0·7 per cent.)	
3	22,784	503 (2·2 per cent.)	60 (0·2 per cent.)	37 (0·12 per cent.)	
4	5,610	142 (2·5 per cent.)	13 (0·2 per cent.)	3 (0·05 per cent.)	
Totals .	48,004	978 (2·0 per cent.)	135 (0·28 per cent.)	180 (0·4 per cent.)	

Females (*A.T.S. Auxiliaries*)

Unit	Totals	Abnormal	Recent T.B.	Old T.B.
1 and 5	5,583	58 (1·0 per cent.)	19 (0·3 per cent.)	27 (0·5 per cent.)
2	390	8 (2·0 per cent.)	1 (0·26 per cent.)	2 (0·5 per cent.)
3	1,216	12 (1·0 per cent.)	2 (0·16 per cent.)	3 (0·25 per cent.)
4	733	3 (0·4 per cent.)	3 (0·4 per cent.)	0
Totals . .	7,922	81 (1·0 per cent.)	25 (0·3 per cent.)	32 (0·4 per cent.)

Follow-up of Suspect Cases—Males. At the static units this presented no problems and a very complete bacteriological investigation of suspects was made, including, where indicated, examination of the fasting gastric juice and guinea-pig inoculation in addition to examination of multiple specimens of sputum. To determine the question of progression 'suspects' were admitted to a military (or Red Cross) hospital for further observation of temperatures, E.S.R. and exercise tolerance, etc.

Females. Auxiliaries were admitted for observation and examination to the nearest military hospitals (i.e., those to which the M.M.R. Units 2, 3 and 4 were attached) and they were thus kept within the observation of the medical officer i/c M.M.R. unit. This resulted in a complete follow-up.

When auxiliaries had been examined by 5 Mobile M.M.R. Unit, there was considerable difficulty in tracing the cases sifted out as requiring further observation and investigation since they were referred for this to a variety of hospitals. Further, it was commonly found that

auxiliaries were posted very rapidly and, though the medical officer i/c auxiliaries notified the medical officer of the unit to which a 'suspect' had been posted, it was frequently difficult to complete the after history.

THE MASS MINIATURE RADIOGRAPHIC EXAMINATION OF REPATRIATED (LIBERATED) PRISONERS-OF-WAR (1945)

Introduction. At the end of war in Europe the Army Medical Services were faced with the care of approximately 150,000 liberated British prisoners-of-war. In this connexion they were radiographed for pulmonary tuberculosis. The Army X-ray Service had prepared for this.

Problems. For the efficient examination of these repatriates it was essential that mass radiography should be an integral part of the arrangements made for their reception on arrival in this country. The fundamental requirements demanded of mass miniature radiography were:

(*a*) that all repatriates should be examined immediately on arrival in this country;

(*b*) that the examination should not materially delay the repatriate's discharge from the military reception camp to his leave;

(*c*) that reports on his miniature radiograph should be immediately available to the officer-in-charge of medical inspection, so that prompt arrangements could be made to deal with such repatriates as required hospitalisation.

With these requirements in mind it was decided that mass radiography could only be carried out by the use of a number of mobile units visiting the reception camps. The mobility of the mass radiographic unit enabled a comprehensive survey to be made.

Organisation. When the examination of repatriated prisoners-of-war became imminent the five static units were made mobile and a further ten mobile units raised, so that fifteen units, complete with personnel and transport, were ready for service. The parent unit for these mobile self-contained units was the Army X-ray School, which was responsible for raising and equipping them. Personnel, both officers, and other ranks, were trained in mass miniature work at the Army X-ray School and the same routine training was given as for the first five units.

The war establishment of each unit was raised to one sergeant radiographer in charge, two privates radiographers, two clerks and one driver R.A.S.C., for the maintenance of the lorry. The original establishment of one clerk was raised to two to deal with the increased documentation associated with the repatriated prisoners. The clerks consisted of one skilled clerk and one private. It was not possible to supply two trained clerks owing to the shortage of clerks throughout the Army. Although typewriters for each unit had been indented for, it was not possible to obtain them; consequently clerical work was all hand-written.

Administration. All units were mobilised at the Army X-ray School and were later despatched to the various reception camps at the request of A.D.M.S., 45th Division. Each unit was self-contained and became an extra-regimental unit attached to the reception camp.

Expendable equipment and replacements to units were supplied in conjunction with A.M.D.3 and so arranged that units could indent direct to the Officer Commanding the Army X-ray Service Store and so be supplied with the minimum delay.

Results were recorded as 'normal' or 'abnormal' on the nominal roll. In the abnormals no full-sized films were taken. These nominal rolls were forwarded to Records who, in the case of soldiers showing an abnormality, notified the medical board concerned that a full-sized chest film was required. Gross abnormalities likely to need immediate hospitalisation noted on the miniature examination were immediately communicated to the senior medical officer of the camp. The repatriate was then called back for further medical attention.

Weekly reports of the work done at each unit were forwarded to the appropriate authorities.

At one point the daily numbers suddenly increased as the R.A.F. brought home in bombers in one day thousands of repatriates to these camps. The organisation was able to cope with this influx.

Geographical Distribution. Thirteen reception camps were located in Buckinghamshire and the first two M.M.R. units, 5 and 6, moved to 91 Reception Camp, Hodgemoor, Amersham, Bucks and 90 Reception Camp, The Vache, Chalfont St. Giles, Bucks, on March 31, 1945. Work commenced two or three days later. In the meantime, instructions had already been issued and 2, 3 and 4 M.M.R. Units had been recalled from Catterick, Colchester and Glasgow and were standing by at the Army X-ray School. On April 1, 3 M.M.R. Unit was despatched to 94 Reception Camp, Dropmore Camp, Taplow, Bucks. On April 3, 2 M.M.R. Unit arrived at 93 Reception Camp, Bower Camp, Beaconsfield, Bucks, and on the same day 4 M.M.R.U. was despatched to 92 Reception Camp, Pipers Wood, Amersham, Bucks. In the meantime, 1 M.M.R.U., which had formed the primary training unit at the Army X-ray School, was mobilised and made ready to move. 7 M.M.R.U. was despatched to 2/5 Welch Camp, Hazlemere, Bucks; 8 M.M.R.U. to 11th S. Staffs Camp, Aldbury Common, Ashridge, Berkhamsted, Herts; 9 M.M.R.U. to Reception Camp, Woodlands, Great Missenden, Bucks., and 1 M.M.R.U. to 11th Hants. Regimental Camp, Wotton Underwood, Bucks.

The other camps which were without mass miniature units were served by these units, one unit being moved into another camp when an intake required mass miniature radiography. In this way the nine units were able to serve all the camps in the Buckinghamshire area.

Later, when the Sussex area opened, 10, 11, 12 and 13 M.M.R.Us. were despatched to those camps and 4 M.M.R.U. was moved from Buckinghamshire to the Sussex area. Eight camps were opened in Sussex and were served by five units distributed at various camps. Two officers transferred from Buckinghamshire were responsible for these units.

Senior medical officers in charge of 136th Brigade and 18th A.G.R.A., in whose areas these camps were situated, were responsible in direct consultation with the officer commanding the unit, for the moves of the units locally.

FIELD WORK OF THE MASS SURVEY

Most units were accommodated in Nissen huts or similar buildings. This accommodation was adequate, although during the extremely mild weather that occurred in April during the earlier part of the survey there were many complaints concerning the heat. The Nissen hut served as the permanent base of the mass miniature X-ray unit. Whenever possible the hut chosen was in the immediate vicinity of the M.I. hut as the mass miniature examination generally followed the medical inspection. Units which served other camps from their permanent bases often utilised a large Nissen hut type of garage. Many officers and other ranks expressed their preference for working in this type of hut. In some of the units a single-phase 30-amp. main was utilised as the source of electric power.

The rate of screening varied enormously. It was found that 60–75 repatriates per hour was a comfortable rate. Where repatriates arrived in big numbers a rate of 200 an hour was reached, but this could be maintained only for short periods.

Periodic check of the units for scattered radiation using sensitised dental films was carried out and the safety arrangements were entirely satisfactory.

The one weakness in this vast scheme was the fairly common failure on the part of 45th Division to report the M.M.R. findings to Records.

The Work of the M.M.R. Units, Prisoner-of-War Repatriates

Total examined	Total analysed	Abnormals	Old T.B., calcified foci, old pleurisy, glandular enlargements, etc.	Active T.B.
108,000	92,420	4,433 (4·8 per cent.)	2,171 (2·35 per cent.)	323 (0·35 per cent.)

MEDICAL PHOTOGRAPHY*

Instruction in the principles and practice of photography was included in the courses offered in the Army X-ray School. Such instruction was made all the more necessary because of the prevailing shortage of photographic apparatus and materials. As the war proceeded there came into being a demand for the means whereby permanent graphic records of war injuries might be made. To meet this the Army X-ray School drew up a scale of photographic equipment for such purposes and provided a complete set for use in training. Little use was made of these facilities, however, mainly for the reason that the Medical Research Council accepted responsibility for the systematic collection of illustrations of war-wounds. A team consisting of medical artist and medical photographer was nominated by the M.R.C. and sent to overseas theatres of war by arrangement with the Directorate of Medical Research.

In the considered opinion of the Consultant in Radiology the ideal peace establishment and organisation of such a photographic section of the Army X-ray School would be:

Staff	Officer-in-charge	G.S. officer with suitable technical qualifications.	
	Sergeant instructor	1.	do.
	Other Rank	1.	do.

Duties	Teaching	Service	Records
	Radiographic and medical photography	Testing of materials and chemicals	Care of radiographic and photographic records
	Colour processes	Testing and maintenance of all photographic apparatus	Preparation of reproductions, lantern slides, diagrams, etc.
		Investigation of complaints	Records of A.M.D. documents on microfilm
		Planning of darkrooms, etc.	
		Maintenance of contacts with manufacturers.	

* Many of the achievements of the photographic section of the Army X-ray School are mirrored in *Medical Photography*—(*Focal Press*). ('Radiographic and Clinical') by T. A. Longmore who, during the war, was senior instructor on the staff of this school.

Plates XXIV–XXXVIII comprise a selection of photographs illustrating some of the types of apparatus used in Field X-ray work and the conditions under which it was carried out. Much of this apparatus was specially adapted to suit these conditions.

Plate XXXIX, illustrating a case of gas gangrene is an outstanding example of the work which could be done under the most adverse conditions.

INDEX

AO4173. Wt. 4300. 1/55. J.W. & Sons Ltd. 518. S.O. Code No. 32-423-42-4