WAR CASUALTIES

Their Relation to Medical Service and Replacements

By

Albert G. Love,

Lt. Colonel, Medical Corps, U.S.A.

ARMY MEDICAL BULLETIN No. 24

PUBLISHED AT THE MEDICAL FIELD SERVICE SCHOOL,

CARLISLE BARRACKS, PA.

WAR CASUALTIES

THE ARMY MEDICAL BULLETIN

NUMBER 24

The Army Medical Bulletin is published from time to time for the general dissemination of information relating to administrative reports, statistics of disease, Medical Department training projects and other matters of a medico-military nature to members of the Medical Department of the Army of the United States—Regular Army, National Guard and Organized Reserves.

1930.

By direction of the Secretary of War the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

M. W. IRELAND,
The Surgeon General.

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1931

FOREWORD

The statistical records of the World War, setting forth the incidence of disease, injuries and battle casualties and of the work of the Medical Department during that period have been inscribed in history. As in the case of the Civil War, these records are of great interest from the standpoint of medical science and, for military purposes, furnish the soundest basis for war planning. For the latter purpose, however, these data must be subjected to careful analysis, takng into consideration all evident and conceivable factors creating or influencing them. Upon the figures of experience thus obtained, and comparing the past with present and future conditions, must be based our estimates of the losses to be expected and of medical service requirements in future military operations.

In his official position in the Surgeon General's Office, Colonel Love has had before him the records of the World War and his study of them has been painstaking and exhaustive. The facts and deductions from Colonel Love's study are now available for use by the war planning agencies in estimating Medical Department requirements as to supply, transportation, evacuation, hospitalization, and other essential features that enter into the development of the medical service. Particularly is this study valuable in determining more accurately than by previous methods the hospitalization requirements in any given situation, so that the result can become an entry in the special plan under consideration and thus constitute a directive rather than a contention.

As the wounded and sick returned to duty afford a valuable source of trained replacements, this work will also be of value in studies relating to personnel procurement and replacement.

C. R. REYNOLDS,
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Commandant, Medical Field Service School.

PREFACE

An attempt is made in the following pages to outline a system for estimating, on the basis of our casualty experience in past wars, the requirements for medical service including hospitalization and evacuation of front line casualties; and further to show how intimately the question of replacements for all branches of an army is related to casualty rates, and also to prompt and efficient medical care.

It has been recognized for a number of years both here and abroad that the more efficient the medical service and the nearer the hospitals are to the combat zone, other conditions being equal, the smaller the demands for untrained replacements. Consequently, provisions for an adequate medical service and sufficient hospitalization should be an essential part of every war plan.

The only excuses that can be offered by the author, who makes no claim of having any more than a rudimentary knowledge of mathematics, for not leaving the task to some one better qualified are: First, that he felt that he was reasonably well acquainted with the sources of information and the available basic material; second, that no one better qualified had sufficient time or interest in the subject to undertake it.

For the convenience of the reader, a great many figures have been drawn so as to serve the double purpose of illustrations and tables, although this has often resulted in unorthodox construction.

This work was made possible by General M. W. Ireland, whose thorough knowledge of the medico-military organization and his sympathetic appreciation of the various problems that are connected with it, are a constant help and inspiration to all members of the Medical Department.

Grateful acknowledgement is made to Dr. L. J. Reed, Professor of Biostatistics, Johns Hopkins University, for training in statistical methods while in that institution and for his assistance during the early stages of the work. He has not had an opportunity to follow the development of the study nor to examine the completed manuscript.

Lt. Colonels H. C. Gibner, G. L. McKinney, A. D. Tuttle and C. C. McCornack have made many helpful criticisms and suggestions.

Grateful acknowledgment must be made also to Mr. B. M. Oppenheim for his construction of the Figures, and also for his assistance in the computations.

ALBERT G. LOVE

December 17, 1930.

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SECTION I.

I. MEDICAL SERVICE IN WAR.

A. INTRODUCTION.

An efficient medical service is essential to the military success of an army, not only in protecting the health of the troops by initiating proper sanitary measures, but also by insuring the return of sick and wounded men from the hospitals to their organizations as promptly as possible.

An adequate medical service is also of importance in maintaining the morale of any fighting force. One can easily visualize the difference in the mental attitude of two men going into battle, the one realizing that he will receive medical attention when required, while the other one knows that he may lie wounded on the battle field for many hours before he receives treatment.

In addition to the military necessity for an efficient medical service, the people in all modern, civilized, and well organized countries expect and demand that proper medical attention and adequate hospitalization shall be provided for the men in the military service. This is especially true in time of war, when armies must be composed of young men drawn from practically every family in the country.

Although the public is willing to pay for any amount of medical service which is essential for military success, and to properly care for the individual, yet it must be only so large as the necessity requires. To divert too much material and too many men from the other branches of the army for the medical service may jeopardize the military success of an expedition.

The answer to the question of "What is an adequate medical service?" differs necessarily with each war plan, and its solution requires careful consideration and study. A number of factors must be considered, of which the following are especially important.

a. The size of the military force to be used and the number of recruits included. There is always more sickness among men when assembled in large numbers, and still more among recruits than among seasoned men.

b. The epidemiological condition of the population and of the territory to be occupied. More sickness will inevitably occur among troops operating under war conditions in a country with unfavorable health conditions, or in one with an unhealthy and over-crowded civil population than in the United States.

c. The military forces of the enemy, the character of his military weapons, and the possibilities as to the military defenses of his country are important. A careful study of these latter factors should assist one in making an approximate estimate of the relative number of wounded. Such an estimate is most important since a wounded man requires much greater and more prolonged care than a sick one.

If available statistics are systematically and carefully arranged and studied, the data may be helpful in solving the problem involved. The following study is an attempt in that direction. Before beginning the discussion of such data as may be presented, it is necessary to consider several general terms which will be used throughout.

B. TERMS USED AND CONSTANTS EMPLOYED.

1. **Strength.** — The strength of a command is the number of soldiers in that command. Since it varies materially from day to day, and especially so during periods of mobilization and demobilization, while the sick occur only among those present, it is necessary that we have an average daily strength for any period in question. The average daily strength is computed by adding together the strength of each day in a period, and then dividing the aggregate thus obtained by the number of days in the period, which obviously may vary from 2 to 365 or more days. Ordinarily, since military reports are furnished monthly, the strengths for the various days of the month are added, and the total is then divided by the number of days in the month to obtain an average daily strength for the month. The 12 such average strengths in the year are added and divided by 12 to find the average daily strength for the year. *It is important to remember that the strength used in this study, is always an average daily one although it may be averaged for one day, for a week, a month, a year or more.*

2. **Causes of sickness and injury.** — The causes of sickness and physical disabilities resulting therefrom and deaths are either diseases or injuries.

Injuries are subdivided into non-battle injuries and battle injuries.

a. Non-battle injuries occur either in peace or in war, from external causes other than the hostile act of a military enemy.

b. A battle injury or wound is one that is caused by a primary or secondary missile or by a deleterious gas set in motion by the hostile act of a military enemy. Wounds or injuries from projectiles dropped by airplanes many miles back of the front lines, or as a result of the sinking of a ship by a torpedo from a submarine, are properly included as battle injuries. Accidental injuries received while in action are not included under the head of battle injuries.

3. **Place of treatment.** — Cases of sickness and injury are further classified according to the place of treatment, as follows:

a. Hospital cases include the more seriously ill or injured, who are retained in hospital for treatment and consequently require hospital beds.

b. Quarters cases include the less seriously sick or injured, who require medical attention and are excused from the performance of all or part of their military duty, but remain in their quarters and hence do not require hospital beds.

c. Dispensary cases include the less serious cases of sickness or injury. They require medical attention, but their condition is not of sufficient gravity to necessitate their excuse from the performance of their military duties. Although such cases materially increase the work of the Medical Department as well as the amount of medical supplies required, they will not be included in the subsequent discussion. If, however, the total number of sick for whom medical supplies and attention must be provided should be desired, such data as are presented hereafter should be increased 50%[1].

4. **Percentage of cases treated in hospitals and in quarters.** — The percentage of cases which are treated in hospital or in quarters varies materially from time to time, and especially so during war as compared with peace. This is quite an important item, since it determines in part the number of hospital beds required. Fig. 1 shows the

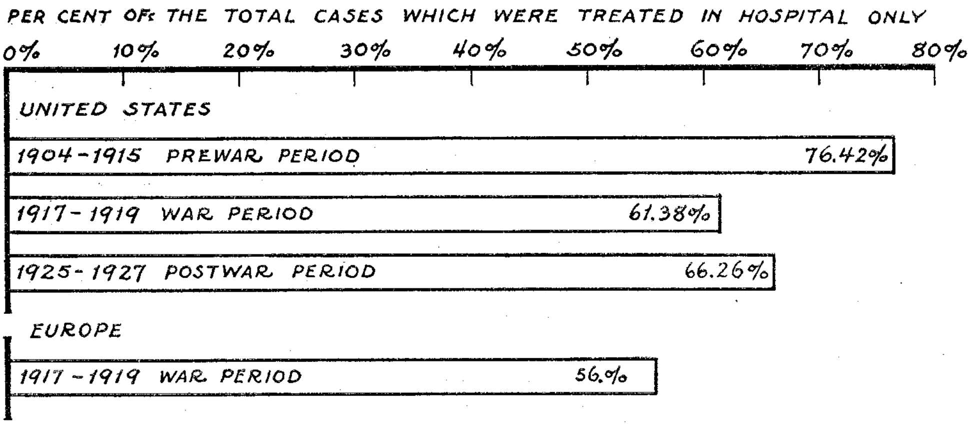


Fig. 1.—Percentage of cases of diseases and nonbattle injuries treated in hospital. Sources of information:

a. United States:

(1) 1904 - 1915. [2]

(2) 1917 - 1919. Total cases as published. [3] Quarter's cases estimated from: (a) Average days lost by each quarter's case during 1904 - 1915 [2] (7.24); and (b) the days lost in quarters in 1917. [2]

(3) 1925 - 1927. Total cases as published. [2] Quarter's cases estimated from: (a) Average days lost by each quarter's case during 1904 - 1915 [2] (7.24); and (b) days lost in quarters during 1925 - 1927. [2]

b. Europe in 1917 - 1919:

Estimated from: (a) Total cases in Europe as determined by the number of deaths there from diseases and nonbattle injuries, [3] and the fatality rate in the U. S. from the same causes during the same period [3] (Deaths ÷ Fatality Rate = Cases); and (b) the hospital cases in Europe during the last six months of 1918. [2]

percentage of cases treated in hospital among troops in the United States before, during and since the World War; and also in hospital in Europe during that period.

During the World War, although there were base hospitals in nearly all of the large camps in the United States, they were usually under different administrative control and were located some distance from the troop areas, hence probably the smaller percentage of cases treated in hospitals during that period, as compared with the prewar and postwar periods. In the Theatre of Operations in the American Expeditionary Forces, where the permanent hospital beds were still further removed from the troop area, the percentage of total sick sent to hospital was still smaller.

5. **Admission rates.** — Cases treated in hospital or quarters are officially reported to the War Department, but only local records are kept of dispensary cases. Each case treated in hospital or quarters is "Admitted to Sick Report", and hence is termed "Admission". Throughout the following discussion, the term "case" will be used as synonymous with "admission" and with "patient".

Before any comparisons can be made of the amount of sickness in the different commands, it is necessary to reduce the number of sick in each one to a common ratio of its strength. The unit of strength used might be the individual. The rates then would be so many cases per man, but this would necessitate the extensive use of decimals, which it is always desirable to avoid. Ordinarily in the United States Army the unit of strength used is 1000 men. Consequently, we speak of so many cases per 1000 strength. Thus, 1200 cases, or admissions, in a command of 2000 gives a rate of

$$1200 \div (2000 \div 1000) = 600 \text{ per } 1000.$$

The admission rates must also show how many cases occur in each 1000 men during any specified time. The time period may be a day, a month, or a year. A day's rate is 1/365 as large as one for a year, and a month's rate is 1/12 as great as that for a year, and also 30 times as large as the one for a day.

It is important to note that the strength used is always an average daily one for the period, but that the admission rate increases in proportion to the length of the period just as the cases do. The following formulae show the method of computing admission rates per 1000 men:

Daily rate per 1000=

$$\text{Day's cases} \div \frac{\text{Average daily strength}}{1000} = \frac{\text{Days cases} \times 1000}{\text{Avg. daily strength}}$$

Monthly rate per 1000=

$$\text{Month's cases} \div \frac{\text{Average daily strength}}{1000} = \frac{\text{Month's cases} \times 1000}{\text{Avg. daily strength}}$$

Annual rate per 1000=

$$\text{Year's cases} \div \frac{\text{Average daily strength}}{1000} = \frac{\text{Year's cases} \times 1000}{\text{Avg. daily strength}}$$

Annual rates are used ordinarily in the discussion of military and public health statistics. If the period during which the cases have occurred is less than one year, they must be increased correspondingly. Thus, if we wish to calculate an annual admission rate for the cases which occurred during one week, they must be multiplied by 52 before the final computing is done, or if an exact figure is desired, by 365 ÷ 7.

Annual admission rate per 1000 from one week's cases =

$$\frac{\text{Week's cases} \times 52 \times 1000}{\text{Average daily strength}}$$

Conversely, if one wishes to calculate an average daily admission rate from the aggregate cases of one month or of one year, they must be divided by 30 or 365 as required. Thus the average daily admission rate per 1000 from cases of one year is

$$\frac{\text{Year's cases}}{365} \div \frac{\text{Average daily strength}}{1000} = \frac{\text{Year's cases} \times 1000}{\text{Avg. daily strength} \times 365}$$

Throughout this study, daily admission rates will be used.

6. **Average days lost per case.** — Since each day of sickness in hospital means that a man is absent from his duty and is using a hospital bed for that time, the duration of treatment is quite an important item. The method of calculating this factor is quite simple. The formula is:

$$\text{Average days per patient} = \frac{\text{Aggregate no. of days lost by all cases}}{\text{Aggregate number of cases.}}$$

As with the admission rate per day, the average days per case may be for those of one day, one month, one year or more. If for one year the formula is:

$$\frac{\text{Days lost by all patients in year}}{\text{Number of patients during year}} = \text{Days lost per patient averaged for one year.}$$

Figs. 2 and 3 show the average days lost per patient (case) in different countries, at different times, and from different causes. In Fig. 2 the average is for the cases treated in *hospital and quarters* combined;

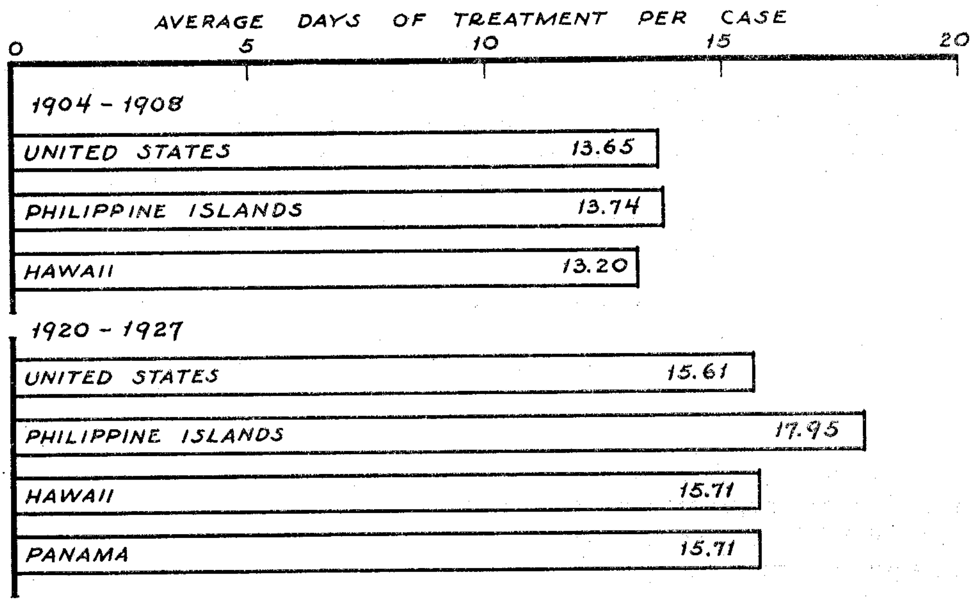


Fig. 2.—Average days of treatment per case of disease and nonbattle injury treated in hospital and quarters combined among white and colored American troops in different countries at different periods.

Sources of information: 1904 - 1908. [2]

1920 - 1927. [2] The averages for the troops in the P. I., Hawaii, and Panama include only time lost while under the treatment there, and do not include the time lost after departure by cases sent back to the U. S.

NOTE: The average days per case of white soldiers in the U.S., 1925 - 1927, was 16.35.

but in Fig. 3, the data shows in addition, the average for each case of disease and non-battle injury in *hospital* only, in the United States and Europe during the World War, and also that for each gas case and gunshot case in hospital in the American Expeditionary Forces.

One sees from Fig. 3 that the duration of treatment for a gunshot case was more than twice as great as it was for a gas one, which in turn was much more than that for a disease and non-battle injury case; and further that the average treatment time for each hospital case of disease or non-battle injury was longer in the American Expeditionary Forces than in the United States. The last mentioned fact was apparently the result of at least three factors:

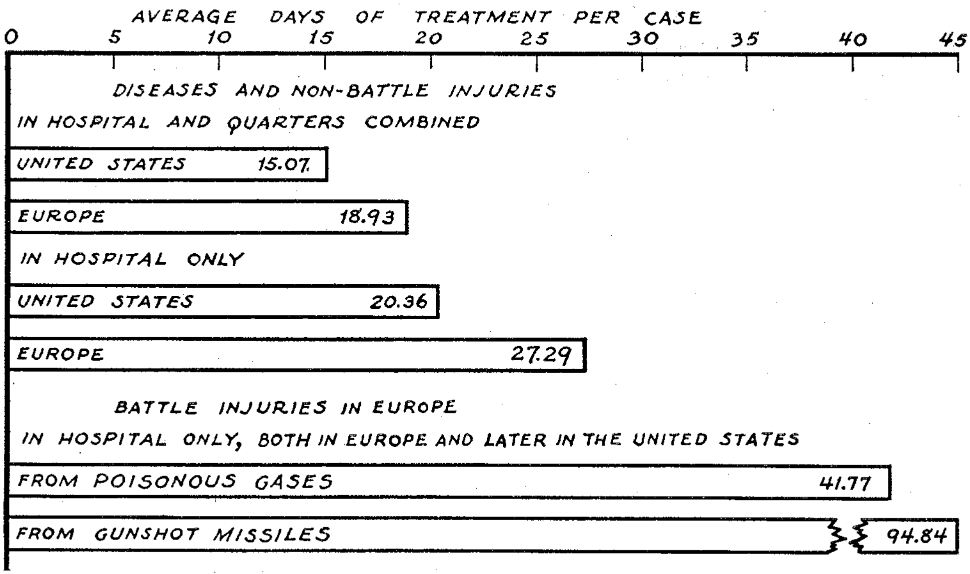


Fig. 3.—Average days of treatment per case in the United States and Europe during the World War (April 1917 - December 1919).

Sources of information:

a. Diseases and nonbattle injuries:

(1) In hospital and quarters combined:

(a) United States.[3] (b) Europe: Total cases as estimated for Fig. 1, (b). Hospital cases as published,[3] slightly reduced to exclude quarter cases during 1917[2] and the first six months of 1918,[2] as indicated by the experience during the last six months of 1918.[2] The difference between the total cases and hospital cases when multiplied by 7.24 (See Fig. 1, (a) (2)) gives the estimated days for quarter's cases. These latter added to the number of days as published[3] give the estimated total days to be divided by the estimated total cases.

(2) In hospital only:

(a) United States. Estimated quarter cases multiplied by 7.24 (See Fig. 1, (a) (2)) to find estimated quarter's days. This number subtracted from the total days[3] gives the estimated days in hospital only, which is then divided by the hospital cases (Total cases[3] - estimated quarter cases) equals average days per case.

(b) Europe.[1]

b. Battle injuries in Europe.[3]

a. A smaller percentage of cases, and only those of a more serious nature and consequently of longer duration, were sent to the hospital in the American Expeditionary Forces.

b. The hospitals in the American Expeditionary Forces were a greater distance from the troop areas, and consequently patients were apparently less promptly returned to their organizations or to replacement depots.

c. To expedite the demobilization after the armistice many patients who had recovered were returned to the United States as sick. This resulted in an unnecessary loss of time in hospital for these cases and increased the average time lost by each one.

The longer treatment since the World War, as compared with that before, is due apparently to the more intensive hospital treatment which patients now receive.

7. **Noneffective rates.** — The noneffective rate shows the number of patients that, after several months accumulation of them, will be sick each day in a period, or as usually expressed "Constantly sick." It is always expressed as *a daily rate* for which the formula is:

Daily noneffective rate per 1000 strength =

$$\frac{\text{Patient days}}{\text{Days in period}} \div \frac{\text{Average daily strength}}{1000} = \frac{\text{Patient days} \times 1000}{\text{Average daily strength} \times \text{days in period.}}$$

Like the daily admission rate, it may be the average for one day, one week, one year, or more. If it is an average for one year, the formula is:

Daily noneffective rate per 1000 strength =

$$\frac{\text{Patient days during year}}{365} \div \frac{\text{Average daily strength}}{1000} = \frac{\text{Patient days during year} \times 1000}{\text{Average daily strength} \times 365.}$$

Fig. 4 shows the relationship that exists between the average daily admission rate, the average days lost per patient, and the noneffective rate. This relationship is very important, for by its use we can determine the ultimate number of sick for any given admission rate, if the average duration of each case (which is more nearly constant than the admission rate) is known.

As an illustration of the use of this formula, let us take our experience with enlisted men in the United States during the World War, when the noneffective rate was 50.40.[3]

$$(a)\quad \frac{\text{Patients per year} \times 1000}{\text{Average daily strength} \times 365} = \text{Daily admission rate per 1000 strength averaged for one year}$$

$$(b)\quad \frac{\text{Days lost from sickness in one year}}{\text{Patients per year}} = \text{Days lost per patient averaged for one year}$$

$$(c)\quad \frac{\text{Days lost from sickness in one year} \times 1000}{\text{Average daily strength} \times 365} = \text{Daily noneffective rate per 1000 strength averaged for one year}$$

$$(d)\quad \frac{\cancel{\text{Patients per year}} \times 1000}{\text{Average daily strength} \times 365} \times \frac{\text{Days lost from sickness in one year}}{\cancel{\text{Patients per year}}}$$

$$= \frac{\text{Days lost from sickness in one year} \times 1000}{\text{Average daily strength} \times 365}$$

$$\therefore$$

$$(e)\quad \text{Daily admission rate} \times \text{Days lost per patient} = \text{Daily noneffective rate}$$

Fig. 4.—The relation of the noneffective rate to the average daily admission rate and the average days lost per patient.

Enlisted men, U. S., April, 1917—December, 1919.

Admissions	2,577,261
Average daily strength per year	766,726
Days lost during period	38,835,016
Days in period	1,005

$$\text{Daily admission rate} = \frac{2{,}577{,}261 \times 1000}{766{,}726 \times 1005} = 3.34466$$

$$\text{Days lost per patient} = \frac{38{,}835{,}016}{2{,}577{,}261} = 15.0683$$

$$\text{Noneffective rate} = 3.3447 \times 15.0683 = 50.3989$$

Note:- All rates are per 1000 of strength.

Since the average duration of treatment includes days lost by cases of long duration as well as by those of short duration, the ultimate noneffective rate is obviously not reached until the cases with the longest treatment have left hospital. As will be shown later, the duration of treatment for cases of disease and nonbattle injuries varies from one day to approximately one year; for men wounded by war gases, from one day to approximately one year; and for gunshot battle injuries, from one day to 2.5 years. Consequently, the ultimate noneffective rate is not reached in cases of disease and nonbattle injuries until the end of one year after M day, and of gas and gunshot injuries not until one and two and one-half years, respectively, from the beginning of hostilities.

Since the noneffective rate is equal to the product of the average days per patient multiplied by the daily admission rate, it necessarily follows that with a theoretical daily admission rate of 1.00 per 1000 the noneffective rate would be equal to the average days per patient. Thus, if the daily admission rate in the United States during the World War had been 1.00 when the average days per sick case treated in *hospital and quarters* were 15.07, the corresponding noneffective rate would have been 15.07 (15.07×1); while in the American Expeditionary Forces with an average of 18.93 days per case, it would have been 18.93 (Fig. 3).

For cases treated in *hospital only,* for which the average days per case were 20.36 in the United States and 27.29 in the A.E.F., the corresponding noneffective rates with a daily admission rate of 1.00 per 1000 to hospital only, would have been 20.36 and 27.29 respectively (Fig. 3.)

These and other related facts are summarized in the following table.

Table 1. Percentage of cases treated in hospital with the average days per case and the corresponding noneffective rates when the admission rates are as assumed.

Country	Percentage of cases treated in hospital.	Hospital & Quarter cases			Hospital cases		
		Admission rate	Average days per case	Noneffectives (Patients)	Admission rate	Average days per case	Noneffectives (Patients)
	(1)	(2)	(3)	(4)a	(5)b	(6)	(7)c
U. S.	61.38	1.00	15.07	15.07	.6138	20.36	12.50
Europe	56.00	1.00	18.93	18.93	.5600	27.29	15.28
U. S.	61.38	1.63	15.07	24.56	1.00	20.36	20.36
Europe	56.00	1.78	18.93	33.70	1.00	27.29	27.29

a. (4) = (2) × (3)
b. (5) = (1) × (2)
c. (7) = (5) × (6)

C. ADMISSION RATES FOR TROOPS IN THE UNITED STATES.

Can any information be obtained from the vital statistical experience of the United States Army which will be helpful in determining approximate future admission rates under specified conditions? The answer is believed to be in the affirmative.

8. **Decline since 1819.** — To find what changes have occurred in the army admission rates in the United States since the beginning of our medico-military records, let us examine such data as are available. Fig. 5 shows the daily admission rates to hospital and quarters from non-

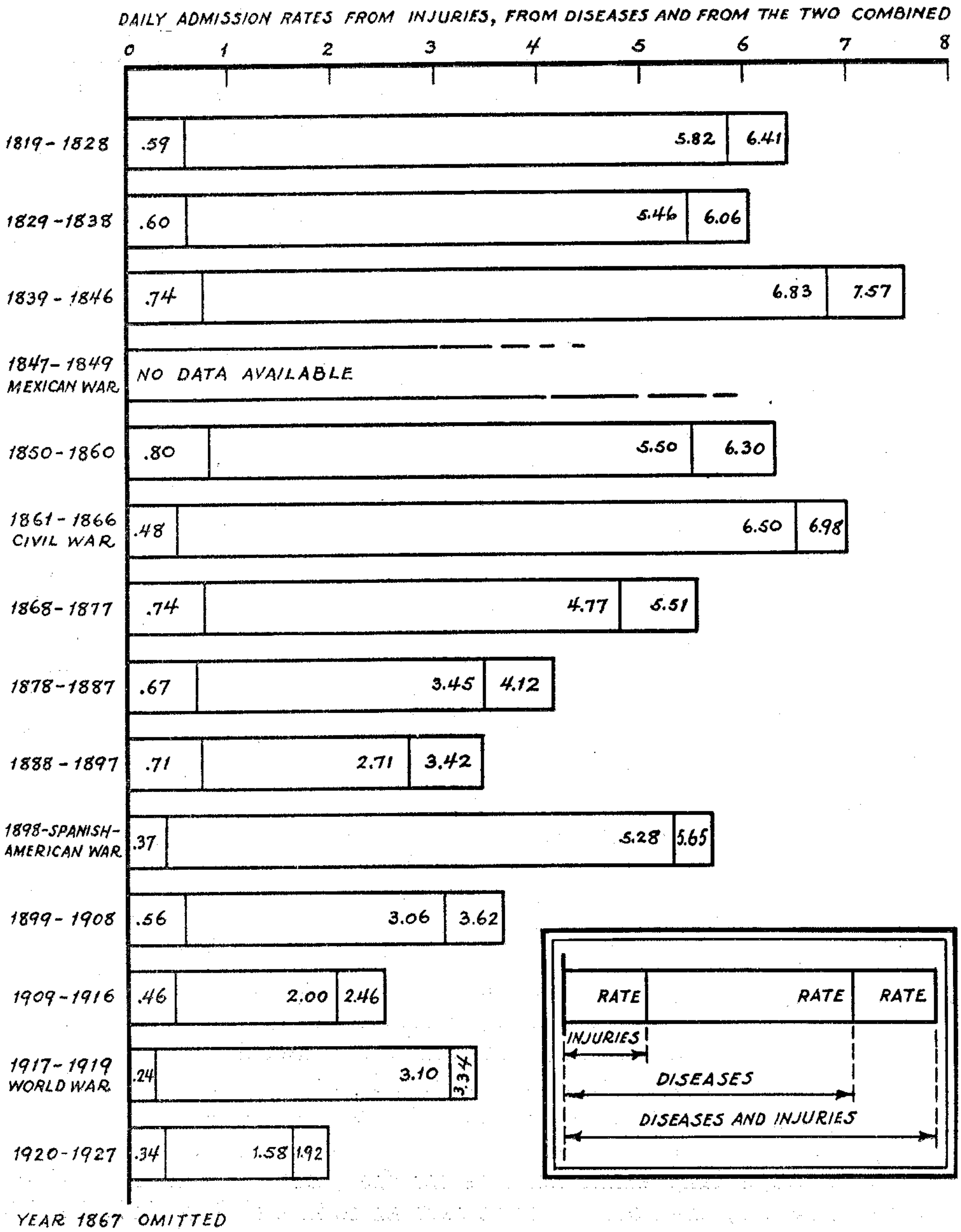


Fig. 5.—Daily admission rates to hospital and quarters combined from nonbattle injuries, diseases, and the two combined per 1000 strength, American troops, serving in the U. S., by periods from 1819 to 1927 inclusive. [1 2 3 4 5 6 7]

battle injuries, from diseases, and from both combined by periods from 1819 through 1927, a period of 108 years. It is apparent from this graph that, with the exceptions as noted below, there has been a very marked and steady decline in the admission rates from all causes during the periods of peace, the one in 1920-1927 being only one-fourth as great as that in 1839-1846. The first exception is that the one for each of the first two periods was lower than that for the third, which is probably to be accounted for by the incompleteness of the reports during the early years; the second is that a slight increase occurred in the rate for the period following the Spanish-American War over that for the one preceding it, due to conditions resulting from the war.

9. **Increase during war.** — Another important fact is that during war periods the general admission rate has always been much greater than the one for the preceding and succeeding periods, due to the marked increase in the number of cases of disease—at the same time an actual decline in the admission rate from non-battle injuries is noted.

10. **Decline in succeeding war rates.** — Although the reporting of cases during the Civil War was not nearly so complete as during the World War, the admission rate during the former was more than twice as great as that during the latter. The Spanish-American War rate was also much greater than that of the World War, notwithstanding the pandemic of influenza which occurred during the latter conflict.

11. **Estimation of future admission rates for unseasoned troops.** — Since there has been such a marked decline in the admission rates under both peace and war conditions, it is obvious that it would be unwise to go back farther than the World War period for experience to use as an indication of future medical requirements. If, then, the World War experience is used, what rate should be selected for a war army in the United States? The average daily admission rate to hospital and quarters of 3.34 per 1000 strength in the United States for the statistical period of the World War (April, 1917 - December, 1919), is not a satisfactory one to use,[3] because it included the year 1919 when the troops who had been well seasoned by service in Europe were returned to the United States for demobilization. What is desired are the probable rates among unseasoned troops as they are mobilized in large numbers for war training. Probably the best experience is that of 1918, for during that year there was a constant inflow and outgo of a large number of men at the various training camps in the United States. If the epidemic influenza months of September and October are excluded, the average daily admission rate to hospital and quarters for the year was 3.50 per 1000.[3]

An average daily admission rate for the year, however, is probably not a satisfactory one upon which to base an estimate of the probable requirements of medical service, since many factors will cause variations above or below the average. Certainly no engineer would plan a bridge to carry only the average load. Similarly, in planning medical service, it would be unwise to base the expectancy upon an average rate. Unusually high rates which continue for only a few days, or those which occur from exceptional outbreaks of infectious disease, can hardly be provided for, but provision should be made for at least a reasonable variation above the average.

12. **Causes of variations in admission rates in United States.** — a. *Season.*—Fig. 6 shows that, after excluding September and October, the average daily admission rate of 3.50 to hospital and quarters in 1918 was exceeded in January, March, and April. If the average for the year

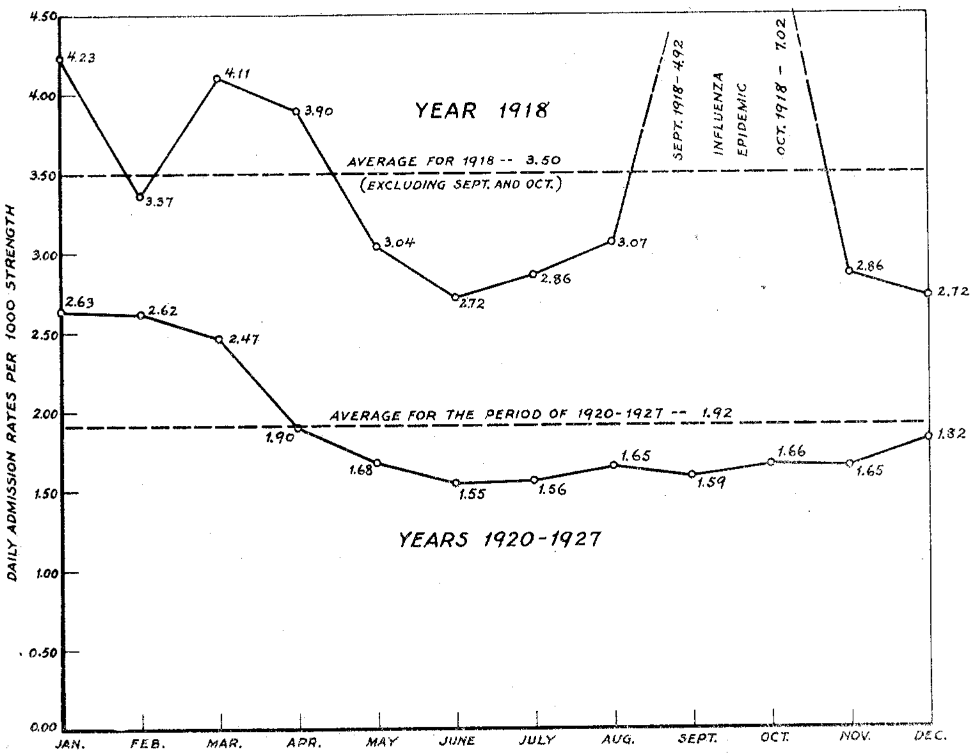


Fig. 6.—Daily admission rates to hospital and quarters from diseases and nonbattle injuries by months per 1000 enlisted men serving in the United States.[2]

had been used as an estimation basis, there would have been a shortage of hospital beds for the United States as a whole during the entire period of those three months; furthermore, these seasonal variations above the average for the entire United States do not show those which occurred in many camps, from factors other than seasonal. Figure 6 shows also the excess of the rates for unseasoned troops in 1918 over those for the peace time Army from 1920 to 1927.

b. *Race.* — Race is another material factor in causing variations in admission rates. Figure 7 shows that during peace there is more sickness among the white than among the colored troops, due apparently in part to the larger percentage of new enlistments among the white soldiers. Thus from 1923-1927, inclusive, 60 per cent of the white men enlisting had no

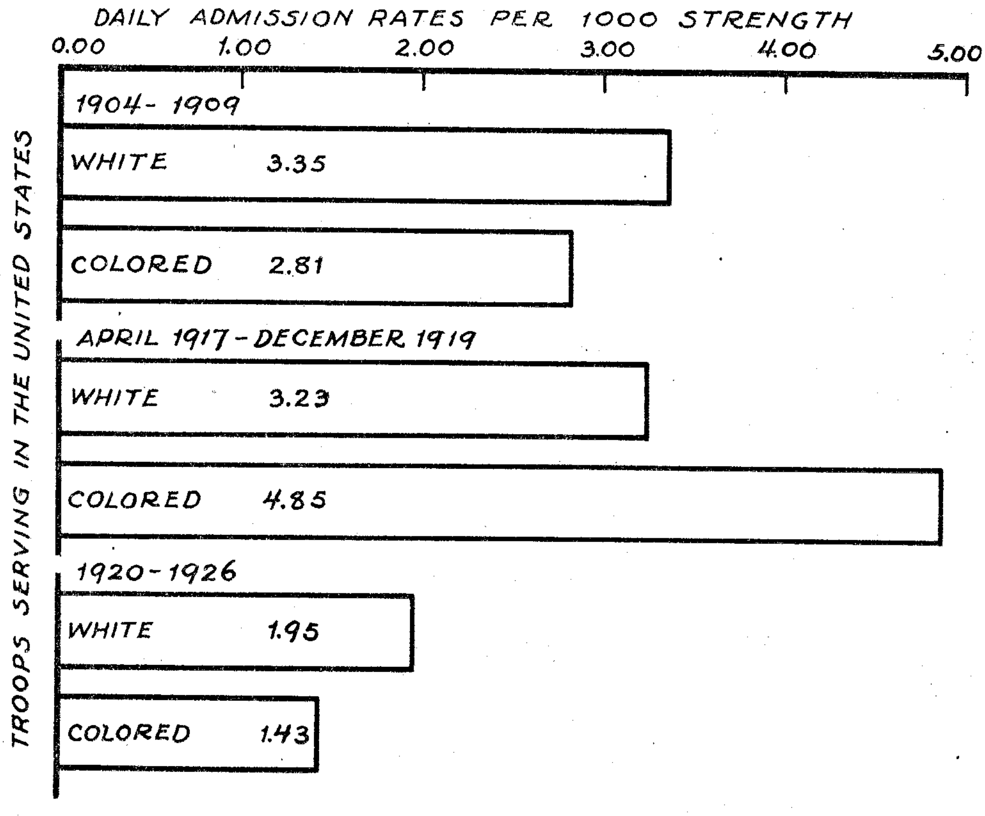


Fig. 7.—Daily admission rates to hospital and quarters from diseases and nonbattle injuries per 1000 strength of white and colored troops by color, serving in the United States at different periods. [2] [3]

previous service, while only 31 per cent of the colored enlistments were without it. The graph points out, however, that during the World War, when practically all recruits, both white and colored, were without previous service, the latter had 1.5 times as much sickness as the white ones.

c. *Nativity.* — The region from which the recruits are drawn is also a very material factor in determining the amount of sickness. Fig. 8 shows the relative amount which occurred among the soldiers from various States, as compared with the average for the United States at 100. The

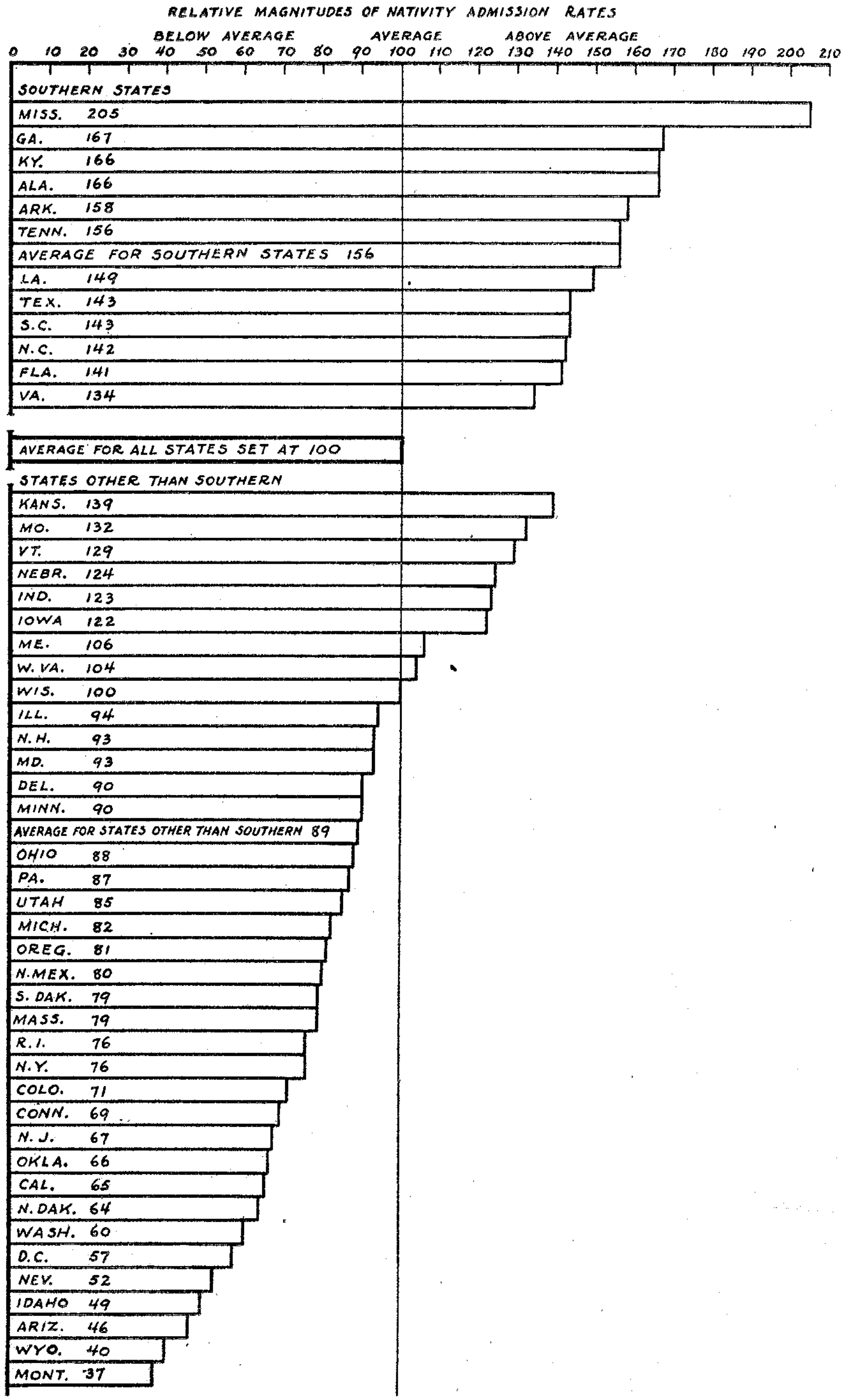


Fig. 8.—Relative magnitude of admission rates to hospital and quarters from diseases and nonbattle injuries among white men by nativity (native state) serving in the United States and Europe from April 1, 1917 through December 1919. [1]

white recruits from the Southern States had 56% more than the average, while those from the other States had 11% less.

These same data arranged by corps areas are shown by Fig. 9 which gives not only the variation in the combined rates for white and colored troops, but also that for the white men alone. The latter from the area of the present Fourth Corps (Southern states) had 59% more than the average amount of sickness, while those from that of the present Ninth

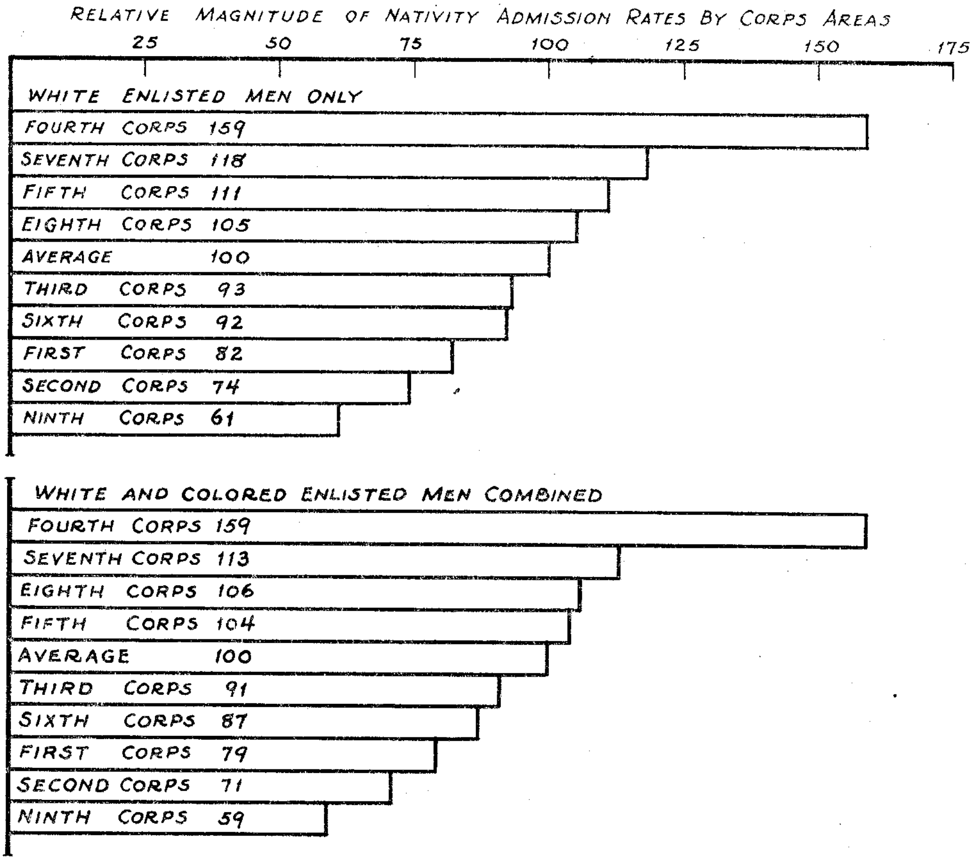


Fig. 9.—Relative magnitude of admission rates to hospital and quarters from diseases and nonbattle injuries by nativity (native state), arranged by Corps Areas, among white troops, and also among white and colored troops combined, who were serving in the United States and Europe from April 1, 1917 through December 1919. [1]

Corps (Pacific coast and Rocky Mountains) had 39% less.

d. *Camps.* — The combined results of the various factors of race, nativity, season, overcrowding, etc., all of which affected the admission rates to hospital and quarters in the various training camps, are shown by Fig. 10. This graph shows not only the average daily admission rate

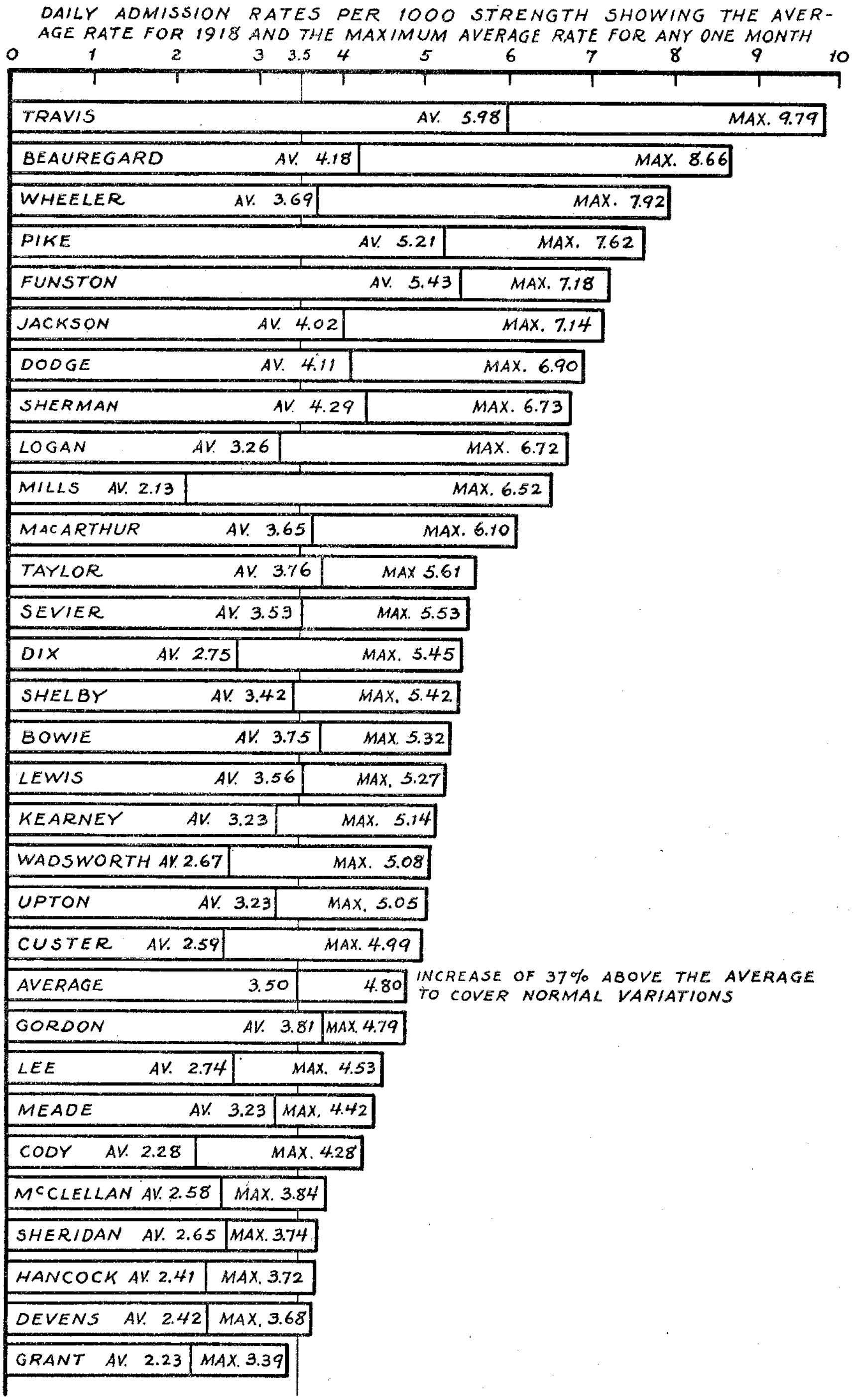


Fig. 10.—Daily admission rates to hospital and quarters from diseases and nonbattle injuries per 1000 strength, American troops in thirty large camps during 1918, excluding September and October. Also the maximum rate averaged for any one month in each camp, again excluding September and October.[3]

for one year in each of 30 concentration camps, but also the average daily rate for the worst calendar month. The average daily admission rate in the United States of 3.50 to hospital and quarters (excluding September and October) was exceeded by the camp average in 14 of the 30 camps, and by the rate for the worst month in all of them except one. Clearly then, the average rate in the United States for the year would have been an unsatisfactory one upon which to base the expectancy of hospital requirements. A daily admission rate of 4.80, or an increase of 37 per cent over the average of 3.50, was exceeded by the maximum daily rate for the worst month in 21 of the 30 camps, and was almost equaled in one other. Apparently then, an increase of 37% to cover expected variations above the average rate would not be excessive for the United States as a whole, higher or lower rates being used locally depending upon the nativity and color of the troops (*infra*).

13. Admission rates in United States camps, 1918. — All of the 30 camps were in operation during the entire year of 1918. The minimum average daily strength in any one of them for any one month was approximately 8,000, and the maximum slightly over 50,000.[3] There was then sufficient population in each camp during every month to furnish reliable admission rates.

a. *To hospital and quarters combined.* — Fig. 11 shows how often the various daily admission rates to *hospital and quarters* combined averaged by months (excluding September and October) occurred in the 300 camp-months (30 camps × 10 months each). Thus there was a daily admission rate of 1.50 per 1000 in 7 per cent of the camp-months; 2.00 per 1000 in 14 per cent, and 4.00 per 1000 in 11 per cent, or in 33 camp-months. The average rate of 3.50 occurred in 12 per cent of the camp months, rates less than 3.50 in 50 per cent, and greater in 38 per cent of them.

One sees then that, if the average rate of 3.50 had been selected as a basis for estimating medical requirements, it would have been exceeded in 38 per cent (see right hand margin of Fig. 11) of the camp-months; that is, in 114 of the 300 camp-months there would have been more hospital sick than available hospital beds. Also, if an admission rate of 4.50 per 1000 had been so selected, there would have been a higher rate of sickness in 19% of the months, or 57 camp-months.

It is suggested that the admission rate of 4.80, or one 37% above the average 3.50 (see Fig. 10), be adopted as the basis for estimating the requirements for medical service and hospital beds for mobilization in the United States under similar circumstances. This rate occurred in 7% of the camp-months and a greater one in approximately 15% of them. Consequently, if we use 4.80 we will have provided for 85% of the probable monthly rates.

If the hospital beds required for such an admission rate (4.80 × 12.50* = 60.00 per 1000) are provided, and properly distributed to corps

* See Table 1, p. 10.

areas, there will usually be a bed for every sick or injured man in the training camps in the United States; the excess can be provided for by emergency beds. This estimate will also be sufficient to provide for dispersion of beds. It does not, however, include any provisions for the sick returning to the United States from any expeditionary area. For such an estimate see page 68.

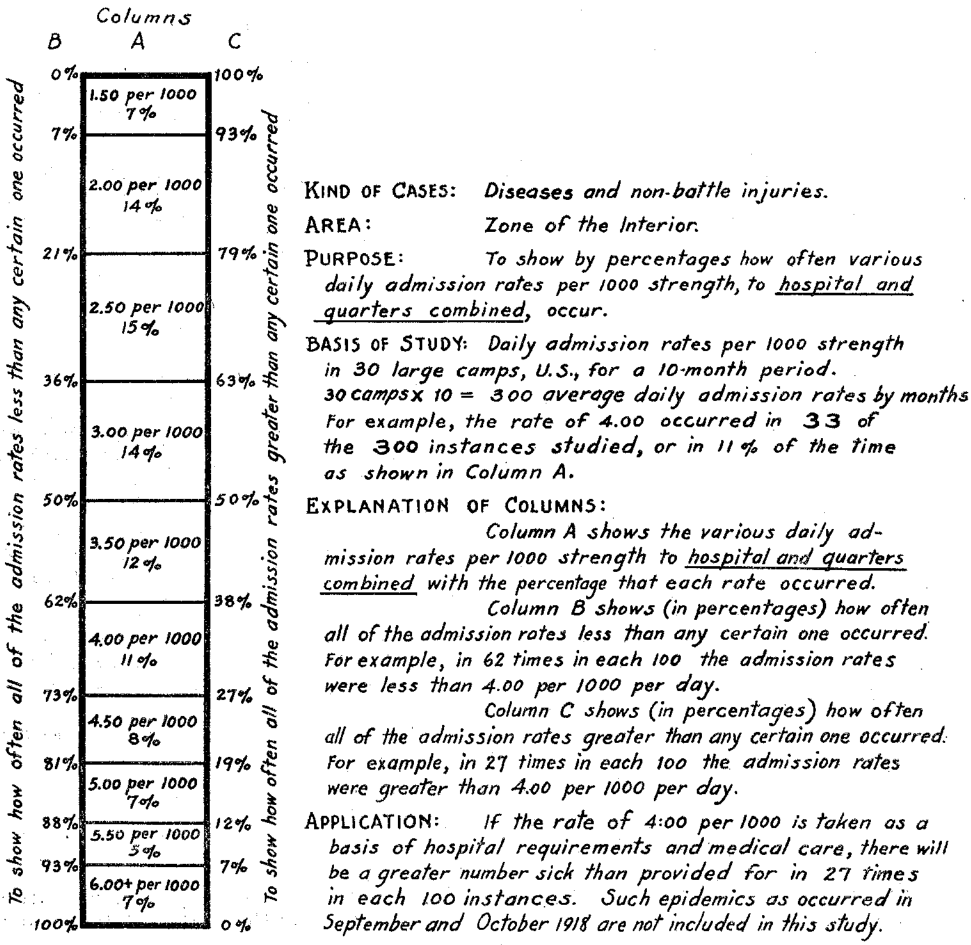


Fig. 11.—Relative frequency of daily admission rates from diseases and nonbattle injuries to hospital and quarters combined per 1000 strength in 30 large camps in the United States during 1918, exclusive of September and October. 3

NOTE: For method of graduation see Fig. 77, p. 144.

b. *To hospital only.* — Fig. 12 shows how often the various admission rates to hospital only (each one of which is 61.38% of the admission rate to hospital and quarters combined) occurred. If the requirements for hospital beds had been based upon an expected daily admission rate of 3.00 to hospital only, there would have been a deficiency of hospital beds in only 14% of the camp-months. We have suggested 2.95 to hospital, or the equivalent of 4.80 to hospital and quarters combined.

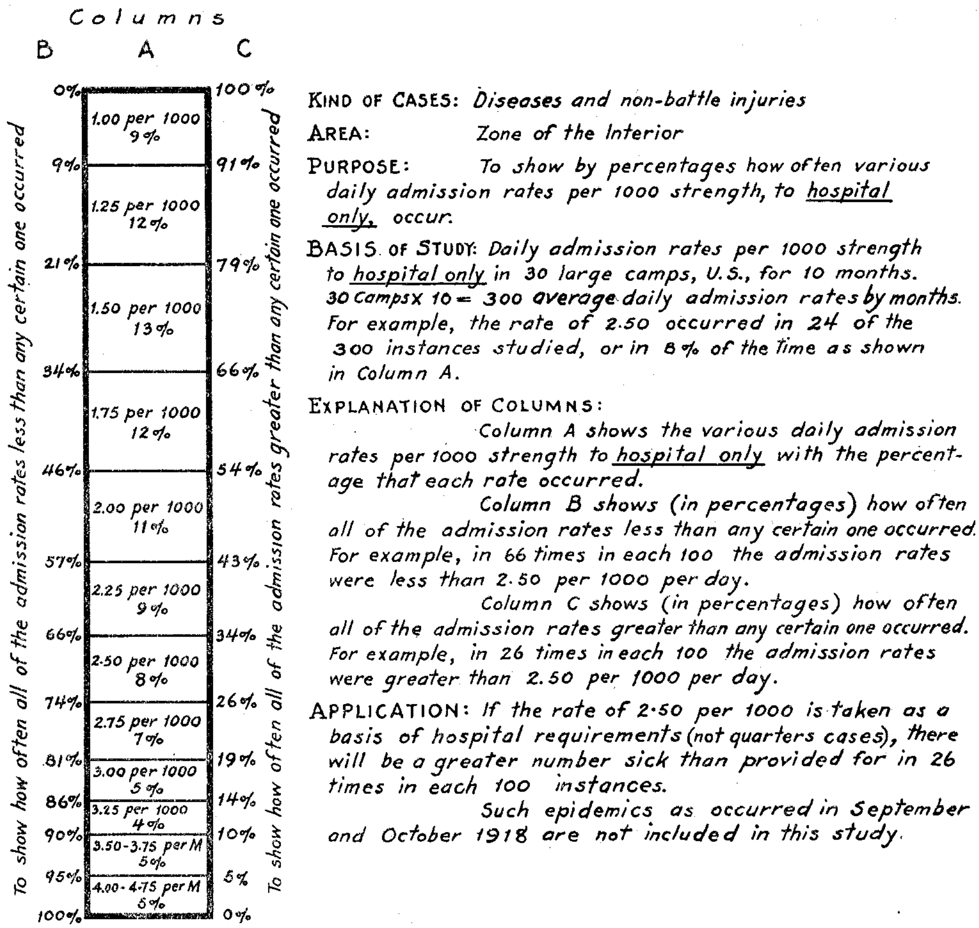


Fig. 12.—Relative frequency of daily admission rates from diseases and nonbattle injuries to hospital only per 1000 strength in 30 large camps in the United States during 1918, exclusive of September and October.

NOTE: For method of graduation see Fig. 78, p. 145. Hospital cases calculated from basic distribution Table 3 as 61.38% (Fig. 77, p. 144) of total cases.

c. *Interrelation of admission and noneffective rates.* — Fig. 13 shows for each admission rate to hospital and quarters, the equivalent one to hospital only, and the two corresponding noneffective rates. Thus when

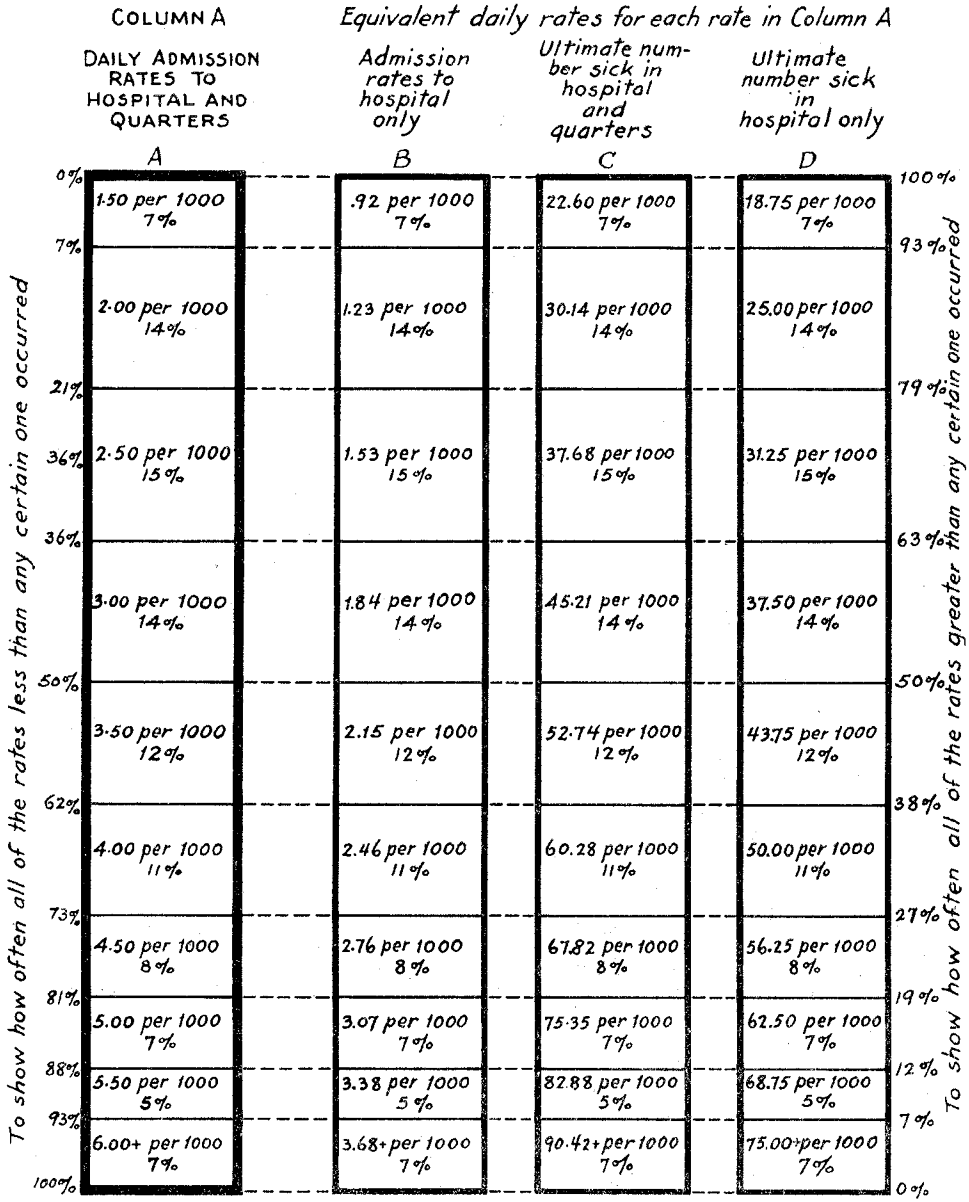


Fig. 13.—To show for each daily admission rate to hospital and quarters combined from dsieases and nonbattle injuries in the Zone of the Interior (See Fig. 11), the corresponding rate to hospital only; and also the ultimate number of sick accumulating from each daily admission rate.

NOTE: Column A is from Fig. 11. The rates in B, C, and D are calculated from the corresponding ones in A by multiplying by 61.38%, (see Fig. 1), 15.07, (see Fig. 3), and 12.50 (see Table 1), respectively.

the admission rate to hospital and quarters is 4.00, the corresponding one to hospital only is 2.46, and the number ultimately sick is 60.28, of which 50.00 are in hospital, with 10.28 in quarters.

Example:

If the admission rate to hospital and quarters combined = 4.00
Then the admission rate to hospital only=4.00 × 61.38%* = 2.46
Also the sick in hospital and quarters=4.00 × 15.07 † = 60.28
And the sick in hospital only=2.46 × 20.36 † = 50.00
Or also the sick in hospital only = 4.00 × 12.50 § = 50.00
Then the sick in quarters only = 60.28 — 50.00 = 10.28.

* Figure 1. † Figure 3. § Table 1.

D. ADMISSION RATES FOR OVERSEAS TROOPS.

14. **Admission rates for seasoned and unseasoned troops.** — There is not only more sickness among unseasoned than among seasoned troops, but also more sickness among seasoned troops living under war condi-

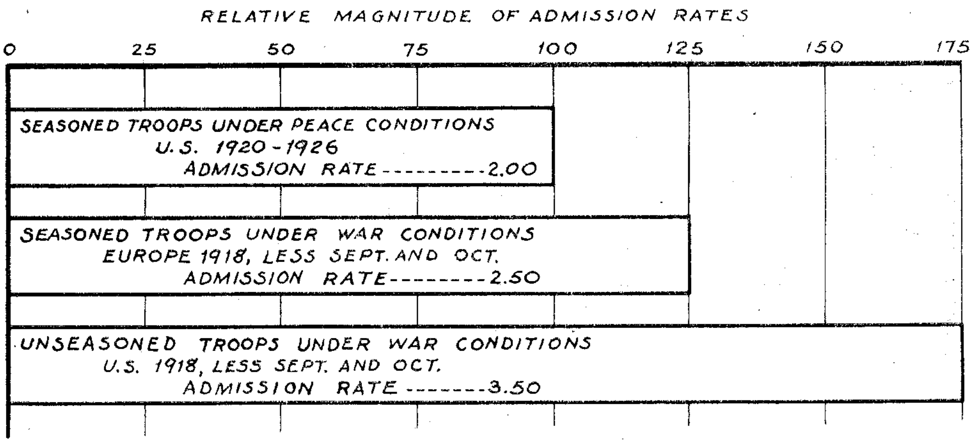


Fig. 14.—A. Comparative daily admission rates to hospital and quarters, from diseases and nonbattle injuries per 1000 strength, seasoned and unseasoned American Troops under peace and war conditions. [2]

B. Also their approximate relative magnitude, as shown by the scale above, where the rate for seasoned troops in the United States under peace conditions is used as a standard at 100.

tions than among such troops during peace. Fig. 14 shows the relative daily admission rates per 1000 men under three sets of conditions. The rate in the United States during the years 1920 to 1926, inclusive, (raised from 1.96 to 2.00 simply for convenience in calculating) is taken as a basis for the seasoned troops; the one for the army in Europe during 1918 (excluding September and October) for seasoned troops under war conditions; and that for the troops in the United States during the same period (excluding September and October)for unseasoned men.

The comparison here is really between partially seasoned troops and raw, green ones. Troops such as followed General Pershing on the Punitive Expedition into Mexico could more properly be called "seasoned".

15. **Comparison of overseas and United States admission rates.**— What experience can be used as a basis for estimating the probable requirements for overseas expeditions? The experience in the Philippine Islands during the Insurrection, in China during the Boxer Rebellion, and in Cuba during the first and second interventions, might conceivably be used for such a purpose. Clearly though, it would not be logical to revert to the Spanish-American War or to the Civil War for experience upon which to base the present medical expectancy in the United States. With modern information in regard to the causes and methods for the prevention of many infectious diseases, there is little probability that we will have such rates as then occurred. Similarly, it is not reasonable to expect that there would be as much sickness among overseas troops as there was a number of years ago.

Can then the admission rates for troops in the United States be used as a basis for estimating those among American troops of the same character, who may be serving in other countries? If this can be done, the expected overseas rates can be lowered as improved sanitation and better knowledge of the causes and prevention of disease make it possible to reduce them in the United States. Let us then examine some comparative rates for United States troops serving in varied climates.

Fig. 15 shows the daily admission rates among American troops in the United States and certain overseas countries during three periods. It is apparent that there has been a very marked reduction in the admission rates in each of the countries in question. But, as the rate has declined in the United States, has there been a corresponding decline in the other countries? Or, in other words, is there any stability in their relative standing?

16. **Relative standing of overseas and United States admission rates.** — In answer to the question raised in the preceding paragraph, Fig. 16 shows the relative standing of the admission rates in Fig. 15. For each period, the rate in the United States is taken as a basis of comparison at 100, and the relative standing of the others computed therefrom. One sees that during the Philippine Insurrection there was almost 38 per cent more sickness in the Philippine Islands than among the troops in the United States at that time; from 1904-1908, approximately 30 per cent more; and from 1920-1926, an excess of almost 48 per cent. It is apparent that, although the relationship varies, there is always more sickness among American troops in the Philippine Islands than in the United States.

During the Boxer Rebellion in China there was 79 per cent more sickness in our expeditionary force than among the troops in the United

States at the same time; and in 1920 to 1926, over 34 per cent more. From this one might reasonably infer that considerably more sickness would occur among troops in China than in the United States.

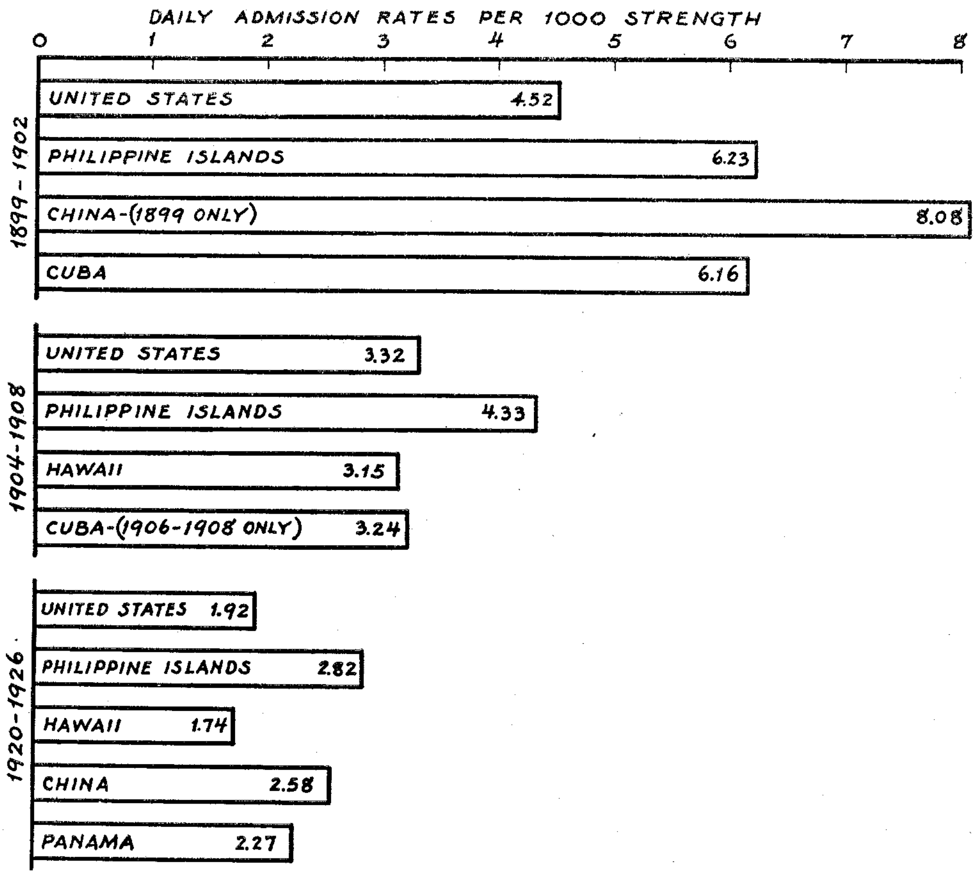


Fig. 15.—Daily admission rates to hospital and quarters from diseases and non-battle injuries per 1000 strength American troops in different countries at different periods.[2]

Using Fig. 16 as a basis, an approximate average of the comparative standing of those rates is given in Fig. 17. Thus the approximate standing of the Philippine Islands is shown as 140, as compared with that of the United States at 100; whereas that of Europe is placed at 100 because it is assumed from the World War experience that among the same character of troops there would be no more sickness in Europe than in the United States.

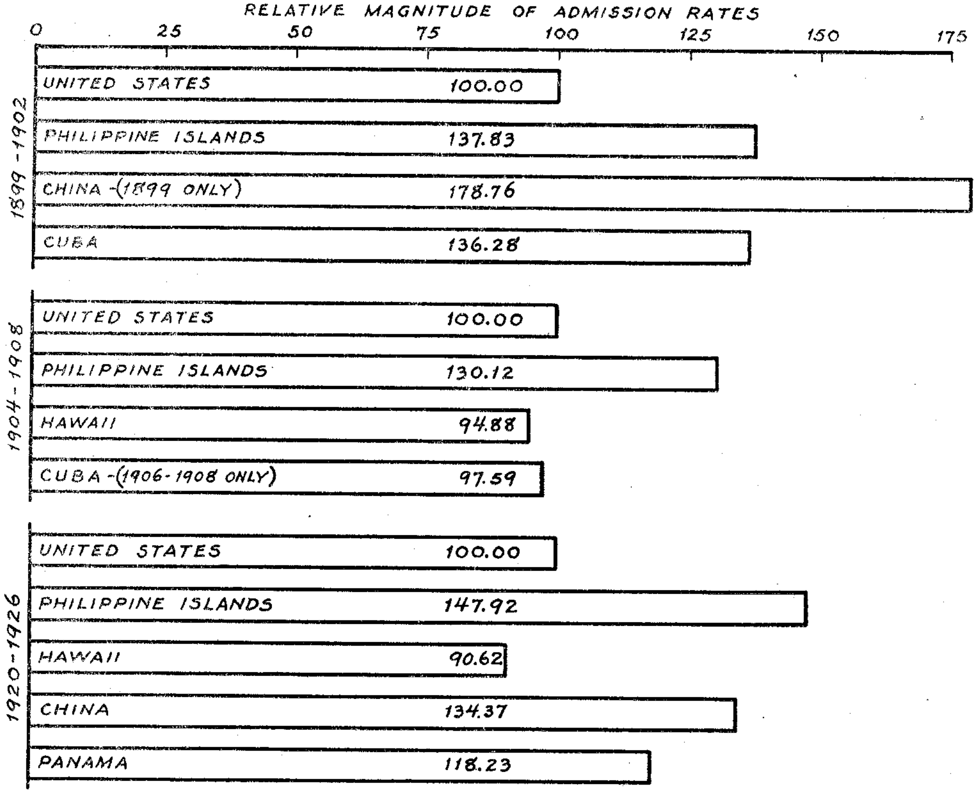


Fig. 16.—Relative magnitude of admission rates to hospital and quarters from diseases and nonbattle injuries among American troops in different countries at different periods, compared with that in the United States during each period set as a standard at 100.

NOTE: Calculated from Fig. 15.

17. **Influence of climate on admission rates.** — Using the countries named as a basis for estimating climatic influences, the lower part of Fig. 17 shows the relative amount of sickness which will probably occur in temperate and tropical countries, under favorable and unfavorable conditions, as compared with that in the United States. Thus it is assumed that in the conduct of warfare in the tropical zone, under the most favorable conditions, there will be 10 per cent more sickness than among the same kind of troops in the United States, and under unfavorable conditions, 40 per cent more. It is also assumed that in temperate zones under favorable conditions there would be no more sickness than in the United States; but, if the conditions are unfavorable, as they would be in a densely populated country with an unhealthy civil population, or where it is difficult or impossible to sanitate the area properly, the relative amount of sickness would be increased 30 per cent.

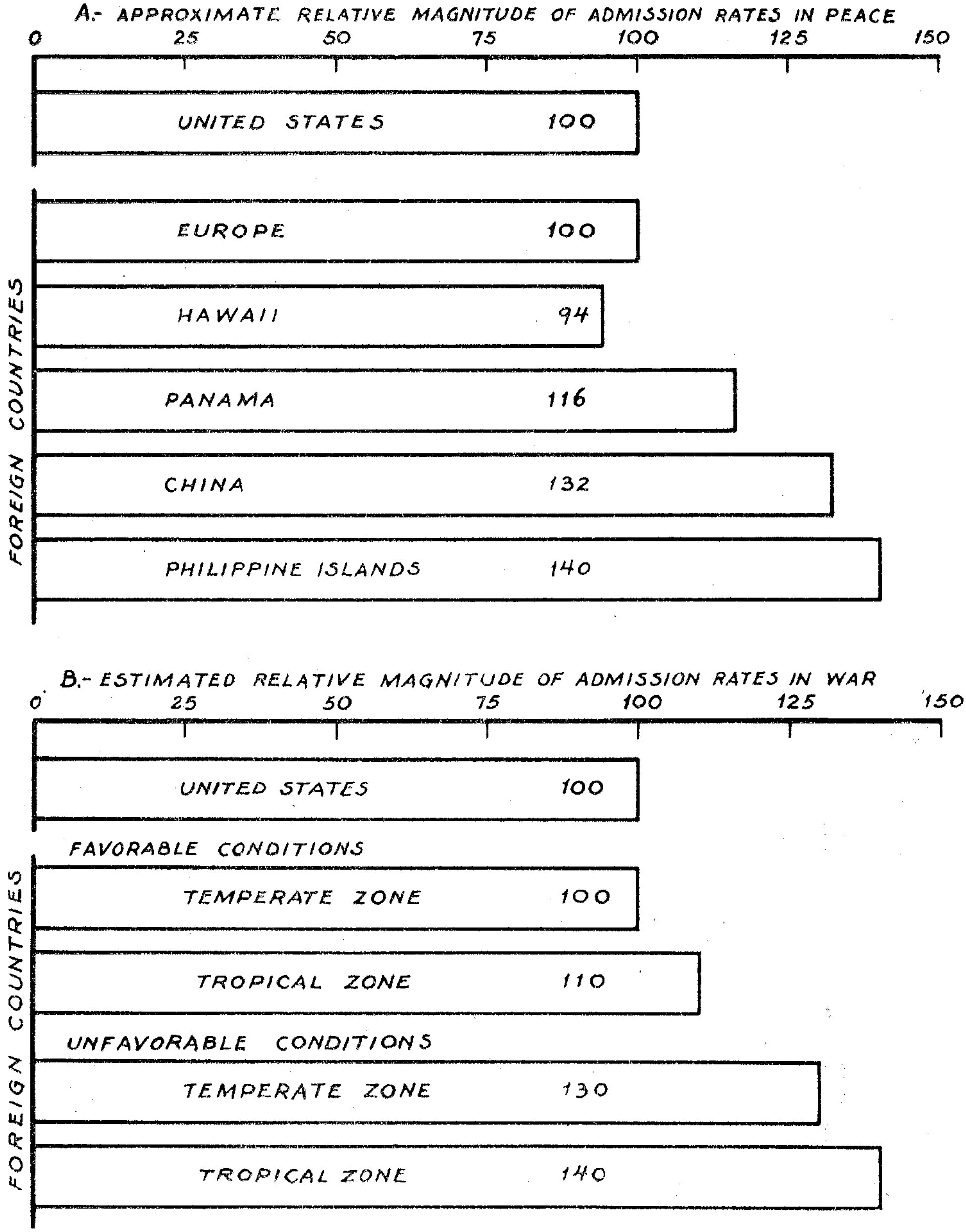


Fig. 17.—A. Approximate average relative magnitude of admission rates to hospital and quarters from diseases and nonbattle injuries among American troops in different countries under peace conditions, compared with that in the United States as a standard at 100.

B. Also the estimated relative magnitude of such rates in war in different climates under favorable and unfavorable conditions.

NOTE: Estimated from Fig. 16.

18. **Combined effect of seasoning of troops and of climate.** — We can then consider four major factors in estimating the probable amount of sickness, and consequently the requirements for medical service in any overseas country. First, the peace or war conditions; second the amount of seasoning of the troops; third, the character of the climate; and fourth, the general possibilities of efficient sanitation. The combination of these factors (the first two as given by Fig. 14 and the other two by the lower section of Fig. 17), gives the result shown by the first section of Fig. 18.

Three rates are given for the United States in Fig. 18: (a) the first for seasoned troops under peace conditions; (b) the second for seasoned troops under war conditions; (c) the third for unseasoned troops under war conditions. These rates when varied according to climatic conditions (Fig. 17 A) give those shown in the next four bars.

But average rates cannot be used as a satisfactory basis upon which to estimate the requirements of a medical service. Consequently the average rates are increased 37% (Figs. 10 and 11). The results are shown in the second section (B). From the second section it is only a step to the third one, which is computed from the second by multiplying each of the daily admission rates to *hospital* and *quarters* combined by 12.50, or the average days in hospital for each such daily admission.

The average of 12.50 days in hospital for each case admitted to hospital and quarters combined is, however, less than our experience in the American Expeditionary Forces (15.28. See Table 1) and also less than can be expected in expeditionary forces. The actual increase in the admission rate to cover expected variations in terms of the American Expeditionary Forces experience is only 12% and not 37%; and is no more than is sufficient to provide for the dispersion of patients when all of the fixed hospitalization is in the rear areas.

Example:

Expected admission rate to hospital and quarters combined during war in a foreign country in a temperate climate and under favorable conditions . . . . = 2.50

If 2.50 is increased 37% (or to 137%) it . . . . =3.42

3.42 × 12.50 (see Table 1, Col. (7)) . . . . =42.75

But the average duration of treatment for expeditionary forces is longer than in the United States (see Fig. 3). Reversing then the process

42.75 ÷ 15.28 (see Table 1, Col. (7)) . . . . =2.80

2.80 ÷ 2.50 . . . . = 112%

The third section (C) of this graph emphasizes the undesirability of rushing unseasoned troops into a war area, and especially so if such area is sanitarily unfavorable. If military necessity demands it, the sacrifice must be made, but the probable cost should be recognized.

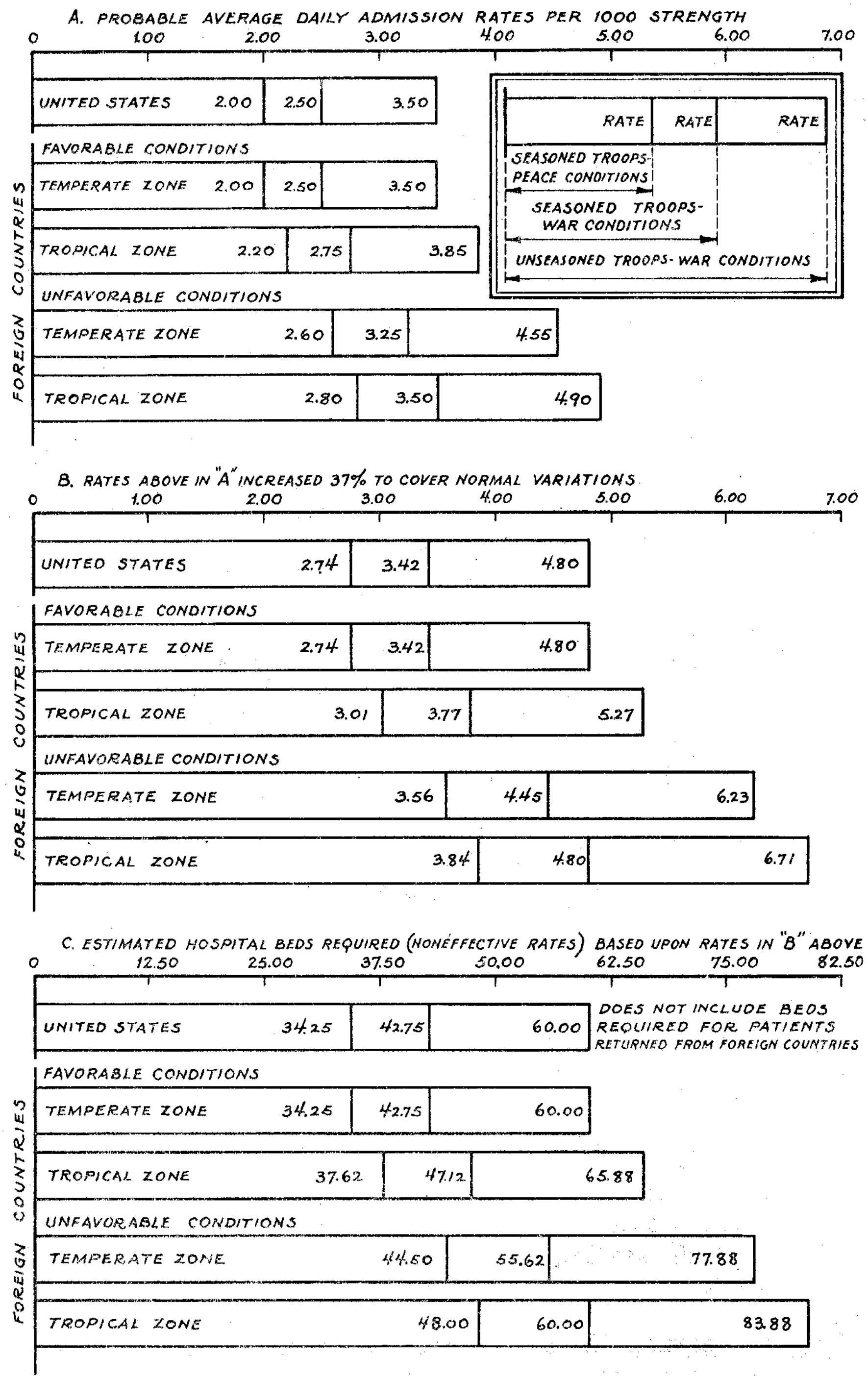


Fig. 18.—Daily admission rates to hospital and quarters and noneffective rates in hospital from diseases and nonbattle injuries per 1000 strength American troops serving in different countries under different conditions.

NOTE: A. Calculated from Figs. 14 and 17. C. Calculated from B by multiplying each rate thereon by 12.50 (see Table 1, p. 10).

E. ADMISSION RATES FROM BATTLE CASUALTIES.

Many more days were lost from each case which was gassed in the American Expeditionary Forces than from each one of disease and non-battle injury (Fig. 3); and more than twice as many days from each gunshot wound as from each gas casualty. Consequently, it is necessary to know what our experience shows in regard to the number of men wounded under various conditions, and as the result of various degrees of military resistance.

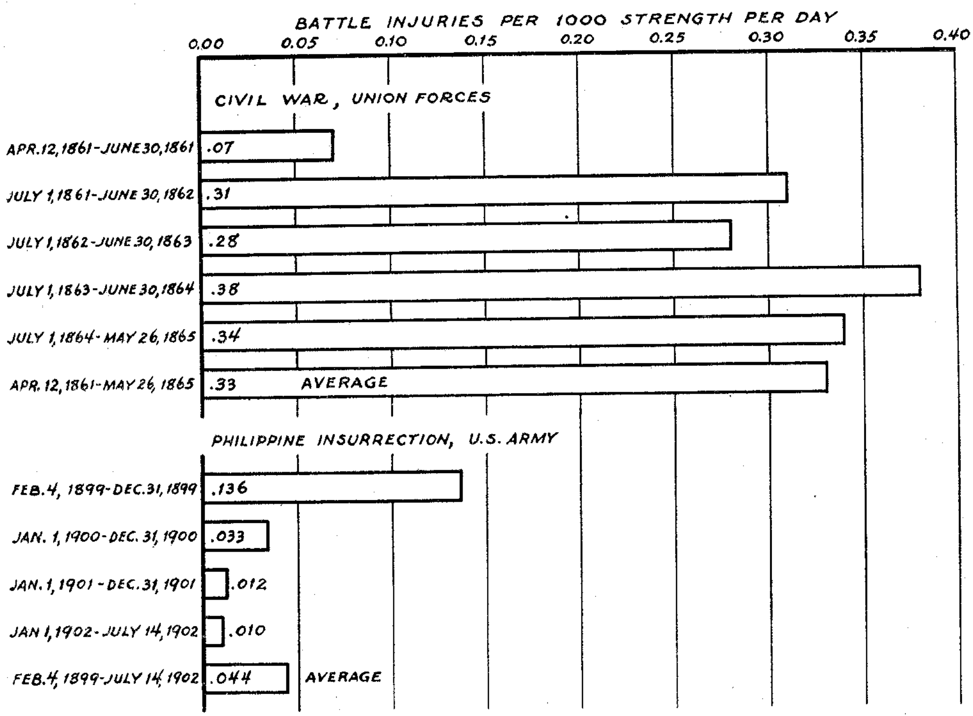


Fig. 19.—Daily admission rates from battle injuries per 1000 men in the Union Army during the Civil War; and also in the U. S. Army in the Philippine Islands during the Philippine Insurrection.
Source of information: (a) Civil War.[8] (b) Philippine Insurrection.[2 9]

19. **Civil War and Philippine Insurrection.** — Fig. 19 shows the daily admission rates per 1000 of the total strength during the various years and the entire period of the Civil War, and in like manner of the Philippine Insurrection. Since the character of future combat will probably be quite different from that which occurred during the Civil War, the data for that period are probably only of historical interest; but the average daily number of wounded during the Philippine Insurrection can be used as a basis to estimate the number of casualties to be expected under like conditions of warfare at the present time.

20. **World War.** — Fig. 20 shows the daily average number of wounded in the American Expeditionary Force: (a) by gas, (b) by gunshot missiles, and (c) by the two combined, arranged by months and by periods. The rates, which are based upon the total strength of the American Expeditionary Forces, probably furnish a very good basis upon which to estimate those for offensive and defensive military operations against a first-class military enemy, when there is the same ratio of

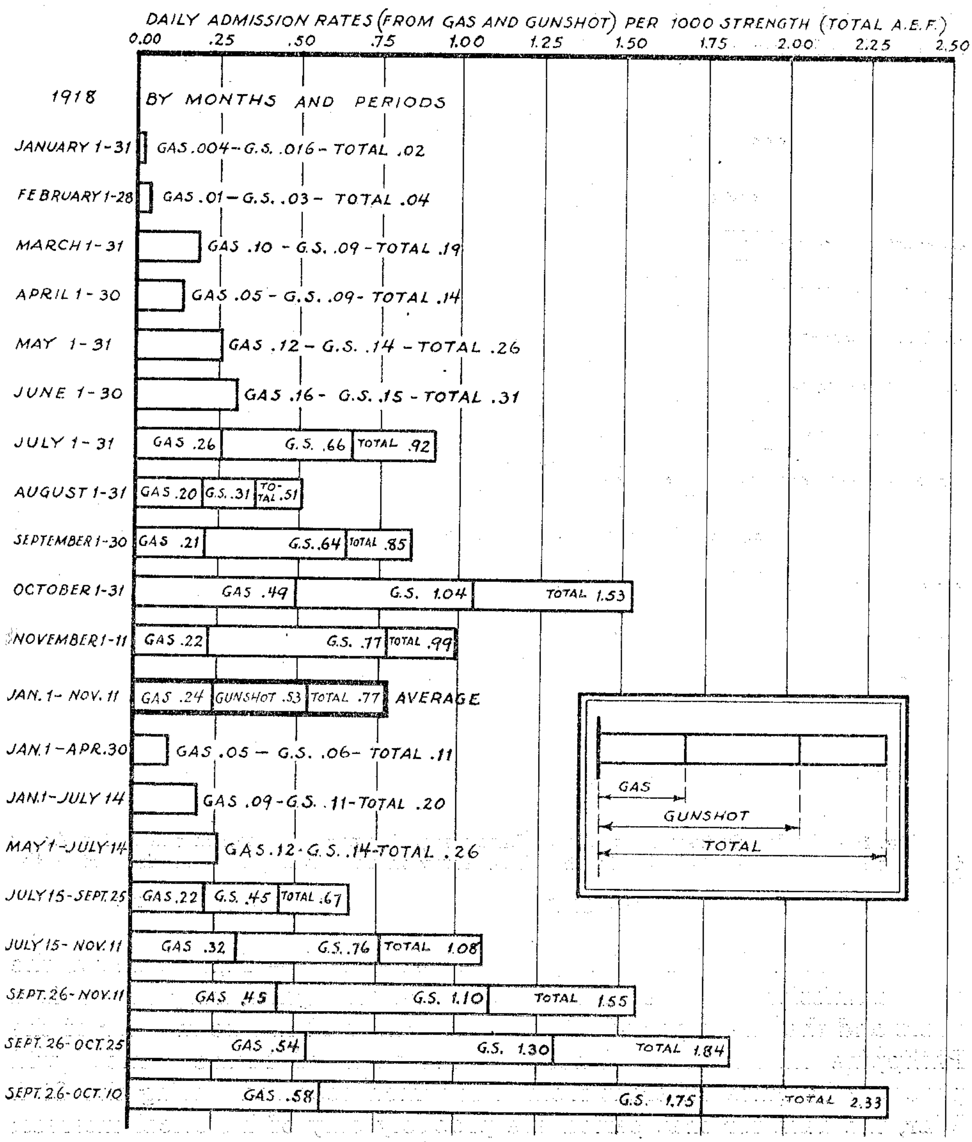


Fig. 20.—Daily admission rates from gas and gunshot missiles separately and combined, per 1000 men in the total American Expeditionary Forces by months and also by periods.[2]

NOTE: The above admission rates are to hospital only.

combat troops to those in the total forces. For similar data for combat Divisions, Corps, and the First American Army, see pp. 106 to 123.

The period from January 1 to April 30, was one of training in trench warfare. From May 1 to July 14 the training in trench warfare continued with some major active operations, including the Cantigny offensive and the Chateau Thierry defensive. From July 15 to September 25 there were the important offensives of the Marne, the Aisne-Marne and the St. Mihiel; also the first phases of the Somme, the Oise-Aisne, and the Ypres-Lys operations. From September 26 to November 11 the major offensive of the Meuse-Argonne occurred, in addition to the later phases of the Somme, the Oise-Aisne, the Ypres-Lys, and the Puvenelle attacks.[10] The greatest resistance was encountered during the first 15 days of the Meuse-Argonne drive, when the average number of wounded per 1000 of the total American Expeditionary Forces strength was 2.33 per day.

F. METHOD OF ESTIMATING THE CONSTANT INCREASE IN THE TOTAL SICK AND THE HOSPITAL POPULATIONS.

21. **Basis of the method.** — As shown by Fig. 4, the ultimate noneffective rate is the product of the daily admission rate multiplied by the average number of days lost by each case. Since the average days lost include those lost by cases remaining in hospital many days, as well as only a few days, it follows that for recently mobilized commands the ultimate noneffective rate is not reached until the completion of the treatment of the long duration cases, or approximately one year after M day.

It is necessary then to find how the noneffective rate increases, especially that part in hospital, before an estimate can be made of the probable requirements for medical service and of the number of hospital beds which will be needed for any command from time to time.

Those who are interested in the technical details of the process are referred to pages 133 to 167. Briefly stated, the noneffectives increase each day by the addition of the incoming sick to those remaining from previous days, and this increase continues until the number leaving equals the number coming on sick report. Fig. 21 shows how many of any day's admissions (as for example, those of M day) continue sick from day to day. The basic material for this graph is from the experience with the white enlisted men in the United States during the years 1925-1927, inclusive,[2] when the daily admission rate to hospital and quarters combined was 1.8954 per 1000 men. One sees from the graph that the greater part of the cases leave the sick report in a very short time, and less than half of them are remaining at the end of the seventh day. At the end of 30 days, only .237 (1 in 8) of the original 1.8954 are remaining sick. Thereafter the cases leave more slowly, and a few remain at the end of one year's time.

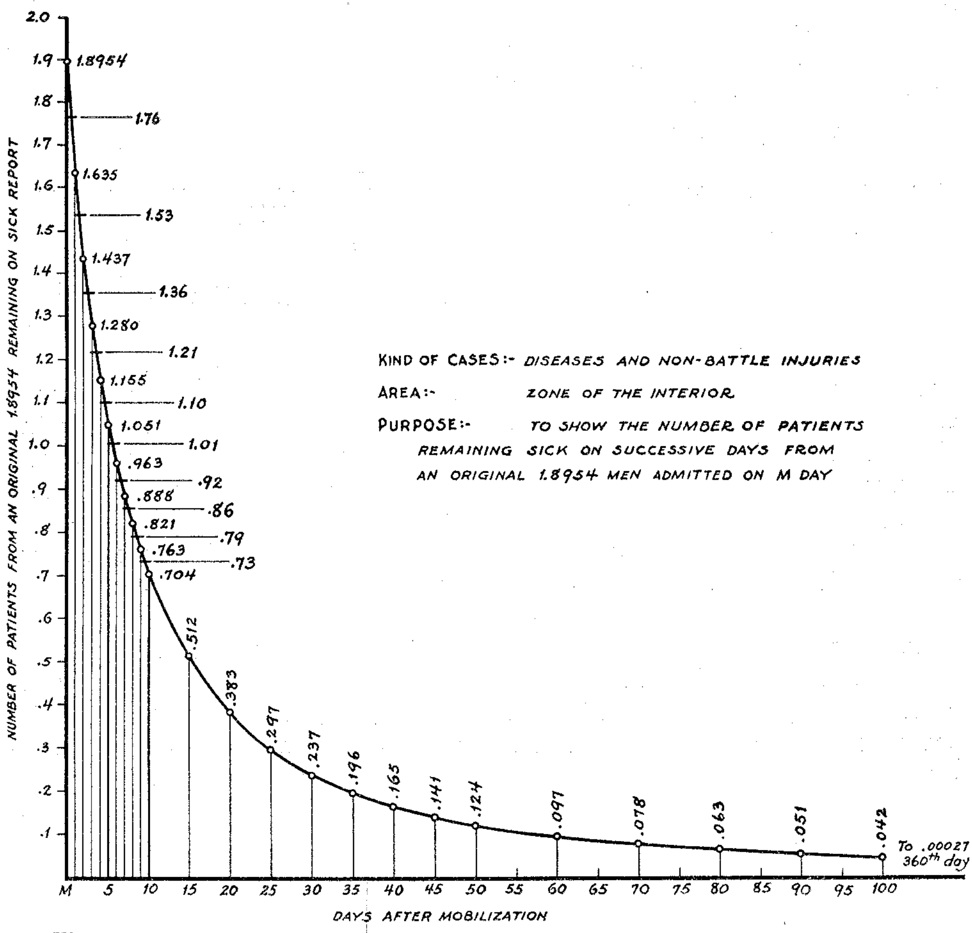


Fig. 21.—Daily reduction during one half day and the entire day in the number of patients in a group admitted on any one day.
NOTE: For basic formulae see Fig. 80, (1), p. 147.

Fig. 22 shows how a sick population builds up. The admissions of each day are added to the number remaining from the preceding ones Thus on the first day after M day, the total sick consist of the day's admissions plus the number remaining from M (A) day. On the tenth day after M (A) day, the total sick is the sum of the number of men admitted that day plus those remaining from each of the preceding nine days and the M day.

The net increase in the total number of patients from day to day equals the remnant still remaining at that time from the original group admitted on M day. Consequently, the ultimate noneffective rate will not be reached until the last of M day's cases have been eliminated from the sick report, either by return to duty, by death, or by discharge for disability. After that time the number coming on sick report each day will be equalled by the number leaving it.

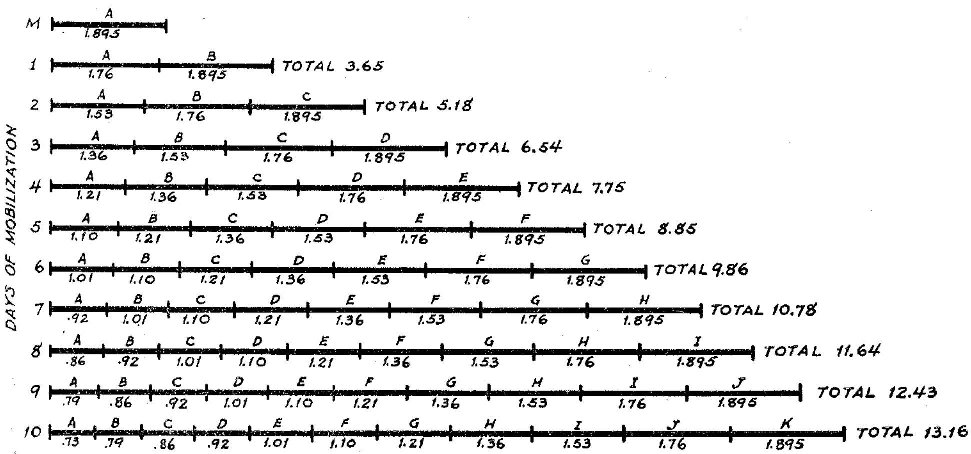


Fig. 22.—Showing how the total number of patients from diseases and nonbattle injuries in the Zone of the Interior increase on each of ten days after mobilization begins (M day) when the daily admission rate is 1.895 per 1000. The letters A to K are used to designate each days group of admissions (1.895) and the continually decreasing number of each individual group that remain sick from day to day.
NOTE: For basic data see Fig. 21.

FOOT NOTE: A hospital, or sick, population continues to increase until the stabilization point (see p. 31) is reached because new cases are admitted each day. After a command is demobilized, no additional cases of diseases or nonbattle injuries will occur; and after military combat ceases no more battle casualties will be admitted. Thereafter then the hospital population will consist of cases remaining from the previous admissions until they all leave hospital.

Thus in Figure 22, if there were no admissions after the fifth day, the cases would b:e On the sixth day 7.96 (9.86 — 1.895) :
On the seventh day 7.12 (10.78 — 1.895 — 1.76).

In connection with Figure 28 (p. 41), let us assume that up to the ninetieth day, there is 1.00 admission per day from war gases, and that after that time there is: (a) No more admissions, and (b) that 0.50 cases are admitted each day. Then on the 120th day and thereafter the patients will be:

(a) With no admissions after 90 days				(b) With .50 admissions per day after 90 days	
Day	A. Day specified (Fig. 28)	B. 90 days earlier (Fig. 28)	C. Patients remaining (A—B)	D. 90 days earlier	E. Patients remaining C + D
120	39.63	22.24	17.39	11.12	28.61
150	40.74	32.41	8.33	16.20	24.53
180	41.28	37.30	3.98	18.65	22.63
210	41.53	39.63	1.90	19.81	21.71
240	41.66	40.74	.92	20.37	21.29

22. **Total sick in United States.** — *a. Daily admission rate to hospital and quarters of 1.8954 per 1000, during 1925-1927.* — Continuing the study of the experience with the white enlisted men in the United States during the years 1925 to 1927, Fig. 23 shows graphically how the noneffective rate increases from day to day. The results are from the same basic process as illustrated by Figs. 21 and 22. Thus we start on M day with 1.8954 admissions to hospital and quarters and on the fifth day after M day (see also Fig. 22), the number of noneffectives in hospital and quarters is 8.85; on the tenth day, 13.16. The ultimate noneffective rate in hospital and quarters as shown by this graph is 30.69, and the one as calculated in the usual way by the formula on page 8 is 30.45.

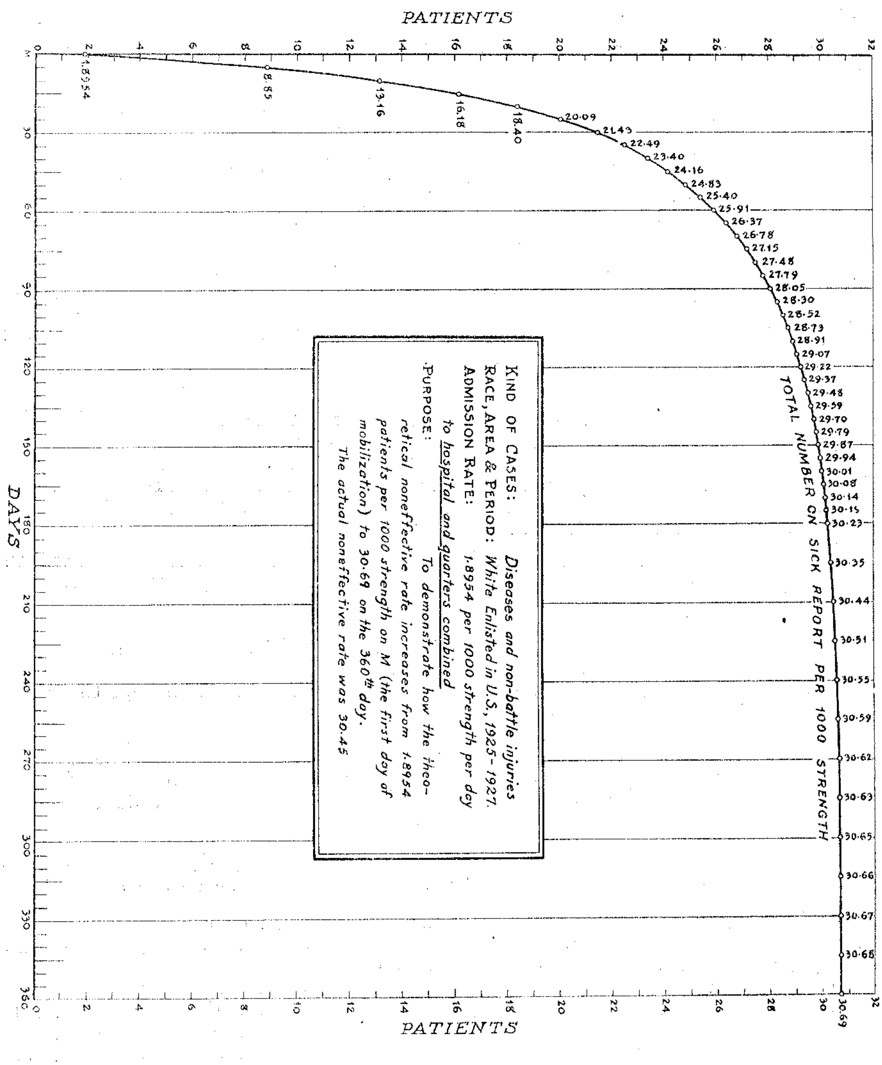


Fig. 23.—Daily increase in the number of disease and nonbattle injury patients in hospitals and quarters in the United States, 1925 to 1927.
NOTE: For basic formula see Fig. 80 (1) p. 147.

b. Daily admission rate to hospital and quarters of 1.00 per 1000, during the World War. — Fig. 23 can be used as a basis in calculating the number of sick at any time with any given admission rate, but to do so would require the division of the noneffectives as calculated for any day by the basic admission rate of 1.8954. This can be done once for all, and the results be given on a unit basis. Then the ultimate noneffective rate is 16.35, which was the average days for each such case among white soldiers during 1925-1927. The upper line on Fig. 24 shows this reduced to 15.07 to conform to the 1918 experience in the United States, when the average days for each case in hospital and quarters was 15.07 (see Fig. 3). It shows the total sick on any day from M to 360, when the daily admission rate to hospital and quarters combined is 1.00 per 1000.

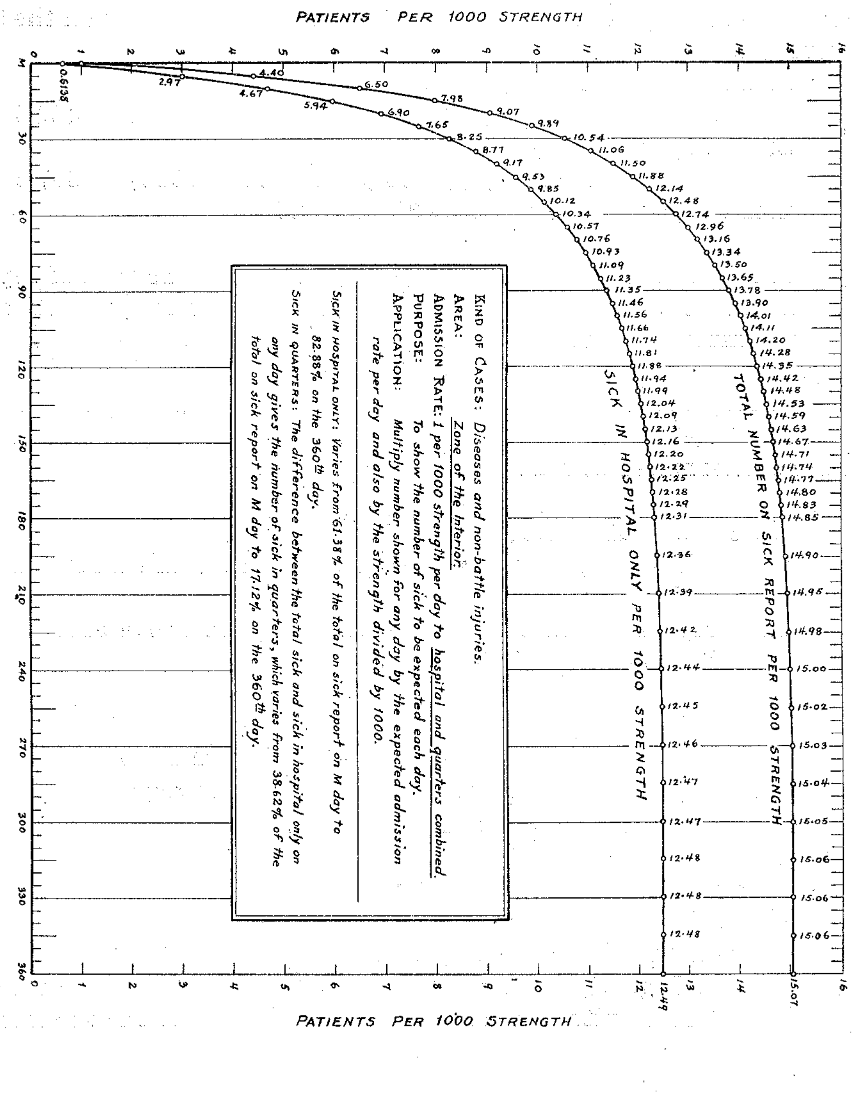


Fig. 24.—Daily increase in the number of disease and nonbattle injury patients in hospital and quarters, in hospital, and in quarters in the United States in 1918.
NOTE: For basic formula see Fig. 80, (3) p. 147.

Since 61.38% of the sick in the United States during the World War were treated in hospital, for 1.00 admission to hospital and quarters combined, 0.6138 was admitted to hospital only. The lower curve (Fig. 24) based upon that admission rate therefore shows the noneffectives in hospital only.

The graph can be used in calculating the number of sick and also of hospital patients to be expected in any command with any estimated basic admission rate to hospital and quarters combined, provided the average duration of treatment remains approximately the same. The difference between the noneffectives shown on the upper line as total sick, and those on the lower line as sick in hospital, represents the sick in quarters.

Example: In a command of 10,000 men with an average daily admission rate to hospital and quarters of 3.50 per 1000, the sick on the 90th day would be

Sick in hospital and quarters =
13.78 (upper curve) $\times$ 3.50 $\times$ (10,000 $\div$ 1000) = 482.3
Sick in hospital only =
11.35 (lower curve) $\times$ 3.50 $\times$ (10,000 $\div$ 1000) = 397.3
Sick in quarters = 482.3 — 397.3 = 85

It is assumed here that 61.38% of the admissions to sick reports are treated in hospital. Consequently, the 85 patients in quarters represent the accumulation from 38.62% (100.00% — 61.38%) of 1.00 case each day.

It may be decided that 70% of all cases will be treated in hospital, and only 30% in quarters. Then the accumulation of patients in quarters can be determined as follows:

85: 38.62 :: X : 30.00
X = 66 patients in quarters when 30% are treated there.

The hospital patients under the conditions as above are:
482.3 — 66 = 416.3

c. Noneffectives in hospital in an increasing command. — To illustrate the use of Fig. 24, when there is an increasing command, let us assume that it is necessary to find the number of hospital beds required at 15 day intervals for a command, which after starting with 10,000 men on M day increases by 10,000 every 15 days. Let us also assume that the daily admission rate to hospital and quarters combined is 3.50 per 1000, as it was in the United States during 1918 (Sept. and Oct. excluded).

The detail work is shown by Fig. 25. The data (third line) from the lower curve, Fig. 24, when multiplied by the assumed rate of 3.50, give the patients in hospital (fourth line) under the conditions as stated. The most rapid increase in the number sick in hospital occurs during the early weeks because the patients coming in during that period greatly exceed those going out of hospital. Each 15 day group of men must then establish its own flow of patients in and out of hospital as has been done by the preceding group; and each succeeding group has 15 days less to establish its hospital population. Then after 180 days, the first 10,000 will have a hospital population of 431 (Fig. 25, last column, fifth line) accumulated during 180 days, whereas the 10,000 that report on the 180th day have only the one day's hospital sick, or 21.

DAILY ADMISSION RATES, HOSPITAL AND QUARTERS	M	M 15	M 30	M 45	M 60	M 75	M 90	M 105	M 120	M 135	M 150	M 165	M 180
	ACCUMULATION OF Z. OF I. HOSPITAL PATIENTS IN EACH 1000 Z OF I. STRENGTH												
1.00 (SEE FIG. 24)	.61	5.94	8.25	9.53	10.34	10.93	11.35	11.66	11.88	12.04	12.16	12.25	12.31
3.50	2.14	20.79	28.88	33.37	36.19	38.29	39.73	40.81	41.58	42.14	42.56	42.88	43.09

DAY	INCREMENT OF STRENGTH	ACCUMULATION OF Z. OF I. HOSPITAL PATIENTS FROM EACH 15-DAY INCREMENT OF STRENGTH AT THE AVERAGE DAILY ADMISSION RATE IN THE U.S. DURING 1918 (EXCLUDING SEPTEMBER AND OCTOBER)												
M	10,000	21	208	289	334	362	383	397	408	416	421	426	429	431
M 15	10,000		21	208	289	334	362	383	397	408	416	421	426	429
M 30	10,000			21	208	289	334	362	383	397	408	416	421	426
M 45	10,000				21	208	289	334	362	383	397	408	416	421
M 60	10,000					21	208	289	334	362	383	397	408	416
M 75	10,000						21	208	289	334	362	383	397	408
M 90	10,000							21	208	289	334	362	383	397
M 105	10,000								21	208	289	334	362	383
M 120	10,000									21	208	289	334	362
M 135	10,000										21	208	289	334
M 150	10,000											21	208	289
M 165	10,000												21	208
M 180	10,000													21
TOTAL PATIENTS		21	229	518	852	1214	1597	1994	2402	2818	3239	3665	4094	4525

Fig. 25.—A method of computing the number of hospital patients in a Zone of the Interior command which is increasing 10,000 each 15 days, when the daily admission rate to hospital and quarters combined is 3.50 per 1000, as it was in the U. S. in 1918 (excluding September and October).

The total beds, required at the end of each 15 day period, by all men then in camp, are shown on the bottom line.

The total patients, including those treated in quarters, can be calculated in like manner by using the data on the top curve of Fig. 24.

23. **Sick in hospital only in United States during the World War.** As shown by Fig. 3, the average number of days spent in hospital in the United States by each case admitted thereto in 1918 was 20.36. One sees from Fig. 26 how the number of patients in hospital increases from 1.00 to 20.36, when the daily admission rate to hospital only is 1.00 per 1000.

For method of estimating the number of patients with a diminishing admission rate see page 33.

The noneffectives in hospital at any time can be calculated from either Fig. 24 or Fig. 26; (a) by multiplying in the first instance by the admission rate to hospital and quarters combined, and (b) in the second by the one to hospital only.

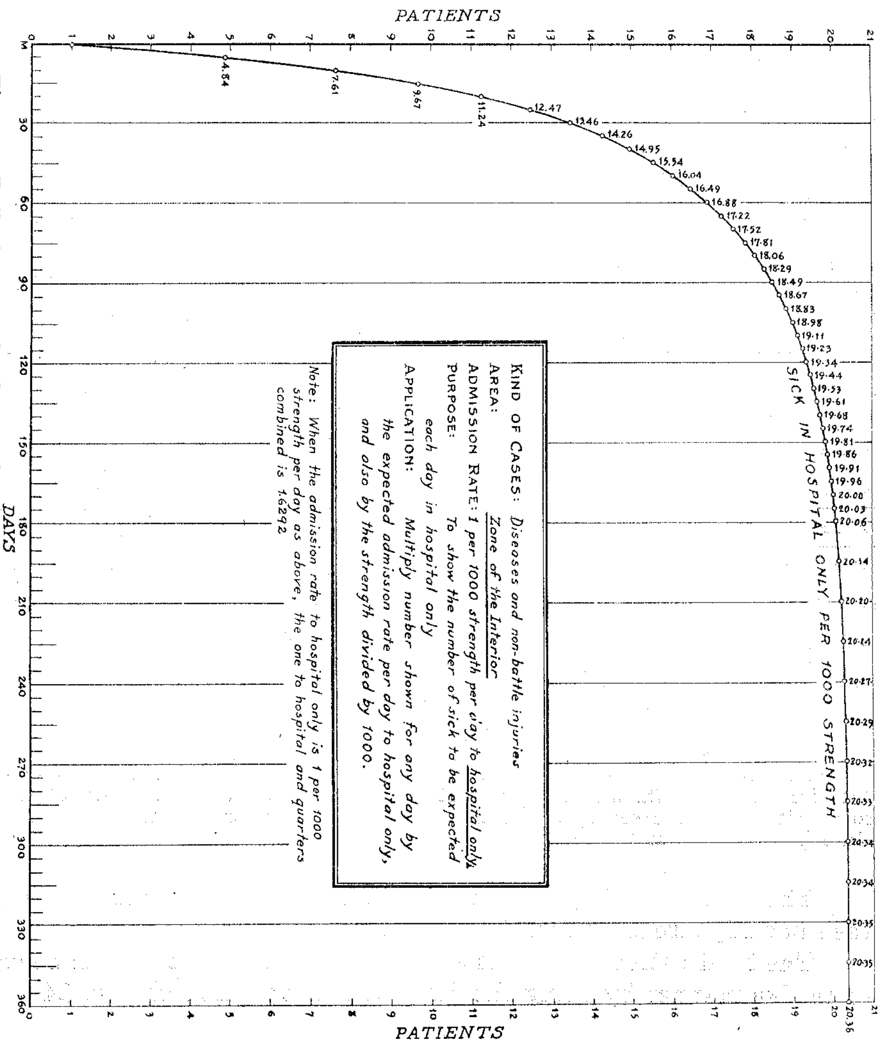


Fig. 26.—Daily increase in the number of disease and nonbattle injury patients in *hospital* only in the United States, 1918.

NOTE: For basic formula see Fig. 82, (2) p. 149. When using this graph, the admission rate to hospital equals 16.38% of the admission rate to *hospital and quarters*.

Example: When Fig. 24 is used, the data on the bottom curve, showing the patients in hospital at any time, when the daily admission rate to hospital and quarters combined is 1.00 per 1000, is multiplied by the assumed daily admission rate to hospital and quarters combined. It answers the question; How many patients will there be in hospital on the 90th day after M day, when the daily admission rate to hospital and quarters combined is 3.50 per 1000 and the strength is 10,000?

Then 11.35 (bottom curve, Fig. 24) $\times$ 3.50 $\times$ (10,000 $\div$ 1000) = 397.3

Fig. 26 answers the question: How many patients will there be in hospital on the 90th day after M day, when the daily admission rate to hospital is 2.15 (61.38% of 3.50) per 1000, and the strength is 10,000?

Then, 18.49 (Fig. 26) $\times$ 2.15 $\times$ (10,000 $\div$ 1000) = 397.5

24. **Hospital patients in the American Expeditionary Forces.** — a. *Disease and nonbattle injury patients.* — As shown by Fig. 3, page 7 the average days lost by each hospital patient sick from disease or nonbattle injury in the American Expeditionary Force was 27.29. Fig. 27 shows how the number of patients in hospital increases from 1.00 patient on M day to 27.29 on M plus 360 days.

A curve to show the total sick from disease and nonbattle injury in the American Expeditionary Force, similar to the one for the United States (top curve, Fig. 24), can not be constructed because there are no experience data available.

When Fig. 27 is used, an admission rate to hospital only similar to the one that occurred in the American Expeditionary Force must be computed; i. e., any admission rate to hospital and quarters combined must be reduced to 56% of the total instead of to 61.38% as in the United States. Thus with a daily admission rate of 3.50 per 1000 to hospital and quarters combined in a command of 10,000, the hospital sick on the 90th day would be

25.08 (Fig. 27) $\times$ 1.96 (56% of 3.50) $\times$ (10,000 $\div$ 1000) = 491.6

This number in hospital is much greater than the 397.5 in the United States under similar conditions (*supra*). Some of the probable reasons are given on pages 7 and 8.

If it is assumed that the duration of treatment in the American Expeditionary Force was too great and that the average time lost by such cases could be reduced by better administration, the curve can be lowered proportionately. Thus, if we feel that the average duration of such cases can be reduced to 24 days and we require the data for the 90th day, then,

$$27.29 : 24 :: 25.08 : X$$
$$X = 22.06$$

Then the hospital sick on the 90th day under the conditions as stated above would be:

22.06 $\times$ 1.96 (56% of 3.50) $\times$ (10,000 $\div$ 1000) = 432.4

This excess, over the figures for the United States, is probably no greater than would be necessary, due to the greater distance of the hospitals for any expeditionary force from the troop area, battle front, etc.

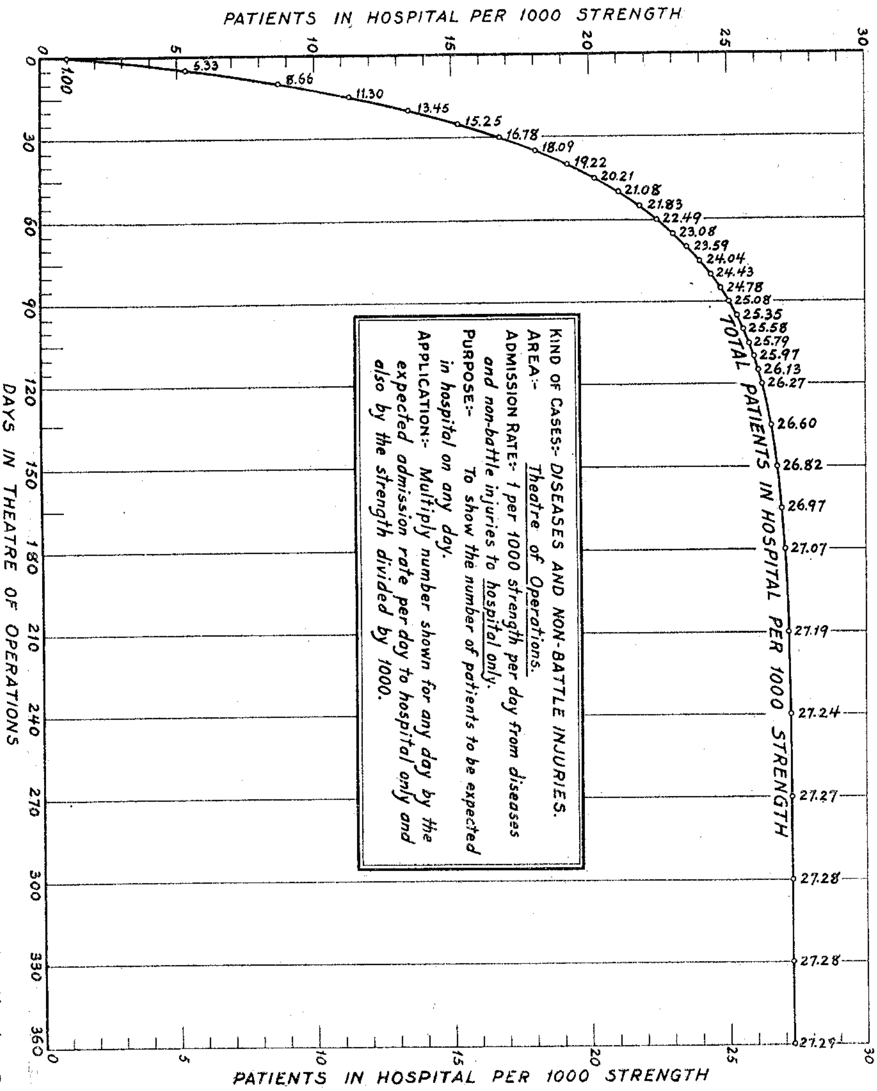


Fig. 27.—Daily increase in the number of Theater of Operations *hospital* patients admitted from diseases and nonbattle injuries.
NOTE: For basic formula see Fig. 84, (1), p. 151. When using this graph the admission rate to hospital equals 56% of the admission rate to *hospital and quarters*.

b. *Gas patients.* — One sees from Fig. 3, that the average days lost by each gas patient was 41.77. With a theoretical daily admission rate of 1.00 per 1000 from gas injuries there would be 22.24 patients in hospital on the 30th day; 40.74 on the 150th day, etc. (Fig. 28). The method of application is similar to that for the preceding graph. Thus the numbers shown for the patients in hospital are multiplied by the anticipated admission rate, and then by the number of men in thousands in the command. Admission rates for gas patients, and also for gunshot patients (Fig. 20), are to hospital. For method of estimating the number of patients with a diminishing admission rate see p. 33.

Example: In a command with an average daily strength of 100,000 and with an average daily admission rate from war gases of .35 per 1000, how many patients would be in hospital after 90 days of fighting?

Then, 37.30 (Fig. 28) × .35 × (100,000 ÷ 1000) = 1306.

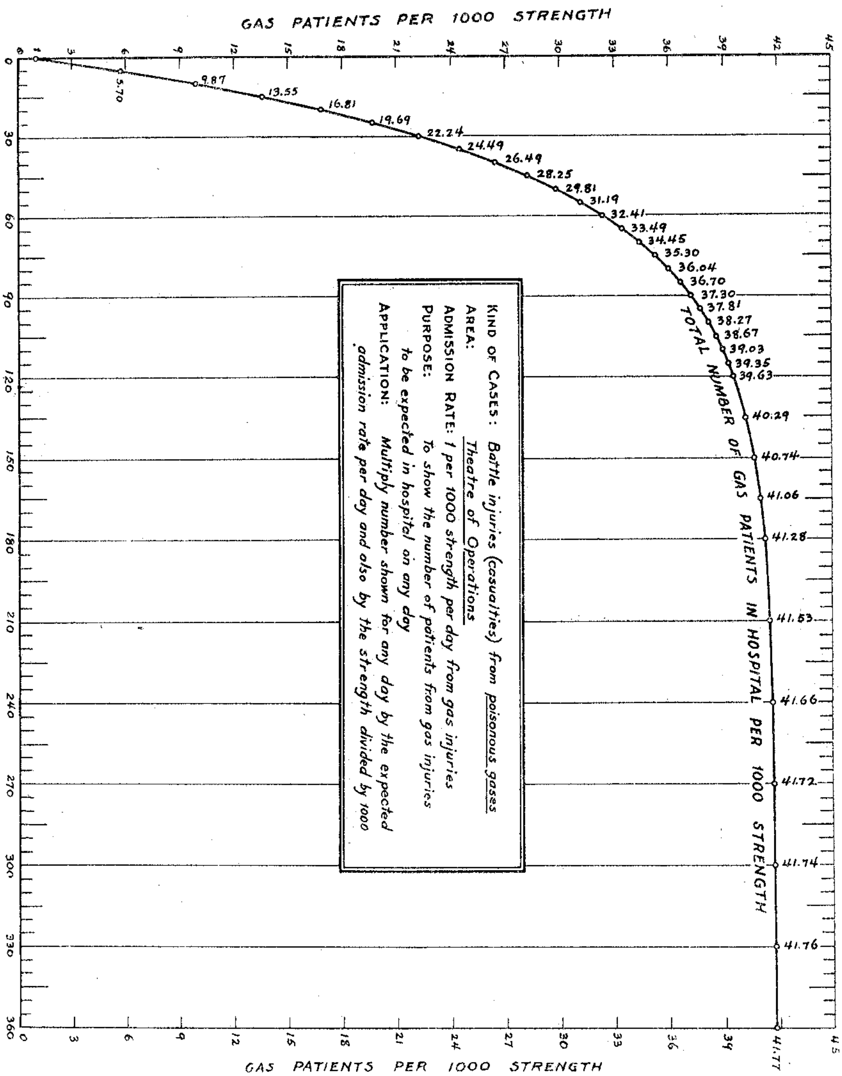


Fig. 28.—Daily increase in the number of Theater of Operations *hospital* patients admitted for wounds by war (poisonous) gases.
NOTE: For basic formula see Fig. 87, (a), p. 154.

c. *Gunshot cases.* — Again referring to Fig. 3, it is noted that the average days per case for each gunshot injury in the American Expeditionary Forces was 94.84. With a theoretical admission rate of 1.00 per 1000 per day, we would then expect the ultimate noneffective rate to be 94.84 × 1.00 = 94.84. From Fig. 29, it is apparent that the ultimate noneffective rate is not reached until the 920th day, because of the long duration of cases of compound fractures of the long bones and other serious wounds.

The daily admission rate from gunshot wounds during the Meuse-Argonne offensive was 1.10 per 1000 men in the total American Expeditionary Forces. With such a rate in a command of 150,000 men, the number of gunshot wounded patients in hospital on the 150th day would be.

$$75.89 \text{ (Fig. 29)} \times 1.10 \times (150{,}000 \div 1000) = 12{,}522 \text{ patients.}$$

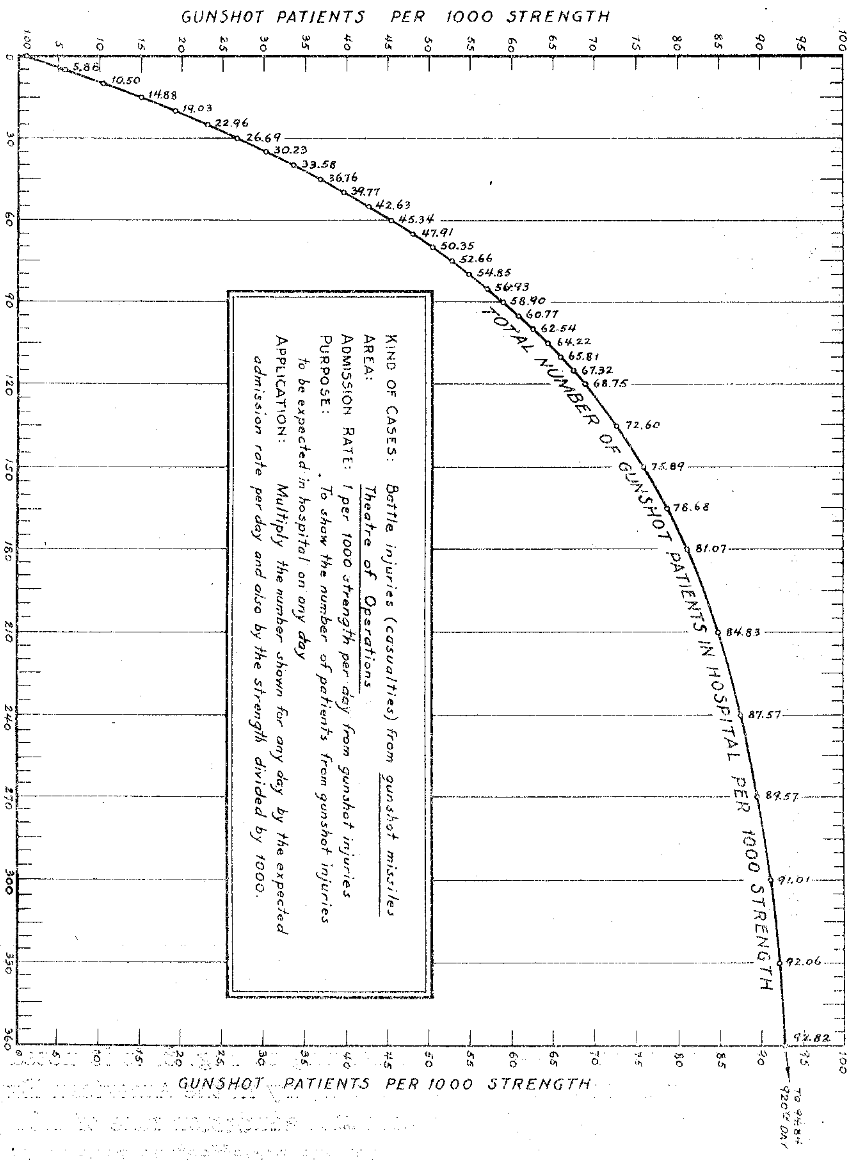


Fig. 29.—Daily increase in the number of Theater of Operations *hospital* patients admitted for wounds by gunshot missiles.
NOTE: For basic formula see Fig. 88, (a), (1), p. 155.

d. Gas and gunshot cases. — Although separate graphs for gas and gunshot wounds are much more useful as a basis for estimating medical requirements (since there is but slight possibility that they will occur again in the same proportion as in the American Expeditionary Forces), one based upon the experience there may be of interest. This is exhibited in Fig. 30, which indicates how the number of patients wounded by gas and gunshot, when admitted in the same proportions as they occurred in the American Expeditionary Forces, increases from day to day.

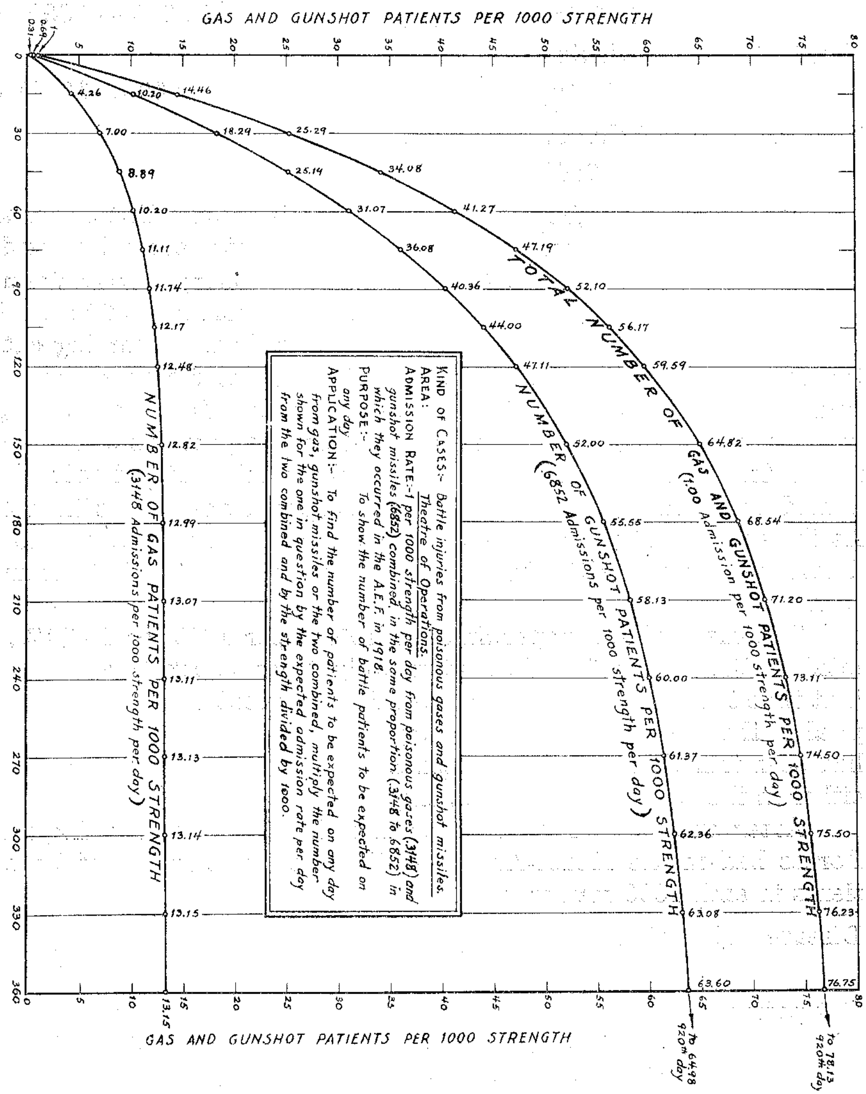


Fig. 30.—Daily increase in the number of battle injury cases in *hospital* in the American Expeditionary Forces in 1918.
NOTE: For basic data see Figs. 28 and 29.

Example: In a command with an average daily strength of 100,000 and with an average daily admission rate of 1.25 per 1000 from war gases and gunshot wounds combined in the same proportions as in the American Expeditionary Forces, how many patients would there be in hospital from these causes on the 120th day?

Gas patients =

12.48 (lower curve) × 1.25 × (100,000 ÷ 1000) = 1560

Gunshot patients =

47.11 (middle curve) × 1.25 × (100,000 ÷ 1000) = 5889

Gas & Gunshot patients =

59.59 (upper curve) × 1.25 × (100.000 ÷ 1000) = 7449

The percentage of the command in hospital would be,

7449 ÷ 100,000 = 7.45%.

e. Hospital cases from all causes in the American Expeditionary Forces. — Fig. 31 demonstrates how hospital patients accumulate under such conditions as existed in the American Expeditionary Forces from July 1 to November 11, 1918. One sees again the importance of battle injuries when converted into requirements for hospital beds. Starting out with a theoretical admission rate of 1.65 per 1000 from diseases and nonbattle injuries, and with only 1.00 per 1000 per day from gas and gunshot wounds combined in approximately the same proportions as they occurred in the American Expeditionary Forces, the number of patients of the last named group exceeded those of the first named one in less than 45 days. At the end of one year there would have been only 45.03 per 1000 from diseases and nonbattle injuries as compared with 76.75 from battle wounds.

The curve shows approximately 105.00 per 1000, or 10.50%, in hospital at the end of 130 days after July 1, or about November 11. At that time there were between 9.0 and 10.0 per cent of the command in hospital in the American Expeditionary Forces, in addition to a number who had been transferred to the United States and then occupied hospital beds either in the United States or on ships enroute thereto.

After one year of such experience, as the American Expeditionary Forces had in the Meuse-Argonne offensive, the number of hospital patients in each 1000 men would be as follows:

Disease and nonbattle injury patients =

27.29 (Fig. 27) × 1.65 × (1000 ÷ 1000) = 45.03

Gas patients =

41.77 (Fig. 28) × .45 (Fig. 20) × (1000 ÷ 1000) = 18.80

Gunshot patients =

92.82 (Fig. 29) × 1.10 (Fig. 20) × (1000 ÷ 1000) = 102.10

Total patients = 165.93

The 165.93 per 1000 strength would be the actual number of patients in hospital; and if only 10% is added for the dispersion of patients, the number of beds required would be 182.52 per 1000, or 18.25%, of the total strength of a force organized with the same proportion of combat and communications zone troops as the American Expeditionary Forces.

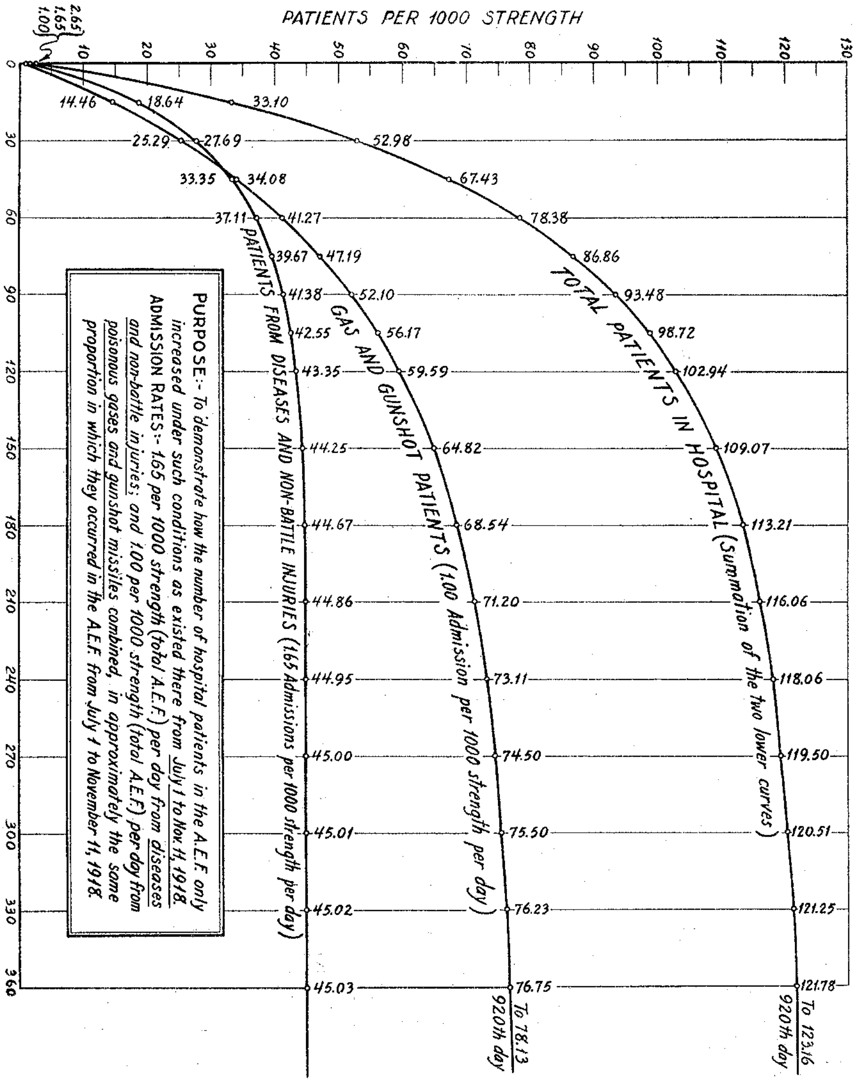


Fig. 31.—Daily increase in the total number of American Expeditionary Forces patients in *hospital* in 1918.
NOTE: For basic data see Figs. 27 and 30.

G. DISPOSITION OF PATIENTS.

25. **Disposition of Zone of Interior cases in the United States.** — After mobilization day in the Zone of the Interior, and the beginning of operations or of military combat in the Theatre of Operations, the number of patients in hospital in either area gradually increases until the outflow of men from the hospital equals the inflow (Figs. 23 - 31).

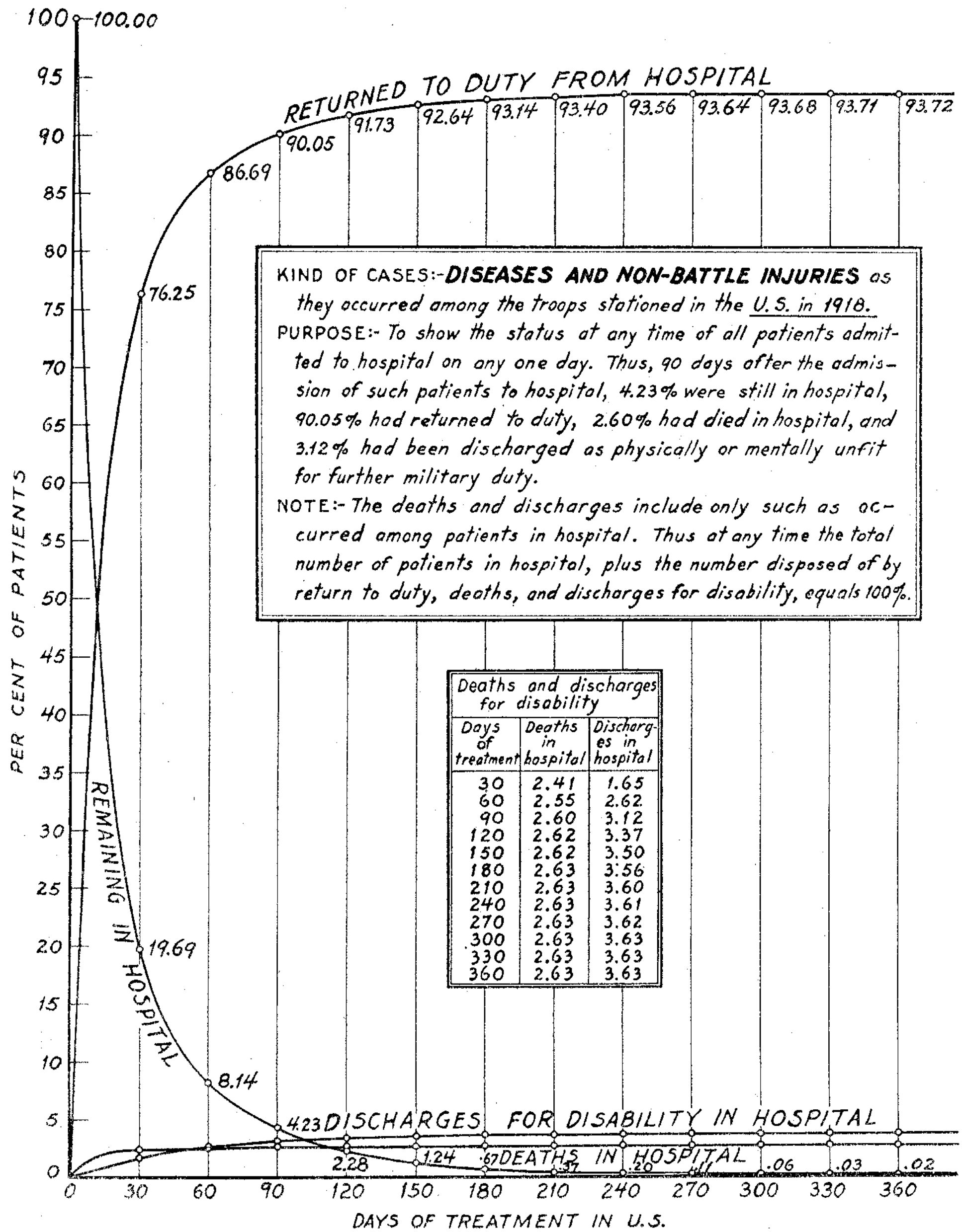
A large proportion of the patients who enter the hospital from day to day will recover and will be available again for military duty. A much smaller percentage of cases, who also recover after a more prolonged stay in hospital, will be incapacitated for further military duty on account of a physical disability or chronic disease; still others will die in hospital.

Fig. 32 shows the constant changes among patients admitted to hospital in the United States in 1918. Thus, 30 days after any group was admitted, 19.69% were in hospital. 76.25% had returned to duty, 2.41% had died, and 1.65% had been discharged as disabled. At the end of one year, only 0.02% were in hospital, 93.72% had returned to duty, 2.63% had died, and 3.63% had been discharged as disabled. Most of the deaths occurred during the first few weeks of treatment, but the majority of the disability discharges were later. The deaths and discharges referred to here include only those which occurred among patients in hospital.

26. **Disposition of Theater of Operations cases in the American Expeditionary Forces.** — Figs. 33 - 37 show the continuous change in the American Expeditionary Forces. Thus, transfer to the United States was an American Expeditionary Force disposition, even though such patients remained under treatment after leaving there.

Table 2. — Disposition of any one group of American Expeditionary Forces patients in the American Expeditionary Forces during one year following admission.

Group	Died a	Sent to U. S., including disability cases b	Total losses c=a +b.	In hospital at the end of one year. d.	Returned to duty. 100—(c +d)	From Fig. No.
Disease & non-battle injuries	3.70	7.52	11.22	.00	88.78	33
Gas wounds	1.73	9.08	10.81	.01	89.18	34
Gunshot wounds	8.12	29.58	37.70	.42	61.88	35
Gas & gunshot wounds	6.10	23.12	29.22	.29	70.49	36
Total American Expeditionary Forces cases	4.60	13.42	18.02	.11	81.87	37



Deaths and discharges for disability

Days of treatment	Deaths in hospital	Discharges in hospital
30	2.41	1.65
60	2.55	2.62
90	2.60	3.12
120	2.62	3.37
150	2.62	3.50
180	2.63	3.56
210	2.63	3.60
240	2.63	3.61
270	2.63	3.62
300	2.63	3.63
330	2.63	3.63
360	2.63	3.63

Fig. 32.—Continuous change in the status of disease and nonbattle injury patients in the United States.

NOTE: For basic formulae see:
Remaining in hospital, Fig. 82, (3), p. 149.
Deaths in hospital, Fig. 93, (1), p. 160.
Discharges for disability in hospital, Fig. 94, (1), p. 161.
Patients returned to duty equals difference between 100% and the sum of the three above.

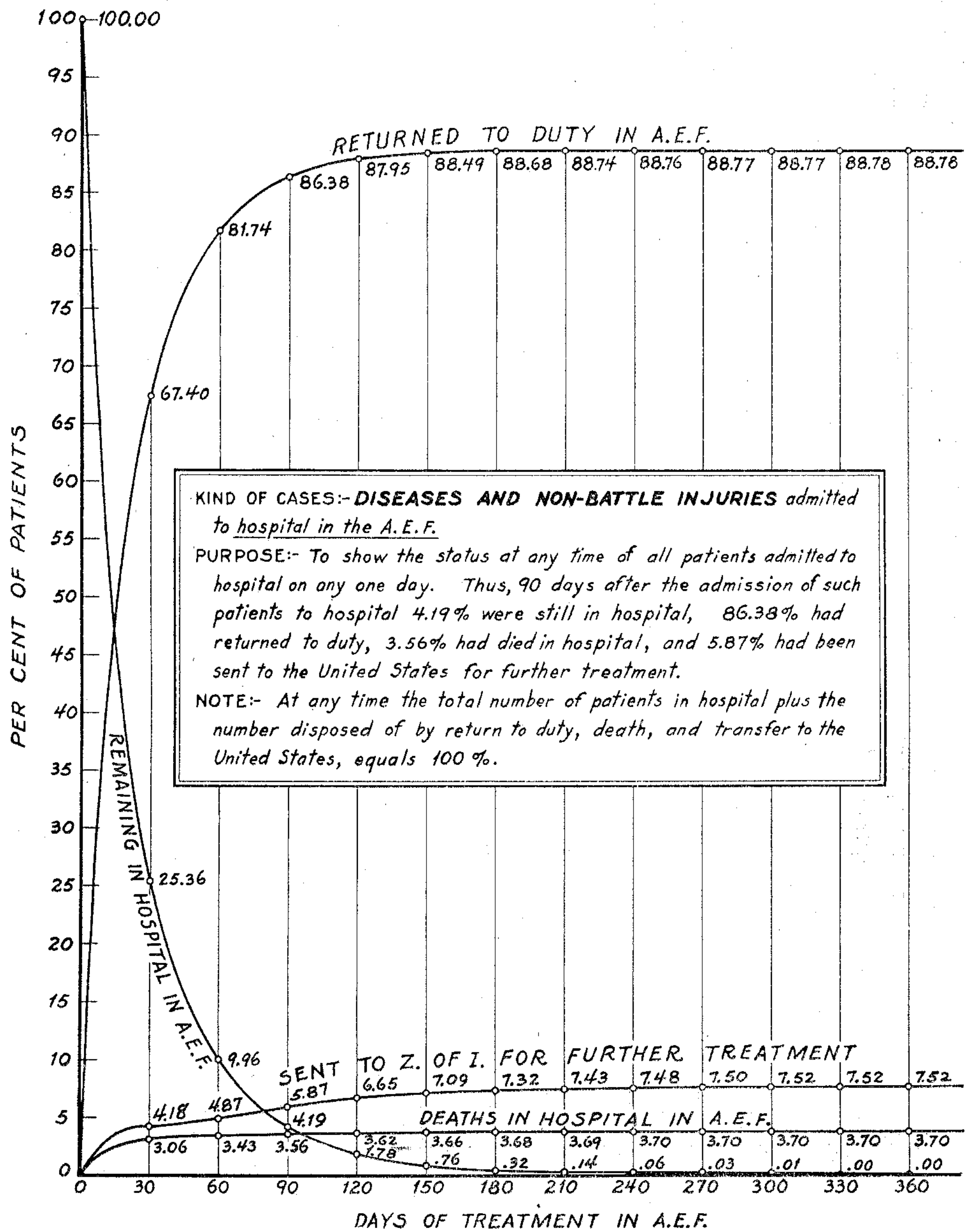


Fig. 33.—Continuous change in the status of disease and nonbattle injury hospital patients while in the American Expeditionary Forces.

NOTE: For basic formulae see:

Remaining in hospital, Fig. 86, (3), p. 153.
Return to duty, Fig. 90, (1), p. 157.
Deaths in hospital, Fig. 96, (3), p. 163.
Patients sent to the Zone of the Interior eqauls difference between 100% and the sum of the three above.

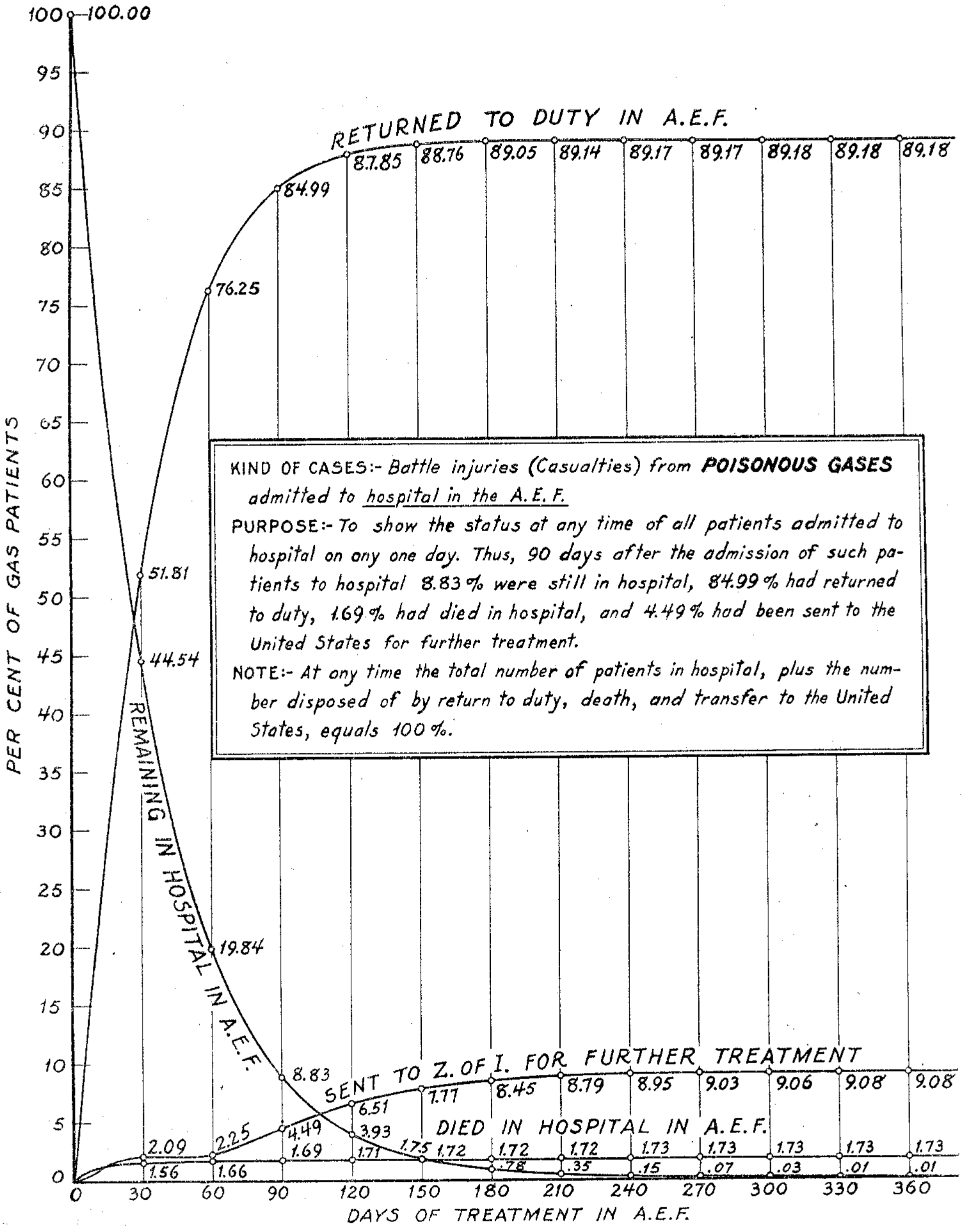


Fig. 34.—Continuous change in the status of gas patients while in the American Expeditionary Forces.

NOTE: For basic formulae see:
Remaining in hospital, Fig. 87, (b), (2), p. 154.
Return to duty, Fig. 91, (1), p. 158.
Deaths in hospital, Fig. 97, (3), p. 164.
Patients sent to the Zone of the Interior equals difference between 100% and the sum of the three above.

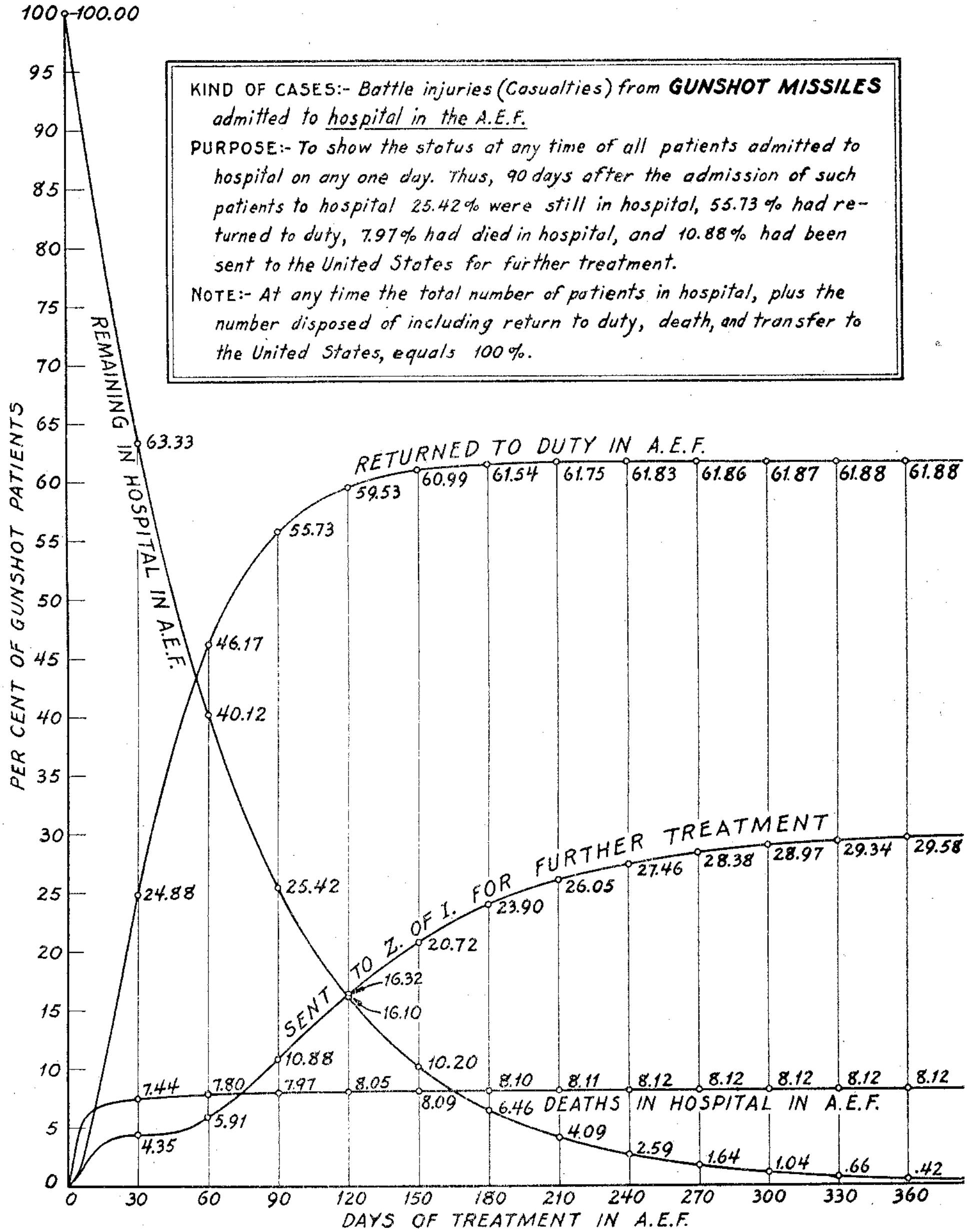


Fig. 35.—Continuous change in the status of gunshot patients while in the American Expeditionary Forces.

NOTE: For basic formulae see:

Remaining in hospital, Fig. 88, (b), (2), p. 155.
Return to duty, Fig. 92, (1), p. 159.
Deaths in hospital, Fig. 98, (3), p. 165.
Patients sent to the Zone of the Interior equals difference between 100% and the sum of the three above.

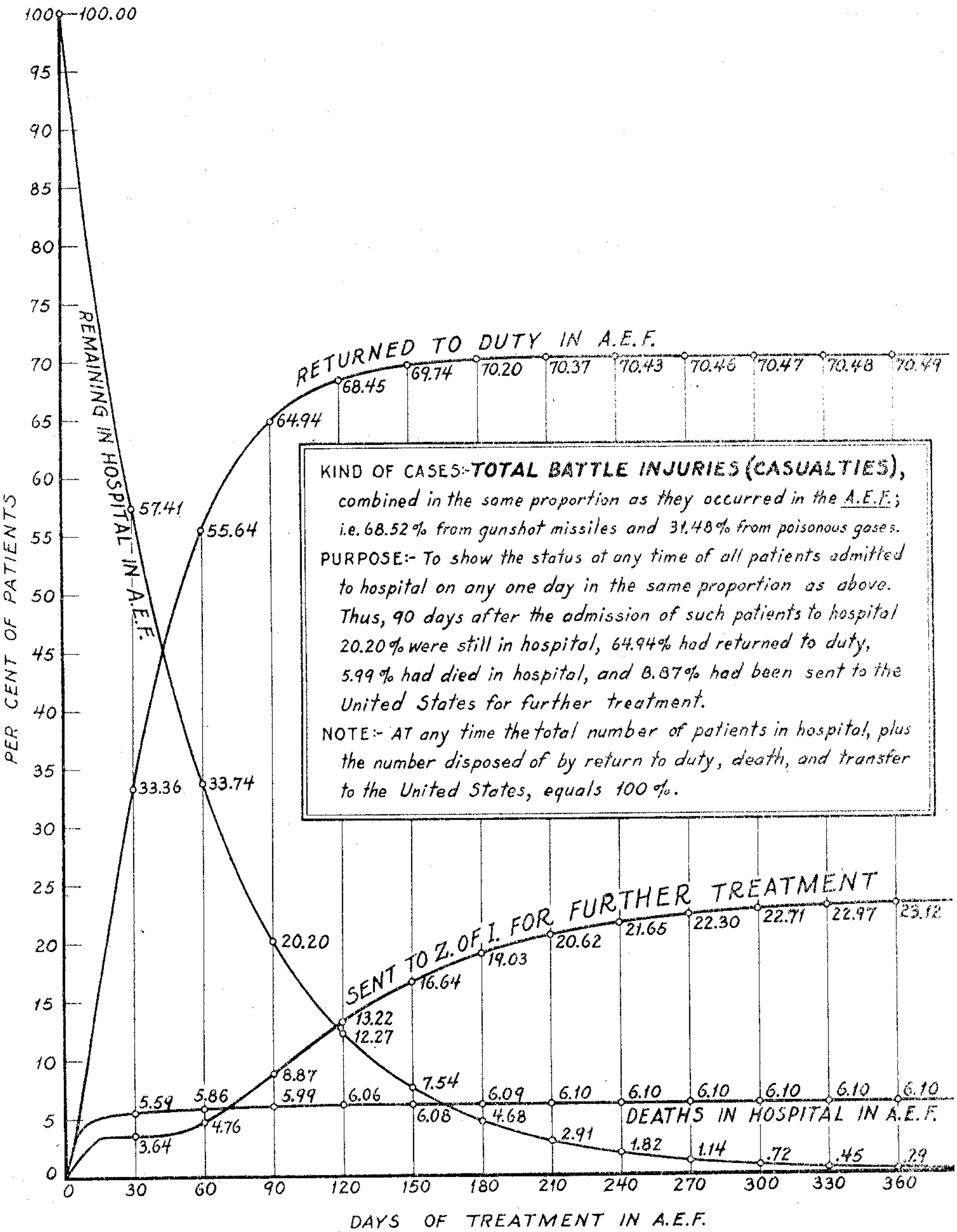


Fig. 36.—Continuous change in the status of gas and gunshot patients while in the American Expeditionary Forces combined in the same proportion as they occurred there. NOTE: For basic data see Figs. 34 and 35.

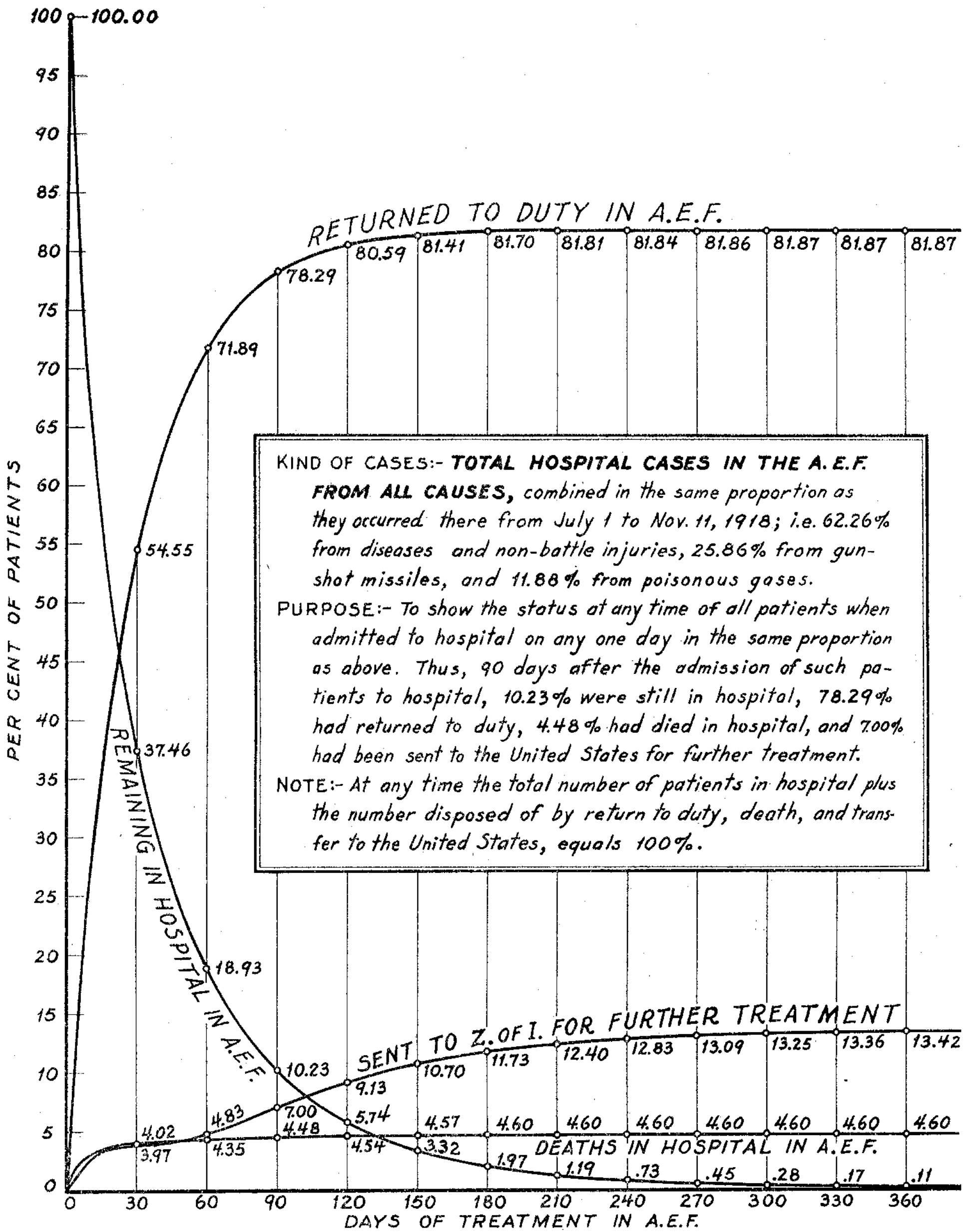


Fig. 37.—Continuous change in the status of *hospital* patients, while in the American Expeditionary Forces, admitted for all causes and in the same proportions as in the American Expeditiinary Forces.

NOTE: For basic data see Figs. 33, 34, and 35.

27. **Total duration of treatment of Theater of Operations cases.** — Figs. 33 - 37 show, among other items, the percentage of Theater of Operations cases remaining under treatment in the American Expeditionary Forces after various periods of treatment. But the treatment of some of the cases which were sent to the Zone of the Interior (United States) continued after transfer from the American Expeditionary Forces. Consequently the total duration of treatment was greater than that shown by Figs. 33 - 37, which include only time spent in the American Expeditionary Forces. The total duration of treatment of American Expeditionary Forces cases is shown by Figs. 38 - 40. These graphs are so closely associated with the question of the treatment of Theater of Operations cases, both there and in the Zone of the Interior, that they are discussed in connection with that subject.

H. HOSPITAL CARE OF THEATER OF OPERATIONS PATIENTS IN THEATER OF OPERATIONS AND IN THE ZONE OF THE INTERIOR.

28. **Character of patients to be sent to the Zone of Interior.**— Hospital patients in the Theater of Operations who are permanently incapacitated should be returned to the Zone of the Interior as promptly as the interests of the patients and the military situation will permit. Thus patients with pulmonary tuberculosis, those who are mentally unsound, and those who have such definite surgical disabilities as deformed or amputated limbs, often can be classified as disability cases very soon after entering hospital; while in other cases a more extended period of observation will be necessary before the ultimate results of treatment can be determined.

The return of patients to the Zone of the Interior reduces the hospitalization requirements in the Theater of Operations but correspondingly increases them in the Zone of the Interior. Inadequate hospital facilities, the scarcity of material from which they can be provided, proximity to the Zone of the Interior, or other reasons may make it necessary or desirable to send to the Zone of the Interior patients who may be returned to duty eventually. Usually this will be undesirable from a military viewpoint because patients returning to duty from hospital are trained replacements, and a temporary or permanent replacement must be supplied for every man who is sent away from the Theater of Operations. Even when the lines of communication are open and the distance between the Zone of the Interior and Theater of Operations is not great, unnecessary time is lost when potential duty cases are sent to the Zone of the Interior, and then returned to the Theater of Operations. The nearer the hospitals are to the troop area, the less will be the average time lost by each hospital case. In addition to the unnecessary loss of time in transit to and from the Zone of the Interior, there is also always a probability that many patients who completely recover after return to the Zone of the Interior will never return to the Theater of Operations, or that their return will be greatly delayed.

To insure then that all Theater of Operations patients who recover will return to organizations there as promptly as possible, hospital facilities should be provided for as large a percentage of cases as practicable, and these hospitals should be as near to the active troop areas as the military situation will permit.

The unnecessarily high percentage of cases returned to the Zone of the Interior from the American Expeditionary Forces was due largely to the return of many recovered patients after the Armistice, who would ordinarily have been retained for duty in the Theater of Operations. If it is desired to conserve the man power in the Theater of Operations our experience indicates that it will not be necessary to return to the Zone of the Interior, more than 3% of the cases of diseases and nonbattle injuries, 6% of those wounded by war gases, and 20% of those wounded by gunshot missiles. These percentages would be sufficient to cover the physically disabled and also the recovery cases requiring prolonged treatment, provided that the men sent to the Theater of Operations are selected physically. Obviously all physically unfit men who are sent to the Theater of Operations will have to be returned to the Zone of the Interior. Thus during the years 1923-1927, when the men for overseas duty were not selected so carefully as during the World War, 3.5% of all overseas disease and nonbattle injury hospital patients were eventually discharged as physically disabled, as compared with 2% of the American Expeditionary Forces hospital cases. The percentage of such cases from the American Expeditionary Forces who were eventually discharged in the United States were: Diseases and nonbattle injury, 2%; gas wounded, 4%; and gunshot wounded, 15%.

29. **Duration of hospital treatment of Theater of Operations patients.** — *a. Disease and nonbattle injury patients.* (1) *Percentage remaining in hospital.*— As shown by Fig. 38, of the American Expeditionary Forces cases admitted for diseases and nonbattle injury, 47.39% remained in hospital more than 15 days either there or in the United States; 28.26% more than 30 days; and 12.39% more than 60 days.

(2) *Relation to hospital beds required in Theater of Operations and in Zone of the Interior.* — This graph answers the questions: (a) What percentage of patients remain beyond a certain time, and (b) at what time is there a certain percentage of patients remaining in hospital? Thus on the 90th day of treatment 5.70% of the patients are remaining; similarly 9% of all patients are remaining on the 72nd day of treatment.

The number of hospital beds required in the Theater of Operations and in the Zone of the Interior, when a certain percentage of the Theater of Operations admissions are returned to the Zone of the Interior, can be determined from Figs. 27 and 38. Thus if 3% of the admissions from diseases and nonbattle injuries are so returned, all cases averaging more than 115 days will be included (Fig 38). This means then that the hospital curve in the Theater of Operations (Fig. 27) will become stabilized at that time, for all cases averaging longer will be sent to the Zone of the Interior. Fig. 27 shows that on the 115th day the hospital curve has reached 26.13 patients per 1000 men. This then is the number of patients to be treated in the Theater of Operations and the difference between 26.13 and the total hospital cases under these assumed conditions (27.29) must be provided for in the Zone of the Interior (1.16).

Similarly if 6% of admissions for diseases and nonbattle injuries are to be returned to the Zone of the Interior, all cases averaging more than 88 days will be transferred, (Fig. 38) on which day the hospital curve has reached about 24.95 patients (Fig. 27). The difference between 27.29 and 24.95, or 2.34, must be provided for in the Zone of the Interior.

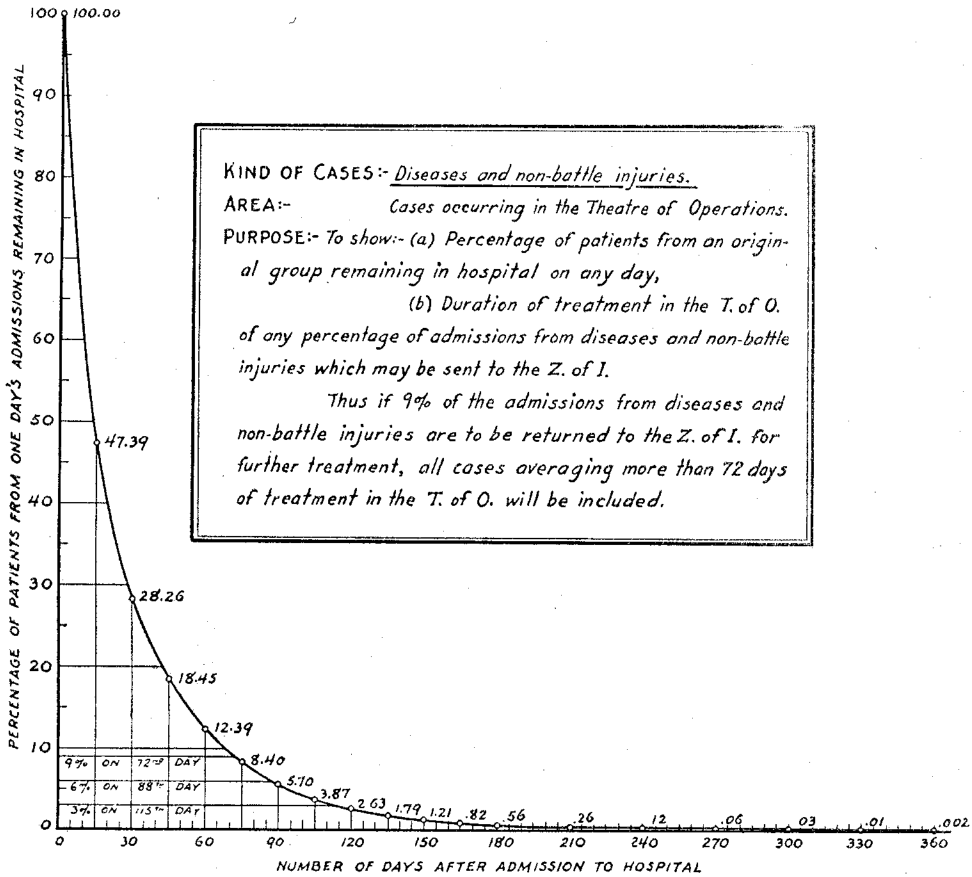


Fig. 38.—Duration of treatment both in the Theater of Operations and Zone of the Interior of Theater of Operations disease and nonbattle injury patients.
NOTE: For basic formula see Fig. 84, (2), p. 151.

b. *Gas patients.* — Fig. 39 shows what percentage of one day's group of gas patients are remaining in hospital at different periods of time. The average duration of each case of disease and nonbattle injury in the American Expeditionary Forces was 27.29, and of each gas case 41.77 (Fig. 3). Consequently during the first few months a larger percentage of each day's gas cases, than of disease and nonbattle injury ones, remain in hospital. Thus at the end of 30 days there is 46.50% (Fig. 39) of gas cases remaining, as compared with 28.26% (Fig. 38) of those of disease and nonbattle injury; and at the end of 60 days, 21.96% of the former and 12.39% of the latter.

If 6% of gas admissions are sent to the Zone of the Interior, all cases averaging more than 115 days will be included (Fig. 39). Turning to

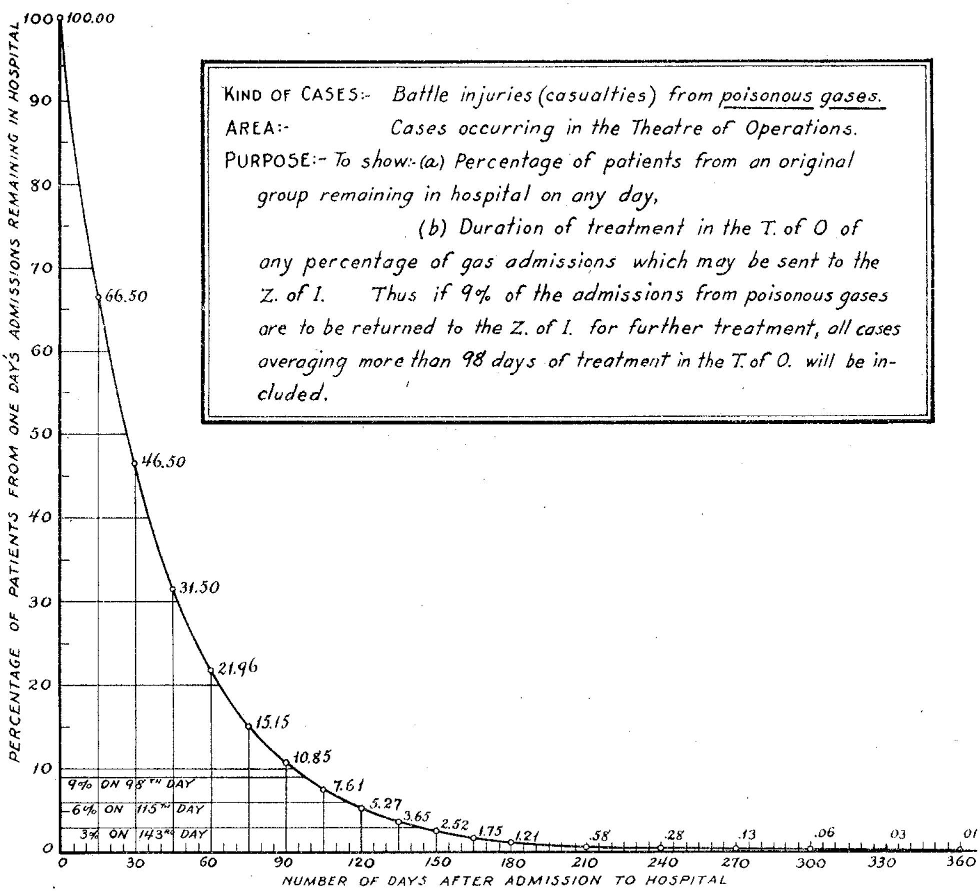


Fig. 39.—Duration of treatment both in the Theater of Operations and Zone of the Interior of Theater of Operations gassed patients.

NOTE: For basic formula see Fig. 87, (a), (2), p. 154.
Graduated points for the first 90 days altered very slightly to agree with results on Fig. 34.

Fig. 28, one sees that on that day the hospital curve reaches 39.35 gas patients. This then is the number to be provided for in the Theater of Operations under the assumed conditions, and 2.42, or the difference between 41.77 and 39.35, in the Zone of the Interior.

c. *Gunshot patients.* — The percentage of one day's group of gunshot cases remaining in hospital at different time intervals is shown by **Fig. 40.** It appears from Fig. 3 that the average duration of each gunshot case in the American Expeditionary Forces was 94.84 days, as compared with 41.77 for each gas case. Consequently a larger percentage of any one group of gunshot cases are remaining at each time interval. Thus at the end of 30 days, 66.00% (Fig. 40) of the gunshot admissions are remaining, as compared with 46.50% (Fig. 39) of the gas cases, and 28.26%

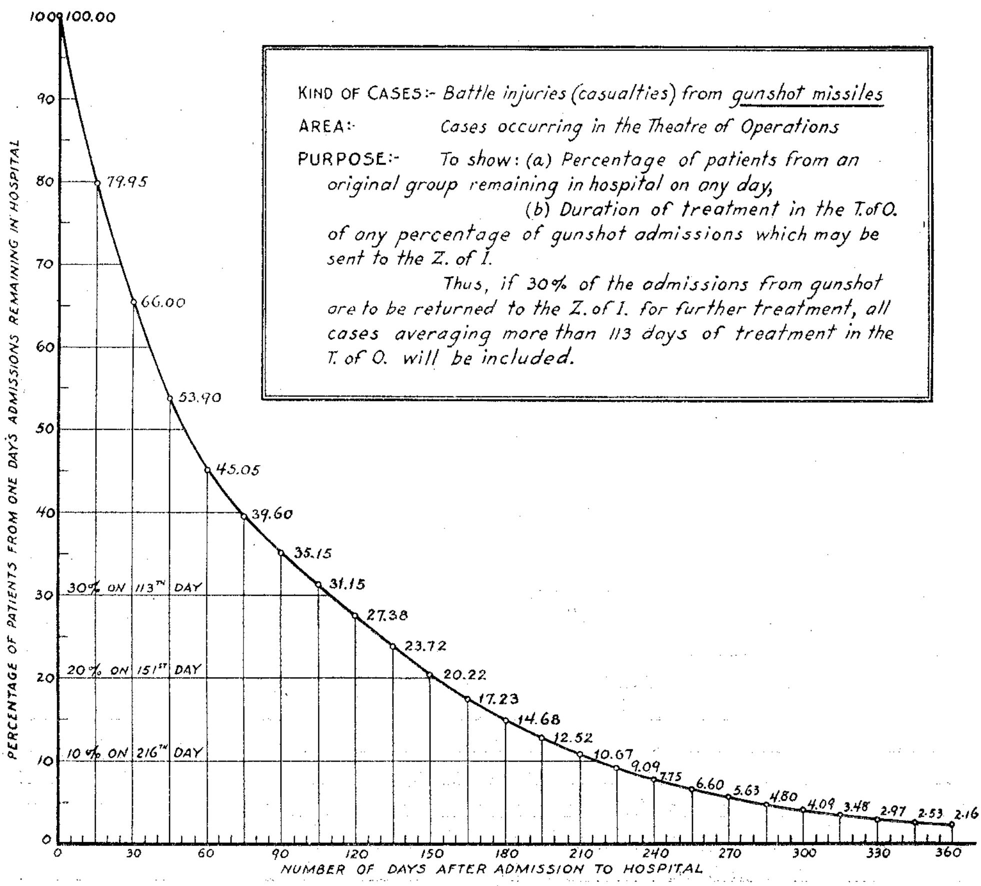


Fig. 40.—Duration of treatment both in the Theater of Operations and **Zone of the** Interior of Theater of Operations gunshot patients.

NOTE: For basic formula see Fig. 88, (a), (2), p. 155.

Graduated points for the first 105 days altered slightly to agree with results on Fig. 35.

(Fig. 38) of the disease and nonbattle injury ones. Similarly at the end of 60 days, 45.05% of the gunshot cases, 21.96% of the gas cases, and 12.39% of the disease and nonbattle injury admissions are remaining.

If, as previously suggested, 20% of all gunshot admissions are sent to the Zone of the Interior, all cases averaging more than 151 days will be so transferred. Turning to Fig. 29 it appears that on that day the hospital curve reaches approximately 76.07 patients. This then is the number to be provided for in the Theater of Operations and the difference between 94.84 and 76.07, or 18.77, must be cared for in the Zone of the Interior.

30. **Percentage of Theater of Operations patients sent to the Zone of the Interior in relation to hospital beds required in each area.** — It obviously would be impracticable to adhere rigidly to a program of sending any definite percentage of Theater of Operations cases of various kinds to the Zone of the Interior, but if the effort is made to conserve the strength of the military forces in the Theater of Operations by providing a sufficient number of hospital beds there and by returning to the Zone of the Interior only such cases as will be physically unfit for further military duty, or whose treatment will be unduly prolonged, the percentage suggested can be approximated. *To repeat, this means the return to the Zone of the Interior of 3% of all admissions for diseases and nonbattle injuries, 6% of all those wounded by gases, and 20% of all wounded by gunshot missiles.*

Of the cases transferred to the Zone of the Interior, some will remain in hospital, while others will be disposed of by return to duty in the Zone of the Interior, discharge for disability, or death.

a. Disease and nonbattle injury patients. — Fig. 41 shows (upper curve) the total number of Theater of Operations patients sick from disease and nonbattle injuries in hospital at different intervals of time, when 1.00 per 1000 strength is admitted each day. It also shows how many of such patients are in hospital in the Theater of Operations and also in the Zone of the Interior when 9%, 6%, or 3% are returned to the Zone of the Interior for treatment. For the purpose of this study all cases are counted as in the Zone of the Interior as soon as they leave the Theater of Operations, and the number of beds required in the Zone of the Interior for Theater of Operations cases includes those occupied on troop ships.

Under each set of conditions, the number of patients in the Zone of the Interior is necessarily the difference between the total number and those remaining in the Theater of Operations. From these data it is easy to calculate like data for any similar set of conditions. Thus, suppose it is decided to return to the Zone of the Interior all cases of diseases and nonbattle injuries averaging more than 60 days in hospital. Turning to Fig. 38 we find that this will include 12.39% of all such admissions, which is the percentage remaining on that day. From Fig. 27 we see that on the 60th day the hospital curve has reached 22.49 patients, which is the number to be treated in the Theater of Operations under the assumed set of conditions, and the difference between 27.29 and 22.49, or 4.80, is the number to be cared for in the Zone of the Interior.

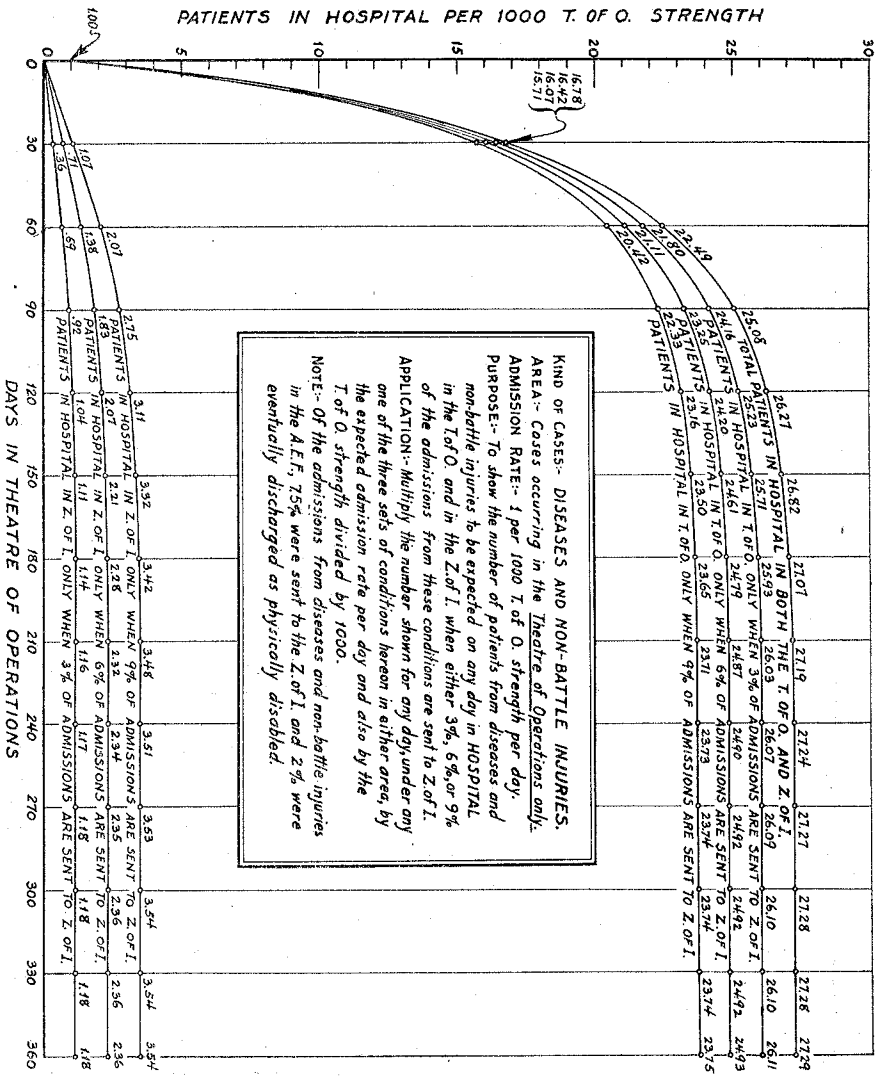


Fig. 41.*—Number of Theater of Operations patients from diseases and nonbattle injuries in hospital in the Theater of Operations and Zone of the Interior, when certain percentages of the Theater of Operations admissions are sent to the Zone of the Interior.

*NOTE: For basic formula see:- (a) Total patients in hospital, Fig. 84, (1) p. 151. (b) Patients in hospital in American Expeditionary Forces (Theater of Operations) only, when 9% are sent to the Zone of the Interior, Fig. 86, (2), p. 153. (c) Patients in hospital in American Expeditionary Forces (Theater of Operations) only, when 3% or 6% are sent to the Zone of the Interior, calculated from (a) and (b). (d) Patients in hospital in Zone of the Interior only are the differences between total patients (a) and those in Theater of Operations (b) and (c).

To calculate the number of beds required at different periods in each area, find the number of times that 3% is contained in 12.39%; i.e., the percentage remaining in hospital on the 60th day, and multiply the data for the 3% assumption (Fig. 41) by the quotient (12.39 ÷ 3 = 4.13). The following table shows the calculation in detail:

Table 3. — Disease and nonbattle injury Theater of Operations patients in hospital at the end of each month, when the daily admission rate is 1.00 per 1000 total American Expeditionary Forces strength; the number of those in hospital in the Zone of Interior, when either 3% or 12.39% of all admissions are sent there; and the number in the Theater of Operation hospitals when the latter percentage has been transferred.

A. Days of operation in Theater of Operations.	B. Total patients.	C. Patients in Zone of Interior when 3% are sent there.	D. Patients in Z. of I., when 12.39% are sent there. (C × 4.13)	E. Patients in T. of O., when 12.39% of all admissions are sent to Z. of I. (B - D).
0	1.00	0.	0.	1.00
30	16.78	.36	1.49	15.29
60	22.49	.69	2.85	19.64
90	25.08	.92	3.80	21.28
120	26.27	1.04	4.30	21.97
150	26.82	1.11	4.58	22.24
180	27.07	1.14	4.71	22.36
210	27.19	1.16	4.79	22.40
240	27.24	1.17	4.83	22.41
270	27.27	1.18	4.87	22.40
300	27.28	1.18	4.87	22.41
330	27.28	1.18	4.87	22.41
360	27.29	1.18	4.87	22.42

The differences between the ultimate numbers calculated as in the Theater of Operations (22.42) and in the Zone of the Interior (4.87), and those shown on p. 59 (22.49 and 4.80) are small and are the result of using the decimals to only the second place.

b. *Gas patients.* — Fig. 42 shows the number of patients for whom hospital beds must be provided in the Theater of Operations and the Zone of the Interior when 1.00 patient wounded by war gases per 1000 strength is admitted each day, and 9%, 6%, or 3% of such admissions are returned to the Zone of the Interior for further treatment. The method of calculating data for different percentages is the same as that shown by Table 3.

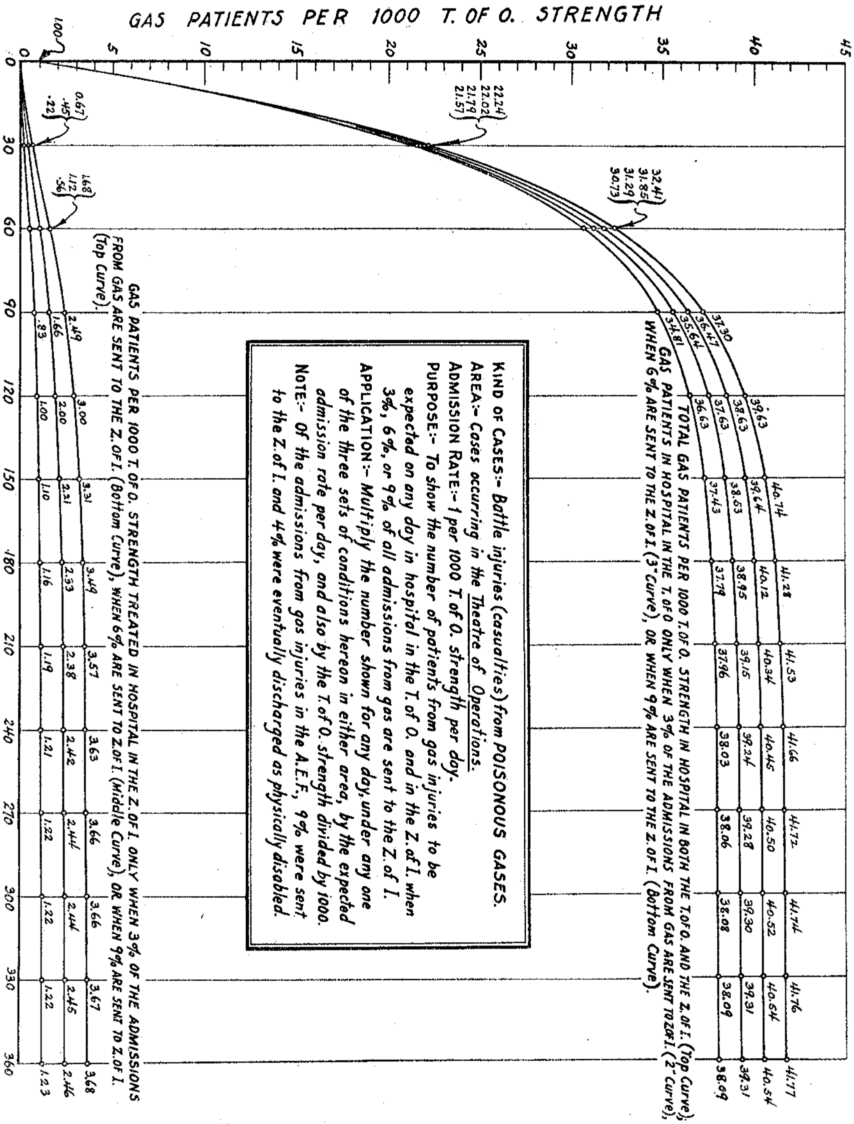


Fig. 42.*—Number of Theater of Operations patients from gas injuries in hospital in the Theater of Operations and Zone of the Interior, when certain percentages of the Theater of Operations admissions are sent to the Zone of the Interior.

*NOTE: For basic formula see: (a) Total patients in hospital, Fig. 87, (a), (1) p. 154. (b) Patients in hospital in the American Expeditionary Forces (T. of O.) only, when 9% are sent to the Zone of the Interior, Fig. 87, (b), (1), p. 154. (c) Patients in hospital in the American Expeditionary Forces (T. of O.) only, when 3% or 6% are sent to the Zone of the Interior, calculated from (a) and (b). (d) Patients in hospital in Zone of the Interior only are the differences between total patients (a) and those in Theater of Operations (b) and (c).

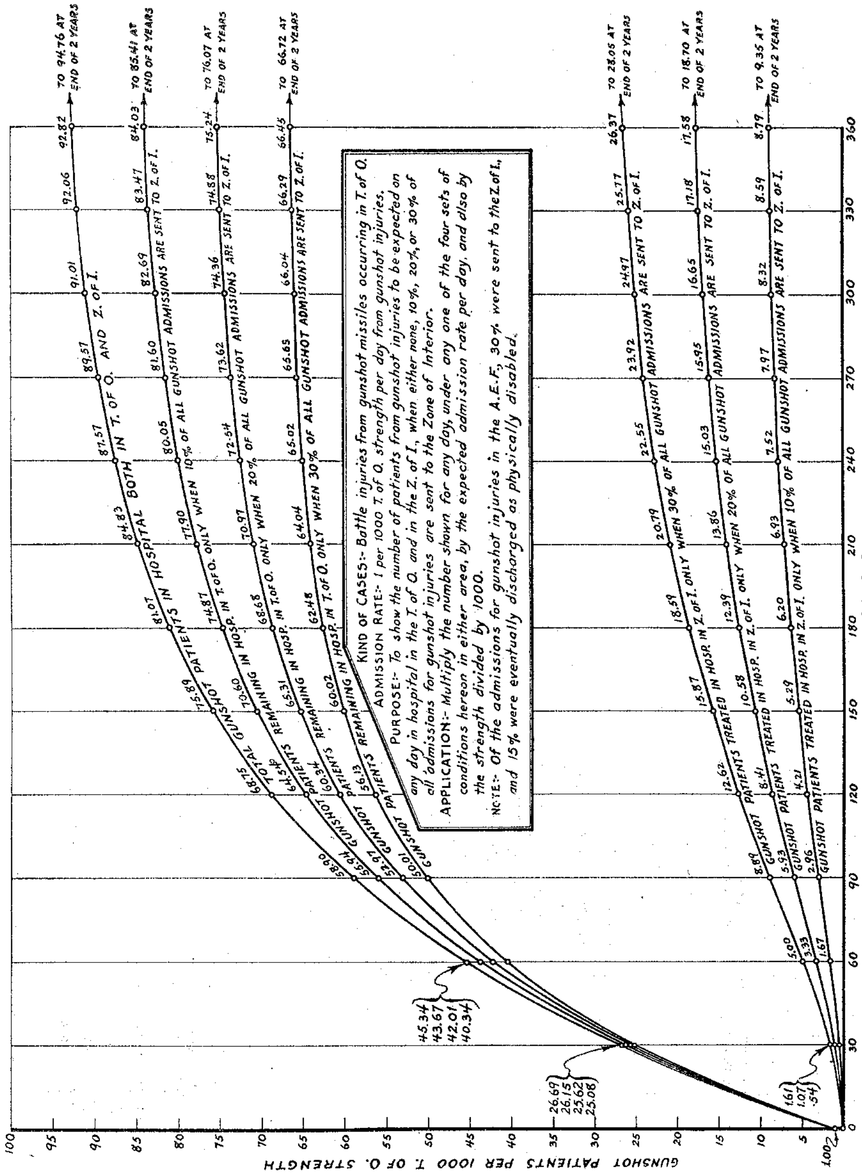


Fig. 43.*—Number of Theater of Operations patients from gunshot injuries in hospital in the Theater of Operations and Zone of the Interior, when certain percentages of the admissions are sent to the Zone of the Interior.

*NOTE: For basic formula see:

(a) Total patients in hospital, Fig. 88, (a), (1), p. 155.
(b) Patients in hospital in A. E. F. (T. of O.) only, when 30% are sent to the Z. of I., Fig. 88, (b), (1), p. 155.
(c) Patients in hospital in A. E. F. (T. of O.) only, when 10% or 20% are sent to Z. of I., calculated from (a) and (b).
(d) Patients in hospital in Z. of I., only are the differences between total patients (a) and those in T. of O., (b) and (c).

c. Gunshot patients. — In like manner Fig. 43 shows the number of gunshot patients for whom hospital beds must be provided in the Theater of Operations and Zone of the Interior, when 1.00 patient per 1000 strength is admitted each day, and when 30%, 20%, or 10% of all such admissions are sent to the Zone of the Interior. The data for other percentages to be sent to the Zone of the Interior can be calculated as shown by Table 3.

d. Total of Theater of Operations patients. — (1) *With constant rates and constant strength.* — The following table shows: (1) the patients in hospital in the Theater of Operations and Zone of the Interior when the admissions from diseases and nonbattle injuries, gas, and gunshot injuries are each 1.00 per 1000 strength per day, and when 3%, 6%, and 20% respectively of each class of cases are sent to the Zone of the Interior; and (2) the same as above but with approximately the same admission rates as there were in the American Expeditionary Forces from July 1 to November 11, 1918.

Table 4.—(1) Patients per 1000 Theater of Operations strength in hospital in the Theater of Operations and Zone of Interior when 1.00 per 1000 Theater of Operations strength is admitted each day from each cause, and the specified percentages are sent to the Zone of Interior.

A	B		C		D	
Days of operation in T. of O.	Disease and nonbattle injury patients when 3% are sent to Z. of I. (Fig. 41).		Gas patients when 6% are sent to Z. of I. (Fig. 42).		Gunshot patients when 20% are sent to Z. of I. (Fig. 43).	
	In T. of O.	In Z. of I.	In T. of O.	In Z. of I.	In T. of O.	In Z. of I.
0	1.00	0.	1.00	0.	1.00	0.
30	16.42	.36	21.79	.45	25.62	1.07
60	21.80	.69	31.29	1.12	42.01	3.33
90	24.16	.92	35.64	1.66	52.97	5.93
120	25.32	1.04	37.63	2.00	60.34	8.41
150	25.71	1.11	38.53	2.21	65.31	10.58
180	25.93	1.14	38.95	2.33	68.68	12.39
210	26.03	1.16	39.15	2.38	70.97	13.86
240	26.07	1.17	39.24	2.42	72.54	15.03
270	26.09	1.18	39.28	2.44	73.62	15.95
300	26.10	1.18	39.30	2.44	74.36	16.65
330	26.10	1.18	39.31	2.45	74.88	17.18
360	26.11	1.18	39.31	2.45	75.24	17.58
920	26.11	1.18	39.31	2.45	76.09	18.75

Table 4.— (2) Patients per 1000 Theater of Operations strength in hospital in the Theater of Operations and Zone of the Interior when 1.65 from diseases and nonbattle injuries, .3148 from gas wounds and .6852 from gunshot wounds per 1000 Theater of Operations strength are admitted each day, (or opproximately the same rates as occurred in the American Expeditionary Forces from July 1 - November 11, 1918) and the specified percentages are sent to the Zone of the Interior.

Days of operation in the T. of O. E.	F Diseases and nonbattle injury patients when 3% are sent to the Z. of I. Data in 4 (1) B × 1.65		G Gas patients when 6% are sent to the Z. of I. Data in 4 (1) C × .3148.		H Gunshot patients when 20% are sent to the Z. of I. Data in 4 (1) D × .6852		I Total F+G+H	
	In T. of O.	In Z. of I.	In T. of O.	In Z. of I.	In T. of O.	In Z. of I.	In T. of O.	In Z. of I.
0	1.65	0.	.3148	0.	.6852	0.	2.65	0.
30	27.09	.59	6.86	.14	17.55	.73	51.50	1.46
60	35.97	1.14	9.85	.35	28.79	2.28	74.61	3.77
90	39.86	1.52	11.22	.52	36.30	4.06	87.38	6.10
120	41.63	1.72	11.85	.63	41.34	5.76	94.82	8.11
150	42.42	1.83	12.14	.70	44.75	7.25	99.31	9.78
180	42.78	1.88	12.26	.73	47.06	8.49	102.10	11.10
210	42.95	1.91	12.32	.75	48.63	9.50	103.90	12.16
240	43.02	1.93	12.35	.76	49.70	10.30	105.07	12.99
270	43.05	1.95	12.37	.77	50.44	10.93	105.86	13.65
300	43.06	1.95	12.37	.77	50.95	11.41	106.38	14.13
330	43.06	1.95	12.37	.77	51.31	11.77	106.74	14.49
360	43.08	1.95	12.37	.77	51.55	12.05	107.00	14.77
920	43.08	1.95	12.37	.77	52.14	12.85	107.59	15.57

Under the conditions as assumed, at the end of 360 days there would be 107.00 patients per 1000 strength in hospital in the Theater of Operations, and 14.77 in the Zone of the Interior, a total of 121.77. If 10% increase is allowed for dispersion of patients, the bed requirements would be 117.70 in Theater of Operations and 16.25 in the Zone of the Interior, a total of 133.95 per 1000, or 13.40%.

With a force of 1,900,000 men as there was in the American Expeditionary Forces, and under approximately such conditions as existed there from July 1 to November 11, 1918, the bed requirements at the end of a year, with a 10% dispersion factor for safety, would be 254,499, with 223,630 in the Theater of Operations and 30,869 in the Zone of the Interior.

If these same conditions had continued there would have been a slight though continued increase in the bed requirements after 360 days and until the 920th day, due to the prolonged treatment required for gunshot cases. On the 920th day, the total beds required would have been 107.59 in the Theater of Operations and 15.57 in the Zone of the Interior, or a total of 123.16 per 1000 Theater of Operations strength. With 10% increase for dispersion of patients these figures would have been 118.35 in the Theater of Operations and 17.13 in the Zone of the Interior, or a total of 135.48 beds per 1000 strength.

With military combat of the same intensity as there was during the Meuse-Argonne offensive from September 26 - November 11, 1918, when

DAILY ADMISSION RATE PER 1000 MEN	CAUSE OF ADMISSION	M 30	M 60	M 90	M 120	M 150	M 180	M 210	M 240	M 270	M 300
		ACCUMULATION OF T. OF O. HOSPITAL PATIENTS IN EACH 1000 T. OF O. STRENGTH									
		AT A DAILY ADMISSION RATE OF 1.00									
1.00 (SEE FIG. 41)	DISEASES & NON-BATTLE INJURIES	16.78	22.49	25.08	26.27	26.82	27.07	27.19	27.24	27.27	27.28
1.00 (SEE FIG. 42)	WAR GASES	22.24	32.41	37.30	39.63	40.74	41.28	41.53	41.66	41.72	41.74
1.00 (SEE FIG. 43)	GUNSHOT MISSILES	26.69	45.34	58.90	68.75	75.89	81.07	84.83	87.57	89.57	91.01
AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918.											
1.65	DISEASES & NON-BATTLE INJURIES	27.69	37.11	41.38	43.35	44.25	44.67	44.86	44.95	45.00	45.01
.24	WAR GASES	5.34	7.78	8.95	9.51	9.78	9.91	9.97	10.00	10.01	10.02
.53	GUNSHOT MISSILES	14.14	24.03	31.22	36.44	40.22	42.97	44.96	46.41	47.47	48.24
TOTAL		47.17	68.92	81.55	89.30	94.25	97.55	99.79	101.36	102.48	103.27

MONTHLY INCREMENTS OF T. OF O. STRENGTH AS IN THE A.E.F. IN 1918			ACCUMULATION OF T. OF O. HOSP. PATIENTS FROM EACH MONTHLY INCR. OF T. OF O. STR. AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918									
JAN.	M 30	194,000	9151	13 370	15 821	17 324	18 284	18 925	19 359	19 664	19 881	20 034
FEB.	M 60	38,000		1 792	2 619	3 099	3 393	3 582	3 707	3 792	3 852	3 894
MAR.	M 90	49,000			2 311	3 377	3 996	4 376	4 618	4 780	4 890	4 967
APRIL	M 120	88,000				4 151	6 065	7 176	7 858	8 294	8 584	8 782
MAY	M 150	167,000					7 877	11 510	13 619	14 913	15 740	16 291
JUNE	M 180	223,000						10 519	15 369	18 186	19 914	21 018
JULY	M 210	258,000							12 170	17 781	21 040	23 039
AUG.	M 240	268,000								12 642	18 470	21 855
SEPT.	M 270	263,000									12406	18 126
OCT.	M 300	222,000										10 472
TOTAL T. OF O. PATIENTS AT CLOSE OF EACH PERIOD			9151	15 162	20 751	27 951	39 615	56 088	76 700	100 052	124 777	148 478

Fig. 44.—Method of computing the total hospital patients to be expected in a Theater of Operations command under approximately the same conditions as there was in the American Expeditionary Forces in 1918, with a material increase in the strength each month, and where the daily admission rate to hospital only from diseases and nonbattle injuries was 1.65; from war gases, 0.24; and from gunshot missiles, 0.53 per 1000 strength.

the admission rate (see Fig. 20) from gas was .45, from gunshot missiles 1.10, and from diseases and nonbattle injuries 1.65 per 1000 Theater of Operations strength, the number of beds required for Theater of Operations patients in the Theater of Operations and Zone of Interior at the end of 360 and 920 days when 3% of diseases and nonbattle injuries, 6% of

DAILY ADMISSION RATE PER 1000 MEN	PERCENTAGE OF ADMISSIONS SENT TO Z. OF I.	CAUSE OF ADMISSION	M 30	M 60	M 90	M 120	M 150	M 180	M 210	M 240	M 270	M 300
			ACCUMULATION OF HOSPITAL PATIENTS IN THE T. OF O. IN EACH 1000 T. OF O. STRENGTH									
			AT A DAILY ADMISSION RATE OF 1.00									
1.00 (SEE FIG. 41)	3%	DISEASES & NON-BATTLE INJURIES	16.42	21.80	24.16	25.23	25.71	25.93	26.03	26.07	26.09	26.10
1.00 (SEE FIG. 42)	6%	WAR GASES	21.79	31.29	35.64	37.63	38.53	38.95	39.15	39.24	39.28	39.30
1.00 (SEE FIG. 43)	20%	GUNSHOT MISSILES	25.62	42.01	52.97	60.34	65.31	68.68	70.97	72.54	73.62	74.36
AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918												
1.65	3%	DISEASES & NON-BATTLE INJURIES	27.09	35.97	39.86	41.63	42.42	42.78	42.95	43.02	43.05	43.06
.24	6%	WAR GASES	5.23	7.51	8.55	9.03	9.25	9.35	9.40	9.42	9.43	9.43
.53	20%	GUNSHOT MISSILES	13.58	22.27	28.07	31.98	34.61	36.40	37.61	38.45	39.02	39.41
TOTAL			45.90	65.75	76.48	82.64	86.28	88.53	89.96	90.89	91.50	91.90

MONTHLY INCREMENTS OF T. OF O. (A.E.F.) STRENGTH			ACCUMULATION OF HOSPITAL PATIENTS IN THE T. OF O. FROM EACH MONTHLY INCREMENT OF T. OF O. STR.									
			AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918									
JAN.	M 30	194,000	8 905	12 756	14 837	16 032	16 738	17 175	17 452	17 633	17 751	17 829
FEB.	M 60	38,000		1 744	2 498	2 906	3 140	3 279	3 364	3 418	3 454	3 477
MAR.	M 90	49,000			2 249	3 222	3 748	4 049	4 228	4 338	4 408	4 454
APRIL	M 120	88,000				4 039	5 786	6 730	7 272	7 593	7 791	7 916
MAY	M 150	167,000					7 665	10 980	12 772	13 801	14 409	14 784
JUNE	M 180	223,000						10 236	14 662	17 055	18 429	19 240
JULY	M 210	258,000							11 842	16 964	19 732	21 321
AUG.	M 240	268,000								12 301	17 621	20 497
SEPT.	M 270	263,000									12 072	17 292
OCT.	M 300	222,000										10 190
TOTAL PATIENTS IN HOSPITAL IN THE T. OF O. AT CLOSE OF EACH PERIOD			8 905	14 500	19 584	26 199	37 077	52 449	71 592	93 103	115 667	137 000

Fig. 45.—Method of computing for a command in the Theater of Operations the hospital patients to be treated in the Theater of Operations when: (a) There is an increasing strength; (b) admissions from both battle and nonbattle causes; (c) and certain percentages are sent to the Zone of the Interior for further treatment.

DAILY ADMISSION RATES PER 1000 MEN	PERCENTAGE OF ADMISSIONS SENT TO Z. OF I.	CAUSE OF ADMISSION	M 30	M 60	M 90	M 120	M 150	M 180	M 210	M 240	M 270	M 300
			ACCUMULATION IN THE Z. OF I. OF T. OF O. PATIENTS PER 1000 T. OF O. STRENGTH									
			AT A DAILY ADMISSION RATE OF 1.00									
1.00 SEE FIG. 41	3%	DISEASES & NON-BATTLE INJURIES	.36	.69	.92	1.04	1.11	1.14	1.16	1.17	1.18	1.18
1.00 SEE FIG. 42	6%	WAR GASES	.45	1.12	1.66	2.00	2.21	2.33	2.38	2.42	2.44	2.44
1.00 SEE FIG. 43	20%	GUNSHOT MISSILES	1.07	3.33	5.93	8.41	10.58	12.39	13.86	15.03	15.95	16.65
			AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918.									
1.65	3%	DISEASES & NON-BATTLE INJURIES	.59	1.14	1.52	1.72	1.83	1.88	1.91	1.93	1.94	1.95
.24	6%	WAR GASES	.11	.27	.40	.48	.53	.56	.57	.58	.59	.59
.53	20%	GUNSHOT MISSILES	.57	1.76	3.14	4.46	5.61	6.57	7.35	7.97	8.45	8.82
TOTAL			1.27	3.17	5.06	6.66	7.97	9.01	9.83	10.48	10.98	11.36

MONTHLY INCREMENTS OF T. OF O. STRENGTH AS IN THE A.E.F. IN 1918			ACCUMULATION OF HOSPITAL PATIENTS IN THE Z. OF I. FROM EACH MONTHLY INCREMENT OF T. OF O. STR. AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918									
JAN.	M 30	194,000	246	615	982	1292	1546	1748	1907	2033	2130	2204
FEB.	M 60	38,000		48	120	192	253	303	342	374	398	417
MAR.	M 90	49,000			62	155	248	326	390	442	482	514
APRIL	M 120	88,000				112	279	445	586	701	793	865
MAY	M 150	167,000					212	529	845	1112	1331	1505
JUNE	M 180	223,000						283	707	1128	1485	1777
JULY	M 210	258,000							328	818	1305	1718
AUG.	M 240	268,000								340	850	1356
SEPT.	M 270	263,000									334	834
OCT.	M 300	222,000										282
TOTAL PATIENTS AT THE CLOSE OF EACH PERIOD			246	663	1164	1751	2538	3634	5105	6948	9108	11472

Fig. 46.—Method of computing the Theater of Operations hospital patients to be treated in the Zone of the Interior when certain percentages of patients are sent there from a command in the Theater of Operations, where there is an increasing strength, and where there are admissions from both battle and nonbattle causes with the same rates as there were in the American Expeditionary Forces in 1918.

gassed cases, and 20% of gunshot cases are sent to the Zone of Interior, would be as follows:

Table 5.—Beds required for Theater of Operations patients as per preceding paragraph.

Kind of cases	At end of 360 days.			At end of 920 days.		
	T. of O.	Z. of I.	Total	T. of O.	Z. of I.	Total
Diseases and non-battle injuries	43.08	1.95	45.03	43.08	1.95	45.03
Gas wounds	17.69	1.10	18.79	17.69	1.10	18.79
Gunshot	82.76	19.34	102.10	83.70	20.62	104.32
Total	143.53	22.39	165.92	144.47	23.67	168.14
10% increase	157.88	24.63	182.51	158.92	26.04	184.96

(2) *With constant rates but an increasing strength.*—It will be necessary quite often to estimate the number of Theater of Operations patients to be hospitalized either there or in the Zone of the Interior when there is an increasing strength. The details of the method of computing the data, are shown by Figures 44, 45, and 46.

The method is the same as that outlined (*supra*) for Figure 25, the principal difference being that in Figures 44 - 46, there are three causes of admissions considered, whereas in Fig. 25 there is only one.

I. TOTAL HOSPITAL BEDS REQUIRED IN THE ZONE OF THE INTERIOR.

It has been estimated on page 18, that 6% of hospital beds should be provided in mobilization camps such as existed in the United States during 1918. The 30,869 Theater of Operations patients (see page 64) to be cared for on transports and in Zone of the Interior beds means 1.9% in terms of the strength in the United States in October, 1918. If we can assume that .4% are in transit, 1.5% remain to occupy Zone of Interior hospital beds, which raises the total required there to 7.5%.

II. LOSS OF MAN POWER IN WAR.

J. LOSSES IN THE THEATER OF OPERATIONS.

31. **Cases disposed of in the Zone of the Interior.** — The loss of man power in the Theater of Operations forces of which the medical department has knowledge is due to: (a) noneffectives in hospital, i.e., patients receiving treatment in hospital both in the Theater of Operations and Zone of the Interior; (b) deaths from various causes within or without the hospital; (c) cases disposed of in the Zone of the Interior after being sent there for treatment. This latter group includes the men who are permanently incapacitated physically for further military

service. In the following discussion, the cases sent from the Theater of Operations to the Zone of the Interior for further treatment are divided into two groups and are so treated throughout: (a) cases in hospital; (b) cases disposed of after reaching the Zone of the Interior by return to duty, death, or discharge for disability. *The cases in hospital are losses in the Theater of Operations strength no matter where the hospitals are located, but cases disposed of in the Zone of the Interior may represent an unnecessary loss in the Theater of Operations strength if too many men who are ultimately returned to duty are sent to the Zone of the Interior.*

As stated above, if sufficient care is exercised, the number of cases sent to the Zone of the Interior can be limited practically to potential disability cases, and the additional loss of man power will be small. Thus, if as suggested, 3% of disease and nonbattle injury cases, 6% of the gassed ones, and 20% of the gunshot cases are sent to the Zone of the Interior, the excess over the physically unfit will be only 1% of the cases of diseases and nonbattle injury cases, 2% of the gassed cases, and 5% of the gunshot ones, and even this excess would consist of cases requiring prolonged treatment.

The cases remaining in hospital in the Zone of the Interior of those sent there for treatment are shown by Figs. 41-43, but those disposed of after arrival there by return to duty, discharge for disability, or death are shown by Figs. 47 - 49.

a. Disease and nonbattle injury patients.—The number of cases so disposed of among those admitted for diseases and nonbattle injuries with a daily admission rate of 1.00 per 1000 Theater of Operations strength is shown by Fig. 47. This graph illustrates that the loss of man power in the Theater of Operations from the disposition of such cases in the Zone of the Interior increases in proportion to the percentage of hospital cases returned there for treatment. Thus the difference in such losses when 3% or 9% are so sent to the Zone of the Interior, accumulated to the end of one year would be 28.95 — 9.65, or 19.30, per 1000 Theater of Operations strength. To visualize this, let us assume that a force of 2,000,000 men is operating in the Theater of Operations in a well sanitated area in a temperate climate, and that the daily admission rate to hospital is 1.40 per 1000 per day. Then the number of men leaving hospital in the Zone of the Interior during one year if 3% are sent there would be 27,020, and if 9% are sent 81,060, including in each instance only 18,014 disability cases.

If the military authorities decide to send to the Zone of the Interior all Theater of Operations disease and nonbattle injury cases requiring hospital treatment for longer than 60 days, which will be 12.39% of all admissions (Fig. 38), the accumulated losses from this cause at the end of the year, with a daily admission rate of 1.00 per 1000, would be 39.85 ($9.65 \times 12.39 \div 3$) per 1000 men. In a force of 2,000,000 with a daily admission rate of 1.40 per 1000, the accumulated losses from cases disposed of in the Zone of the Interior at the end of a year would be 111,580 (39.85×1.40

× 2000); of this number 93,566 (111,580 — 18,014) are duty cases. Obviously these men may be sent again to the Theater of Operations, time and conditions permitting.

It will be observed from Fig. 47 that losses of this **character continue** to occur indefinitely as long as the basic conditions remain the same.

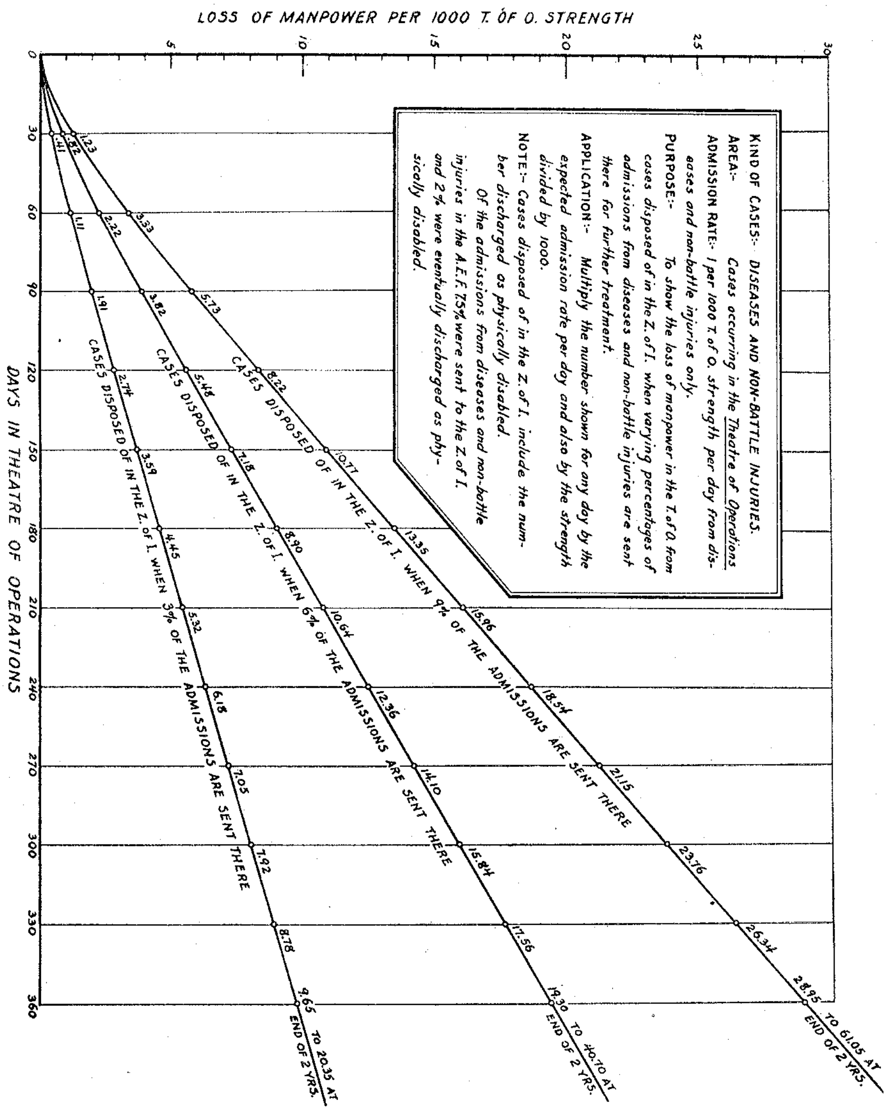


Fig. 47.*—Theater of Operations cases of diseases and nonbattle injuries disposed of in the Zone of the Interior by return to duty, death, or disability discharge when sent to the Zone of the Interior for further treatment.

*NOTE: (a) Total cases disposed of in one year equals total admissions less all patients in hospital at the end of that period. (b) Cases disposed of in the Zone of the Interior during one year, equals those sent there less the ones in hospital. (c) The relationship of (b) to (a) gives the percentage of the total dispositions which occur in the Zone of the Interior. (d) It is estimated that this same percentage relationship applies to cases disposed of during any period, as one month, etc.

b. *Gas and gunshot patients.* — Similar information in regard to cases wounded by poisonous gases and by gunshot missiles are shown by Figs. 48 and 49. The same remarks apply to those two graphs as to Fig. 47.

c. *Total of Theater of Operations patients.*—(1) *With a constant rate and a constant strength.*—As an illustration of the difference in the number of cases disposed of in the Zone of the Interior in one year when different percentages of cases are sent there, let us make the following as-

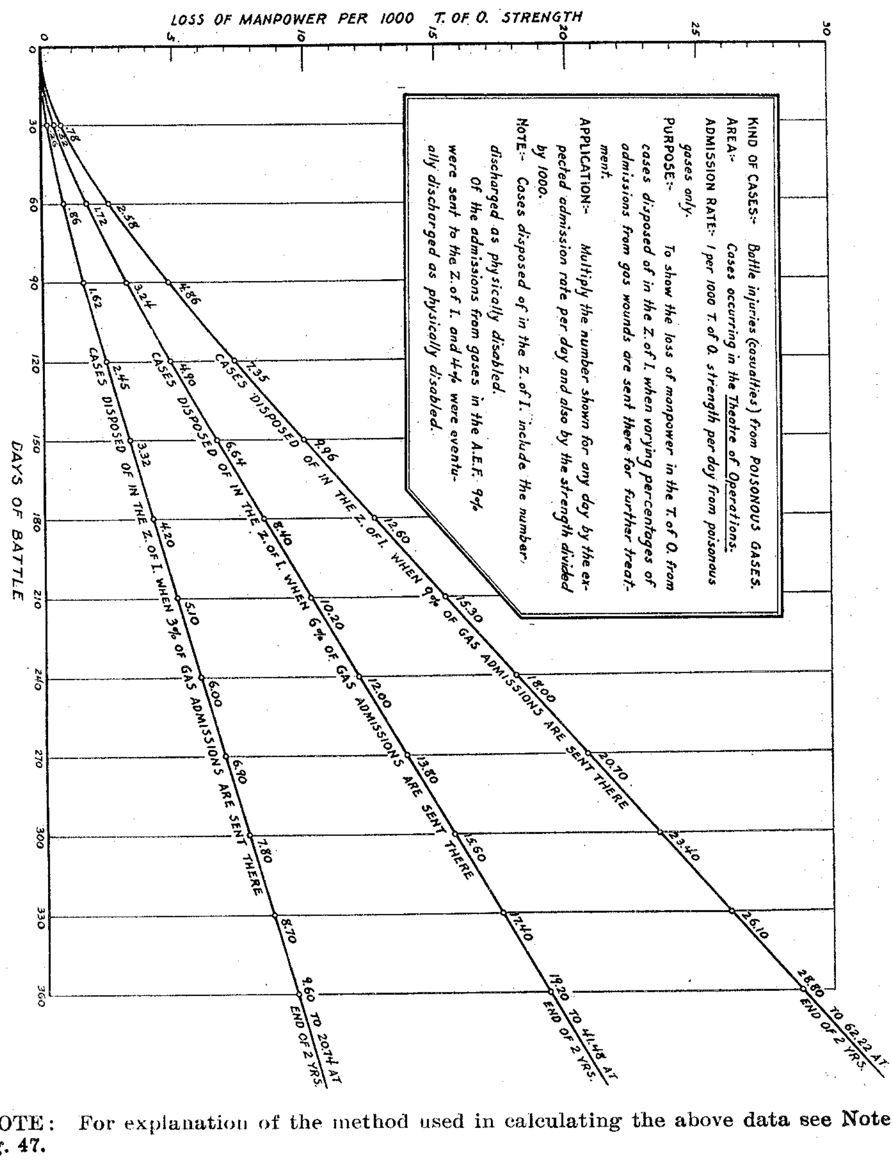


Fig. 48.—Theater of Operations war gas cases disposed of in the Zone of the Interior by return to duty, death, or disability discharge when sent to the Zone of the Interior for further treatment.

NOTE: For explanation of the method used in calculating the above data see Note on Fig. 47.

sumptions: (a) Two expeditionary forces, each of 2,000,000, both in well sanitated areas in the temperate zone and both engaged in continued and severe military combat: (b) a daily admission rate to hospital of 1.40 per 1000 strength from diseases and nonbattle injuries, .31 from wounds by poisonous gases, and .69 from wounds by gunshot missiles; (c) that one of the expeditionary forces sends to the Zone of Inter-

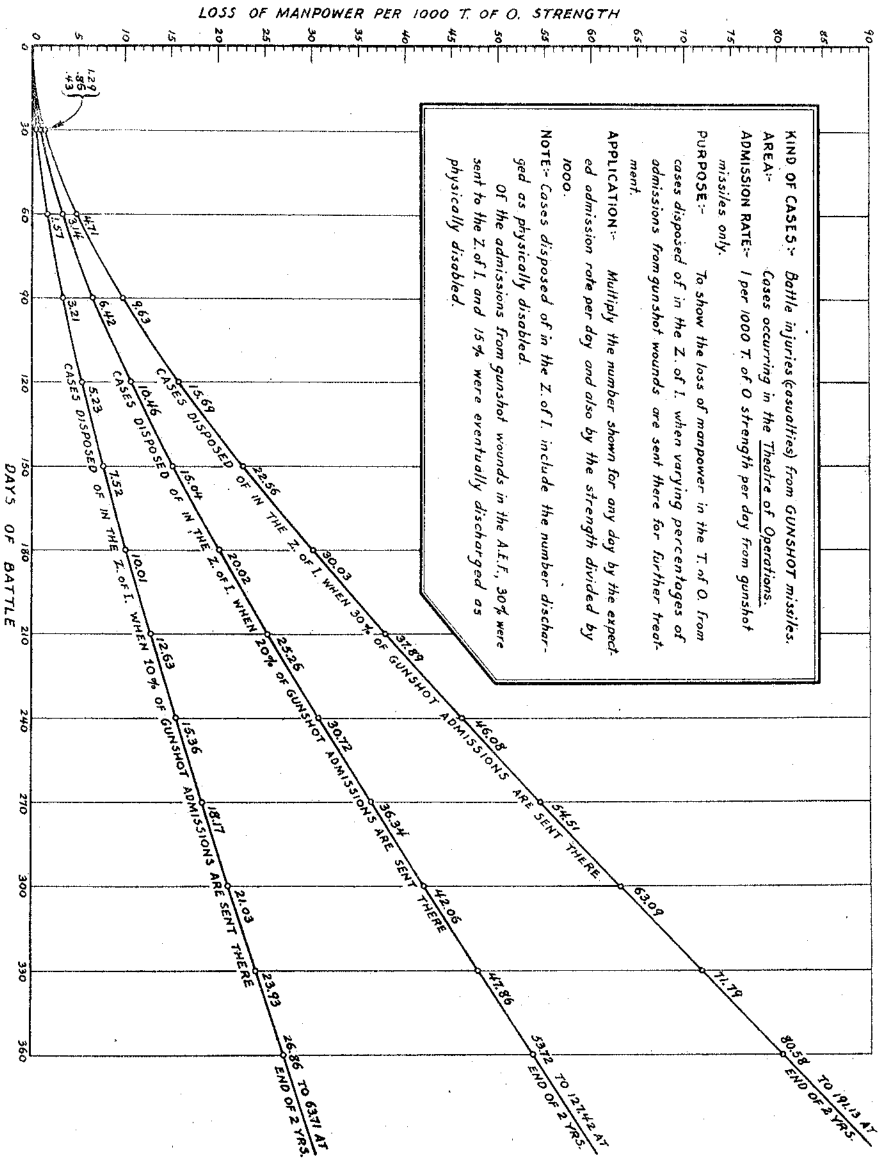


Fig. 49.—Theater of Operations gunshot cases disposed of in the Zone of the Interior by return to duty, death, or disability discharge when sent to the Zone of the Interior for further treatment.

NOTE: For explanation of the method used in calculating the above data see note on Fig. 47.

ior 3% of admissions for diseases and nonbattle injuries, 6% of cases wounded by poisonous gases, and 20% of those wounded by gunshot missiles, while the other sends 9% of the first and second named and 30% of the third.

Table 6.—Number of cases disposed of during one year in the Zone of Interior, from the two expeditionary forces.

Kind of cases	Daily admission rate per 1000 strength	Number of cases disposed of in the Zone of Interior in one year.		
Diseases and nonbattle injuries	1.40	If 3% are sent to Z. of I.	27,020	
		If 9% are sent to Z. of I.	....	81,060
Gas wounded	.31	If 6% are sent to Z. of I.	11,904	
		If 9% are sent to Z. of I.	....	17,856
Gunshot wounded	.69	If 20% are sent to Z. of I.	74,134	
		If 30% are sent to Z. of I.	....	111,200
			113,058	210,116

The difference (210,116 — 113,058 = 97,058) is the excess over the number of men physically disabled or requiring prolonged treatment, and consists of men who will be able eventually to return to duty. They must either be sent again to the Theater of Operations from the Zone of the Interior or be replaced, and even if the former is done unnecessary time is lost.

(2) *With a constant rate but an increasing strength.* — Fig. 50 shows a method of estimating the Theater of Operations patients to be disposed of in the Zone of the Interior when the admission rates from the various causes, as specified, are constant but when there is an increasing strength. The method of computation is the same as that outlined (see p. 36) for Fig. 25, the principal difference being that in Fig. 50 there are three causes of admissions considered, whereas in Fig. 25 there is only one.

d. *Number of Theater of Operations patients to be handled in the Zone of the Interior.* The bottom line of Fig. 50 shows the total Theater of Operations patients to be handled in the Zone of the Interior under the conditions outlined. *Such data may be of value when estimating requirements for hospital ships and hospital trains.*

32. **Deaths.** — In addition to the noneffectives in hospital and the cases disposed of in the Zone of the Interior from among those sent there, losses occur as the result of deaths.

A larger part of the fatalities which result from diseases and nonbattle injuries is among the cases admitted to hospital, but some occur among men not in hospital. Both classes of deaths are counted here as hospital admissions and are included in the total of such cases.

DAILY ADMISSION RATE PER 1000 MEN	PERCENTAGE OF ADMISSIONS SENT TO Z. OF I.	CAUSE OF ADMISSION	M 30	M 60	M 90	M 120	M 150	M 180	M 210	M 240	M 270	M 300
			ACCUMULATION OF T. OF O. PATIENTS PER 1000 T. OF O. STRENGTH TO BE DISPOSED OF IN THE Z. OF I.									
			AT A DAILY ADMISSION RATE OF 1.00									
1.00 SEE FIG. 47	3%	DISEASES & NON-BATTLE INJURIES	.41	1.11	1.91	2.74	3.59	4.45	5.32	6.18	7.05	7.92
1.00 SEE FIG. 48	6%	WAR GASES	.52	1.72	3.24	4.90	6.64	8.40	10.20	12.00	13.80	15.60
1.00 SEE FIG. 49	20%	GUNSHOT MISSILES	.86	3.14	6.42	10.46	15.04	20.02	25.26	30.72	36.34	42.06
AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918												
1.65	3%	DISEASES & NON-BATTLE INJURIES	.68	1.83	3.15	4.52	5.92	7.34	8.78	10.20	11.63	13.07
.24	6%	WAR GASES	.12	.41	.78	1.18	1.59	2.02	2.45	2.88	3.31	3.74
.53	20%	GUNSHOT MISSILES	.46	1.66	3.40	5.54	7.97	10.61	13.39	16.28	19.26	22.29
TOTAL			1.26	3.90	7.23	11.24	15.48	19.97	24.62	29.36	34.20	39.10

MONTHLY INCREMENTS OF T. OF O. STRENGTH			ACCUMULATION OF CASES TO BE DISPOSED OF IN THE Z. OF I. IN EACH MONTHLY INCREMENT OF T. OF O. STR.									
			AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918									
JAN.	M 30	194,000	244	757	1403	2181	3003	3874	4776	5696	6635	7585
FEB.	M 60	38,000		48	148	275	427	588	759	936	1116	1300
MAR.	M 90	49,000			62	191	354	551	759	978	1206	1439
APRIL	M 120	88,000				111	343	636	989	1362	1757	2166
MAY	M 150	167,000					210	651	1207	1877	2585	3335
JUNE	M 180	223,000						281	870	1612	2506	3452
JULY	M 210	258,000							325	1006	1865	2900
AUG.	M 240	268,000								338	1045	1938
SEPT.	M 270	263,000									331	1026
OCT.	M 300	222,000										280
TOTAL T. OF O. PATIENTS TO BE DISPOSED OF IN THE Z. OF I.			244	805	1613	2758	4337	6581	9685	13 805	18 046	25 421
TOTAL T. OF O. PATIENTS TO BE HOSPITALIZED IN THE Z. OF I.			246	663	1164	1751	2538	3634	5105	6948	9108	11 472
GRAND TOTAL T. OF O. PATIENTS TO BE HANDLED IN THE Z. OF I.			490	1468	2777	4509	6875	10 215	14 790	20 753	27 154	36 893

Fig. 50.—A. Method of computing the Theater of Operations hospital patients to be disposed of in the Zone of the Interior when certain percentages of patients are sent there from a command in the Theater of Operations where there is an increasing strength and where there are admissions from both battle and nonbattle causes at a constant rate.

B. The total Theater of Operations patients to be hospitalized in the Zone of the Interior. (See Fig. 46).

C. The grand total Theater of Operations patients to be handled in the Zone of the Interior.

On the other hand, the larger part of the deaths which result from military combat occurs on the field of action. The last named is not included in the number of admissions for wounds, but in this study they are proportioned to the number of men wounded so that the expectancy of such losses can be computed from the admission rate for the wounded.

a. *Fatality rates.* — The fatality rate for hospital cases in the American Expeditionary Forces in 1918 from diseases and nonbattle injuries, including deaths from such causes not in hospital, was 3.70%[2]; while that from poisonous gases, including only such as occurred in hospital, was 1.73%[2], and similarly the one from gunshot cases was 8.12%[2]. The deaths from diseases and nonbattle injuries included, however, a large number from the unusually widespread and fatal epidemic of influenza with accompanying pneumonias. After excluding the unusual number of deaths from these causes, it is estimated that 1.44% of hospital disease and nonbattle injury cases in the Theater of Operations may be expected to die. This fatality rate is one and two-thirds times as great as the usual peace time one among troops in the United States. In the following estimation of losses among troops in the Theater of Operations, the fatality rates used are 1.44%, 1.73%, and 8.12% for hospital cases of disease and nonbattle injuries, gas, and gunshot wounds respectively.

b. *Duration of treatment of fatal cases.* — Men who ultimately die as the result of gunshot wounds do so after a shorter interval of time than do those from either of the other two causes. Thus during the first 15 days of treatment 85.36% of the deaths from gunshot wounds occurred, as compared with 76.37% of those from gas wounds, and 64.56% of those from diseases and nonbattle injuries.

Table 7.—Percentage of the total deaths in hospital from the three classes of causes in the American Expeditionary Forces, which occurred in any group at different time intervals.

Days after admission to hospital	Diseases and nonbattle injuries	Gas wounds	Gunshot wounds
1 - 5	32.16	41.14	58.80
6 - 10	19.46	22.62	19.46
11 - 15	12.95	12.61	7.10
16 - 20	9.51	7.18	3.13
21 - 25	4.72	4.22	1.79
26 - 30	3.95	2.59	1.28
31 - 45	6.54	3.72	2.69
46 - 60	3.23	1.72	1.80
61 - 75	2.02	1.15	1.15
76 - 90	1.42	.79	.85
91 -105	1.04	.58	.58
106 -120	.77	.43	.40
over 121	2.24	1.25	.88

Note:- For basic formulae see Figs. 96, 97 and 98.

c. *Killed in action.* — In addition to 13,691 deaths from battle wounds in hospital in the American Expeditionary Forces, 36,694 men were killed on the field of battle.*

There is no information available upon which to base an estimate of how many of those who were killed outright died from poisonous war gases and how many from gunshot missiles. Hearsay evidence indicates that comparatively few men died as the result of poisonous gases before they reached hospital.

d. *Killed in relation to number wounded.* — An examination of the casualties of infantry regiments by combat days in the American Expeditionary Forces shows that the proportion of the killed to the number gassed decreased as the number of reported gassed cases increased; on the other hand, the proportion of the killed to the number of men wounded by gunshot missiles remained practically constant. Thus the proportion of the killed to the number wounded by gas was almost twice as great when there were 10 gassed as when there were 100, while the proportion of killed to wounded by gunshot missiles was the same when there were 10 wounded as when there were 100.†

We have assumed here simply for ease in calculation that 1000 men were killed in action by poisonous gases, and the remainder (35,694), by gunshot missiles. Under this assumption the percentage of the killed to the wounded were: Gas 1.42%; gunshot 23.25%; or as expressed in the usual way, it is assumed there was 1 killed in action by poisonous gases to 70.4 so wounded, and 1 killed by gunshot missiles to 4.3 wounded.

e. *Total deaths.* — These relationships of killed in action to the wounded, and fatality rates for cases in hospital to the number of cases of diseases and nonbattle injuries, of gas wounds, and of gunshot wounds were used in computing the data shown for deaths by Figs. 51, 52, and 53. These Figures show graphically the accumulated number of deaths as time advances computed on the basis of 1.00 admission per day to hospital per 1000 strength in the Theater of Operations.

33. **Total losses in the Theater of Operations.** — a. *Disease and nonbattle injury patients.* — The total accumulated losses from month to month in the Theater of Operations as the result of diseases and nonbattle injuries from (a) noneffectives in hospital (patients in hospital), (b) deaths, and (c) cases disposed of after being sent to the Zone of the Interior (including disability cases), are shown graphically by Fig. 51. As stated in the legend of the graph, all of the data are based upon 1.00 admission per day per 1000 Theater of Operations strength.

The noneffectives, or number of patients in hospital, stabilize after one year and consequently there is no additional loss from this factor thereafter; but the accumulated number of deaths and of cases disposed of in

* The A. G. O. figures are: Killed 37,541; died of wounds 12,934; total 50,475.[11]
Used here: Killed 36,694; died of wounds 13,691; total, 50,385.

† For basic formula see Fig. 100.

the Zone of the Interior, from cases sent there, continues to increase as long as the basic conditions remain the same.

The losses from noneffectives in hospital and from deaths are shown separately and combined. To the combination of the two there must be added losses from the cases disposed of in the Zone of the Interior. As has been shown on page 69 and by Fig. 47, this latter factor in the total loss rate increases in proportion to the percentage of cases sent to the

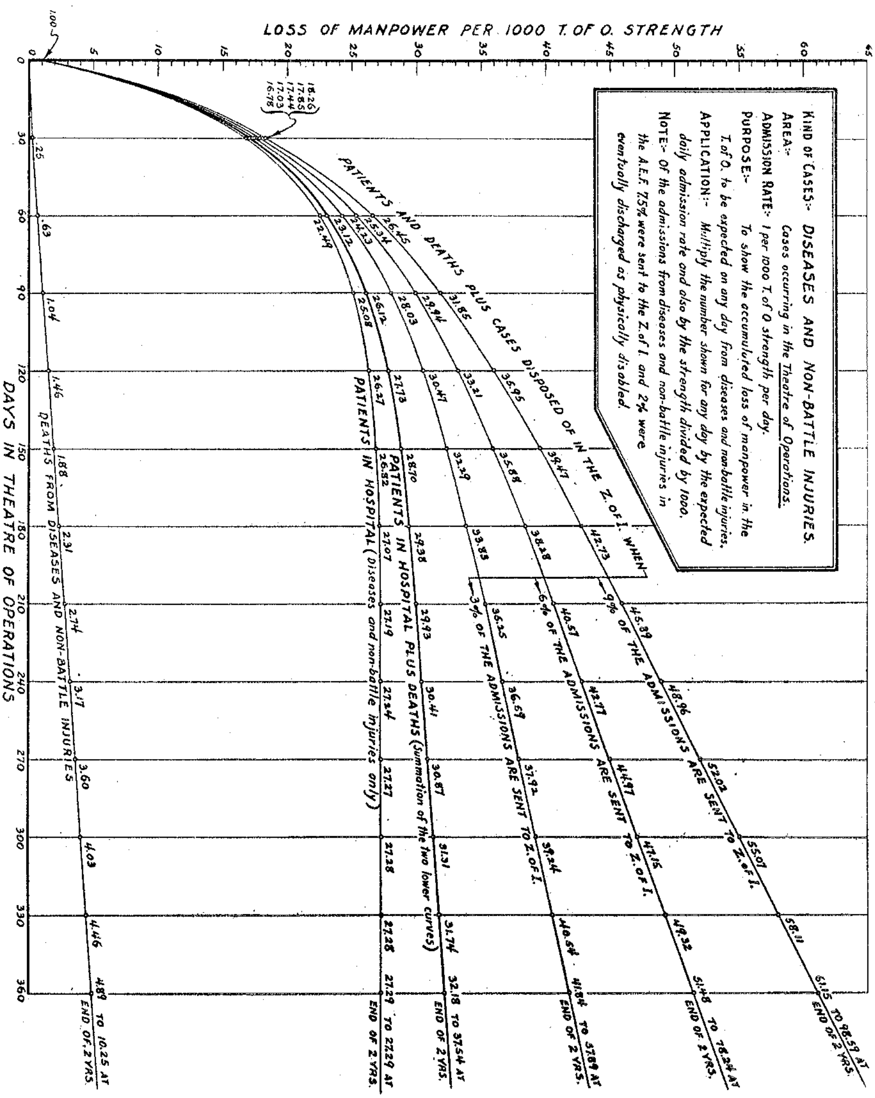


Fig. 51.*—Loss of manpower in the Theater of Operations from diseases and non-battle injuries due to deaths, noneffectives in hospital (patients), and cases disposed of in the Zone of the Interior when sent there for further treatment.

*NOTE: For basic formula see: (a) Deaths, Fig. 96, (2), p. 163. (b) Patients in hospital, Fig. 84, (1), p. 151. Total losses equal sum of the two above (a) and (b), plus cases disposed of in the Zone of the Interior as per Fig. 47.

Zone of the Interior. The following table shows the movement of the cases in and out of the hospital, with the summation of the losses up to the end of 360 days, when 3%, 6%, or 9% of all admissions are sent to the Zone of the Interior.

Table 8.—Disposition of disease and nonbattle injury patients admitted to hospital during the first 360 days of operations in the Theater of Operations, when the daily admission rate from such admissions is 1.00 per 1000 Theater of Operations strength.

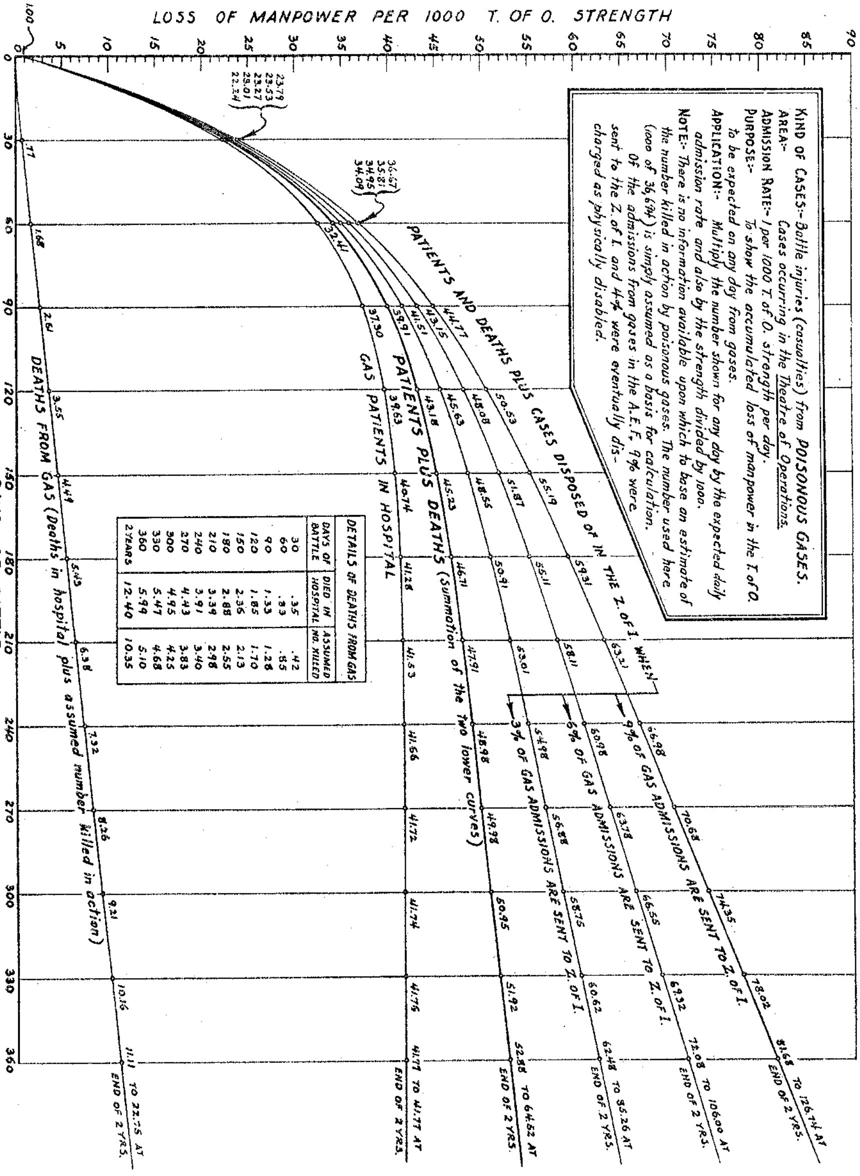
Percentages of Theater of Operations admissions sent to the Zone of the Interior	9%	6%	3%
Time—360 days			
Patients admitted to hospital	360	360	360
Losses:			
Patients in hospital:†			
In Theater of Operations	23.75	24.93	26.11
In Zone of the Interior	3.54	2.36	1.18
Deaths which have occurred in and out of hospital: ††	4.89	4.89	4.89
Cases disposed of in Z. of I.: ‡	28.95	19.30	9.65
Total losses: §	61.13	51.48	41.83
Cases returned to duty in Theater of Operations	298.87	308.52	318.17
Total accounted for	360.	360.	360.

† See Fig. 41. †† See Fig. 51. ‡ See Fig. 47. § See Fig. 51.

To convert these data into terms of any admission rate with any strength, multiply any item shown above by the product of the admission rate by the strength in thousands. Thus if the expected daily admission rate to hospital is 1.40 per 1000 and the strength 2,000,000 multiply the items in question by 1.40 × (2,000,000 ÷ 1000), or 2,800.

As shown on page 55 if the military authorities consider it advisable to send to the Zone of the Interior all disease and nonbattle injury Theater of Operations hospital cases averaging more than a certain time in hospital, the percentage of cases to be so transferred can be found by referring to Fig. 38. Then by referring to Fig. 47, and multiplying the data shown there on the 3% line by the number of times that 3 is contained in the predetermined percentage of cases to be returned to the Zone of the Interior, the cases disposed of in the Zone of the Interior under such conditions can be obtained (see Table 3). The results so obtained, when added to the accumulation of patients in hospital and of deaths at any time, will show the total losses.

b. *Gas patients.* — Fig. 52 shows in a similar way the losses which occur as the result of poisonous gases, both from the various reasons and also the total. As stated on p. 76, there are no data available upon which to base an estimate of the number of cases killed in action by poisonous gases. It is assumed for ease of calculation that 1000 of the men killed in action died from gas. The detail in regard to the deaths is shown in the table on the graph, and if it is desired to increase or decrease the 1000, the items can be changed correspondingly and the total losses so altered.



DETAILS OF DEATHS FROM GAS		
DAYS OF BATTLE	DIED IN HOSPITAL	ASSUMED NO. KILLED
30	.35	.42
60	.83	.85
90	1.33	1.28
120	1.85	1.70
150	2.36	2.13
180	2.88	2.55
210	3.39	2.98
240	3.91	3.40
270	4.43	3.83
900	4.95	4.25
330	5.47	4.68
360	5.99	5.10
2 YEARS	12.40	10.35

Fig. 52.*—Loss of manpower in the Theater of Operations from war (poisonous) gases due to deaths, noneffectives in hospital (patients), and cases disposed of in the Zone of the Interior when sent there for further treatment.

*NOTE: For basic formulae see:-
(a) Deaths in hospital, Fig. 97, (2), p. 164. (b) Killed in action, Fig. 97, (4), p. 164.
(c) Patients in hospital, Fig. 87, (a), (1), p. 154. Total losses equal sum of the above (a), (b), and (c), plus cases disposed of the the Z. of I., as per Fig. 48.

The following table shows the movement of the gassed cases in and out of hospital with the summation of the losses up to the end of 360 days, when 3%, 6%, or 9% of all gas admissions are sent to the Zone of the Interior.

Table 9.—Disposition of gas casualties during the first 360 days of battle, when the daily admission rate from poisonous gases is 1.00 per 1000 Theater of Operations strength.

Percentages of Theater of Operations admissions sent to the Zone of the Interior	9%	6%	3%
Time—360 days			
Total to be accounted for:			
Patients admitted to hospital	360	360	360
Assumed number killed in action	5.10	5.10	5.10
Total	365.10	365.10	365.10
Losses:			
Patients in hospital:†			
In the Theater of Operations	38.09	39.31	40.54
In the Zone of the Interior	3.68	2.46	1.22
Deaths which have occurred: ††			
In hospital	5.99	5.99	5.99
Assumed number killed	5.10	5.10	5.10
Cases disposed of in Zone of the Interior‡	28.80	19.20	9.60
Total losses:††	81.66	72.06	62.45
Cases returned to duty in T. of O.	283.44	293.04	302.65
Total accounted for	365.10	365.10	365.10

† See Fig. 42. †† See Fig. 52. ‡ See Fig. 48.

To convert any of the items above into terms of any admission rate with any strength, multiply the ones in question by the product of the admission rate by the strength in thousands. Thus if the expected daily admission rate is .31 per 1000 and the strength 2,000,000, multiply by $.31 \times (2{,}000{,}000 \div 1000)$, or 620.

c. *Gunshot patients.* — Fig. 53 shows in a similar way the losses from gunshot casualties in detail and in totals.

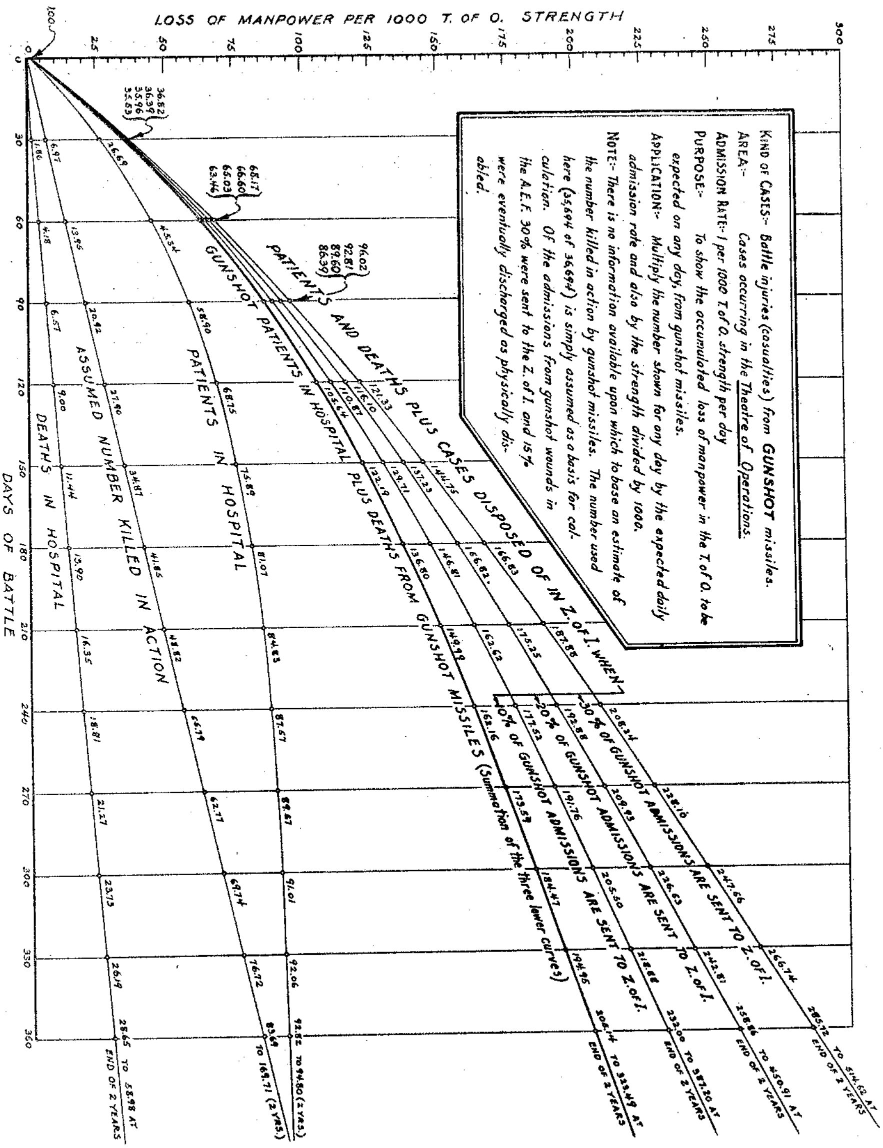


Fig. 53.*—Loss of manpower in the Theater of Operations from gunshot missiles due to deaths, non-effectives in hospital (patients), and cases disposed of in the Zone of the Interior when sent there for further treatment.

*NOTE: For basic formulae see:-
(a) Deaths in hospital, Fig. 98, (2), p. 165. (b) Killed in action, Fig. 98, (4), p. 165.
(c) Patients in hospital, Fig. 88, (a), (1), p. 155. Total losses equal sum of the three above (a), (b) and (c) plus cases disposed of in the Z. of I., as per Fig. 49.

The following table shows the movement of such cases in and out of hospital, with the summation of the losses up to the end of 360 days, when 10%, 20%, or 30% of such cases are sent to the Zone of the Interior.

Table 10.—Disposition of gunshot casualties during the first 360 days of battle, when the daily admission rate from gunshot missiles is 1.00 per 1000 Theater of Operations strength.

Percentages of Theater of Operations admissions sent to the Zone of the Interior	30%	20%	10%
Time—360 days.			
Total to be accounted for:			
Patients admitted to hospital	360	360	360
Assumed number killed in action	83.69	83.69	83.69
Total	443.69	443.69	443.69
Losses:			
Patients in hospital:†			
In Theater of Operations	66.45	75.24	84.03
In Zone of the Interior	26.37	17.58	8.79
Deaths which have occurred: ††			
In hospital	28.65	28.65	28.65
Assumed number killed	83.69	83.69	83.69
Cases disposed of in Z. of I:‡	80.58	53.75	26.86
Total losses:§	285.74	258.88	232.02
Cases returned to duty in T. of O.	157.95	184.81	211.67
Total to be accounted for	443.69	443.69	443.69

† See Fig. 43. †† See Fig. 53. ‡ See Fig. 49. § See Fig. 53.

d. *Total patients.* — The following table shows the movement of the total cases in and out of hospital, with the summation of the losses up to the end of 360 days.

Table 11.— After 360 days of battle: (1) Total cases to be accounted for, including the killed in action; (2) cases returned to duty in the Theater of Operations; (3) total losses.

	(1) Total to be accounted for, including killed in action.	If there is sent to the Z. of I., 3% of (a), 6% of (b), and 20% of (c) (as below).		If there is sent to the Z. of I., 9% of (a) and (b), and 30% of (c) (as below).	
		(2) Duty in T. of O.	(3) Losses	(2) Duty in T. of O.	(3) Losses
If the strength is 1000 and the daily admission rate to hospital is 1.00 per 1000 from each cause.					
(a) Disease and nonbattle injuries	360.00	318.17	41.84	298.87	61.13
(b) Gas	365.10	293.04	72.06	283.44	81.66
(c) Gunshot	443.69	184.81	258.88	157.95	285.74
Total	1,168.79	796.02	372.78	740.26	428.53
If the strength is 1000 and the admission rates to hospital are from each cause (a) 1.40; (b) .31; (c) .69.					
(a) Diseases and nonbattle injuries	504.00	445.44	58.58	418.42	85.58
(b) Gas	113.18	90.84	22.34	87.87	25.31
(c) Gunshot	306.15	127.52	178.63	108.99	197.16
Total	923.33	663.78	259.55	615.28	308.05
If the average daily strength is 2,000,000, and the rates are as above.					
(a) Diseases and nonbattle injuries	1,008,000	890,880	117,160	836,840	171,160
(b) Gas	226,360	181,680	44,680	175,740	50,620
(c) Gunshot	612,300	255,040	357,260	217,980	394,320
Total	1,846,660	1,327,600	519,100	1,123,560	616,100

34. **Total losses by separate months.** — (a) *Disease and nonbattle injury patients.* — Fig. 51 shows the summation of losses from month to month from disease and nonbattle injuries, when the daily admission rate is 1.00 per 1000 Theater of Operations strength. Each month's losses are added to the accumulated losses of the preceding months, and the curve is consequently a constantly ascending one, although there is a progressive decline in the loss rate for each separate month, with a descendnig curve (Fig. 54) until it stabilizes at the end of the 12th month. The rapid fall of this latter curve (Fig. 54) during the first few months is caused by the rapid increase in the number of patients returning to duty from the hospital (Fig. 55). After the first six months there is but little

change in the loss rate from cases disposed of in the Zone of the Interior, among those sent there from the Theater of Operations, and also from the deaths; but the total for each month continues to decline until the end of one year, or until the outflow of patients from hospital equals the inflow. After the end of the year, the loss rate from the deaths in the Theater of Operations and the disposition of cases in the Zone of the Interior (includ-

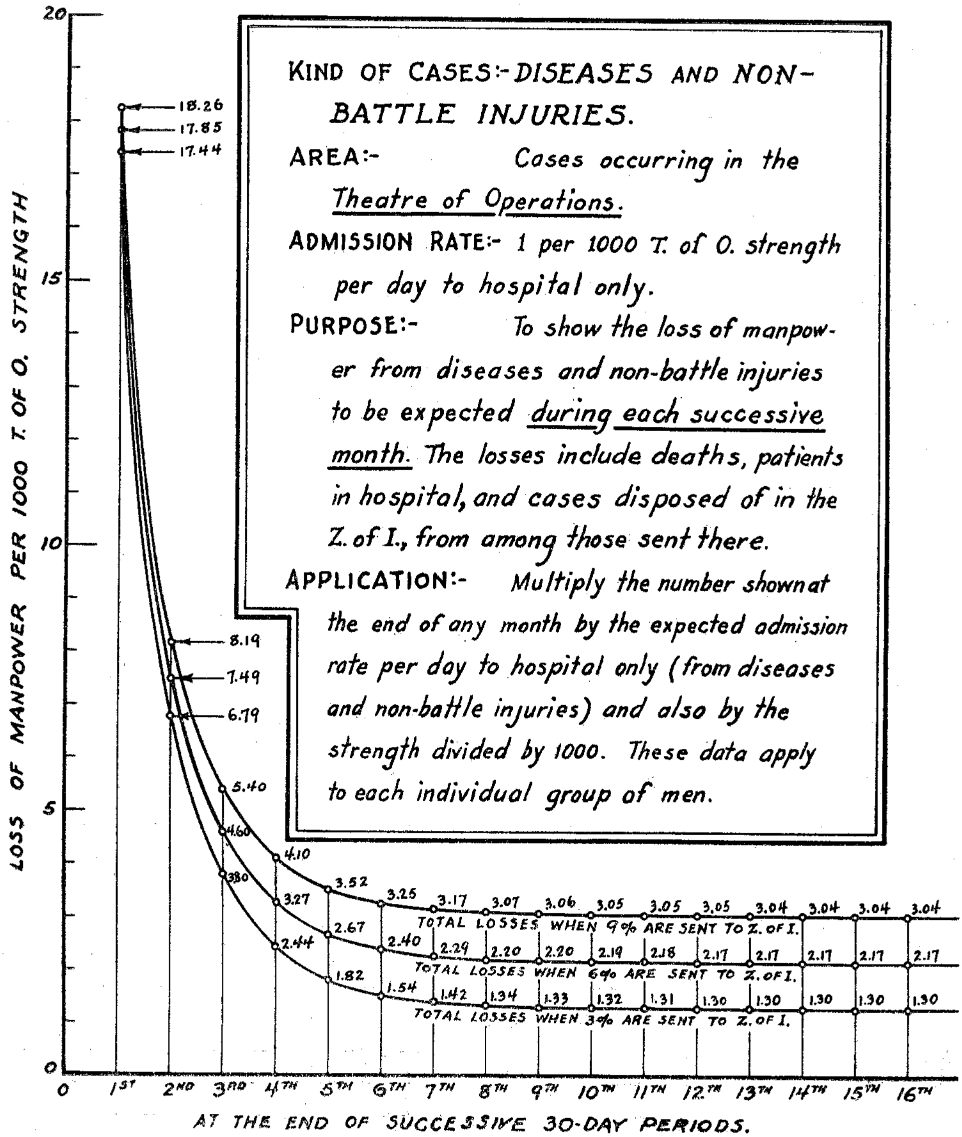


Fig. 54.—Loss of manpower from diseases and nonbattle injuries in the Theater of Operations during successive months.

NOTE: Calculated from data from the three upper curves, Fig. 51.

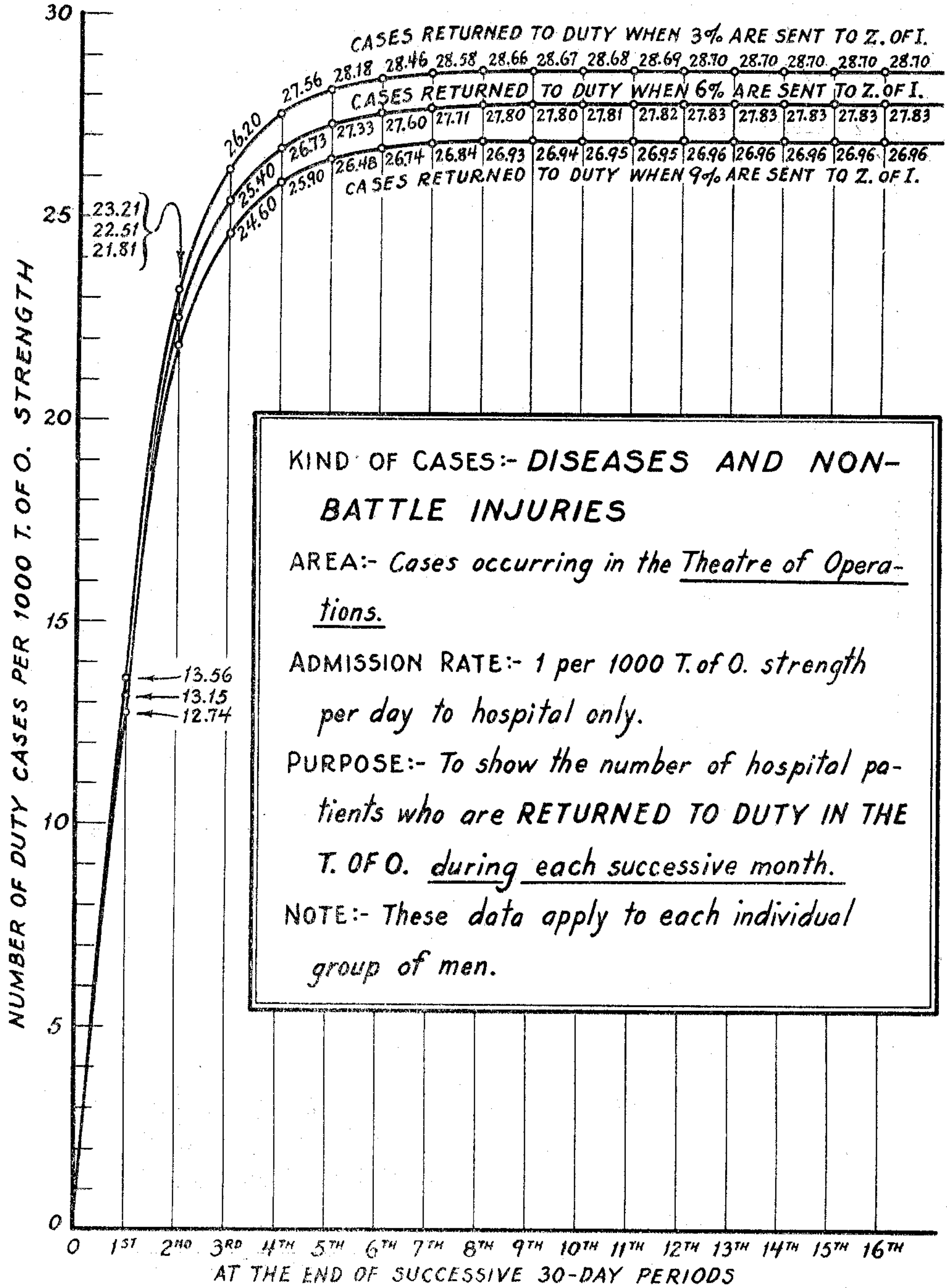


FIG. 55.—Cases of diseases and nonbattle injuries returned to duty in the Theater of Operations during successive months.
NOTE: Number returned to duty by months equals number admitted during that month less the month's losses as per Fig. 54.

ing disability cases) will continue as long as the basic conditions do.

The decline in the loss rates during the first 12 months is therefore due chiefly to the increasing number of patients returning to duty from hospitals. Consequently as stated in the last sentence of the legend of Fig. 54 these data apply only to each individual group of men. This group

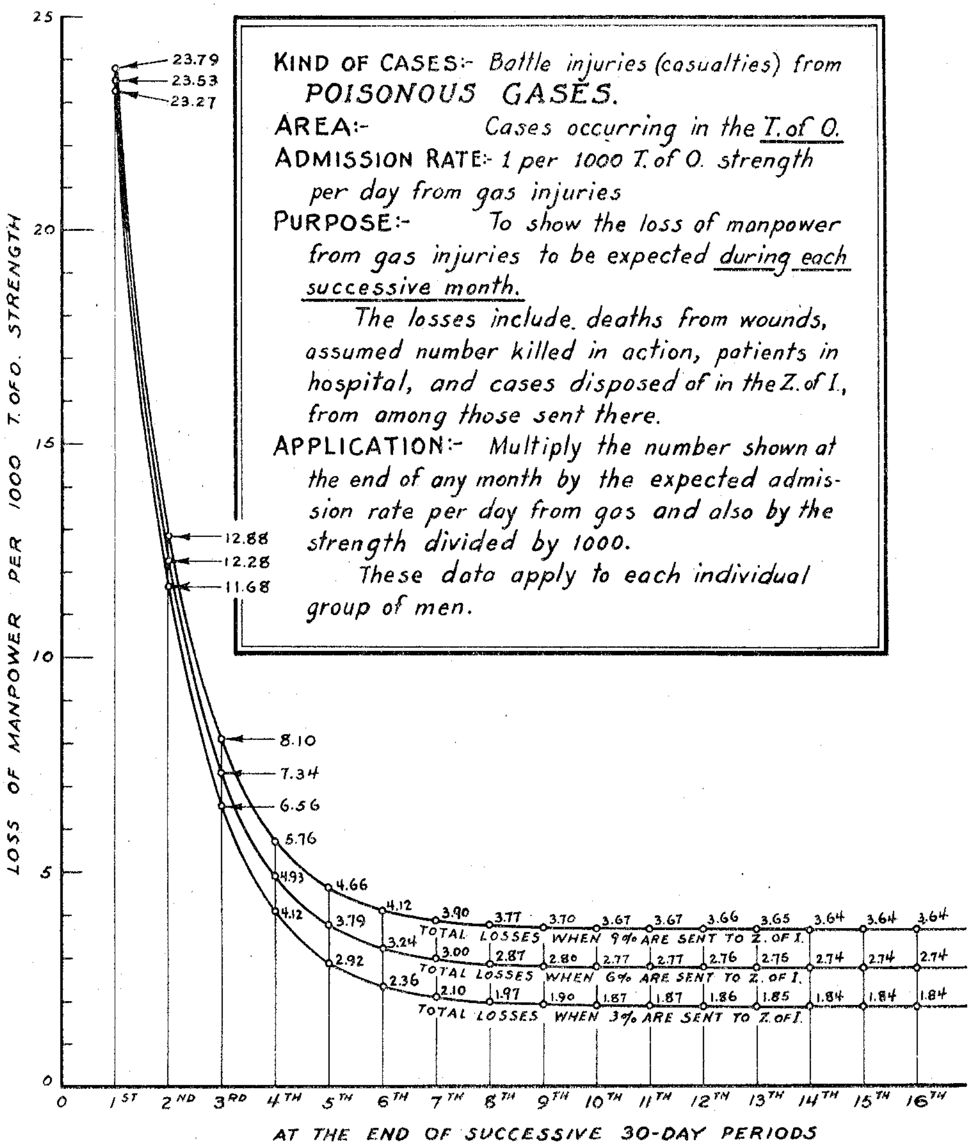


Fig. 56.—Loss of manpower from war (poisonous) gases in the Theater of Operations, during successive months.
NOTE: Calculated from data from the three upper curves, Fig. 52.

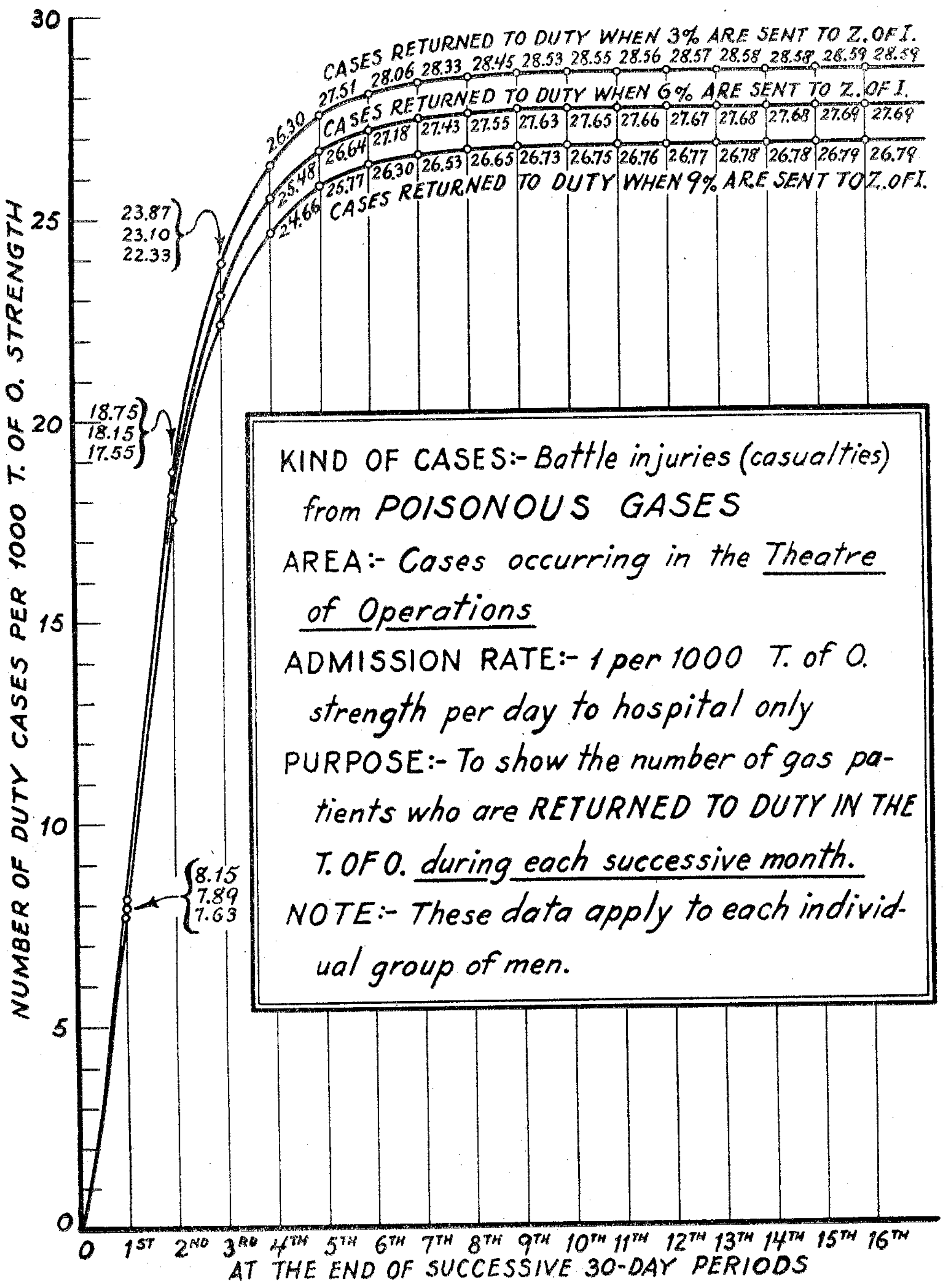


Fig. 57.—Gas cases returned to duty in the Theater of Operations during successive months.

NOTE: Number returned to duty be months equals number admitted during that month plus the number killed in action, less the month's losses as per Fig. 56.

may be a field army, corps, division, or a regiment, or lesser body, but the essential point is that each one must establish its own increasing flow of men out of hospital to replace those entering hospital before its loss rate can decline.

The 3%, 6%, and 9% curves again show the importance as a loss factor of the disposition of cases in the Zone of the Interior from among those sent there.

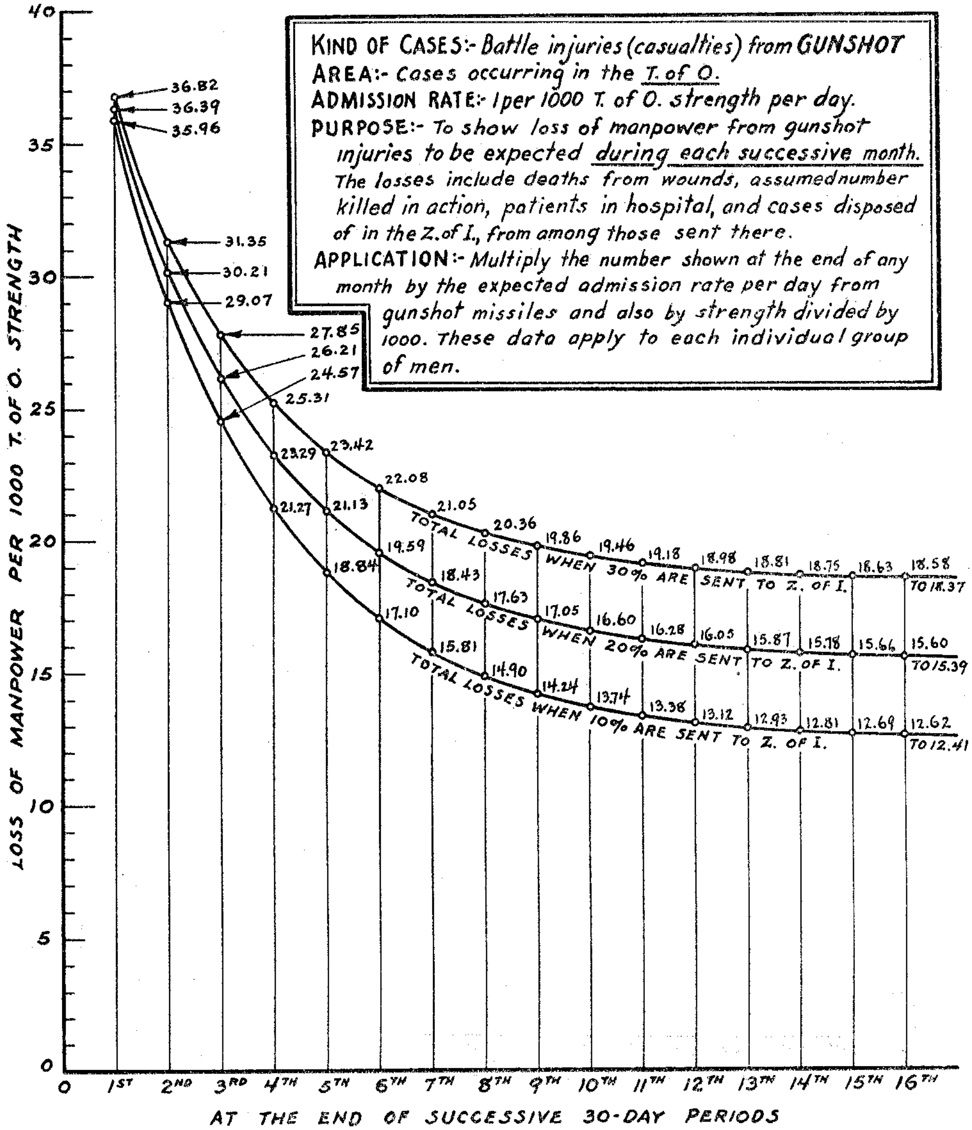


Fig. 58.—Loss of manpower from gunshot injuries in the Theater of Operations during successive months.

NOTE: Calculated from data from the three upper curves, Fig. 53.

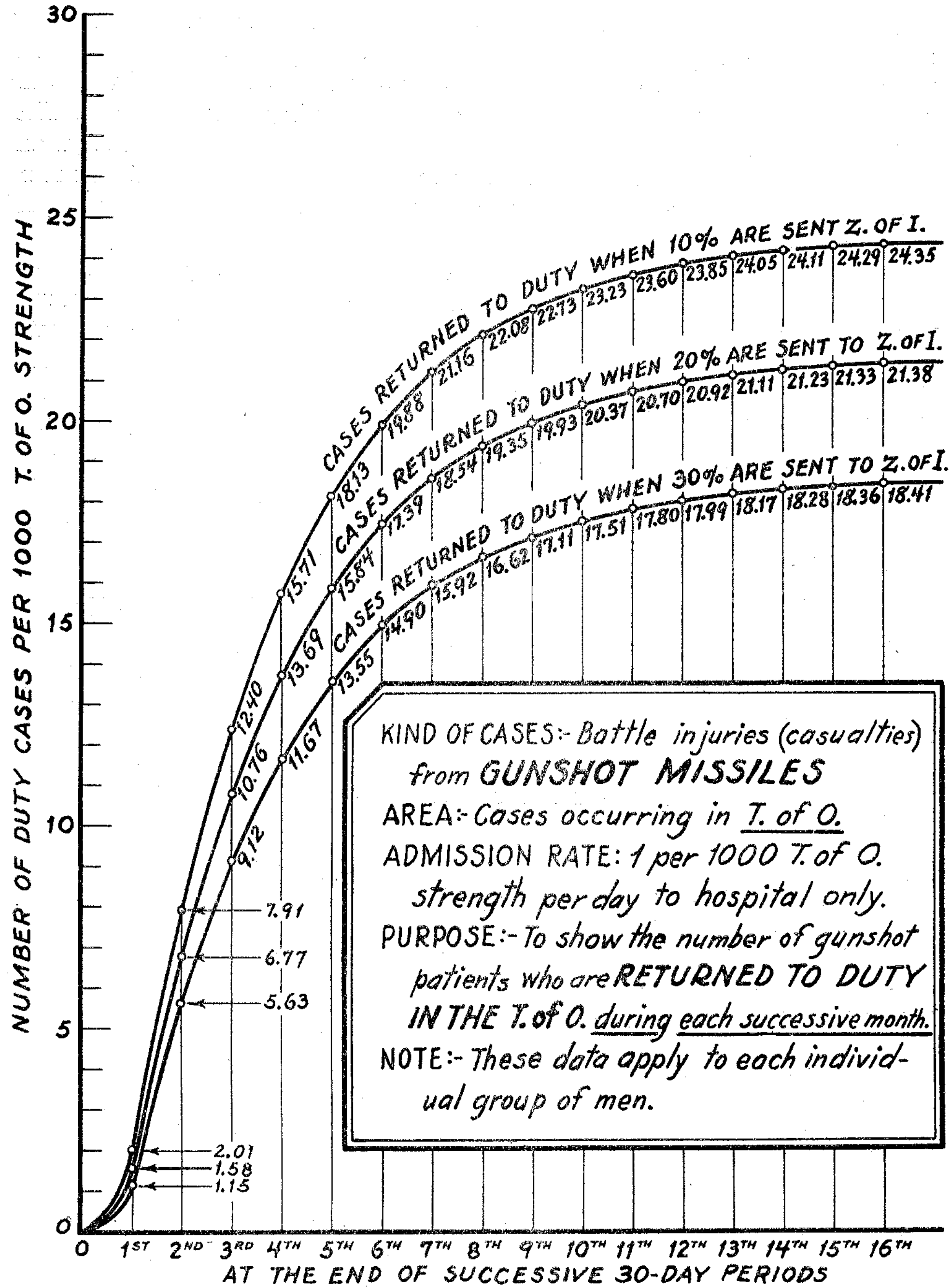


Fig. 59.—Gunshot cases returned to duty in the Theater of Operations during successive months.

NOTE: Number returned to duty by months equals number admitted during that month plus the number killed in action, less the month's losses as per Fig. 58.

b. *Gas patients.* — Fig. 56 shows the same data for casualties from poisonous gases as Fig. 54 does for those from diseases and nonbattle injuries. Losses from gas casualties also stabilize at the end of the 12th month, as does the return of patients to duty from hospital (Fig. 57). The loss rate from gas casualties after the 12th month is a little greater than the one from diseases and nonbattle injuries, due to the assumed number killed in action by gas, and to the assumed larger fatality rate for gas cases.

c. *Gunshot patients.* — The very great and continued importance of gunshot casualties as a loss factor is again shown by Fig. 58. As a result of the long duration of treatment of cases of this character, the loss rate continues to decline even after the 16th month (480th day), and until the 920th day. During the last several months shown on the graph, the cases disposed of in the Zone of the Interior, the deaths in hospital, and the assumed number killed in action account for a stabilized loss rate of 18.37, 15.39, and 12.41, according to the percentage of admissions sent to the Zone of the Interior, and the gradual increase of the noneffectives in hospital for the excess, as shown by Fig. 58, above them. With the larger less rates, fewer men are returned to duty from hospital (Fig. 59).

d. *With a constant strength and a constant admission rate.* — Here as elsewhere the possibilities of sanitation and the climate of the Theater of Operations area, the amount of seasoning of the troops, and military resistance of the enemy must be estimated before the total loss rate can be determined.

Table 12 again shows the influence of the percentage of cases which are sent to the Zone of the Interior upon the loss rate.

Table 12.—Losses per 1000 men in any group of them by months of service in the Theater of Operations, when the daily hospital admission rate per 1000 total strength is: (a) From diseases and nonbattle injuries, 1.40; (b) from gases .31; (c) from gunshot wounds, .69, or approximately the same rates as occurred in the American Expeditionary Forces, from July 1 to November 11, 1918 (excluding the influenza epidemic).

30 day periods	(1) When there is sent to Z. of I. 3% of (a), 6% of (b), and 20% of (c).				(2) When there is sent to Z. of I., 9% of (a), 9% of (b), and 30% of (c).			
	(a) Diseases and nonbattle injuries.	(b) Gas	(c) Gunshot	Total	(a) Diseases and nonbattle injuries.	(b) Gas	(c) Gunshot	Total
1st	24.42	7.29	25.11	56.82	25.56	7.37	25.41	58.34
2nd	9.51	3.81	20.84	34.16	11.47	3.99	21.63	37.09
3rd	5.32	2.28	18.08	25.68	7.56	2.51	19.22	29.29
4th	3.42	1.53	16.07	21.02	5.74	1.79	17.46	24.99
5th	2.55	1.17	14.58	18.30	4.93	1.44	16.16	22.53
6th	2.16	1.00	13.52	16.68	4.55	1.28	15.24	21.07
7th	1.99	.93	12.72	15.64	4.44	1.21	14.52	20.17
8th	1.88	.89	12.16	14.93	4.30	1.17	14.05	19.52
9th	1.86	.87	11.76	14.49	4.28	1.15	13.70	19.13
10th	1.85	.86	11.25	14.16	4.27	1.14	13.43	18.84
11th	1.83	.86	11.23	13.92	4.27	1.14	12.23	18.64
12th	1.82	.86	11.07	13.75	4.27	1.13	13.10	18.50
	58.61	22.35	178.59	259.55	85.64	25.32	197.15	308.11

Note: Basic data from Fig. 54, 56 and 58 multiplied by 1.40, .31, and .69 respectively.

Under both sets of conditions, the loss rate falls rapidly after the the first month, in the first declining from 56.82 per 1000 men during the first month to 13.75 in the 12th, and in the second from 58.34 in the first to 18.50 in the 12th month.

e. *With an increasing strength but constant admission rate.*—(1) From *one cause.*—The problem of determining the probable loss rate for an expeditionary force is seldom so simple as the one above, for it will rarely happen that an entire force will be sent into an expeditionary area at one time. Then again, while in the interest of simplicity an average daily admission rate from diseases and nonbattle injuries may be used throughout, the military resistance encountered and the amount of military combat engaged in will probably vary so greatly that it will be necessary to use more than one rate.

Let us consider first the simpler of the two situations; that is, where we have a constantly, although not uniformly, increasing force with an average daily admission rate from diseases and nonbattle injuries. Fig. 60 shows the method of computing the data for such a problem. The strength of the military force with monthly increases is approximately the same as existed in the American Expeditionary Forces to the middle of each month; and the daily admission rate, the average one for the year (including the influenza epidemic).

As we have found the greatest loss rate for any one force is during the first month because the patients, or noneffectives, in hospital are rapidly increasing and comparatively few men are returning to duty. As each group enters the Theater of Operations and establishes its own flow of patients out of hospital, its loss rate declines. The strength of each monthly increment in the Theater of Operations (Fig. 60) is multiplied by the initial month loss rate at the basic daily admission rate of 1.00 per 1000 strength, and during the following month by the loss rate

MONTHS	INCREASE IN STRENGTH IN THOUSANDS	LOSSES EACH MONTH AT A DAILY ADM. RATE OF 1 PER 1000 OF EACH INCREASE IN STRENGTH											NOV. 1-11 11/30 OF NOV.	LOSSES FOR MONTHLY INCREMENTS	LOSSES FOR MONTHLY INCREMENTS TIMES 1.65
		1- 17.44 JAN.	2- 6.79 FEB.	3- 3.80 MAR.	4- 2.44 APRIL	5- 1.82 MAY	6- 1.54 JUNE	7- 1.42 JULY	8- 1.34 AUG.	9- 1.33 SEPT.	10- 1.32 OCT.	11- 1.31 NOV.			
JAN.	A 194	1A 3383	2A 1317	3A 737	4A 473	5A 353	6A 299	7A 275	8A 260	9A 258	10A 256	11A 254	93	7704	12,712
FEB.	B 38		1B 663	2B 258	3B 144	4B 93	5B 69	6B 58	7B 54	8B 51	9B 50	10B 50	18	1458	2,406
MAR.	C 49			1C 854	2C 333	3C 186	4C 120	5C 89	6C 75	7C 70	8C 66	9C 65	24	1817	2,998
APRIL	D 88				1D 1535	2D 598	3D 334	4D 215	5D 160	6D 136	7D 125	8D 118	43	3146	5,191
MAY	E 167					1E 2912	2E 1134	3E 635	4E 407	5E 304	6E 257	7E 237	87	5736	9,464
JUNE	F 223						1F 3889	2F 1514	3F 847	4F 544	5F 406	6F 343	126	7326	12,088
JULY	G 258							1G 4500	2G 1752	3G 980	4G 690	5G 470	172	8034	13,256
AUG.	H 268								1H 4674	2H 1820	3H 1018	4H 654	240	7752	12,791
SEPT.	K 263									1K 4587	2K 1786	3K 999	366	6739	11,119
OCT.	L 222										1L 3872	2L 1507	553	4425	7,301
NOV.	M 110											1M 1918	703	703	1,160
LOSSES EACH MO. AT DAILY ADM. RATE OF 1.00 PER 1000		3383	1980	1849	2485	4142	5845	7286	8229	8750	8466	(6615)	2425	54,840	90,486
LOSSES EACH MO. AT A.E.F. ADM. RATE OF 1.65 PER 1000		5582	3267	3051	4100	6834	9644	12,022	13,578	14,438	13,969	—	4001	90,486	—

Fig. 60.—*Losses from diseases and nonbattle injuries* by months under approximately the same conditions as occurred in the American Expeditionary Forces where there was a material increase in the strength each month, and where the constant average daily admission rate to hospital only from these causes was 1.65 per 1000 American Expeditionary Forces strength. It is here assumed that 3% of these admissions were sent to the Zone of the Interior. The symbols used throughout the body of the table represents the product of a monthly loss at a daily admission rate of 1.00 per 1000 strength multiplied by a monthly increase in strength in thousands. Thus 1 B (17.44 x 38.)=663.

NOTE: Data for losses each month (second line from top), see Fig. 54.

for the second month, etc. The items as computed for the men who were in the Theater of Operations on the middle of January, and for each monthly increment during the next 10 months, are summated from side to side, and from above downward. The several sums so obtained are then multiplied by the daily admission rate of 1.65 per 1000; i.e., the one

DAILY ADMISSION RATE PER 1000 MEN	PERCENTAGE OF ADMISSIONS SENT TO Z. OF I.	CAUSE OF ADMISSION	M 30	M 60	M 90	M 100	M 150	M 180	M 210	M 240	M 270	M 300
			ACCUMULATION OF LOSSES IN EACH 1000 T. OF O. STRENGTH AT A DAILY ADMISSION RATE OF 1.00									
1.00 SEE FIG. 51	3%	DISEASES & NON-BATTLE INJURIES	17.44	24.23	28.03	30.47	32.29	33.83	35.25	36.59	37.92	39.24
1.00 SEE FIG. 52	6%	WAR GASES	23.53	35.81	43.15	48.08	51.87	55.11	58.11	60.98	63.78	66.55
1.00 SEE FIG. 53	20%	GUNSHOT MISSILES	36.39	66.60	92.81	116.10	137.23	156.82	175.25	192.88	209.93	226.53
			AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918									
1.65	3%	DISEASES & NON-BATTLE INJURIES	28.78	39.98	46.25	50.28	53.28	55.82	58.16	60.37	62.57	64.75
.24	6%	WAR GASES	5.65	8.59	10.36	11.54	12.45	13.23	13.95	14.64	15.31	15.97
.53	20%	GUNSHOT MISSILES	19.29	35.30	49.19	61.53	72.73	83.11	92.88	102.23	111.26	120.06
TOTAL			53.72	83.87	105.80	123.35	138.46	152.16	164.99	177.24	189.14	200.78

MONTHLY INCREMENTS OF T. OF O. (A.E.F.) STRENGTH			ACCUMULATION OF LOSSES IN EACH MONTHLY INCREMENT OF T. OF O. STRENGTH AT THE AVERAGE DAILY ADMISSION RATES IN THE A.E.F. DURING 1918									
JAN.	M 30	194,000	10,422	16,271	20,525	23,930	26,861	29,519	32,008	34,385	36,693	38,951
FEB.	M 60	38,000		2041	3187	4 020	4 687	5 261	5 782	6270	6 735	7187
MAR.	M 90	49,000			2632	4110	5184	6044	6784	7456	8084	8685
APRIL	M 120	88,000				4727	7380	9310	10 855	12184	13 390	14519
MAY	M 150	167,000					8971	14 006	17 669	20 599	23123	25 411
JUNE	M 180	223,000						11980	18703	23 593	27507	30 876
JULY	M 210	258,000							13 860	21 638	27 296	31 824
AUG.	M 240	268,000								14 397	22 479	28354
SEPT.	M 270	263,000									14128	22058
OCT.	M 300	222,000										11 926
TOTAL LOSSES AT CLOSE OF EACH PERIOD			10,422	18,312	26,344	36,787	53,083	76,120	105,661	140,522	179,433	219,791

Fig. 61.—Method of computing the losses to be expected in the Theater of Operations in a command in which there is an increasing strength; where there are admissions from both battle and nonbattle causes; and also when certain percentages of the patients are sent to the Zone of the Interior.

that occurred in the American Expeditionary Forces.

The results at the bottom of the graph (Fig. 60) shows the losses which occurred from diseases and nonbattle injuries during each month in the strength of the total American Expeditionary Forces, and those on the extreme right hand margin, the total losses in each month's group of men from the time it entered the Theater of Operations until November 11, 1918.

(2) *From three causes.* — Fig. 61 shows a method of computing the losses in the Theater of Operations from the three causes with rates averaged for the entire American Expeditionary Forces during the year 1918. In Fig. 60, the losses are shown for each individual month, whereas in Fig. 61 the accumulated losses are shown, the February figure including those for January, etc.

f. *With an increasing strength and also an increasing admission rate.*— Figs. 60 and 61 illustrate the method of calculating losses in any expeditionary force when there is an increase each month in the strength, but

MONTHS	INCREASE IN STRENGTH IN THOUSANDS	DAILY ADMISSION RATES	LOSSES EACH MONTH AT A DAILY ADMISSION RATE OF 1 PER 1000 OF EACH INCREASE IN STRENGTH 1-23.53 JAN.	2-12.28 FEB.	3-7.34 MAR.	4-4.93 APR.	5-3.79 MAY	6-3.24 JUNE	7-3.00 JULY	8-2.87 AUG.	9-2.80 SEPT.	10-2.77 OCT.	11-2.77 NOV.	NOV. TOTALS	NOV. 1-11 11/30 OF NOV. TOTALS	LOSSES FOR MONTHLY INCREMENTS
JAN.	A 194	S .10 T .12 U .19	1AS 456	2AS 238	3AS 142	4AS 96	5AS 74	6AS 63	7AS 58 1AT 548	8AS 56 2AT 286	9AS 54 3AT 171	10AS 54 4AT 115 1AU 867	11AS 54 5AT 88 2AU 452	594	218	3496
FEB.	B 38	S .10 T .12 U .19		1BS 89	2BS 47	3BS 28	4BS 19	5BS 14	6BS 12 1BT 107	7BS 11 2BT 56	8BS 11 3BT 33	9BS 11 4BT 22 1BU 170	10BS 10 5BT 17 2BU 89	116	42	672
MAR.	C 49	S .10 T .12 U .19			1CS 115	2CS 60	3CS 36	4CS 24	5CS 19 1CT 138	6CS 16 2CT 72	7CS 15 3CT 43	8CS 14 4CT 29 1CU 219	9CS 14 5CT 22 2CU 114	150	55	855
APR.	D 88	S .10 T .12 U .19				1DS 207	2DS 108	3DS 65	4DS 43 1DT 248	5DS 33 2DT 130	6DS 28 3DT 78	7DS 26 4DT 52 1DU 393	8DS 25 5DT 40 2DU 205	270	99	1510
MAY	E 167	S .10 T .12 U .19					1ES 393	2ES 205	3ES 123 1ET 472	4ES 82 2ET 246	5ES 63 3ET 147	6ES 54 4ET 99 1EU 747	7ES 50 5ET 76 2EU 390	516	189	2820
JUNE	F 223	S .10 T .12 U .19						1FS 525	2FS 274 1FT 630	3FS 164 2FT 328	4FS 110 3FT 196	5FS 84 4FT 132 1FU 997	6FS 72 5FT 101 2FU 520	693	254	3694
JULY	G 258	V .22 U .19							1GV 1336	2GV 697	3GV 417	4GV 280 1GU 1153	5GV 215 2GU 602	817	300	4183
AUG.	H 268	V .22 U .19								1HV 1387	2HV 724	3HV 433 1HU 1198	4HV 291 2HU 625	916	336	4078
SEPT.	K 263	V .22 U .19									1KV 1361	2KV 711 1KU 1176	3KV 425 2KU 614	1039	381	3629
OCT.	L 222	W .41										1LW 2142	2LW 1118	1118	410	2552
NOV.	M 110	W .41											1MW 1061	1061	389	389
TOTAL LOSSES DURING EACH MONTH			456	327	304	391	630	896	4008	3564	3451	11,178	7290	7290	2673	27,878

Fig. 62.—*Losses from war (poisonous) gases* by months under approximately the same conditions as occurred in the American Expeditionary Forces where there was a material increase in: (a) The strength each month; (b) also in the admission rate at different periods. The average daily admission rates from war gases per 1000 American Expeditionary Forces strength were: Jan. to June 0.10; July to Sept. 0.22; Oct. to Nov. 0.41. It is here assumed that 6% of the admissions from gas were sent to the Zone of the Interior. The symbols used throughout the body of this table represent the product of a monthly loss by a monthly increase in strength in thousands and by a daily admission rate. Thus 1BS (23.53 x 38 x .10) = 89.

NOTE: Data for losses each month (second line from top), see Fig. 56.

with a constant average daily admission rate. Figs. 62 and 63 show, however, how to compute the data when there is not only an increasing strength, but also an increasing admission rate. The same basic principle applies to the latter factor as to the former. Thus a group of men with an average daily admission rate establishes a return flow of men from the hospital at that rate, but when the rate increases materially and consequently more men are admitted to hospital, the return flow from that increased number must be established before there can be a decline in the specific loss rate.

Fig. 20 shows the daily admission rates per 1000 total American Expeditionary Forces strength from gas and from gunshot missiles during each month, and also during several grouped periods. From this graph, it is apparent that during the early weeks in 1918 the American Expeditionary Force troops engaged in but little military combat, but as time advanced the amount and intensity of the fighting increased and finally culminated in the prolonged and severe fighting during September, October, and early November.

MONTHS	INCREASE IN STRENGTH IN THOUSANDS	DAILY ADM. RATES	LOSSES EACH MONTH AT A DAILY ADM. RATE OF 1 PER 1000 OF EACH INCREASE IN STRENGTH 1- 36.39 JAN.	2- 30.21 FEB.	3- 26.21 MAR.	4-23.29 APRIL	5- 21.13 MAY	6- 19.59 JUNE	7- 18.43 JULY	8-17.63 AUG.	9-17.05 SEPT.	10-16.60 OCT.	11- 16.28 NOV.	NOV. TOTALS	NOV. 1-11 11/30 OF NOV. TOTALS	LOSSES FOR MONTHLY INCREMENTS
JAN.	A 194	S 0.11 T .42 U .43	1AS 777	2AS 645	3AS 559	4AS 497	5AS 451	6AS 418	7AS 393 1AT 2,965	8AS 376 2AT 2,462	9AS 364 3AT 2,136	10AS 354 4AT 1,898 1AU 3,036	11AS 347 5AT 1,722 2AU 2,520	4,589	1,683	19,014
FEB.	B 38	S .11 T .42 U .43		1BS 152	2BS 126	3BS 110	4BS 97	5BS 88	6BS 82 1BT 580	7BS 77 2BT 482	8BS 74 3BT 418	9BS 71 4BT 372 1BU 594	10BS 69 5BT 337 2BU 494	900	330	3,653
MAR.	C 49	S .11 T .42 U .43			1CS 196	2CS 163	3CS 141	4CS 126	5CS 114 1CT 749	6CS 106 2CT 622	7CS 99 3CT 539	8CS 95 4CT 479 1CU 767	9CS 92 5CT 435 2CU 636	1,163	426	4,622
APRIL	D 88	S .11 T .42 U .43				1DS 352	2DS 292	3DS 254	4DS 226 1DT 1,345	5DS 204 2DT 1,116	6DS 190 3DT 968	7DS 178 4DT 861 1DU 1,377	8DS 171 5DT 781 2DU 1,143	2,095	768	8,131
MAY	E 167	S .11 T .42 U .43					1ES 668	2ES 555	3ES 481 1ET 2,552	4ES 428 2ET 2,119	5ES 388 3ET 1,838	6ES 360 4ET 1,633 1EU 2,613	7ES 338 5ET 1,482 2EU 2,169	3,989	1,463	15,098
JUNE	F 223	S .11 T .42 U .43						1FS 893	2FS 741 1FT 3,408	3FS 643 2FT 2,830	4FS 571 3FT 2,455	5FS 518 4FT 2,181 1FU 3,489	6FS 480 5FT 1,979 2FU 2,897	5,356	1,964	19,693
JULY	G 258	V .53 U .43							1GV 4,976	2GV 4,131	3GV 3584	4GV 3,185 1GU 4,037	5GV 2,890 2GU 3,351	6,241	2,288	22,201
AUG.	H 268	V .53 U .43								1HV 5,168	2HV 4,291	3HV 3,723 1HU 4,193	4HV 3,308 2HU 3,481	6,789	2,489	19,864
SEPT.	K 263	V .53 U .43									1KV 5,072	2KV 4,211 1KU 4,115	3KV 3,653 2KU 3,416	7,069	2,592	15,990
OCT.	L 222	W 96										1LW 7,755	2LW 6,439	6,439	2,361	10,116
NOV.	M 110	W .96											1MW 3,843	3,843	1,409	1,409
TOTAL LOSSES DURING EACH MONTH			777	797	881	1,122	1,649	2,334	18,612	20,764	22,987	52,095	48,473	48,473	17,773	139,791

Fig. 63.—*Losses from gunshot injuries* by months under approximately the same conditions as occurred in the American Expeditionary Forces where there was a material increase in: (a) The strength each month; (b) also in the admission rate at different periods. The average daily admission rates per 1000 American Expeditionary Forces strength were: Jan. to June 0.11; July to Sept. 0.53; Oct. to Nov. 0.96. It is here assumed that 20% of the gunshot admissions were sent to the Zone of the Interior. The symbols used throughout the body of this table represent the product of a monthly loss by an increase in strength in thousands and by a daily admission rate. Thus 1BS (36.39 x 38 x .11) =152.

NOTE: Data for losses each month (second line from top), see Fig. 58.

For convenience in calculating the data on Figs. 62 and 63, the time from January 1 to November 11, 1918 is divided into three periods, although more exact results could be obtained by dividing the entire time more nearly in accordance with the intensity of fighting.

As an illustration of the method of determining losses from gunshot missiles (Fig. 63), the January strength is multiplied by each loss rate from No. 1 to No. 11 at the basic daily admission rate of 1.00 per 1000; and also for each month of its service in the American Expeditionary Forces, (11 months) by the admission rate of .11. The increase in the admission rate of .42 (.53 — .11) in July is then multiplied by the January strength and the initial five loss rates. These additional losses are entered in the table on the line with the January strength under the months from July through November. The further increase in the admission rate of .43 [.96 — (.42 + .11)] in October is then multiplied by the January strength and the two initial loss rates. These additional losses as computed are entered on the January line under October and November as they occurred.

In computing the losses for the increase in strength during February, that increment is multiplied by the loss rates from No. 1 to No. 10 inclusive, then throughout by .11, by .42 for the last five groups, and by .43 for the last two. For the March increase in strength, the loss rates from No. 1 to No. 9 are used, for the April one, No. 1 to No. 8, etc. For the July strength, the only loss rates used are from No. 1 to No. 5 inclusive, and consequently the second multiplication is by .53 (.11 + .42). Similarly the October increase is first multiplied by the first two loss rates and then by .96 (.53 + .43).

The following table shows a summary of the monthly losses as computed on Figs. 60, 62, and 63.

Table 13. Total losses in the American Expeditionary Forces by months.

Month	Strength in thousands to middle of the month.		Losses by months.				
	Increase in strength	Accumulated strength	Diseases and non-battle injuries.	Gas	Gunshot	Total	Per 1000 total strength.
Jan.	194	194	5,582	456	777	6.815	35.13
Feb.	38	232	3,267	327	797	4,391	18.93
March	49	281	3,051	304	881	4,236	15.07
April	88	369	4,100	391	1,122	5,613	15.21
May	167	536	6,834	630	1,649	9,113	17.00
June	223	759	9,644	896	2,334	12,874	16.96
July	258	1,017	12,022	4,008	18,612	34,642	34.06
August	268	1,285	13,578	3,564	20,764	37,906	29.50
Sept.	263	1,548	14,438	3,451	22,987	40,876	26.41
October	222	1,770	13,969	11,178	52,095	77,242	43.64
Nov. 1 to 11	110	689*	4,001	2,673	17,773	24,447	35.48
Aggregate		8,680	90,486	27,878	139,791	258,155	29.74

* 11/30 of accumulated strength for month of November.

As nearly as can be estimated, the total losses in the American Expeditionary Forces to November 11, including deaths, cases in hospital and cases returned to the United States, was about 267,000, or about 9,000 more than the total 258,155 as shown above. The results then of these calculations approximate the actual losses as closely as could be expected from a computation in which grouped average rates and strengths are used.

To repeat, the rapid decline in loss rate as shown by Figs. 54, 56, and 59 occurs only when an expeditionary force has a constant strength throughout with constant admission rates from all causes. The loss rates per 1000 total Theater of Operations strength in the last column of Table 13 show how much such rates depend upon the increases in strength and upon the intensity of fighting.

K. LOSSES IN THE MOBILIZATION AREA.

The losses in the mobilization area consist of:

a. Noneffectives in hospital.
b. Deaths and discharges for disability among patients in hospital.
c. Deaths and discharges for disability among men not in hospital.

After the mobilization camps are filled, there is but little increase in the strength of the command. As the troops are trained and equipped they are sent to the expeditionary area and are replaced by incoming recruits. Consequently the number of men mobilized is greater than the average daily strength for one year. Thus in 1918, the former was 3,310,246, and the latter 1,310,246.

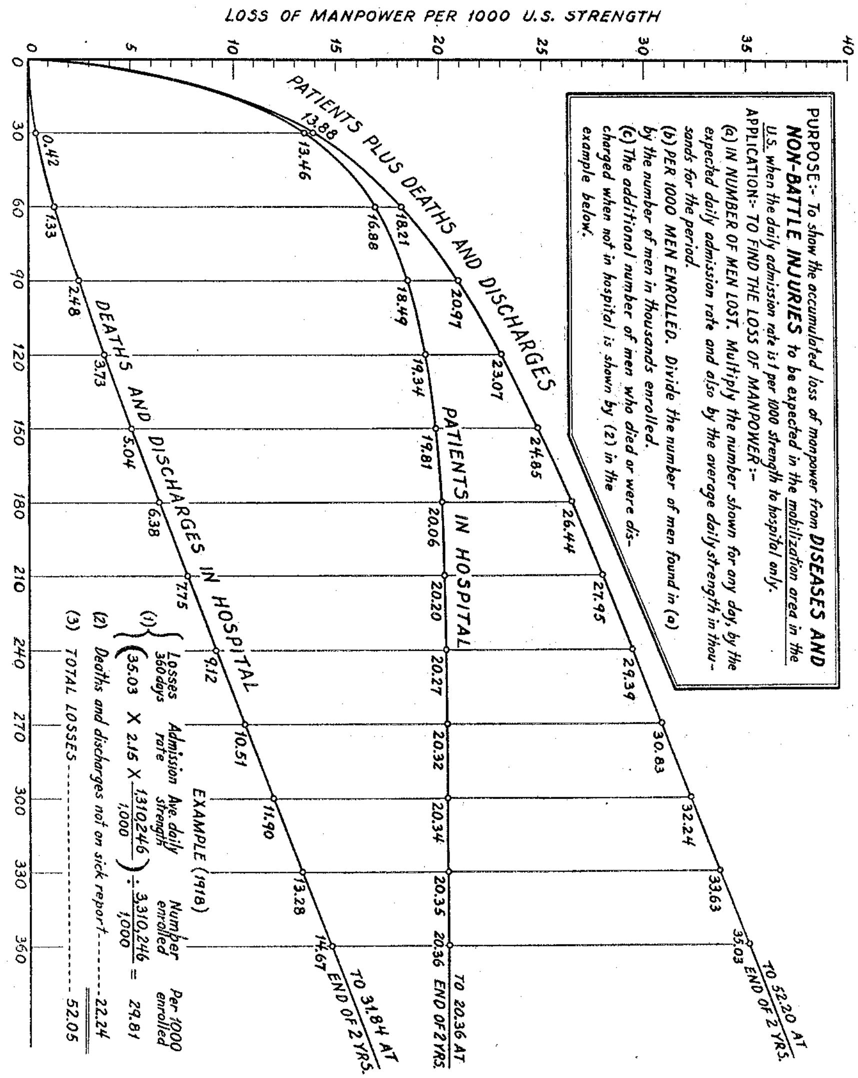


Fig. 64.*—Loss of manpower in the mobilization area (U.S.) among those actually enrolled in the military service from diseases and nonbattle injuries, due to deaths, discharges for disability, and noneffectives in hospital (patients).

*NOTE: For basic formula see: (a) Patients in hospital, Fig. 82, (2) p. 149. (b) Deaths and discharges in hospital, Fig. 95 (2) p. 162. (c) Deaths and discharges not on sick report based on experience in U. S., 1918.

The troops while in training establish a return flow of patients from hospital, and when they depart their sick in hospital remain behind, thus acting as a replacement flow for the incoming recruits. The ultimate number of noneffectives will then be divided among the total number of men passing through the mobilization area rather than among the average daily number present for the year. The men in camp during the first few weeks, when the noneffective rate rises quite rapidly, lose a larger percentage than those during the later periods when it is more nearly stabilized; but for all practical purposes we may disregard this and consider that the noneffectives are distributed evenly among the men mobilized. Then as in Fig. 64, with an ultimate noneffective rate of 20.36 to the average annual strength, the same rate to each 1000 men mobilized was

$$20.36 \times \frac{1{,}310{,}246}{1000} \div \frac{3{,}310{,}246}{1000} = 8.06.$$

The time element is an important one in connection with deaths and discharges among patients in hospital, for the number of cases with their associated deaths and discharges for disability increase in proportion to the length of the time period, like the noneffective rate. Consequently this class of losses must be proportioned to the total number of men mobilized rather than to the daily strength averaged for one year. With a loss rate from these causes at the end of one year of 14.67 per 1000 in an average daily strength of 1,310,246, the corresponding one for 3,310,246 men mobilized is

$$14.67 \times \frac{1{,}310{,}246}{1000} \times \frac{3{,}310{,}246}{1000} = 5.81.$$

The third class of losses are from deaths and from discharges for disability (of which the latter comprised 95% of the two during 1918), among men not on sick report. This group consisted chiefly of the physically unfit men whose deficiencies escaped the scrutiny of the local and camp examining boards. The physical imperfections of such men soon became apparent to officers of organization and to the medical officers assigned to them, and they were discharged as physically unfit. Probably all such cases can be culled out within a month or six weeks, and there should be no material increase in the percentage of them thereafter, no matter how long the men remain in the mobilization area. Since the time element need not be considered in connection with them, as it is assumed that the training period will be long enough for their detection and elimination, the rates for them can be based upon the actual number of men mobilized. In 1918 it was 22.24 per 1000 men (Fig. 64).

Since the total losses in man power in the mobilization area is 52.05 per 1000 men mobilized (See Fig. 64), or 5.20%, the number of men available for duty with any expedition will be 100 % — 5.20% = 94.80%. For each 1000 men required for a large expeditionary force, when the troops are to be equipped and trained in the mobilization area, the number that will be required, after passing the camp examining board will be:

$$94.80\% = 1000$$
$$100\% = 1054.85$$

Since 6.6%,[12] of all men sent to the military camps by the Local Boards were found to be physically unfit, the percentage of the men actually called for service who will eventually be available for duty with an expeditionary force will be:

$$100\% - (5.2\% + 6.6\%) = 88.2\%.$$

Then for each 1000 men required for an expeditionary force, the number to be called after passing the rather careful scrutiny of the Local Examining Boards will be:

$$88.2\% = 1000$$
$$100\% = 1133.79$$

Of this number of men called there will be:

1. Found physically unfit by Camp Examining Boards	74.83
2. Noneffectives, deaths, and discharges as physically unfit in training camps	58.96
3. Available for duty with an expeditionary force	1000.00
Total to be called	1133.79

Since 14.6% of all Class I men were found physically disqualified for full military service by local boards; and an additional 8.0% as available only for limited or domestic service by the local and camp examining boards, the percentage of Class I men between the ages of 21 and 30 who were eventually available for combat service with the expeditionary force was $100\% - (14.6\% + 8.0\% + 6.6\% + 5.2\%) = 65.6\%$. Then for each 1000 men for combat duty required for an expeditionary force, the number of Class I men, ages 21 to 30, who must be available will be:

$$65.6\% = 1000$$
$$100\% = 1524.39$$

Of this number of men called there will be:

1. Found physically unfit by local examining board	222.56
2. Found physically fit for only limited service by local and camp examining boards	121.95
3. Found physically unfit by camp examining board	100.61
4. Non-effectives, deaths, and discharges as physically unfit in training camps	79.27
5. Available for combat duty with an expeditionary force	1000.00
Total Class I men	1524.39

III. MEDICAL SERVICE IN THE COMBAT ZONE.

The care of the sick and injured of the units operating in the Theater of Operation and the evacuation to general hospitals are important functions of the Medical Department. The efficient and systematic performance of this duty assists materially in insuring the mobility of the troops in the front area, and it is also a very important factor in maintaining the morale of the troops.

The character of cases to be treated and evacuated are:

a. Diseases and nonbattle injuries.

d. Battle wounds from:

(1) Gunshot missiles.

(2) War gases.

L. DISEASES AND NONBATTLE INJURIES

35. **Total in the Theater of Operations.** — Our experience shows (Fig. 18) that the daily admission rate from diseases and nonbattle injuries to *hospital and quarters* combined for seasoned troops operating under favorable conditions in a temperate climate in an area such as the American Expeditionary Forces, with a large number of men in the line of communications area, was 2.50 per 1000. It further shows (Fig. 1) that 56% of such cases were admitted to hospital and 44% were treated in quarters, infirmaries, improvised hospitals, etc. We know also (p. 3) that approximately one half as many cases are treated as dispensary cases as in hospital and quarters combined.

Under such conditions as outlined above the average daily sick rate per 1000 men among such troops would be:

Hospital sick	1.40
Quarters sick	1.10
Dispensary sick	1.25

If this rate is increased 20% to allow for normal variations, the daily sick rate per 1000 men in the Theater of Operations is 4.50, of which approximately one third would be sent to station or general hospitals, one third would be cared for in quarters, dispensaries, etc., and one third would be returned to duty with their organization. In the further discussion of this subject no mention will be made of the care of the dispensary sick, but there will always be a large number of such cases to be treated, and supplies and personnel must be available for this purpose.

36. **In the Combat area.** — When troops enter the combat zone and then advance to the battle line, the incidental hardships and unfavorable conditions probably would cause an increase in the sick rate. To obtain data in regard to the actual increase to be expected, a study was made of the medical records of the *infantry regiments* of the 1st,

Table 14. — Daily admission rates from diseases by systems by months, among each 1000 white enlisted men in combat divisions and in the total American Expeditionary Forces, June to October, 1918.

Systems	June		July		August		September		October	
	Combat Divisions	Total A. E. F.	Combat Divisions	Total A. E. F.	Combat Divisions	Total A. E. F.	Combat Divisions	Total A. E. F.	Combat Divisions	Total A. E. F.
Infectious, not specified	.08	.11* / .29†	.09	.08 / .14	.12	.09 / .16	.17	.11 / .20	.38	.16 / .29
Tuberculosis	.02	.01 / .02	.02	.01 / .02	.02	.01 / .02	.02	.01 / .02	.02	.01 / .02
Venereal	.09	.05 / .09	.05	.03 / .06	.08	.05 / .07	.16	.04 / .07	.10	.04 / .07
General	.06	.02 / .04	.07	.02 / .04	.04	.02 / .04	.11	.03 / .06	.25	.04 / .07
Nervous and mental	.20	.03 / .06	.88	.08 / .14	.23	.06 / .11	.19	.05 / .09	.45	.06 / .11
Eye, ear, and nose	.16	.04 / .07	.09	.03 / .06	.10	.04 / .07	.13	.03 / .06	.11	.04 / .07
Circulatory	.10	.03 / .06	.09	.03 / .06	.10	.04 / .07	.14	.04 / .07	.19	.04 / .07
Respiratory	1.67	.34 / .61	.41	.21 / .38	.46	.25 / .45	1.40	.77 / 1.34	2.81	1.15 / 2.05
Digestive	.21	.10 / .18	.32	.11 / .20	.67	.23 / .41	.56	.15 / .27	1.39	.28 / .50
Genito-urinary and skin	.34	.06 / .11	.27	.06 / .11	.22	.09 / .16	.41	.07 / .13	.39	.08 / .14
Bones, organs of locomotion, con. malformation, & ill defined	.72	.08 / .14	.31	.06 / .11	.22	.07 / .13	.28	.07 / .13	.58	.09 / .16
TOTAL	3.65	.87 / 1.55	2.63	.71 / 1.27	2.27	.90 / 1.61	3.57	1.37 / 2.45	6.67	1.98 / 3.54

*Admission rates to hospital.
†Estimated total admission rates, including cases in quarters.
NOTE: The Combat Divisions include the Infantry Regiments of the 1st, 3rd, 26th and 42nd Divisions. The rates for the Combat Divisions apparently include as hospital cases those ordinarily treated in quarters; whereas those computed for the total American Expeditionary Forces include only hospital cases. The estimated ones which include also quarters cases can be more properly compared with those for the Combat Divisions (Front Area).

3rd, 26th and 42nd Divisions, all active combat divisions, for the period June 1 to October 31, 1918, inclusive.[1]

Since the Divisions selected were composed of white men, their rates are compared with those for the total white troops in the American Expeditionary Forces.[3] The computed data as presented by Tables 14 and 15, and Figs. 65 and 66, shows that there was more sickness among the front area white troops than in the total group. It is apparent also that the excess among the front line troops occurred each month and from each class of disease, the most important increase being in the number of

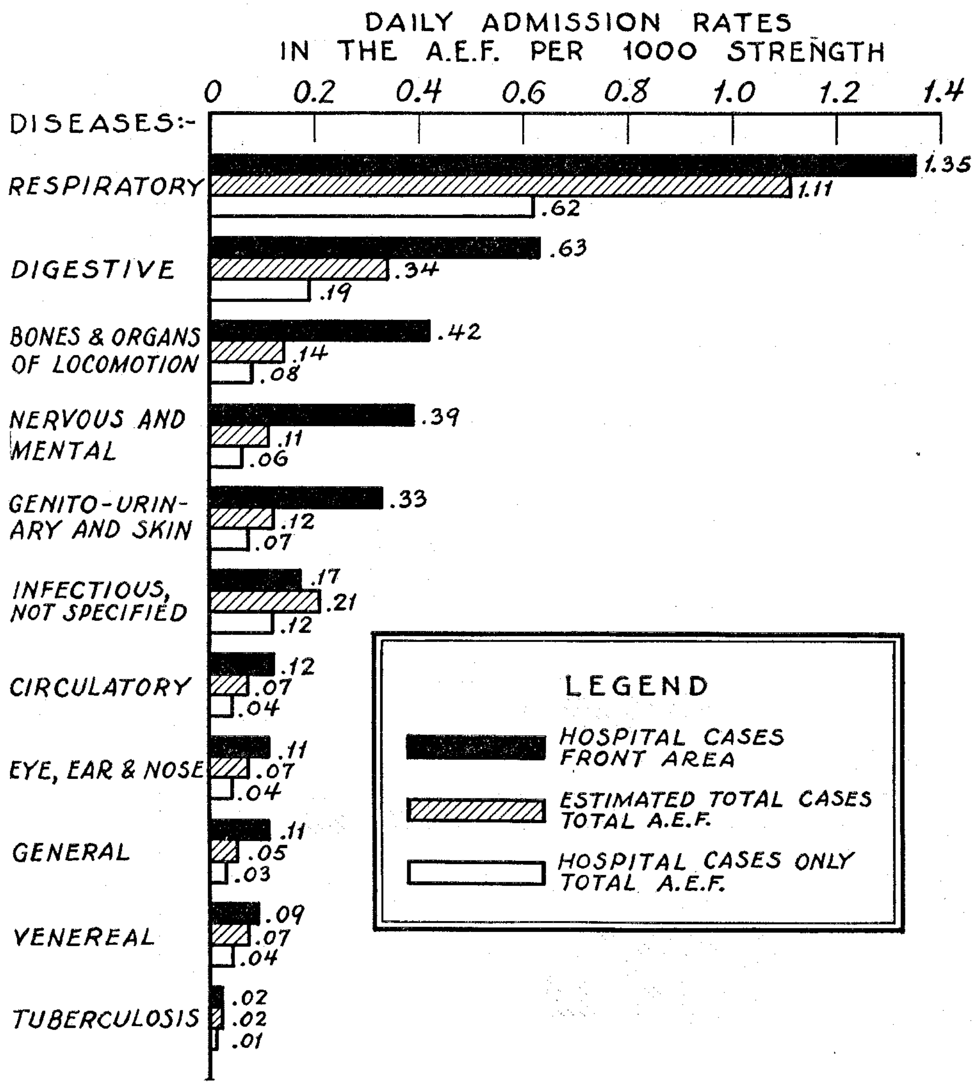


Fig. 65.—Daily admission rates by classes of diseases per 1000 strength of white troops in the front area, and also in the total American Expeditionary Forces, for the period from June 1 to October 31, 1918. [1 3]

cases of respiratory and digestive diseases.

Table 15 and Fig. 66 also indicate that there was more sickness among the troops on the battle line than among the other front area troops. The data, as computed, shows that the average daily *hospital* admission rate from diseases only for the white troops in the front area was 3.76 per 1000, as compared with 1.26 for the total American Expeditionary Forces,[3] or practically 3 to 1. If the admissions from nonbattle injuries are included the rate of 1.26 is raised to 1.40; and if the ratio of 3 to 1 is continued, the 3.76 is raised to 4.20 (hospital only).

Before any real comparison can be made, however, of the rates for the combat divisions with those for the total American Expeditionary Forces, the character of the cases included in the two sets of rates must be considered. As stated above, many of the cases of sickness among the men in the training area were treated in quarters, infirmaries, etc., and were not made of record. Among the combat divisions, however, and especially so when in the actual combat area, a large part of the sick had to

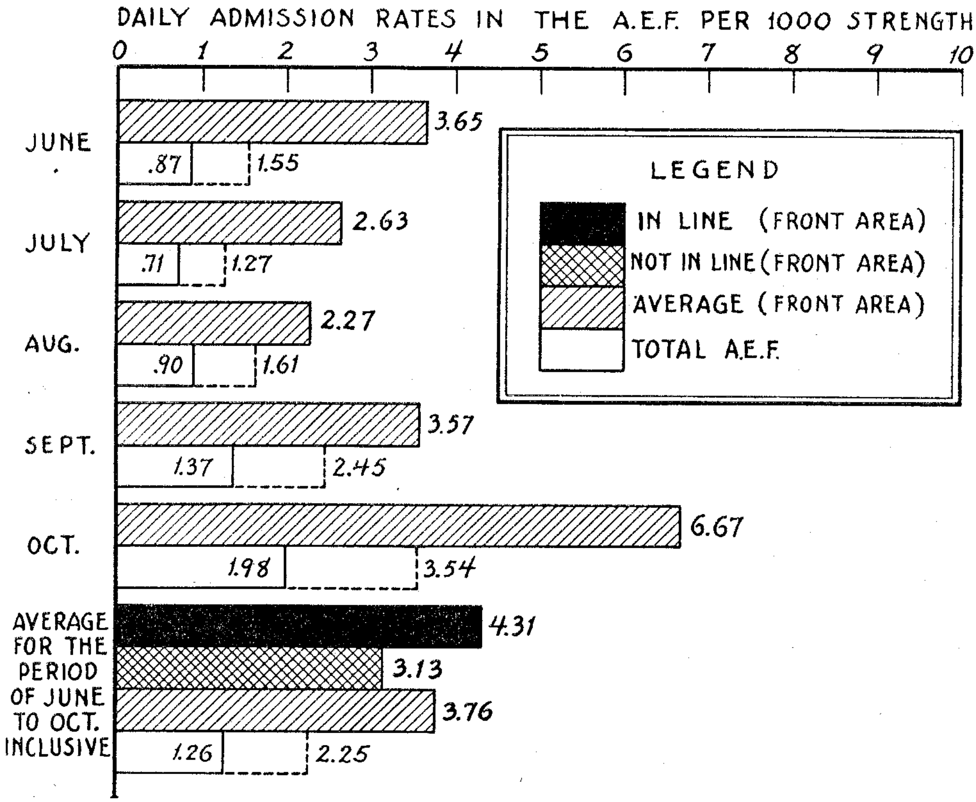


Fig. 66.—Daily admission rates from diseases per 1000 strength of white troops in the front area, and in the total American Expeditionary Forces, for the period June 1st to October 31st, 1918, and also for each month of that period. 1 3

be evacuated, and consequently were admitted to either temporary or permanent hospitals where records were made. Apparently then, the comparison should be between the total admission rate in the American Expeditionary Forces; that is, the one including both hospital and quarters cases, and the one available for the combat division. For this purpose, the estimated rates to include both *hospital and quarter* cases for the total American Expeditionary Forces are shown both in the tables and on the graphs. The comparison is then between 2.50 and 4.20. Consequently, we would expect the sick rate to be 1.70 (1.68) as great among the personnel of the front line combat divisions as in a total area, such as the

Table 15. — Daily Admission Rates from Disease by Systems among each 1000 White Enlisted Men, on the battle line, among other troops in combat divisions, and in the total American Expeditionary Forces, June to October, 1918.

Systems of Diseases	Combat Divisions			Total[s] A. E. F.
	On battle line	Not on battle line	Total	
Infectious, not specified	.15	.19	.17	.12* .21†
Tuberculosis	.02	.02	.02	.01 .02
Venereal	.10	.09	.09	.04 .07
General	.13	.09	.11	.03 .05
Nervous and mental	.57	.20	.39	.06 .11
Eye, ear and nose	.13	.10	.11	.04 .07
Circulatory	.12	.12	.12	.04 .07
Respiratory	1.58	1.09	1.35	.62 1.11
Digestive	.63	.64	.63	.19 .34
Genito-urinary and skin	.33	.32	.33	.07 .12
Bones, organs of locomotion, congenital malformations and ill-defined	.56	.27	.42	.08 .14
TOTAL	4.31	3.13	3.76	1.26 2.25

*Admission rates to hospital.
†Estimated total admission rates including cases in quarters.

American Expeditionary Forces. Furthermore, when the troops are on the actual battle line this excess may be 2.00 to 1.00 instead of 1.70 to 1.00.

Even with the estimated increase added, the total American Expeditionary Forces rates are still much lower than those for the Combat Divisions (Front Area) for each month, and for each group of diseases with the two exceptions, one for infectious not specified (which is lower), and the other for tuberculosis (which is the same) (see Table 14 and Fig. 65).

Table 16. — Relative number of cases of sickness among the front area troops as compared with the *estimated total* in the American Expeditionary Forces set as a standard at 1.00.

a. By months.

Month	*Front Area*
June	2.35 to 1.00
July	2.07 to 1.00
August	1.41 to 1.00
September	1.46 to 1.00
October	1.88 to 1.00
TOTAL	1.67 to 1.00

b. By class of disease.

Disease	*Front Area*
Respiratory	1.21 to 1.00
Digestive	1.85 to 1.00
Bones & organs of locomotion	3.00 to 1.00
Nervous and mental	3.55 to 1.00
Genito-urinary and skin	2.75 to 1.00
Infectious, not specified	0.81 to 1.00
Circulatory	1.71 to 1.00
Eye, ear and nose	1.57 to 1.00
General	2.20 to 1.00
Venereal	1.28 to 1.00
Tuberculosis	1.00 to 1.00

M. BATTLE CASUALTIES — COLLECTION OF DATA.

The following data show the average and maximal casualty rates, and also how often rates of various magnitude occurred among the United States troops in the American Expeditionary Forces during 1918. The information as assembled is for the American part of the First American Army and its component units, and also for other selected Divisions and regiments. The sources of the information and the method of assembling the data are as follows.

37. **Composition of Organizations.** — a. *First American Army.* — The Report of the First Army[13] was used to determine its component organizations from day to day. This information was supplemented by information obtained from "Field Operations, Volume VIII, The Medical De-

partment of the United States Army in the World War".[14] The Corps of the First Army were I, III, and V, from September 26 to November 11; the IV from September 26 to October 12; and the Divisions serving with the French, for this study, grouped and included as a Corps, from Sept. 26 to Nov. 11.

b. *Corps.* — The report of the First Army[13] was also used to determine the Divisions in each Corps from day to day, and also those in the Army Reserve. "Field Operations" [14] was again used to supplement the information obtained. In addition, "Battle Participations of Organizations of the American Expeditionary Forces in France, Belgium, and Italy"[10] was used quite freely to verify the location of Divisions, and especially to determine when a Division left the line for reserve or vice versa.

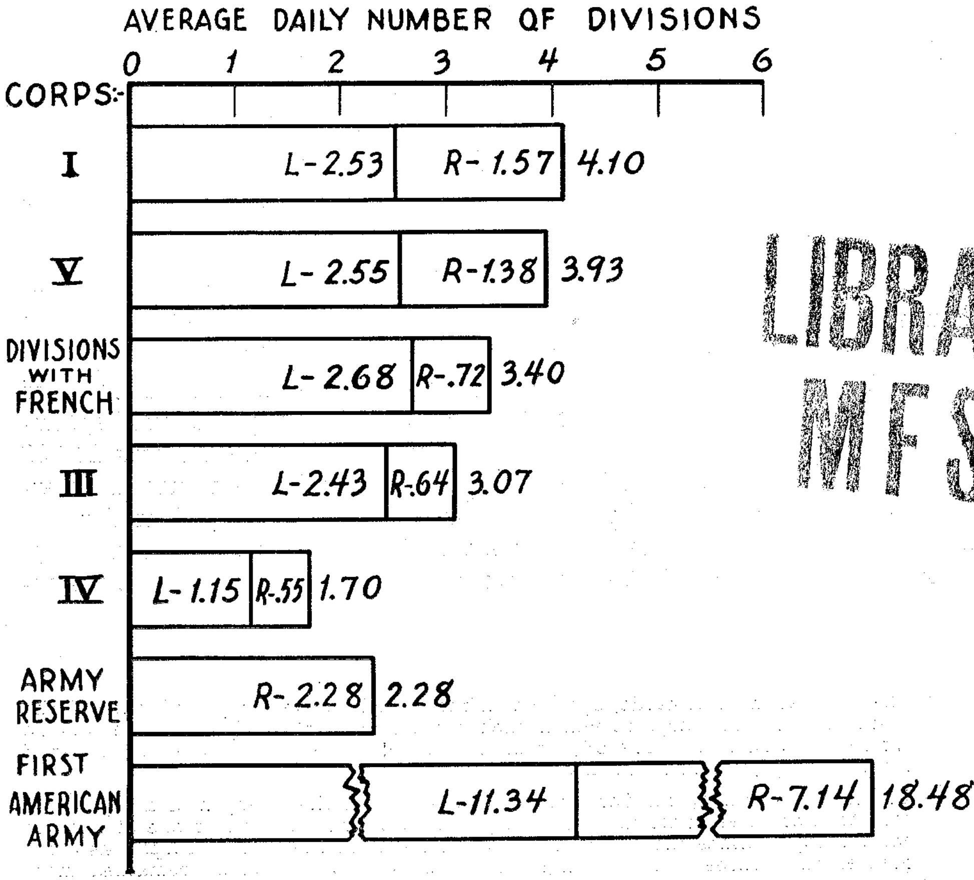


Fig. 67.—Average daily number of American divisions in the First American Army, in each of its Corps, both in line (L) and in reserve (R), and also in the Army Reserve for the period of 47 days, from September 26 to November 11, 1918. [3]

NOTE: The IV Corps was a part of the First Army only until October 12, a period of 17 days. During that time the average daily number of divisions in line was 3.18 and in reserve 1.53, whereas the figures for the entire 47 days was L-1.15 and R-.55 as shown above.

Fig. 67 shows the daily average number of American Divisions in each Corps and also in the First American Army during the Meuse-Argonne offensive.

c. *Divisions.*—The information in regard to the operations of Divisions was obtained from the "Battle Participations of Organizations of the American Expeditionary Forces " etc [10]. This information was supplemented by a mimeographed copy of "Brief Histories of Divisions, U. S. Army, 1917 - 1918"[15], June, 1921, from the Historical Branch, War Plans Division, General Staff.

38. **Strength of the Organizations.** — a. *First Army.* — The strength of the First Army is given on page 113 of the "Report of the First Army"[13]. Examination of the casualties in organizations by days, as will be referred to later, showed that only 91% of the total casualties were distributed by divisional organizations by days.* Apparently then. only 91% were included in the total casualties assembled for the First Army. Therefore, the daily strength of the First Army as shown in the official report, was reduced in each instance to 91% to compensate for the difference in the total of casualties as they occurred and as assembled.

b. *Corps.* — The daily strength of the individual corps was found by multiplying the assumed strength of a division; that is, 24,000, by the number of divisions, including those in reserve, in the Corps, and then adding 33%† to cover corps troops not included in divisional organizations. The total figures thus obtained were reduced then in each instance to 91% to compensate for the unassembled casualties, as referred to above.

c. *Divisions.* — An examination made by the Historical Branch of the War College of the returns of 14 Combat Divisions on or about September 26, 1918 showed that the average strength of each one was 24,128 men. It was assumed then that 24,000 was a fair figure to use in determining the strength of the corps, as referred to above. But for the purpose of calculating rates for Divisions, the 24,000 was reduced to approximately 91%, or to 22,000, to compensate for the unassembled divisional casualties.

* The original medical cards, upon which the casualties were reported, showed the regiments or staff corps to which each patient was attached, but there was no reference to Division. The 9% of undistributed casualties occurred among staff or corps troops, not in regiments.

† The increase of 33% for Corps troops is based upon the strength of a type corps composed of three divisions and the equivalent of the strength of one division in corps troops. Since the daily number of divisions in the various corps was often greater than three while the number of corps troops probably remained more nearly constant, the increase of 33% for the latter probably results in too great a strength for the corps, and consequently in too low a rate. Hence an increase of from 5% to 10% in such rates as are given may be justifiable.

d. *Regiment.* — An examination made by the World War Division of The Adjutant General's Office of reports of the Infantry Regiments in the 1st, 42nd, and 80th Divisions on October 31, 1918 showed that the average strength of each regiment was 2,732. To compensate for the lag in reporting casualties, the round number of 2,500 was used in calculating regimental rates.

39. **Sources of Casualty data.** — a. *Immediate source of information.* The immediate source of the casualty data was the tables in the latter part of "Medical and Casualty Statistics, Part 2, Volume 15, The Medical Department of the United States Army in the World War"[3] In these tables the number of gas wounded, gunshot wounded, and killed in action is given for each day for each Infantry, Artillery, and Engineer Regiment, and each Machine Gun Battalion.

b. *Original source of information.* — The original source of the information was: (a) For the number wounded by war gasses and by gunshot missiles, the Sick and Wounded Report cards forwarded from the American Expeditionary Forces to the Office of the Surgeon General; (b) for the killed in action, a nominal list of the deaths in the American Expeditionary Forces arranged by organization and by day, prepared in the Office of The Adjutant General and loaned to the Surgeon General's Office in 1921. It will be noted that in some instances during severe engagements, such as when the 27th and 30th Divisions participated in the attack on the Hindenburg line (Somme offensive) on the 29th and 30th of September, 1918, apparently all of the killed on the two days were reported as of the first day of the engagement. This results in a too high casualty rate for the first of the two days and in one too low for the second.

40. **Engagements Studied.** — a. *First Army and Corps.* — The Meuse-Argonne offensive from September 26 to November 11.

b. *Divisions.* — All of the Divisions comprising the Corps of the First Army, including those with the French. In addition, the following were included:§

1. First Division, Aisne-Marne, July 18 - 23.
2. Third Division, Aisne-Marne, July 18 - 31.
3. Fourth Division, Aisne-Marne, August 2 - 7.
4. Twenty-Sixth Division, Aisne-Marne, July 18 - 25.
5. Twenty-Seventh Division, Somme offensive, Sept. 26 - Oct. 20.
6. Thirtieth Division, Somme offensive, Sept. 26 - Oct. 20.
7. Thirty-Second Division, Aisne-Marne, July 30 - August 6.
8. Forty-Second Division, Aisne-Marne, July 25 - August 3.

§ The Second Division could not be included because the data by days for its Marine organization were not available.

c. *Infantry regiments.* — All of the Infantry regiments of the Divisions referred to; and, in addition, the 9th and 23rd Infantry regiments of the Second Division in the Aisne-Marne, July 18 and 19.

41. **Method of Assembling Data.** — a. *Infantry regiments.* — In the study of casualties by regiments, only Infantry regiments were included, because the Artillery and Engineer regiments had relatively few casualties as compared with the Infantry. The tabulation of the casualties for the Infantry regiments included only those assigned to Divisions operating on the front line, and none of those assigned to Divisions in the Corps or Army Reserve. It was, however, impossible to select out the Infantry Regiments when in the reserve of the selected Divisions.

b. *Divisions.* — The casualties as assembled for Divisions include those for the four Infantry regiments; three Machine Gun Battalions; the Engineer regiment; and the three Artillery regiments, when operating with the Divisions.‡ The daily casualties of these organizations were added to find those for the Divisions. As stated above, the Division strength was reduced to 91% of the total to compensate for the casualties which occurred in the organizations of the Divisions but for whom such data could not be assembled. In the study of the Divisions per se, the casualties of a Division was included only for the days when the Division was actually on the front line.

c. *Corps.* — In assembling the data for the Corps by day, the casualty data for all of the Divisions with the Corps on that date, both on the line and in reserve, were included. These were added to find the total for the Corps. In some instances, when more than one day was necessary to change a Division from the line to reserve or vice versa, the casualty rate for the Division shown as in reserve may be seemingly quite high.

d. *Army.* — The daily casualties of the Divisions in the Army Reserve were added to the total of those in the Corps to find the aggregate for the Army.

42. **Percentage of gas wounded, gunshot wounded, and killed.** — The term battle casualties as used here includes wounds by war gases, wounds by gunshot missiles, and the killed in action. In planning the evacuation of the wounded some approximate estimate must be made of the percentage of the gas and of the gunshot wounded in the total casualties.

As shown by Fig. 99 p. 166, the daily proportion of gas wounded to gunshot wounded decreased as the number of the latter increased; and also as shown by Fig. 100, p. 167, the daily proportion of gas wounded to the number killed in action decreased as the latter increased, while the proportion of gunshot wounded to the number killed remains practically constant. In other words the relative number of men wounded each day by war gasses decreased as the intensity of the military combat increased.

‡ No allowance could be made for the absence of Artillery regiments on certain days. Consequently the casualty rates as computed for such days are slightly lower than they should be.

Fig. 68 shows how the proportion of the gas wounded, gunshot wounded, and killed in the total casualties varied according to the resistance. It is suggested that the approximate average percentage distribution of casualties in Infantry regiments in engagements with casualties varying from 100 to 400 (rates varying from 4% to 16%) be used in estimating the percentage of killed in action, gas wounded, and gunshot wounded in the total casualties. We would then assume that in severe engagements 16% of the casualties would be the "killed in action", 64% gunshot wounded, and 20% gas wounded. There would then be 4 gunshot wounded to 1 killed in action, and 3.2 gunshot wounded to 1 gas wounded.

The percentage of killed to wounded would then be:

(a) 16% when there are both gas and gunshot wounded;

(b) 20% when there are only gunshot wounded.

Other American Expeditionary Forces experience indicates that in open warfare the killed would be 16-2/3% (1 to 5) when war gases are not used.

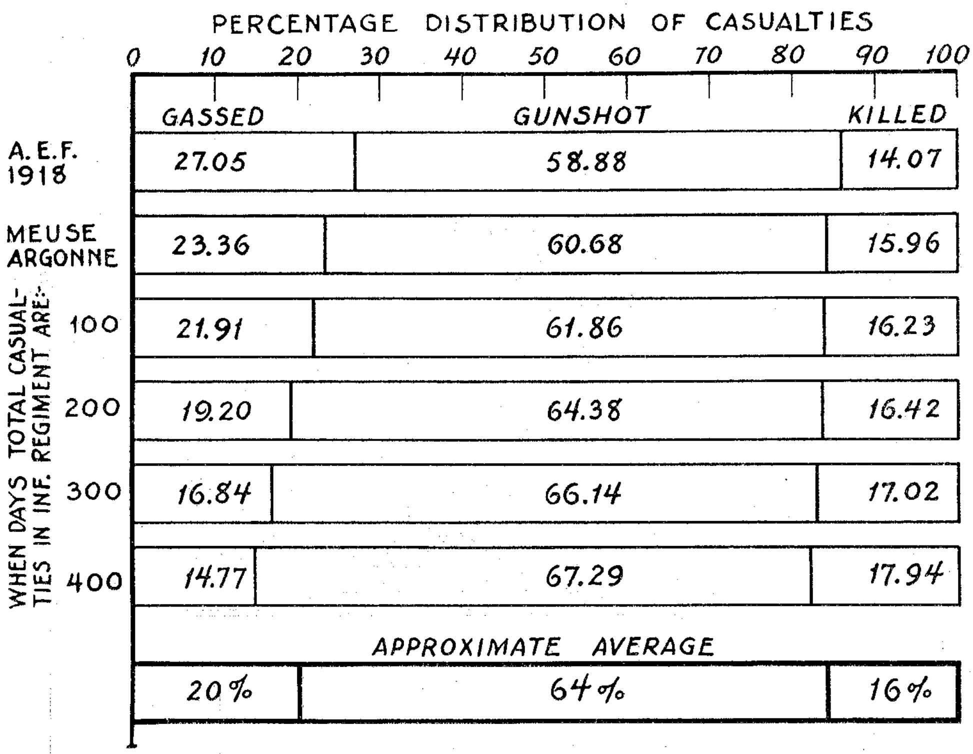


Fig. 68.—Variation in the percentage that the gassed, gunshot wounded and killed in action were of the total casualties according to the severity of the engagement. [3]

NOTE: It is suggested that the approximate average percentages be used in estimating the distribution of total casualties. The data on the left hand margin show the actual number of casualties.

N. BATTLE CASUALTIES—PRESENTATION OF DATA.

In presenting the casualty data for the Infantry regiments, Divisions, Corps, and the First American Army, four items are shown for each one: (a) The average daily casualty rate during the Meuse-Argonne offensive; (b) the frequency of various daily casualty rates, that is, how often each one occurred; (c) the maximal daily casualty rates with the proportionate part which occurred in the component unit of the Army, each Corps, and each Division; (d) important casualty rates on days either preceding or following the maximal casualty day.

43. **Infantry Regiments.** — a. *Frequency of casualty rates.* — The summation curve, Fig. 69, shows how often casualty rates greater or less than a certain one, occurred in infantry regiments. Thus, in 97.15% of the

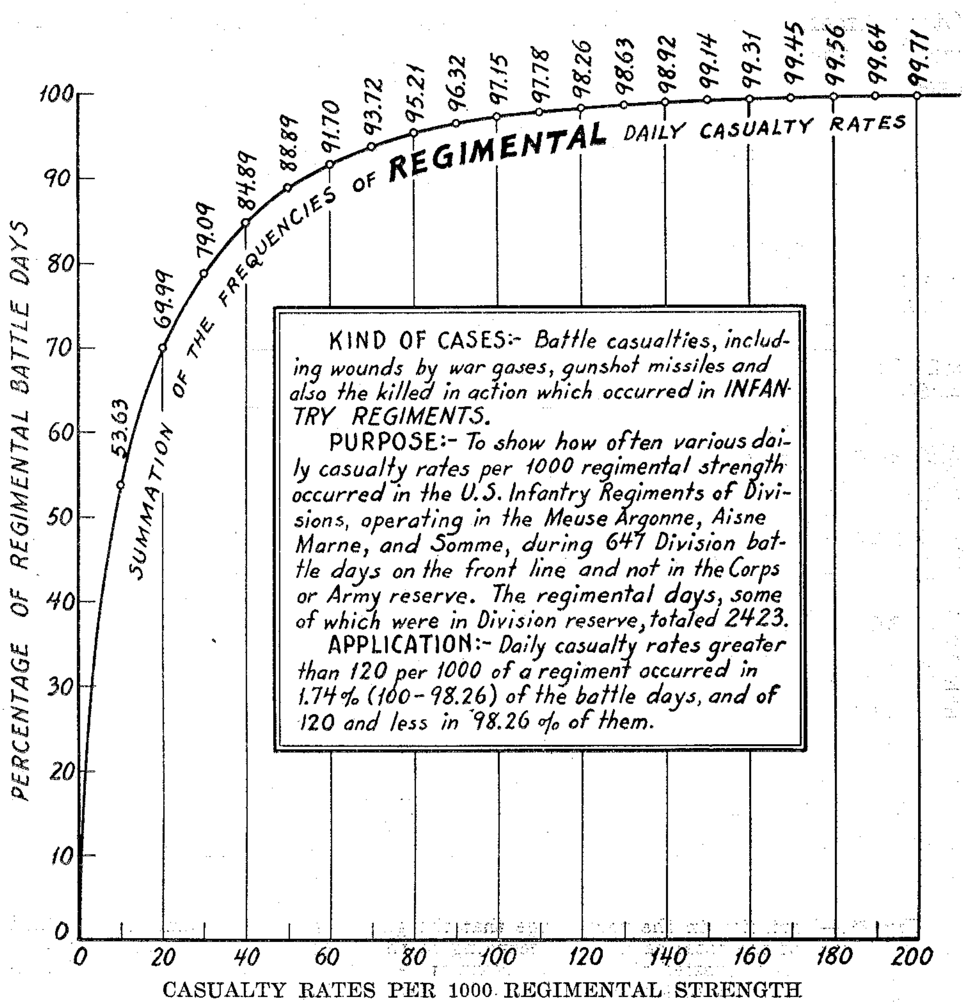


Fig. 69.—Summation curve showing how often various regimental daily casualty rates occurred during major operations in the American Expeditionary Forces in 1918. [3]

infantry regimental combat days in question (both in line and in reserve of the Divisions operating on the line) the loss was 100 per 1000 or less; and further the loss was greater than 100 per 1000 of the regimental strength in 2.85% (100.0% — 97.15%) of the days.

The Figure also shows how often casualty rates between certain ones occurred. Thus a rate between 90 and 100 per 1000 of the regimental strength occurred in 0.83% (97. 15% — 96.32%) of the battle days in question.

b. *Average casualty day.* — It is apparent then that high casualty day rates were comparatively infrequent. The average daily casualty rate, which was 20.36 per 1000 for the days in question, was also low. Since the average includes the days spent in the reserve of the Divisions which were on the front line, it is necessarily lower than it would have been for regiments in action only, and should probably be raised to approximately 25.00 per 1000 when comparing regimental losses with those in Divisions and Corps in combat.

c. *Maximal casualty days.* — An estimate of the medical personnel and equipment required for infantry regiments in severe combat cannot be based with safety on the most frequent daily casualty rates, or even on the average one, but should be based upon rates during severe combat.

In 1.74% (100% — 98.26%) of the combat days the casualty rates were greater than 150 per 1000 regimental strength; and in .86%, or 21

Table 17. — Maximal infantry regimental casualty day rates per 1000 men with the five next highest on days either immediately preceding or following each one; i. e., the rates are shown for six consecutive days.

Inf. Regt.	Div.	Date of highest casualty rate	Daily casualty rates per 1000 regimental strength.					
107	27	Sept. 29	30.0	*349.6*	98.4	39.6	25.6	11.6
120	30	Sept. 29	*298.4*	69.6	29.2	20.8	14.4	5.6
108	27	Sept. 29	28.8	*292.4*	89.2	34.0	18.4	12.0
9	2	July 18	*262.4*	90.0	46.4	25.6	36.4	24.0
119	30	Sept. 29	14.4	*234.8*	75.6	22.8	15.6	6.4
106	27	Sept. 27	22.4	*214.0*	30.8	78.0	25.6	17.2
114	29	Oct. 12	*205.6*	122.0	38.0	30.0	15.6	24.8
117	30	Oct. 8	31.2	72.4	*197.6*	63.6	20.0	11.2
16	1	Oct. 4	23.6	56.8	22.4	*190.4*	52.8	20.0
26	1	Oct. 4	*188.4*	126.8	75.6	25.6	31.2	45.6
18	1	Oct. 4	*180.8*	86.0	87.2	26.4	25.2	99.2
6	5	Oct. 14	9.2	*170.8*	61.6	19.2	13.6	9.2
18	1	July 18	*169.2*	79.6	92.0	121.6	64.4	27.6
105	27	Sept. 29	57.2	19.2	*168.0*	51.6	23.2	17.6
165	42	July 28	14.0	*166.4*	116.0	73.2	52.4	33.6
16	1	July 18	*165.2*	134.0	122.8	90.0	68.4	31.6
140	35	Sept. 28	21.6	66.8	*164.8*	157.2	70.8	39.2
165	42	Oct. 14	*162.4*	125.6	32.0	22.0	19.6	8.4
28	1	July 18	*160.4*	138.4	102.4	140.4	55.2	35.2
26	1	July 19	110.4	*158.4*	142.4	104.4	54.4	27.2

days, they were greater than 200 per 1000 of the regimental strength. Table 17 shows the regimental daily combat casualty rates greater than 150 per 1000 of the regimental strength, and it also shows the more important loss rates on five other days, either immediately preceding or following each maximal casualty day; i.e., on six consecutive days.

d. *Estimated combat requirements.* — After considering such daily rates as above it would apparently be expedient to make provision for a 15% casualty day for an infantry regiment in severe combat, with the following distribution of the total casualties:

Killed in action 2.4%, gunshot wounded 9.6%, gas wounded 3%.

44. **Casualties by arms of service.** — In the American Expeditionary Forces the casualty rate for the infantry was much greater than those for the other branches. The following table shows the relative standing of the casualty rates, infantry being taken as 100.[2]

Infantry	100.00
Machine Gun	70.12
Signal Corps	16.46
Tank Corps	15.85
Artillery	11.58
Engineers	9.15
Medical Department	8.54
Quartermaster Department	3.05
Cavalry	3.05
Ordnance	1.83
Aviation	1.83

45. **Infantry Divisions.** — a. *Frequency of casualty rates.* — The summation curve, Fig. 70, shows how often during this experience casualty rates in Infantry Divisions greater or less than any specified one occurred. Thus in 98.80% of the infantry divisional combat days in question, the loss was 50 per 1000 or less of division strength, and in 1.2% (100.0% — 98.8%) of the days it was greater.

A casualty rate between 40 and 50 per 1000 of the divisional strength occurred in 1.28% (98.80% — 97.52%) of the battle days.

b. *Average casualty day.* — The average divisional casualty rate for all of the combat days in line in question was 9.61 per 1000, or slightly less than 1%.

c. *Maximal casualty day.* — Fig. 71, shows the divisional battle days with casualty rates greater than 60.0 per 1000, of the divisional strength. The graph also shows what part of the divisional casualty rate occurred in each of its component regiments, both in line and in reserve. The regimental rates are based here upon the divisional strength, so that the sum of the several component rates are equal to the divisional one.

The following table shows the more important loss rates on five days either immediately preceding or following each maximal one; i.e., on six consecutive days.

Table 18. — Maximal infantry divisional casualty day rates per 1000 men with the five next highest ones on days immediately preceding or following: i. e., the rates are shown for six consecutive days.

Division	Date of highest casualty rate	Daily casualty rates per 1000 divisional strength.					
27	Sept. 29	5.2	35.7	13.0	*105.6*	31.7	14.2
1	Oct. 4	*84.2*	51.0	30.0	12.7	14.9	41.9
30	Sept. 29	8.6	4.5	4.1	*77.8*	25.3	10.9
1	July 18	*74.8*	62.2	58.9	58.7	33.3	16.4
5	Oct. 14	15.8	12.5	*65.0*	30.4	15.5	7.4

d. *Estimated combat requirements.* — Since a casualty day of approximately 6% or greater occured not infrequently in Divisions in severe combat, it would apparently be expedient to make provision for a 6% casualty day for infantry divisions in severe combat with the following distribution: Killed in action, 0.96%, gunshot wounded 3.84% and gas wounded 1.20%.

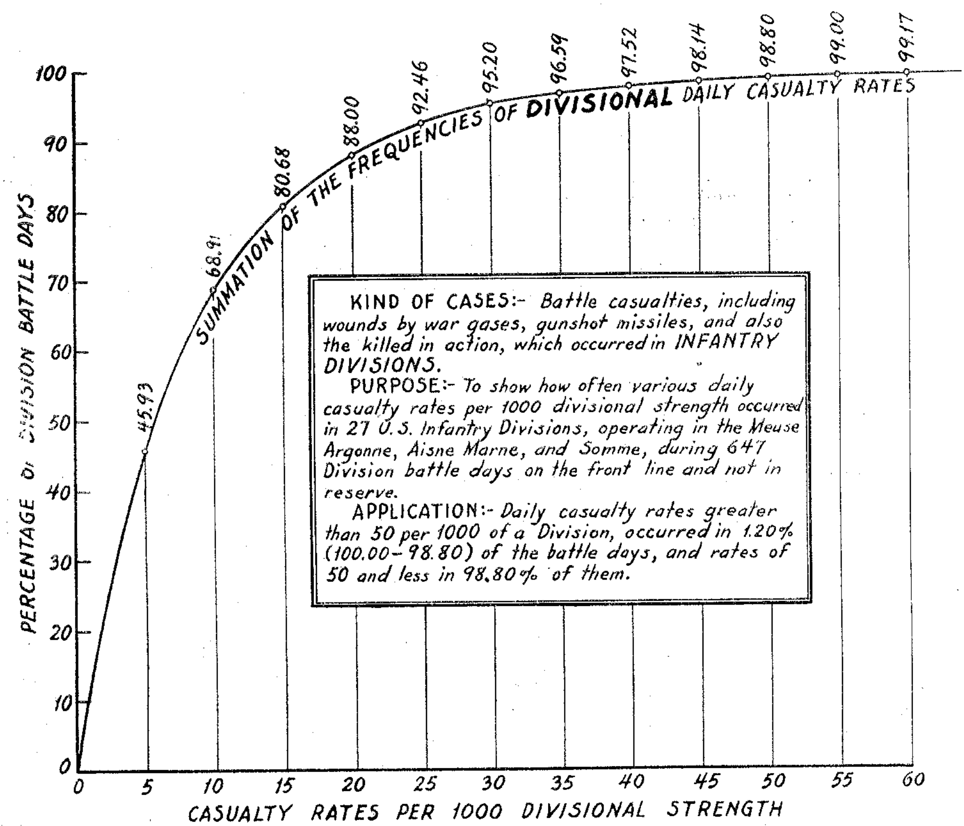


Fig. 70.—Summation curve showing how often various divisional daily casualty rates occurred during major operations in the American Expeditionary Forces in 1918.[3]

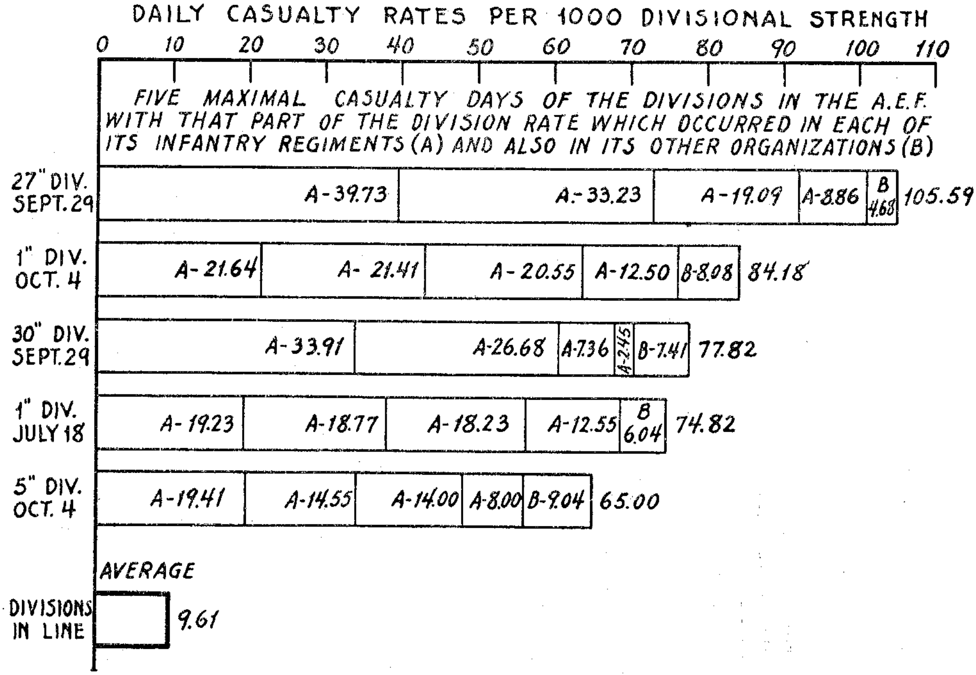


Fig. 71.—The daily casualty rates on the five maximal casualty days for divisions (not including the 2nd) in line (not in reserve) in the First American Army during the Meuse-Argonne and selected divisions in the Aisne-Marne and Somme Offensives; also the average daily casualty rate for the divisions during those engagements.[8]

NOTE: The above rates for the component regiments of the divisions are based upon the divisional strength (22,000) and are consequently only 11.36% of those in Table 17 for the infantry regiments which are computed upon the regimental strength (2,500).

46. **Army Corps.** — a. *Frequency of casualty rates.* — The summation curve, Fig. 72, shows how often casualty rates in Army Corps greater or less than any certain one occurred during the Meuse-Argonne offensive. As stated on the graph, casualty rates greater than 20 per 1000 of corps strength, occurred in 1.95% (100% — 98.05%) of the battle days; and that rate or less in 98.05% of the combat days. Casualty rates between 15 and 20 per 1000 of the Corps strength occurred in 1.97% (98.05% — 96.08%) of the battle days.

b. *Maximal rates in each Corps.* — Fig. 73 shows the maximal rate which occurred in each Corps, and also the average for each one during the period of the Meuse-Argonne offensive. The graph also shows what part of the corps rate occurred in each of its component divisions, the latter rates being based upon corps strength. It is apparent that in each instance the greater part of the maximal rate occurred in one division. If two divisions in line had been engaged in equally severe combat, the total corps maximal rate would have been nearer 30 than approximately 20 per 1000 corps strength.

The following table shows the maximal casualty days for the Corps in question, and also the more important loss rates on four days immediately preceding or following each such day; i. e., on five consecutive days.

Table 19. — Maximal daily casualty rates in the Corps of the First American Army during the Meuse-Argonne offensive with the four next highest rates on either immediately preceding or following days; i. e., on five consecutive days.

Corps	Date of highest casualty rate	Daily casualty rates per 1000 corps strength.				
III	Oct. 14	*21.32*	13.34	8.10	4.36	4.50
I	Oct. 4	10.11	7.46	*21.22*	14.70	8.32
V	Oct. 14	*20.63*	12.76	7.14	3.59	3.07
V	Sept. 29	15.32	*20.52*	13.77	7.89	4.42
I	Sept. 28	13.30	*16.10*	15.27	6.37	12.32
V	Oct. 9	*15.32*	10.48	8.17	4.65	3.59

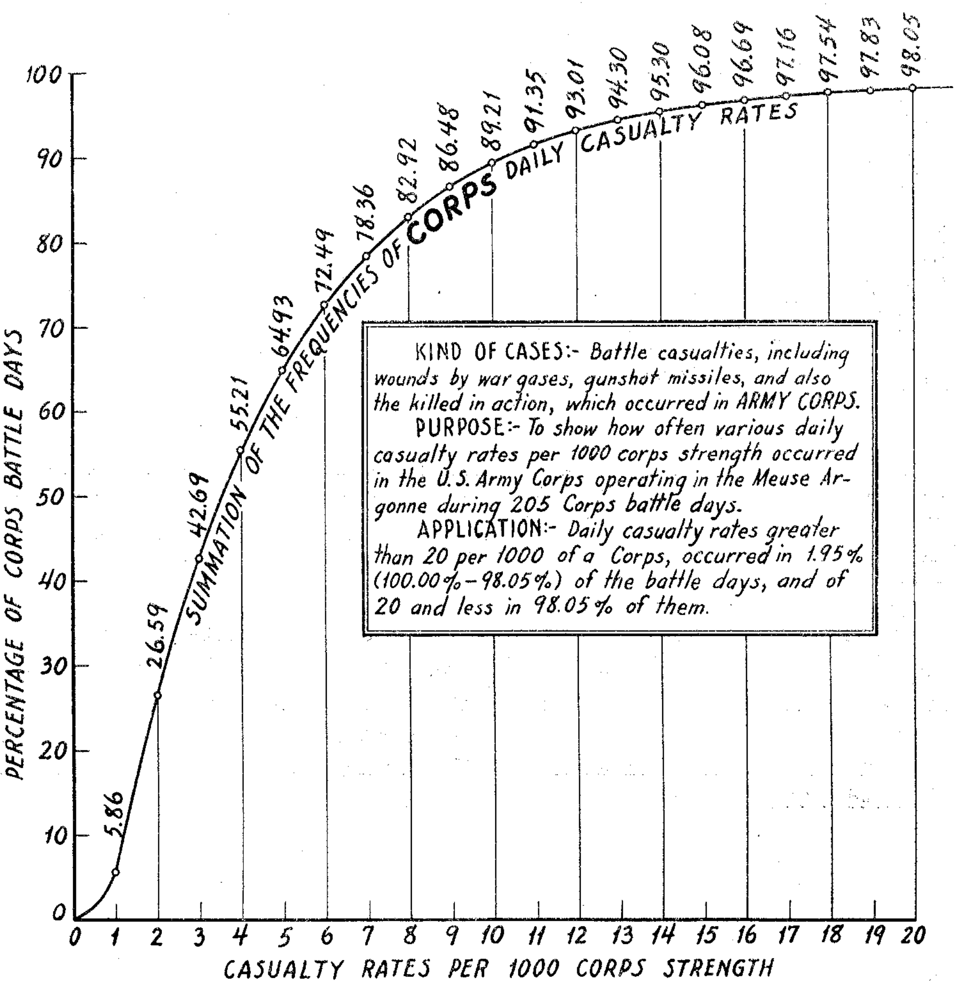


Fig. 72.—Summation curve showing how often various Corps daily casualty rates occurred in the five Corps of the First American Army, including the divisions with the French as a Corps, during the Meuse-Argonne Operation, Sept. 26 to Nov. 11, 1918. [3]

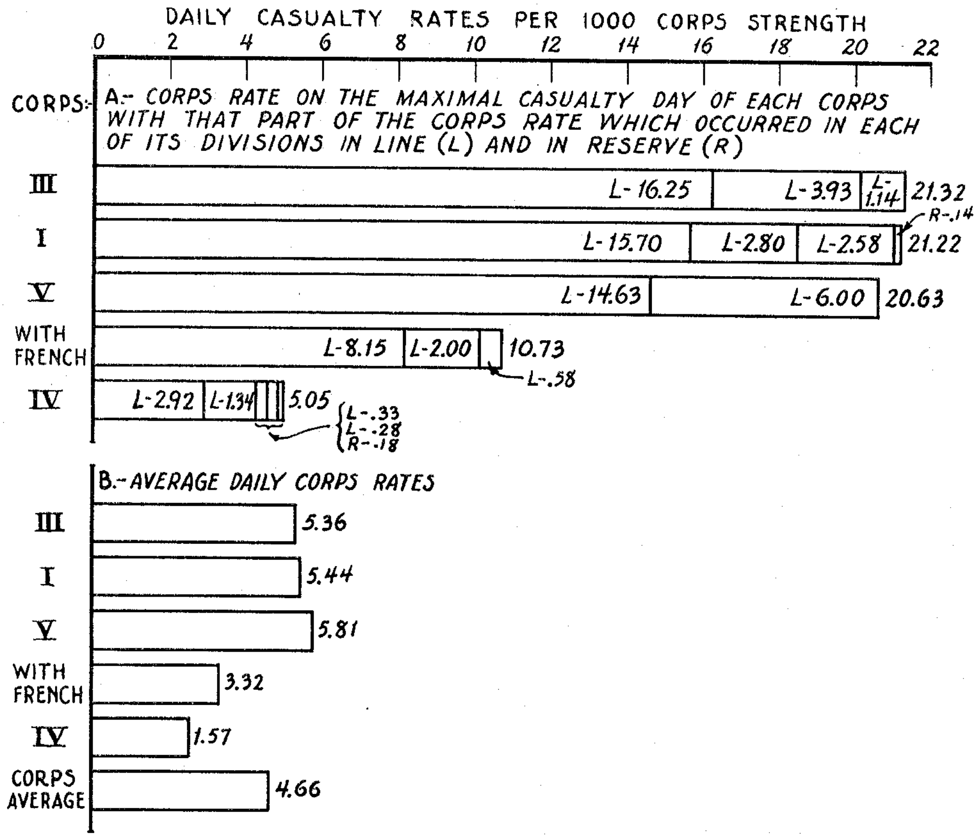


Fig. 73.—The maximal daily casualty rate for each Corps of the First American Army during the Meuse-Argonne Sept. 26 to Nov. 11, 1918, and also the average rate for each one during the entire period. [3]

NOTE: The above rates for the component divisions of the Corps are based upon the Corps strength on the specified dates and are consequently less than those shown in Table 18 for the divisions, which are computed upon the divisional strength.

c. *Estimated combat requirements.* — If an estimate is based then upon the American Expeditionary Forces experience modified as suggested above it would apparently be expedient to make provisions for a 3% casualty day for Army Corps when engaged in severe combat, with the following distribution: Killed in action 0.48%, gunshot wounded 1.92%, and gas wounded 0.60%.

47. **First American Army.** — a. *Frequency of casualty rates.* — The summation curve, Fig. 74, shows how often casualty rates, greater or less than a certain one occurred in the First American Army during the Meuse-Argonne offensive. The lowest daily casualty rate recorded was 1.05 per 1000 Army strength, and the highest, 7.75 per 1000.

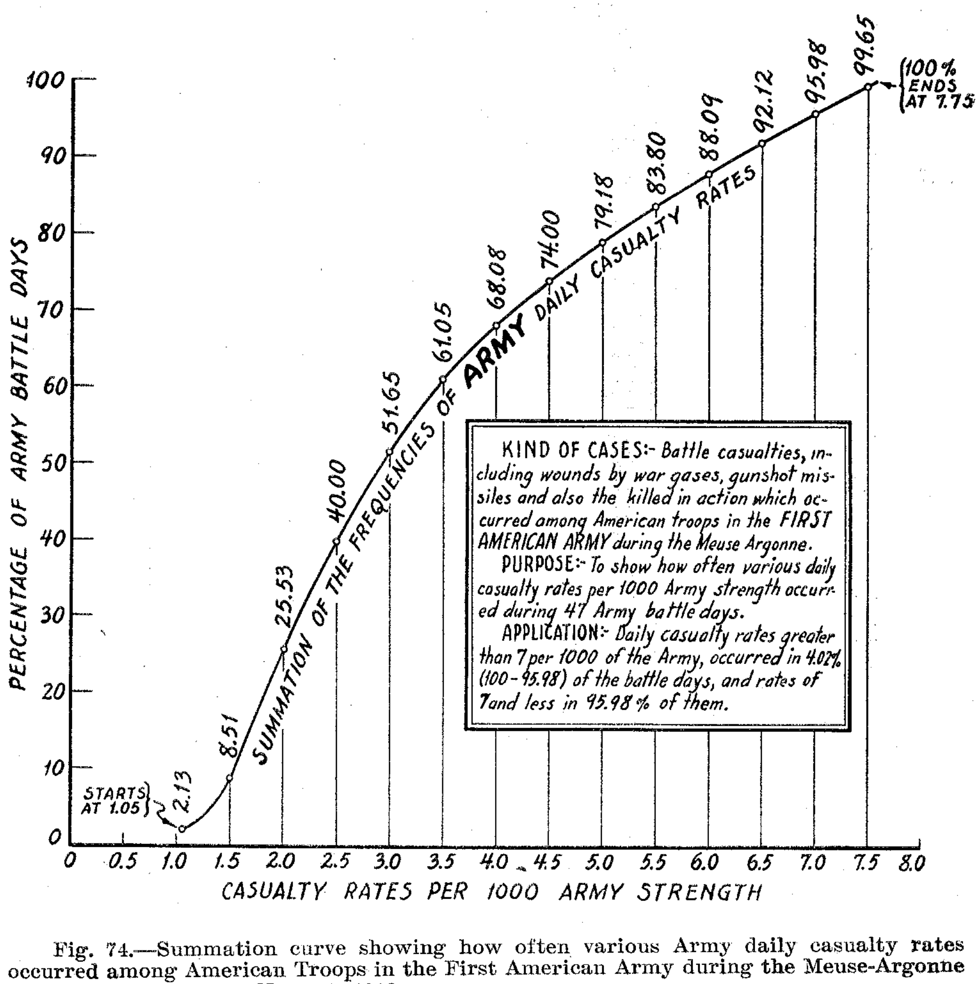


Fig. 74.—Summation curve showing how often various Army daily casualty rates occurred among American Troops in the First American Army during the Meuse-Argonne Operation, Sept. 26 to Nov. 11, 1918.

b. *Daily casualty rates.* — The following table shows the Army casualty rates for each day during the operations:

Table 20. — Casualty rates for the First American Army on each day during the Meuse-Argonne Offensive.

Date	Rate per 1000	Date	Rate per 1000
Sept. 26	5.40	Oct. 20	2.07
27	4.67	21	2.27
28	6.26	22	1.67
29	6.85	23	2.48
30	4.34	24	2.19
Oct. 1	4.17	25	2.05
2	2.84	26	1.56
3	2.61	27	1.80
4	7.15	28	1.63
5	5.41	29	1.05
6	3.72	30	1.20
7	2.68	31	1.50
8	3.56	Nov. 1	5.93
9	4.95	2	2.54
10	4.78	3	2.28
11	4.04	4	3.51
12	3.75	5	2.50
13	3.65	6	1.98
14	7.75	7	1.80
15	7.17	8	1.19
16	5.46	9	1.37
17	3.82	10	2.68
18	3.63	11	2.19
19	1.93		

c. *Maximal casualty rates.* — Fig. 75 and Table 21 shows the maximal Army rates, with the part which occurred in each corps, based upon Army and not Corps strength.

Table 21.—Maximal daily casualty rates per 1000 strength in the First American Army during the Meuse-Argonne offensive.

Date	I Corps	III Corps	IV Corps	V Corps	American Divisions with the French	Army Re-serve.	First Army
Oct. 14	1.57	3.26	*	2.12	.54	.26	7.75
Oct. 15	1.76	2.15	*	2.04	1.06	.16	7.17
Oct. 4	3.22	1.36	.54	1.73	.16	.14	7.15
Sept. 29	2.33	.86	.37	3.13	.10	.06	6.85
Sept. 28	2.50	.83	.41	2.38	.08	.06	6.26

* Not a part of the First Army on this date.

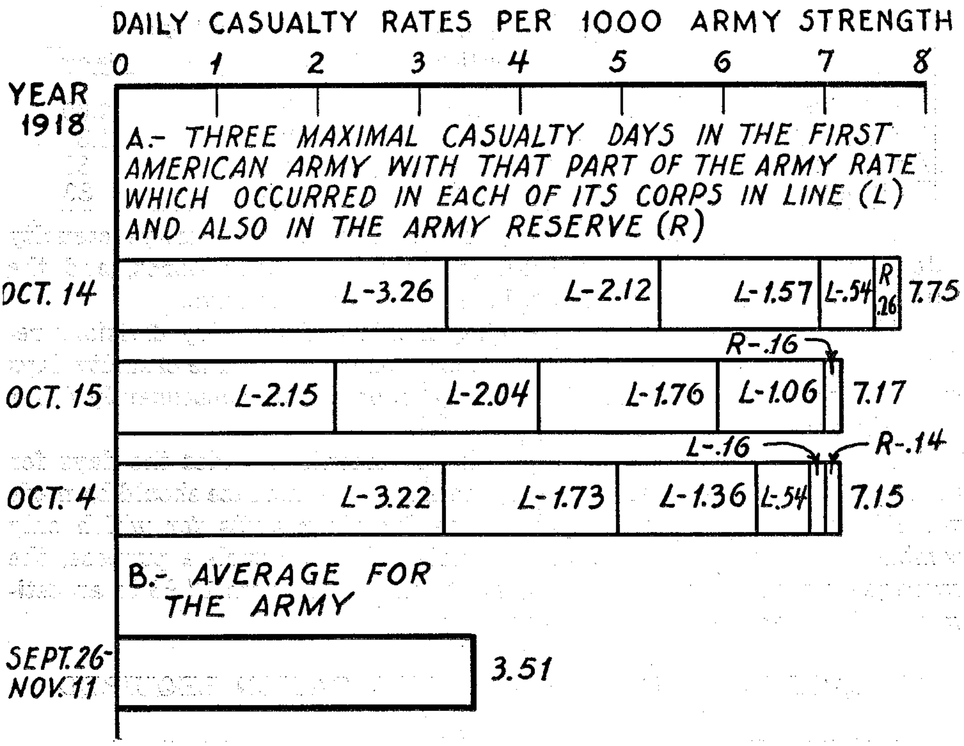


Fig. 75.—The daily casualty rates on the three maximal casualty days for the First American Army in the Meuse-Argonne Sept. 26 to Nov. 11, and also the average daily casualty rate during the same period.

The above rates for the component Corps of the Army are based upon the army strength on the specified dates and are consequently less than those shown in Table 19 for the Corps, which are based upon the Corps strength on the same date.

d. *Estimated combat requirements.* — On each maximal casualty day, the greater part of the casualties occurred in two Corps out of a total of four or five. If the Corps in line had been equally engaged, the Army maximal rate would have been nearer 15.00 per 1000 than 7.75. If an estimate then is based upon the American Expeditionary Forces experience as modified, it would seem to be expedient to provide for a 1.5% casualty day for a Field Army when engaged in severe combat with the following distribution of the casualties: Killed in action 0.24%, gunshot wounded 0.96%, gas wounded .30%.

48. **Summary.** — a. *Estimated combat requirements.* — The following table gives a summary of the daily casualty rates as suggested above, under discussion of each unit, to be used as a basis for estimating the requirement for medical personnel and equipment on severe combat days.

Table 22. — Casualty rates per 100 (%) of unit strength suggested as a basis for estimating the necessary medical relief on severe combat days, as determined by the American Expeditionary Forces experience.

	Total Casualties	Killed in action	Wounded by:	
			Gunshot missiles	Gasses
Inf. Regiment	15.0	2.40	9.60	3.00
Inf. Division	6.0	.96	3.84	1.20
Army Corps	3.0	.48	1.92	.60
Field Army	1.5	.24	.96	.30

b. *Average casualty rates.* — Fig. 76 shows the average casualty rates for infantry regiments, infantry divisions, Army Corps, and the First American Army during the Meuse-Argonne offensive.

The average rates for infantry regiments and infantry divisions referred to under the discussion of those organizations include casualty days in engagements other than in the Meuse-Argonne, and consequently differ from the ones shown here.

Since the average rate for infantry regiments includes the days for the regiments in divisional reserve some estimated increase should be made when their rate is compared with those for other units for which only combat days are included. It is suggested that for such a purpose, the average daily regimental casualty rate be increased from 17.96 to an estimated 20.00 per 1000 regimental strength.

O. BATTLE CASUALTIES—TRANSPORTATION REQUIRED.

It is difficult to secure accurate information in regard to the character of transportation required for battle casualties. During or after a severe combat day there will seldom if ever be enough litter bearers to carry all of the gassed and gunshot wounded to the Collecting Station, even if such was desirable. Consequently a certain number of the less severely gassed or gunshot wounded must walk to advanced relief stations. After the Collecting Station is reached, the more severely wounded must be transported as "Recumbent", while the less severely wounded can be carried as "Sitters".

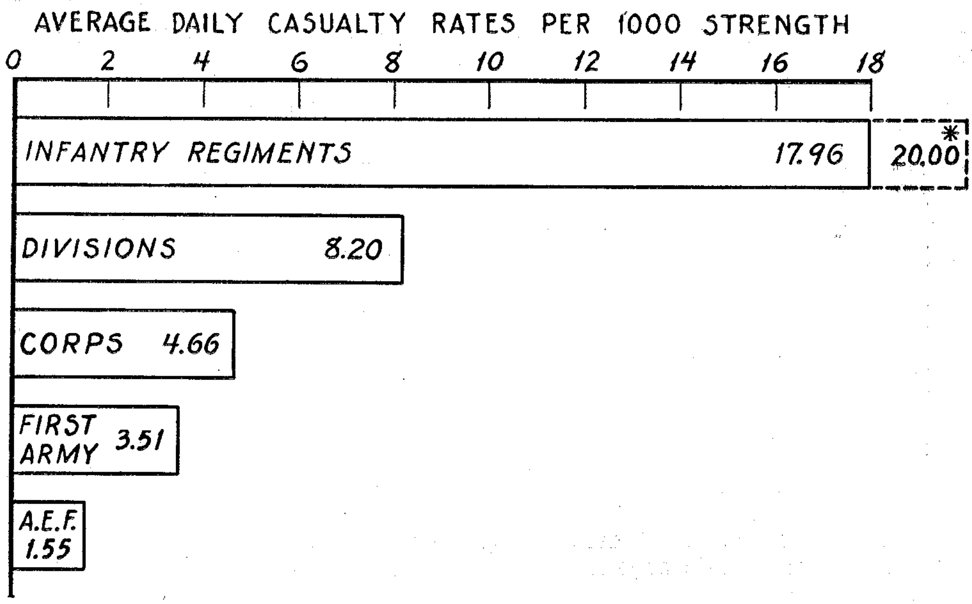


Fig. 76.—Average daily casualty rates per 1000 strength, for the period from Sept. 26 to Nov. 11, 1918, inc., for the total American Expeditionary Forces, First American Army, corps of the First American Army, divisions in line (not in reserve) of the First American Army, and infantry regiments of all divisions in line (including those in divisional reserve).

*This rate (20.00) estimated for infantry regiments in combat only.

The following data, which have been assembled from the medical records of the American Expeditionary Forces, may be of some assistance in arriving at an approximate estimate of the problem.

49. **Gunshot wounded.** — a. *Location.* — It is suggested that the location of the gunshot wound, varied as the available information suggests, be used as a general index of the gravity of the wound and of the transportation required. Wounds of the soft tissue of the extremities when associated with extensive destruction of tissue, hemorrhage, shock, etc., are obviously more serious than fractures of the corresponding long bones associated with little destruction of tissue. Probably, however, the deaths which occurred in such cases can be used as an indication of the proportion of the wounds of relatively unimportant tissues which are very severe.

When a soldier had two or more wounds, the preference is given in the following tables to the location associated with the highest average fatality rate. The table shows how often wounds involving various tissues occurred, and also the fatality rate for each group. Wounds involving the abdominal or pelvic organs occurred in 11.07 per 1000 cases, with a fatality rate of 66.80%; while those of the soft tissues of the lower extremity (not involving important blood vessels or nerves) occurred in 333.86 per 1000 wounds, with a fatality of 6.09%. Apparently then it may be said with safety that a patient of the latter class was a much less serious transportation problem than one of the first named group.

Table 23. — Location of battle gunshot wounds in the American Expeditionary Forces with rates per 1000 total cases; and percentage fatality rate of each location.[16]

Location of wound	Frequency per 1000	Fatality rate in percentage
Soft tissues, lower extremity	333.86	6.09
Soft tissues, upper extremity	198.61	4.27
Bones of wrist and hand*	118.23	1.47
Long bones and joints, lower extremity*	70.52	17.53
Soft tissues of face and head	59.19	2.31
Metatarsus and toes*	51.96	2.56
Clavicle, humerus and scapula*	32.74	9.46
Other long bones of the upper extremity*	30.24	4.39
Cranial bones and brain	20.46	37.11
Bones of the ankle	13.83	2.56
Important blood vessels & nerves, upper extremity	13.36	7.11
Abdominal and pelvic organs	11.07	66.80
Thoracic organs	10.52	47.68
Bones of the face*	10.24	8.45
Muscles of neck, chest, abdomen and back	5.95	21.49
Genital organs	4.86	8.65
Bones of pelvis*	4.22	26.98
Spinal cord and vertebra	3.64	55.85
Important blood vessels and nerves, lower extremity	3.33	11.90
Important organs and blood vessels of the neck	3.16	11.39

* Fractures.

The fatality rate from artillery wounds was 7.03% and from small arms 4.82%.[16]

Artillery missiles caused 70% of the gunshot wounds among American troops during the World War as compared with 10% among the Union troops during the Civil War.[2]

The following table shows that the general location of the gunshot wounds was very much the same during the two wars.[2]

General location of gunshot wounds	*Percentage*	
	Civil War	*World War*
Head	11	13
Trunk	18	14
Upper extremity	36	32
Lower extremity	35	40

Table 24. — **Estimation of evacuation requirements for patients wounded by gunshot missiles. Number in each 1000 total wounded.**

Location of Wound	To Collecting Station			To Hospital Station			To Evacuation Hospital			
	Littered Expected to:		Walking	Recumbent Expected to:		Sitting	Recumbent Expected to:**			Sitting
								Recover		
	Die	Recover		Die	Recover		Die	Severe	Others	
Soft tissues, lower extremity	23.71	210.15	100.00	23.71	210.15	100.00	23.71	—	210.15	100.00
Soft tissues, upper extremity	8.48	63.38	126.76	8.48	63.38	126.76	8.48	—	63.38	126.76
Bones of wrist and hand*	1.74	—	116.50	1.74	—	116.50	1.74	—	—	116.50
Long bones and joints, lower ex.*	12.36	58.16	—	12.36	58.16	—	12.36	5.00	53.16	—
Soft tissues, face and head	1.36	—	57.83	1.36	—	57.83	1.36	—	—	57.83
Metatarsus and toes*	1.33	50.63	—	1.33	—	50.63	1.33	—	—	50.63
Clavicle, humerus, & scapula*	3.10	29.64	—	3.10	29.64	—	3.10	—	29.64	—
Other long bones, upper ex.*	1.33	—	28.91	1.33	—	28.91	1.33	—	—	28.91
Cranial bones and brain	7.59	12.87	—	7.59	12.87	—	7.59	12.87	—	—
Bones of ankle*	.35	13.47	—	.35	13.47	—	.35	—	13.47	—
Important blood vessels and nerves, upper extremity	.95	12.41	—	.95	12.41	—	.95	6.00	6.41	—
Abdominal and pelvic organs	7.39	3.67	—	7.39	3.67	—	7.39	3.67	—	—
Thoracic organs	5.02	5.50	—	5.02	5.50	—	5.02	5.50	—	—
Bones of the face*	.87	3.13	6.25	.87	3.13	6.25	.87	—	3.13	6.25
Muscles of neck, chest, abdomen, and back	1.28	4.67	—	1.28	4.67	—	1.28	—	4.67	—
Genital organs	.42	4.44	—	.42	4.44	—	.42	—	4.44	—
Bones of the pelvis*	1.14	3.08	—	1.14	3.08	—	1.14	—	3.08	—
Vertebra* and spinal cord	2.04	1.61	—	2.04	1.61	—	2.04	1.61	—	—
Important blood vessels and nerves, lower extremity	.40	2.93	—	.40	2.93	—	.40	2.93	—	—
Important organs and blood vessels of the neck	.36	2.80	—	.36	2.80	—	.36	2.80	—	—
TOTAL	81.22	482.53	436.25	81.22	431.91	486.88	81.22	40.38	391.53	486.88

*Fractures. ** No attempt is made here to determine the proportion of nontransportable cases.

b. *Transportation.* — In Table 24 all cases which ultimately died are listed as "Littered", or "Recumbent"; and the remainder, that is, the cases which recovered, as "Littered" and "Recumbent", or as "Walkers" and "Sitters," according to the location of the wounds. The division of the recovery cases into the "Littered" and "Recumbent" and "Walkers" and "Sitters", such as in the case of those involving the soft tissues of the lower extremity, was based upon the location and fatality rate of the group.

50. **Gunshot and Gas Wounded.** — The medical records show the number of fatalities from war gases (1.73%) but no other information which may be used as a basis in estimating the transportation requirements. Consequently any such estimate must be based upon general experience and supposition.

Table 25. — Estimation of evacuation requirements for patients wounded by war gases and gunshot missiles, separately and combined; rates per 1000 cases.

(a) To Coll. Station	Littered			Walking	Grand Total
	Fatal	Recovery	Total		
Gas	17.30	182.71	200.00	800.00	1000.00
Gunshot	8.22	482.53	563.75	436.25	1000.00
Total	65.24	407.57	472.81	527.19	1000.00

(b) To Hospital Station	Recumbent			Sitting	Grand Total
	Fatal	Recovery	Total		
Gas	17.30	182.70	200.00	800.00	1000.00
Gunshot	81.22	431.91	513.13	486.88	1000.00
Total	65.24	369.61	434.85	565.16	1000.00

(c) To Evacuation Hospital	Recumbent				Sitting	Grand Total
	Fatal	Recovery severe	Recovery others	Total		
Gas	17.30		182.70	200.00	800.00	1000.00
Gunshot	81.22	40.38	391.53	513.13	486.88	1000.00
Total	65.24	30.29	339.32	434.85	565.16	1000.00

Note: The above totals are calculated by multiplying the rates from the gunshot wounded by three, the ones from war gases by one, adding the results, and dividing the sum by four. This procedure is based upon the assumption that in severe combat war gases cause 25% and gunshot missiles 75% of the total wounded. (As calculated from Fig. 68, it would be 23.81% and 76.19%).

In the table above the data in regard to gunshot wounds are from Table 24, but those for the war gas wounds are as stated.

According to Table 25, 47% of ehe wounded would be littered to the Collecting Station and 53% could walk; 43% would be transported to the Hospital stations as "Recumbent" and 57% as "Sitters"; and to the Evacuation Hospital, 43% again would be transported as "Recumbent" and 57% as "Sitters."

Colonel Alexander N. Stark, who was Chief Surgeon of the First American Army, American Expeditionary Forces, says in his report of the Meuse-Argonne offensive, that 42% of the patients evacuated were carried "Prone" and 58% as "Sitters". He includes in his total, however, the sick as well as wounded.[2]

P. BATTLE CASUALTIES — DISPOSITION OF CASES IN THE COMBAT AREA.

The experience in the American Expeditionary Forces may be helpful in forming an approximate estimate of the relative number of the sick and wounded to be evacuated from the Combat Area. When considering this phase of the problem, the patients may be divided into two groups: (a) Long duration cases, and (b) short duration cases. The first group will require evacuation to the base and general hospitals, and second may be hospitalized somewhere within the Army Area.

The time limit for the latter group will depend to some extent upon the existing conditions. It is subdivided into: (a) cases that return to duty, and (b) those that die within a few days.

As stated elsewhere, the medical records from the American Expeditionary Forces show the duration of treatment both of cases that recovered and those that died. The value of this information is reduced materially because: (a)Patients in some instances were retained for treatment in the Combat Area, and no records were made for them; and (b) trivial cases, which were sent to the base hospital, lost unnecessary time.

51. **Percentage of short duration cases.*** — The following table shows the percentage of patients which: (a) Returned to duty, or (b) died during the first 10 days, treatment in hospital.

*The method of computing the data in this section is explained on pages 140 to 143.

Table 26. — Percentage of short duration cases, as reported in the American Expeditionary Forces, leaving hospital each day from the first to the tenth.

Day of treatment	Percentage leaving hospital by return to duty or death by the end of each day.					
	Duty§			Death‡		
	Sick†	Gassed	Gunshot wounded	Sick†	Gassed	Gunshot wounded
1	5.35	1.97	.10	.06	.18	1.43
2	10.25	3.95	.33	.11	.34	2.57
3	14.75	5.94	.66	.16	.48	3.47
4	18.91	7.94	1.09	.21	.60	4.20
5	22.74	9.94	1.60	.25	.71	4.78
6	26.28	11.94	2.20	.29	.81	5.24
7	29.56	13.92	2.86	.32	.90	5.61
8	32.60	15.89	3.59	.35	.97	5.91
9	35.42	17.84	4.37	.38	1.04	6.16
10	38.05	19.77	5.20	.40	1.10	6.36

†Diseases and nonbattle injuries.
§From Figs. 90, 91, and 92.
‡These data are 0.78%, 1.73%, and 8.12% of the sick, gassed, and gunshot wounded respectively of those in Table 30.

The maximal day of treatment shows the longest time of treatment, but the group includes all those of shorter duration. Thus, the maximal 5 days group includes cases leaving hospital at any time up to the end of the fifth day. Of the cases of diseases and nonbattle injury sent to hospital in the American Expeditionary Forces, 22.74% returned to duty in 5 days or less, and .25% died; while of the gunshot cases, 5.20% returned to duty in 10 days or less, and, and 6.36% died, etc.

If all duty cases requiring treatment for four days or less are retained within the Division area, 18.91% of the sick, 7.94% of the gassed, and 1.09 % of the gunshot wounded will be so held. Further, if duty cases requiring treatment from 5 to 10 days are hospitalized within the Corps or Army Area, the group will consist of 19.14% (38.05% — 18.91%) of the sick, 11.83% (19.77% — 7.94%) of the gassed cases, and 4.11% (5.20% — 1.09%) of the gunshot cases. Obviously the selection of sick cases whose treatment will require a maximum of 4 days, 10 days etc., must depend upon the judgment of those selecting the cases.

The percentages can be applied to any casualty day for any unit. Assume a Division of 20,000 men with a daily casualty rate of 60 per 1000 men, and with a daily sick rate of 4.20 per 1000. Then there will be:

Casualties		1200
Killed (16%)	192	
Gassed (20%)	240	
Gunshot wounded (64%)	768	
Sick		84

Assume further that all cases returning to duty in 10 days or less, and that all cases dying within 5 days or less are held within the Army Area. Then each day the number so held and evacuated from the above group will be:

	Total (a)	Duty in 10 days or less (b)	Death in 5 days or less (c)	Evacuated (a)—[(b)+(c)]
Sick	84	31.96	.21	51.83
Gassed	240	47.45	1.70	190.85
Gunshot wounded	768	39.94	36.63	691.43
Total	1092	119.35	38.54	934.11

Nontransportable cases held within the front area will reduce still further, at least temporarily, the number to be evacuated.

52. **Hospitalization of short duration cases.** — a. *Accumulation in hospital to the end of any period of cases returned to duty or dying during that length of time.* — The data in Table 27 from the Amercian Expeditionary Forces records shows how short duration duty and death cases accumulate when the number of days of treatment varies from 1 to 5, 1 to 8, 1 to 10, etc. The table is based upon the same assumption as elsewhere in considering hospital populations; that is, that there is an average daily admission rate during the periods with a definite number going out each day. It answers question such as; "After six combat days by an infantry division with an average daily admission rate from diseases and nonbattle injuries of 4.20 per 1000, and from casualties of 50 per 1000 how many duty and death cases of six day or less duration will there be?" Since Table 27 is based upon an average daily admission rate of 1.00. the daily number of sick and wounded must first be determined.

	Rate per 1000	Strength	One-day cases	Six-day cases
Disease & nonbattle injuries	4.20	20,000	84	504
Casualties	50.00	20,000	1,000	6,000
Killed (16%)			160	960
Gassed (20%)			200	1,200
Gunshot wounded (64%)			640	3,840

Table 27 shows how short duration cases accumulate in hospital.

Table 27.—The accumulation in hospital to any day from the first to the tenth of patients who will return to duty or die on that day or before. Admission rate from each cause is 1.00 per day.

Maximal day of treatment‡	Duty*			Expected deaths†		
	Sick§	Gassed	Gunshot wounded	Sick§	Gassed	Gunshot wounded
1	.05	.02	.001	.001	.002	.002
2	.15	.06	.005	.002	.005	.04
3	.29	.12	.015	.003	.01	.06
4	.45	.20	.03	.005	.01	.09
5	.64	.30	.06	.01	.02	.12
6	.86	.42	.09	.01	.03	.15
7	1.09	.56	.14	.01	.03	.18
8	1.33	.71	.20	.01	.04	.20
9	1.58	.89	.27	.02	.04	.22
10	1.84	1.09	.35	.02	.05	.24

*Computed from data in Tables 26 and 32, as per par. 58 a, p. 141.
†Computed from data in Tables 30 and 32, as per par. 58 a, and 58 b, page 141.
‡ Also day of death or duty. § Diseases and nonbattle injuries.

Then in reply to the above question, the accumulation of the 6-day or less cases in hospitals, which must be based upon each day's admissions, would be:

	Duty cases		Death cases		Total
Sick	(84 x .86)	72.24	(84 x .01)	.84	73.08
Gassed	(200 x .42)	84.00	(200 x .03)	6.00	90.00
Gunshot wounded	(640 x .09)	57.60	(640 x .15)	96.00	153.60
Total		213.84		102.84	316.68

The total 6-day or less cases during the six days of treatment in the front area, and the ones to be evacuated which must be based upon the total for six days, would be:

	Total in six days (a)	Duty in 6 days or less (b)		Death in 6 days or less (c)		**Evac. in six days (a)—[(b) +(c)]**
Sick	504	(26.28%)	132.45	(0.29%)	1.46	370.09
Gassed	1200	(11.94%)	143.28	(0.81%)	9.72	1047.00
Gunshot wounded	3840	(2.20%)	84.48	(5.24%)	201.22	3554.30
Total	5544		360.21		212.40	4971.39

At the close then of the six combat days with the admission rates as specified, the account of a division of 20,000 men for the sick and wounded combined would be:

Total to be accounted for (6504 — 960)		5544.00
Evacuated		4971.39
One to six-day cases in hospital in Army Area		316.68
Duty cases	213.84	
Death cases	102.84	
One to six-day cases which have left hospital		255.93
Duty cases (360.21 — 213.84)	146.37	
Death cases (212.40 — 102.84)	109.56	

b. *Accumulation in hospital to the end of any period of cases returning to duty or dying during that length of time*:—But the above question may be worded as follows, "After six combat days by an infantry division of 20,000 men with an average daily admission rate from diseases and nonbattle injuries of 4.20 per 1000 and from casualties of 50 per 1000, how many duty and death cases of 10 days or less duration will there be?" Obviously since the duration here is 10 days or less instead of 6 or less, there will be more cases retained within the Army Area. The answer to the question can be computed from the basic data in the following table.

Table 28.—The accumulation in hospital to any day from the first to the tenth of patients who will return to duty or die on the tenth day or before. Admission rate from each cause is 1.00 per day.

Day of duty or death‡	Duty*			Expected deaths†		
	Sick§	Gassed	Gunshot wounded	Sick§	Gassed	Gunshot wounded
1	.38	.20	.05	.004	.01	.06
2	.71	.38	.10	.007	.02	.11
3	.99	.53	.15	.01	.03	.15
4	1.22	.67	.20	.01	.03	.18
5	1.41	.79	.24	.02	.04	.20
6	1.56	.89	.27	.02	.04	.22
7	1.68	.97	.30	.02	.05	.23
8	1.76	1.03	.33	.02	.05	.24
9	1.81	1.07	.34	.02	.05	.24
10	1.84	1.09	.35	.02	.05	.24

*Computed from data in Table 26, by method as per par. 60 and Table 33, p. 143.
†Computed from data in Table 30, by method as per par. 60 and Table 33, p. 143.
‡ The maximal day of treatment is the tenth.
§ Diseases and nonbattle injuries.

Since this table, as the previous one is based upon a daily admission rate of 1.00, the daily number of sick and wounded must first be determined. The table from page 129 is repeated here.

	Rate per 1000	Strength	One-day cases	Six-day cases
Diseases and nonbattle injuries. (Sick)	4.20	20,000	84	504
Casualties	50.00	20,000	1000	6000
Killed (16%)			160	960
Gassed (20%)			200	1200
Gunshot wounded (64%)			640	3840

Then the accumulation in hospital in six days of 1 to 10 day cases, based upon each days admissions, would be:

	Duty cases		Death cases		Total
Sick	(84 x 1.56)	131.04	(84 x .02)	1.68	132.72
Gassed	(200 x .89)	178.00	(200 x .04)	8.00	186.00
Gunshot wounded	(640 x .27)	172.80	(640 x .22)	140.80	313.60
Total		481.84		150.48	632.32

The total 1 to 10 day cases during six days treated in the front area, and the ones to be evacuated, based upon the total for six days, would be:

	Total in six days (a)	Duty in 10 days or less (b)		Deaths in 10 days or less (c)		Evacuated in six days (a) —[(b)+(c)]
Sick	504	(38.05%)	191.77	(.40%)	2.02	310.21
Gassed	1200	(19.77%)	237.24	(1.10%)	13.20	949.56
Gunshot wounded	3840	(5.20%)	199.68	(6.36%)	244.22	3396.10
	5544		628.69		259.44	4655.87

At the close then of the sixth combat day with the admission rates as specified and with the 1 to 10 day cases treated in the front area, the account of a division of 20,000 men for the sick and wounded combined would be:

Total to be accounted for (6504 — 960)			5544.00
Evacuated			4655.87
One to ten day cases in hospital in Army Area			632.32
Duty cases		481.84	
Death cases		150.48	
One to ten day cases which have left hospital			255.81
Duty cases	(628.69 — 481.84)	146.85	
Death cases	(259.44 — 150.48)	108.96	

SECTION II*

IV. EXPLANATORY NOTES AND DEVELOPMENT OF FORMULAE.

Q. EXPLANATORY NOTES.

The basic data and material used in this study are from the sources stated in the reference list. Much of the material is from the unpublished statistical tables and sheets on file in the office of the Surgeon General, which are referred to in the list. New tabulations were made from the statistical cards to show how many cases left sick report during the first seven days, the second seven, etc., during the World War, as follows:

1. All cases wounded by gunshot missiles, and all deaths and disability discharges resulting therefrom.

2. All cases wounded by poisonous gases, and all deaths and disability discharges resulting therefrom.

3. (a) A sample of approximately 150,000 out of about 450,000 disease and nonbattle injury cases in the American Expeditionary Forces during the last six months of 1918. The sample included the same proportion of each diagnosis.

   (b) All of the deaths from diseases and nonbattle injuries in the American Expeditionary Forces during 1918.

4. All deaths and discharges for disability among troops in the United States during 1918.

The task of tabulating a sufficiently large sample of the duty cases in the United States during 1918 was too great a one to be undertaken with the time and personnel available. Similar data were available, however, for the troops in the United States during 1925-1927, and it was assumed that there was no material difference in the duration of treatment of such cases and of similar ones during 1918. Consequently those data available for the 1925-1927 cases were used as 1918 experience with the necessary slight modifications as indicated in Figs. 80 and 82.

In the absence of more exact information, estimates were used in some instances, as noted in the appropriate places. Whenever this was done all available data were checked to test the estimated results.

* **Section II is intended for use by only such as are interested in the technical details in the development of the material in Section I.**

The sources of information, the method of arriving at such estimates as were used, and the changes which were made in the basic data are noted in connection with the various Figures.

R. DEVELOPMENT OF FORMULAE

53. **Patients leaving sick report.** — The data for Figs. 21-64 are largely from formulae. Figs. 79-98 inclusive, show the method of developing them. The basic material as tabulated, shows how many patients of the duty, death, or disability groups left sick report during the first, second, third week, etc. The numbers leaving sick report each week were divided by the total in thousands to reduce each weeks cases to proportional parts per 1000 of the total number.

54. **Graduation of material.** — In some instances attempts were made to fit this basic material to second or third order parabolas and also to Pearsonian curves, but the results were not satisfactory. It soon became apparent that there was a very definite geometrical progression relationship between the groups of cases leaving sick report by time intervals or remaining on it, and that all of the curves were exponential in character. Inspection showed that this type of curve fitted the observed points quite well with only a few exceptions. The apparent failure to fit was due usually to imperfections in, or incompleteness of, the basic material; but in some instances, the necessity of relating the graduated data to those from other curves resulted in the use of a poorer fit than could have been obtained otherwise.

The exponential curve not only best fitted the observed points, but it graduated also satisfactorily the grouped experience beyond the 14th or 20th week; i.e., the limits of the tabulations by weeks.

55. **Patients remaining on sick report.** — During the early stages of this work, the data for leaving hospital, or sick report, were first smoothed by fitting them to an exponential curve; but after a short time it was found that as satisfactory results could be obtained by omitting that step and passing directly from the ungraduated *Leaving* to the ungraduated *Remaining.*

To find the number of patients from an original 1000 remaining sick at the end of the first week, either the graduated, or ungraduated, number leaving was deducted from 1000. From the remainder so obtained, the number leaving during the second week was subtracted to find the number remaining at the end of that time. This process was continued through the 14th, and in some instances through the 20th week. As stated, the number remaining beyond that time was ultimately distributed by the formulae obtained.

The following table shows the general methods of handling the material and the results obtained in this instance.

Table 29.—Number of patients among white enlisted men in the United States, 1925-1927, inclusive, leaving sick report during each week; and also the number remaining on sick report at end of each week.

(1) Weeks	Patients leaving sick report during each week of treatment. (2) Cases	(3) Per 1000 patients Ungraduated	(4) Per 1000 patients Graduated	Patients remaining on sick report at end of each week of treatment. (5) Per 1000 patients From Column (4)	(6) Per 1000 patients Graduated
0	0	0	0	1,000.00	1,000.00
1.	92010	531.61	531.61	468.39	468.39
2.	33293	192.36	186.51	281.88	287.37
3.	15192	87.78	90.05	191.83	191.86
4.	8721	50.39	52.50	139.33	136.78
5.	5723	33.07	33.50	105.83	103.30
6.	3888	22.46	22.46	83.37	81.73
7.	2958	17.09	15.79	67.58	66.89
8.	2009	11.61	11.53	56.05	56.05
9.	1456	8.41	8.74	47.31	47.69
10.	1187	6.86	6.86	40.45	40.97
11.	886	5.12	5.54	34.91	35.41
12.	676	3.91	4.58	30.33	30.72
13.	622	3.59	3.86	26.47	26.71
14.	532	3.07	3.29	23.18	23.25
over 14.	2922	22.66	23.18		
Total	173075	1000.00	1000.00		

56. **Exponential curve.** — a. *One section curve.* — The basic formula of the exponential curve used was

$$y = e^{a+bx}$$

In graduating the Leaving material, Y_l designates the number of patients leaving during each week (x_7) ; and likewise in graduating the Remaining data, Y_r equals the number of patients remaining at the end of each week (x_7). Where x represents a period of one week, or seven days, it is written x_7; and where it represents a five day period, x_5.

The basic ungraduated data were first plotted on arithmetic-logarithmic paper, as is shown by Fig. 79. In some instances where the material was homogenous, as with cases wounded by poisonous gases or by gunshot missiles (See Figs. 87 and 88), a one section curve was sufficient.

b. *Two section curve.* — In another class of cases, such as hospital cases of disease and nonbattle injury patients, certain ones like compound fractures of the femur and pulmonary tuberculosis which required prolonged treatment, were not in the proper proportion to those needing only a few days in hospital to permit of a fit by a one section curve. In such instances there were relatively more short than long duration cases, and a two section curve was required with the general formula

$$y_r = e^{a_1+b_1x_7} + e^{a_2+b_2x_7}$$

The sub 1 and sub 2 appended to the a and b designate the first (1) and second (2) section of the curve (See Fig. 82).

c. *Three section curve.* — In a third class of cases; such as those of patients treated in hospital and quarters in the United States in 1925-1927, the short duration treatment ones, such as the majority of those in quarters, were relatively so much more numerous than the medium and long duration cases, that a three section curve was required with the general formula (See Fig. 80)

$$y_r = e^{a_1+b_1x_7} + e^{a_2+b_2x_7} + e^{a_3+b_3x_7}$$

d. *Plus and minus section curve.* — In a few instances where there was too large a proportion of long duration cases for the short duration ones, it was found necessary to use a two section curve with the second, a minus one.

Here the formula was

$$y_r = e^{a_1+b_1x_7} - e^{a_2+b_2x_7}$$

e. *Method of fitting.* — In fitting the two or three section curves, the second or third section, as the case might be, with the long duration cases and the proper proportion of medium and short duration ones, was fitted first. For this purpose, the observed data were plotted on arithlog paper, and a straight line was drawn through the lower end of the material. The angle of this line was determined by its fit of the observed points in that section, and also by the apparent accuracy of the graduation of the grouped material beyond the end of the available tabulation. This latter point was tested by comparing the total of the graduated and ungraduated material beyond the end of the available tabulation; and also by a careful check against the detail of the basic data, which although scattered and irregular, showed quite definitely the general trend and time limits of treatment.

The material so graduated was next subtracted from the ungraduated total. The remainder was then plotted on the same sheet of arithmetic log paper, and the second or first sections fitted. In every instance, a number of trials was necessary before a satisfactory fit was obtained.

The sum of the different sections as graduated was summated by additions or subtractions, as required, and the graduated total compared with the ungraduated one.

In order to hold the higher points fixed, the fitting was by selected points rather than by the least square method. The points used for fitting were usually two observed ones for each section; but in some instances where the graph or trial showed that it was necessary, the points used were selected rather than observed.

f. Normal equation. — The normal equation used was log to base *e* of b of the equation

$$y = e^{a+bx} \text{ or } \log_e y = a + bx$$

The value of each x chosen with the $\log_e$ of its corresponding y was substituted in two equations, which were then solved for *a* and *b*. This gave a formula of the general form

$$y = e^{a+bx} \text{ or } y = e^a(e^{bx})$$

Here e^a represents the original height of the curve; and e^b the numerical value of the ratio between the height at any time (x) and that of the next following it, or in other words, the slope of the curve. The y then is a function of x, and varies as x varies.

g. *Illustration of use of formula.* — In illustrating the method of developing the specific formulae, in the interest of simplicity the formula of a one section curve will be used. Thus the formula in Fig. 87, showing the number of gas cases remaining in hospital at the end of each week, is

$$y_r = 1000.00\ (.842250)^{x_7}$$

The 1000.00 is the e^a; and the .842250, the e^b. The curve then starts with 1000.00 patients of whom .842250 × 1000, or 842.25, are remaining in hospital at the end of one week (x_7); and then of this remaining group (842.25) the same fraction (.842250) or 842.25 × .842250=709.39 are remaining at the end of the two weeks, etc.

h. *Change in size of basic group and time interval.*—To convert the formula into terms of 1 patient, simply divide by 1000 and then

$$y_r = 1.00\,(.842250)^{x_7}$$

The e^{bx_7} is in terms of seven day periods. To convert it into terms of one day (e^{bx_1}) take the seventh root of it; and then to change the result into terms of any other period, as, for example, a five day one (e^{bx_5}) as used here, raise it to the fifth power.

Thus from the above.

$$x_5 = \text{antilog of } 5\left(\frac{\log .842250}{7}\right) = .884593$$

Then the formula by 5-day periods is

$$y_r = 1.00\,(.884593)^{x_5}$$

Y_r then is the number of patients remaining in hospital at the end of successive five day periods. If, however, it is necessary to find directly the fraction of a patient remaining at the end of any other period, as for example one year (365 days), multiply as above by that number instead of by 5.

$$\text{Thus } x_{365} = \text{antilog of } 365\left(\frac{\log .842250}{7}\right) = .000130$$

If the e^a is 1.00, on the 365th day, .000130 of 1 patient will still be in hospital; but if the e^a is 1000.00, there will be .13 (See Fig. 87).

To convert the e^a into 100.00 patients, so that those remaining at any time will be in terms of percentages, divide the formula showing 1000.00 by 10. Then the formula will be

$$y_r = 100.00\,(.884593)^{x_5}$$

2. *Percentage of patients who have left hospital.* — To find the percentage of patients who have left the hospital, subtract the number remaining in hospital from the original 100.00.

$$\text{Patients who have left hospital} = 100.00 - \left[100.00\,(.884593)^{x_5}\right]$$

Expressed in general terms, the formula is

$$\sum_{0}^{x} dx = e^{a} - e^{a+bx}$$

i. *Graduated increase in the number of patients on sick report or in hospital.* — Cases of sickness and injury occur from day to day. Patients who are admitted to sick report remain under treatment for varying periods of time, depending chiefly upon the severity of illness or injury, but to a certain extent upon the proximity of the hospital to the troop areas, the facility for returning the men to the organization, etc. Of those admitted to sick report, some will have returned to duty by the end of the first period (5 days in this case), others will go out during the second one, while some will remain a longer time, and a few even a year or more. During the second period, in addition to the cases coming in, a certain number of patients will be remaining from those admitted during the first one. Also during the third period, in addition to those admitted, cases will be remaining from the first and second ones. And so, the increase in the number of patients will continue as time advances, until all of the first group of cases admitted have left sick report, which, for all practical purposes, will be at the end of one year. After that time the number of patients leaving sick report during each period by return to duty, deaths, or discharges for disability, will equal the number admitted.

j. *Integration of basic formula.*— To find then the number of patients on sick report, or in hospital as the case may be, at any time, add to the number admitted during the period, the number remaining from all preceding ones. For this purpose the basic formula is integrated between the beginning (M day) and the constantly advancing time, x_5. Using the basic formula with one section, the integrated formula is

$$\int_0^x y\,dx = \frac{e^{a+bx}}{\log_e b} - \frac{e^a}{\log_e b}$$

Substituting the values already found, and using one seventh of the $\log_e b$, the formula for gas patients shows the number of gas patients in hospital at the end of each 5 day periods

$$\int_0^x y\,dx = P = 40.774720 - \left[40.774720\,(.884593)^{x_5}\right]$$

To find the total patients in hospital on any day, the day's basic admissions must be added to the P found from this or any similar formula.

The patients (P) include all who will ultimately return to duty, die, or be discharged as physically disabled. The number who are disposed of in other ways is so small that it can be omitted from consideration.

k. *Formulae for deaths and disability discharges, which have occurred.*— The total number of patients who have left hospital at any time by death, disability, discharge, or duty equals those who have been admitted less the number sick in hospital. This is also true of death and disability cases when considered separately. The integration of the basic formula shows how many cases, which will ultimately result in death or discharge, are in hospital. Then the difference between that group in hospital and the total deaths or disabilities expected among the cases which have been admitted, constitute the number of fatalities or disability discharges which have already occurred.

All of the special formulae relating to death or disability cases are expressed here as parts of the total cases [See Fig. 97, (1) and (2)]. Thus, for every patient wounded by gas who is admitted to hospital, .017306 will die; and if there are 5 cases admitted there will be 5 times .017306, or .086532, fatalities. The basic formula for the eventually fatal gas cases remaining in hospital from 1000.00 of them admitted on any day is (Fig. 97)

$$y_r = 863.02\,(.420133)^{x_7} + 136.98\,(.870099)^{x_7}$$

Changing each e^{bx_7} to e^{bx_5}; reducing the sum of the two e^a from 1000.00 to 1.00 by dividing each by 1000.00; multiplying each resulting e^a by .017306 to reduce the deaths to parts per total cases; and then integrating

$$\int_0^x y\,dx = .239820 - \left[.120563\,(.538258)^{x_5} + .119257\,(.905389)^{x_5}\right]$$

This formula shows the gas cases in hospital, who will eventually die. At the end of 30 days the number of such cases is

$.239820 - (.002932 + .065689) = .171199$

As above, the total patients who have died or who will die out of 5 gas cases, is .086532. Consequently the formula for those who have died is

$.086532x_5$ — the above formula

At the end of 30 days, or after 6 five day periods, it will be

$6\,(.086532) - .171199 = .347993$

Then at the end of 30 days, if 30 gas cases have been admitted at the rate of 1.00 per day, .35 have died, and .17 patients, who are in hospital, will die.

$.35 + .17 = .017306 \times 30 = .519180$

l. *Multiple section curves.* — When two or three section exponential curves are used, the method of developing the formulae from them is the same as that used for a one section curve; and the only additional step which is required is the summation of the different sections.

S. COMPUTATION OF DATA FOR SHORT DURATION CASES.

57. **Percentage leaving hospital each day by return to duty or death.** — Calculate from the formulae on Figs. 90, 91, and 92 for duty cases; and from the last ones on Figs. 96, 97, and 98 for death cases, the percentage of each group who return to duty or die on each day up to and including the tenth. These data are shown by Tables 26 and 30, respectively.

The figures are cumulated and show the percentage of duty or death cases which occur during any period from the beginning of the first day the end of the tenth.

The percentage leaving hospital on any one day by duty, death, etc., can be found easily by subtraction.

Table 30.—Percentage of the total deaths in hospital which occurred during the first ten days from the three classes of cases in the American Expeditionary Forces.

Day after admission to hospital	Diseases and non-battle injuries*	Gassed†	Gunshot wounded‡
1	7.56	10.33	17.60
2	14.59	19.48	31.61
3	21.02	27.59	42.77
4	26.76	34.77	51.68
5	32.16	41.15	58.81
6	36.76	46.80	64.53
7	41.08	51.82	69.13
8	44.86	56.28	72.84
9	48.38	60.24	75.84
10	51.62	63.77	78.28

* See Fig. 96. † See Fig. 97. ‡ See Fig. 98.

58. **Average days of treatment.** — As an illustration of the method, let us find the average duration of treatment for *gassed* cases who die in ten days or less.

a. Divide the percentage of death cases leaving hospital (dying) during each day from the first day to the tenth, by the total leaving (dying) during the ten days. The results expressed in parts per 100 show the percentage of those dying in ten days or less who died on each day from the first to the tenth. (see column 4, Table 31).

b. Beginning with 100; that is, the total percentage to die in 10 days', subtract successively the number leaving hospital (dying) during each day from the first to the tenth. The results show the percentage of the 10 day fatal cases remaining in hospital each day (see column 5, Table 31).

c. Reduce the results to the basis of one case instead of 100% (see column 6, Table 31) and summate. The total shows the eventual death cases in hospital at the end of ten days from the group remaining under treatment from one to ten days, when the daily admission rate of gassed cases who die during period is 1.00.

Table 31.—Method of finding the eventually fatal *gassed* cases in hospital at the end of ten days among those that die in ten days or less, when the daily admission rate from the group is 1.00.

Day	Percentage of deaths		Percentage of ten day deaths		Patients remaining§
	Each day	Cumulated*	Leaving hosp.†	Remaining in hosp.‡	
				100.00	1.00
1	10.33	10.33	16.20	83.80	.84
2	9.15	19.43	14.35	69.45	.70
3	8.11	27.59	12.72	56.73	.57
4	7.18	34.77	11.26	45.47	.45
5	6.38	41.15	10.01	35.46	.35
6	5.65	46.80	8.86	26.60	.27
7	5.02	51.82	7.87	18.73	.19
8	4.46	56.28	6.99	11.74	.12
9	3.96	60.24	6.21	5.53	.06
10	3.53	63.77	5.54	0	0
Total					4.55

*From Table 30. †See Par. 58a. ‡See Par. 58b. §See Par. 58c.

With an admission rate of 1.00, the eventual death cases under treatment (4.55) is the same as the average days treatment for each one. Table 32 shows the average duration of treatment of duty and death cases admitted as sick, gassed, and gunshot wounded, and whose maximal days of treatment are from one to ten. Thus of the fatal *gassed* cases which survive five days or less, the average days was 2.77; and for the group surviving ten days or less, it was 4.55.

In Table 32, the data for "Duty cases" are computed from those for "Duty cases" in Table 26 in same way as Col. 6, Table 32 (gassed) are from those in Table 31. The data for "Death cases" in Table 32, are calculated similarly from those in Table 30.

Table 32.—Average duration of treatment of cases in hospital who will return to duty or die at any time between one day or less, and ten days or less.

Day	Duty*			Expected to die†		
	Sick	Gassed	Gunshot wounded	Sick	Gassed	Gunshot wounded
1	1.00	1.00	1.00	1.00	1.00	1.00
2	1.48	1.50	1.68	1.48	1.46	1.44
3	1.94	2.00	2.34	1.95	1.92	1.85
4	2.40	2.50	3.00	2.38	2.35	2.22
5	2.83	3.00	3.65	2.83	2.77	2.55
6	3.26	3.50	4.27	3.22	3.15	2.87
7	3.67	4.00	4.90	3.63	3.53	3.13
8	4.07	4.50	5.54	3.97	3.88	3.38
9	4.47	5.00	6.15	4.35	4.22	3.61
10	4.84	5.50	6.77	4.70	4.55	3.82

* From Table 26. † From Table 30.

59. **Patients in hospital on the maximal day.** — As stated above, among *gassed* cases who eventually die and for whom the duration of treatment is from one to ten days, there are 4.55 cases in hospital on the tenth day, when the daily admission rate from such cases is 1.00 per day.

a. In the first place, however, only 63.77% of the fatal *gassed* cases die within ten days. Consequently to convert the data into terms of total gassed cases which are fatal, multiply the 4.55 by 63.77%. The results show that when the daily admission rate for fatal *gassed* cases of all durations is 1.00, that among the cases surviving from one to ten days, there are 2.90 (4.55 x 63.77%) such patients in hospital on the tenth day.

b. In the second place, only 1.73% of all *gassed* cases treated in hospital are fatal. Consequently to translate the data to the basis of 1.00 gas admissions per day, the 2.90 must be multiplied by 1.73%. The result shows that there are .05 (2.90 x 1.73%) *gassed* cases in hospital on the tenth day in a group of such cases that will die within ten days, when the daily admission rate from war gases is 1.00 (see Table 27).

The data for the cases who are treated five days or less, six days or less, etc., are found by the same method.

60. **Patients in hospital on any day, when the maximal one is the tenth, etc.** — The problem here is to find how many cases there will be in hospital on any one day, such as the fifth or sixth, *in a group of cases whose treatment is for a longer period; for example, ten days or less.* To illustrate the method let us again use the data for the *gassed* cases who eventually die. The process is the same as in Table 31 until the data in the last column are obtained. Then to find the patients in hospital on any day among those surviving ten days or less, proceed as shown by Fig. 22. The following table shows the method in detail.

Table 33.—Fatal *gassed* cases in hospital on any day in a group surviving ten days or less.

Day	Ten days fatal cases*	Total fatal cases†	Total gassed cases‡
1	1.00	0.64	0.01
2	1.84	1.17	.02
3	2.54	1.62	.03
4	3.11	1.98	.03
5	3.56	2.27	.04
6	3.91	2.49	.04
7	4.18	2.67	.05
8	4.37	2.79	.05
9	4.49	2.86	.05
10	4.55	2.90	.05

* Summation from above downward of data, last column, Table 31.

† Preceding column multiplied by 63.77%.

‡ Preceding column multiplied by 1.73%.

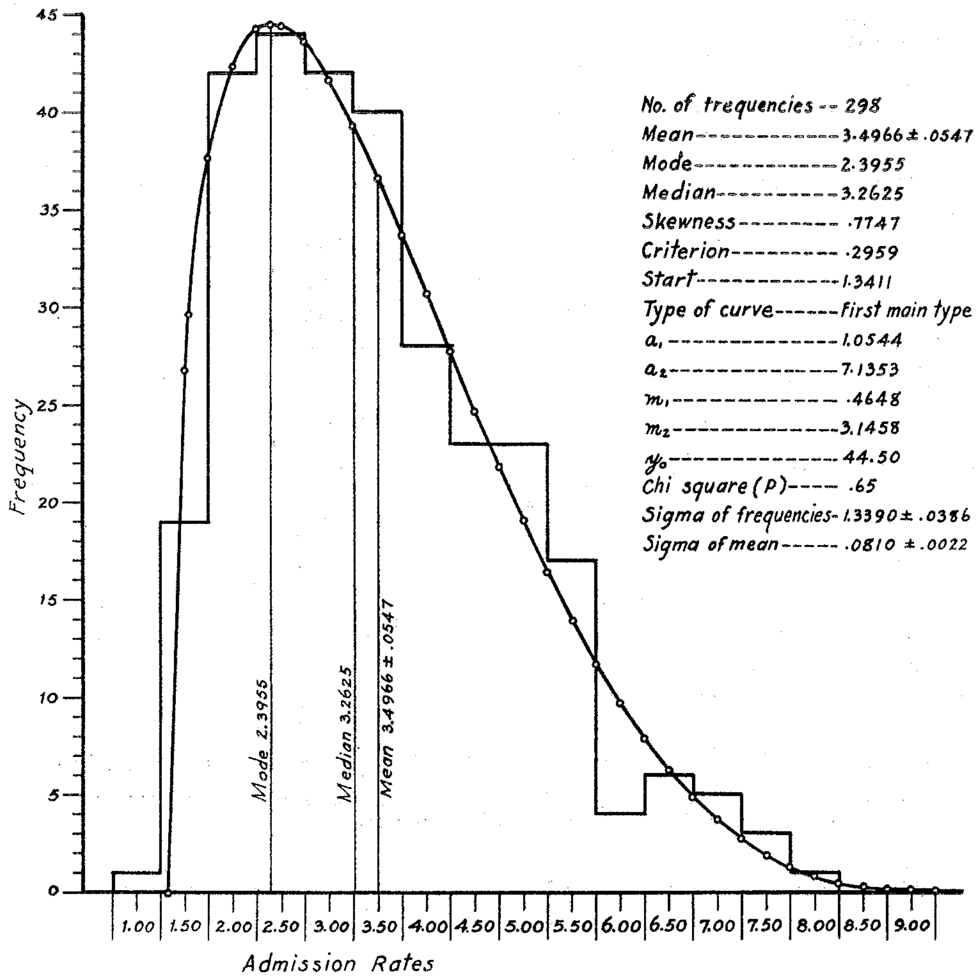


Fig. 77.—Histogram and fitted skew curve for daily admission rates from diseases and nonbattle injuries to hospital and quarters per 1000 strength in 30 large camps in the United States during 1918, excluding September and October.

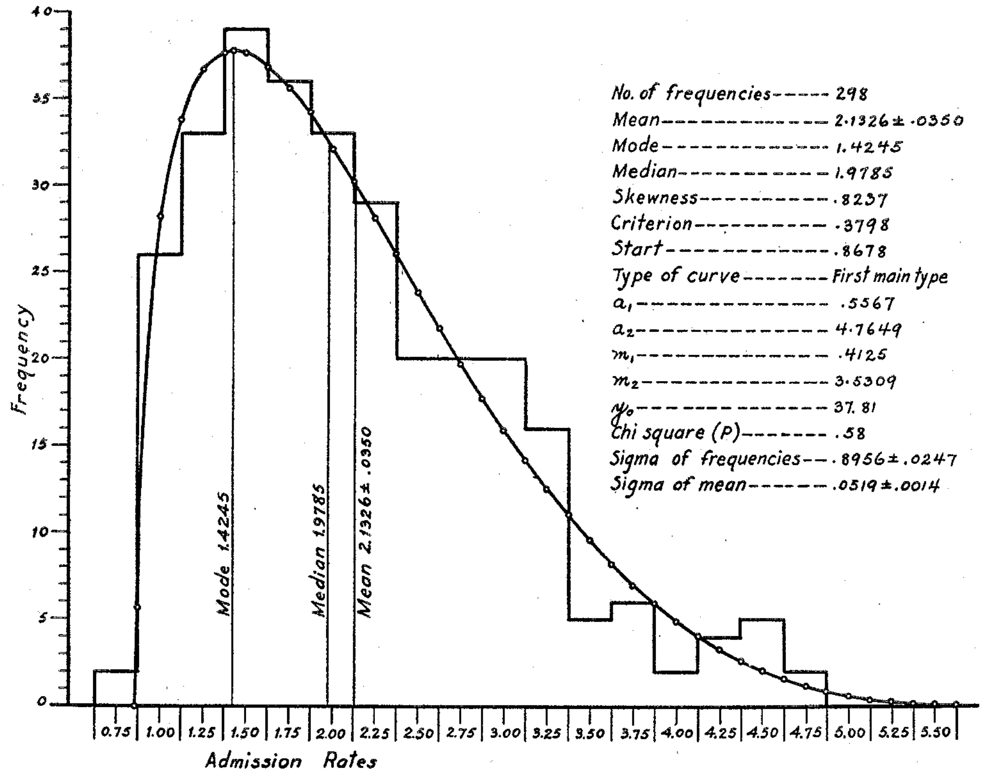


Fig. 78.—Histogram and fitted skew curve for daily admission rates, from diseases and nonbattle injuries to hospital only per 1000 strength in 30 large camps in the United States during 1918, excluding September and October.

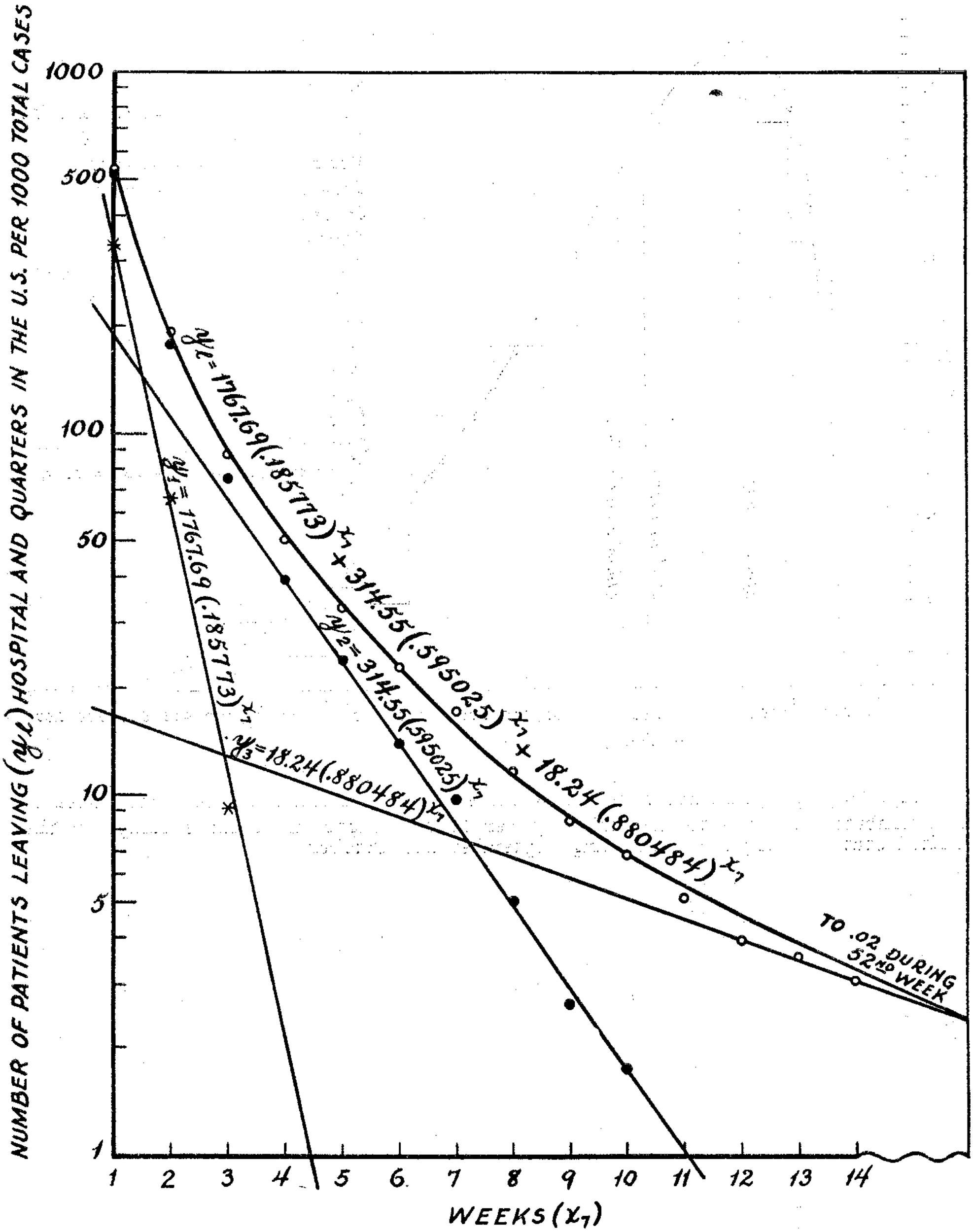


Fig. 79.—Duration of treatment (leaving sick report) of diseases and nonbattle injury cases among white enlisted men in hospital and quarters in the United States in 1925 - 1927. 1 2

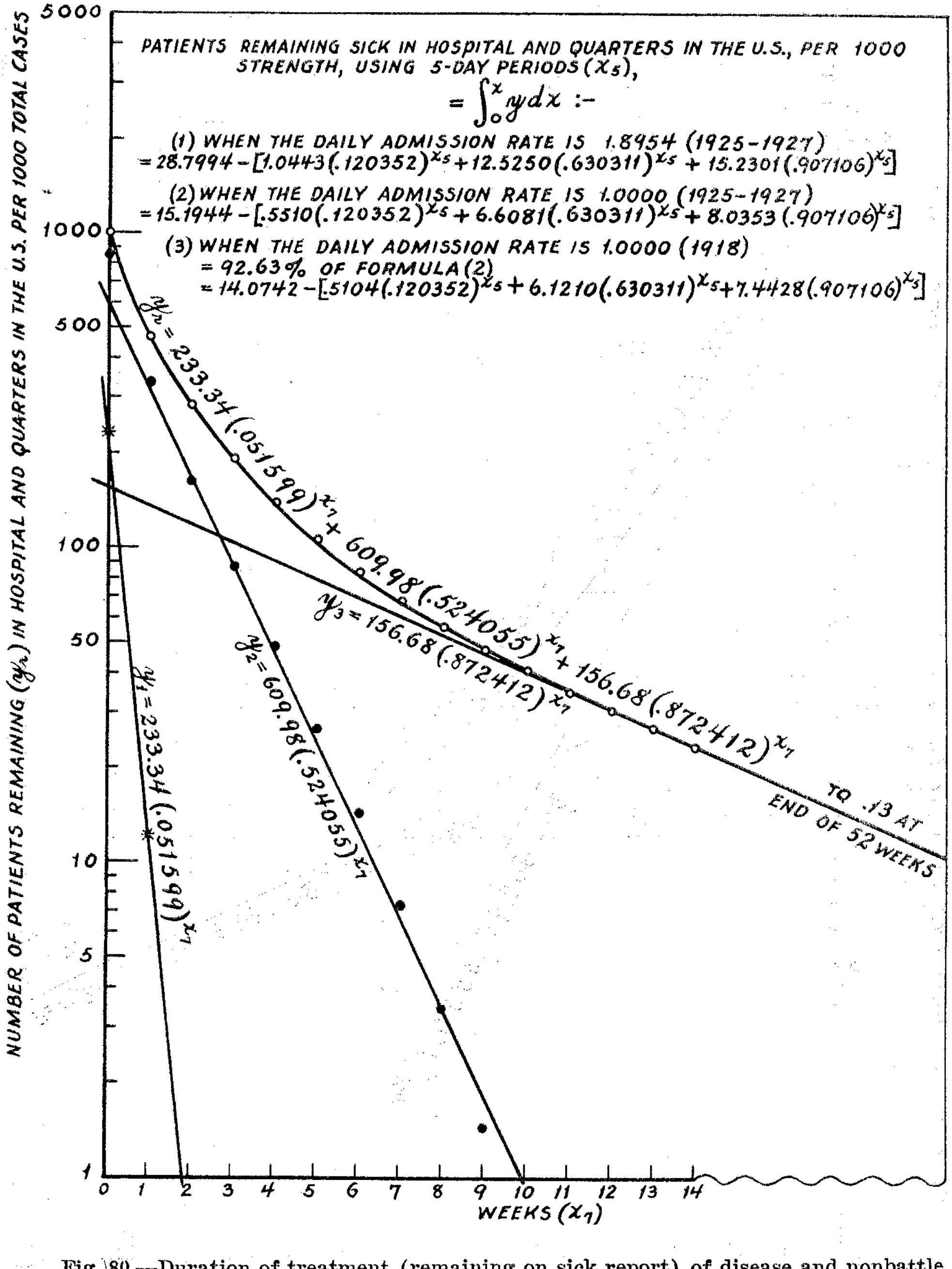


Fig. 80.—Duration of treatment (remaining on sick report) of disease and nonbattle injury cases in hospital and quarters as they occur in the United States.

NOTE: Observed points from data as graduated by Fig. 79.
(1) By multiplying (2) by 1.8954. [1 2]
(2) From integration of formula for curve.
(3) 15.07 (14.0742 + 1.00) was the average number of days lost per case in the U. S. in 1918. [2] Multiply (2) by 92.63% to reduce it to (3).

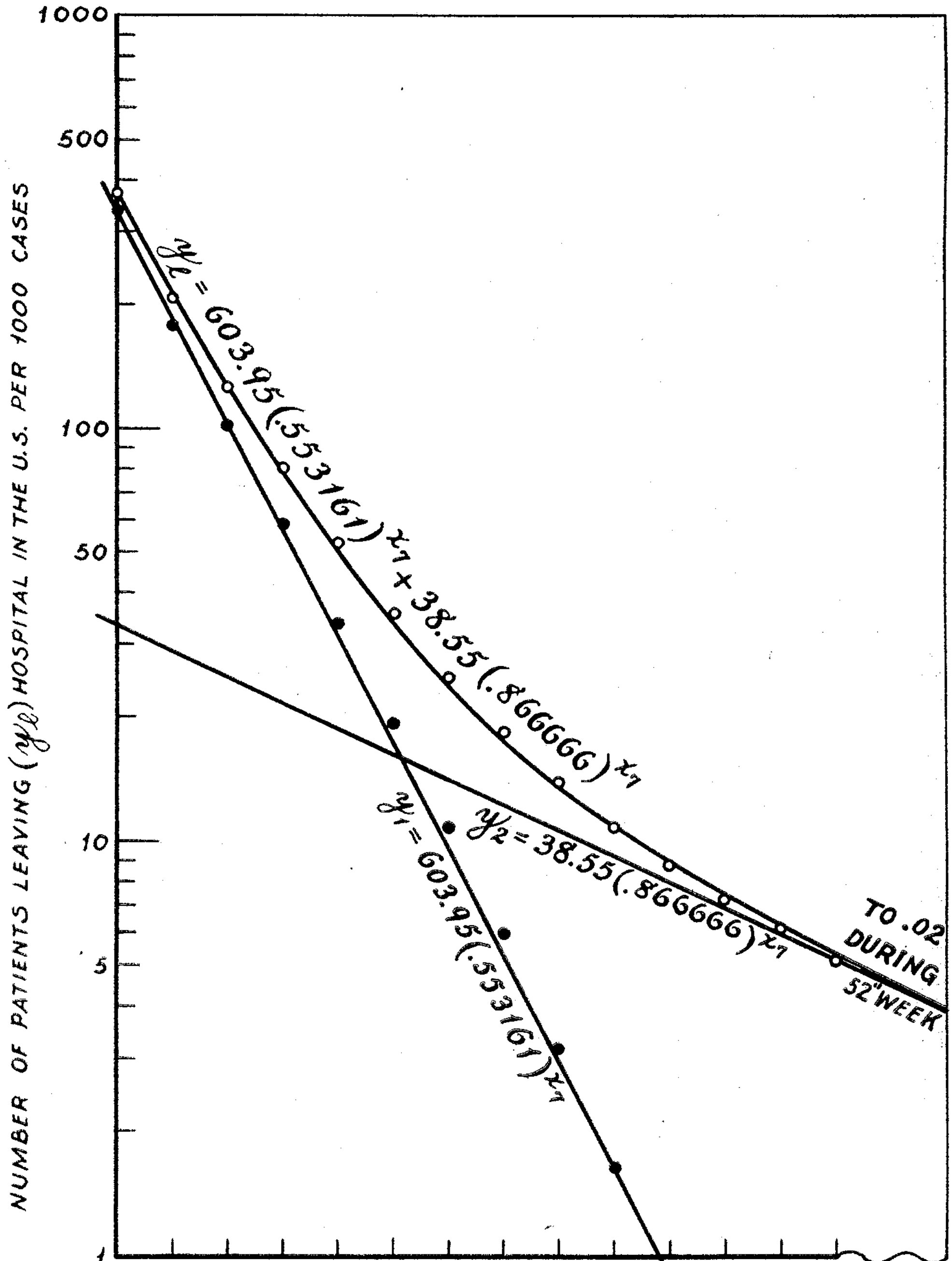


Fig. 81.—Duration of treatment (leaving hospital) of disease and nonbattle injury cases in hospital as they occur in the United States.

NOTE: Observed points based upon the same data as is Fig. 79, after eliminating 91.07% of them as quarter cases as determined by Sect. 1 of Fig. 79. 1

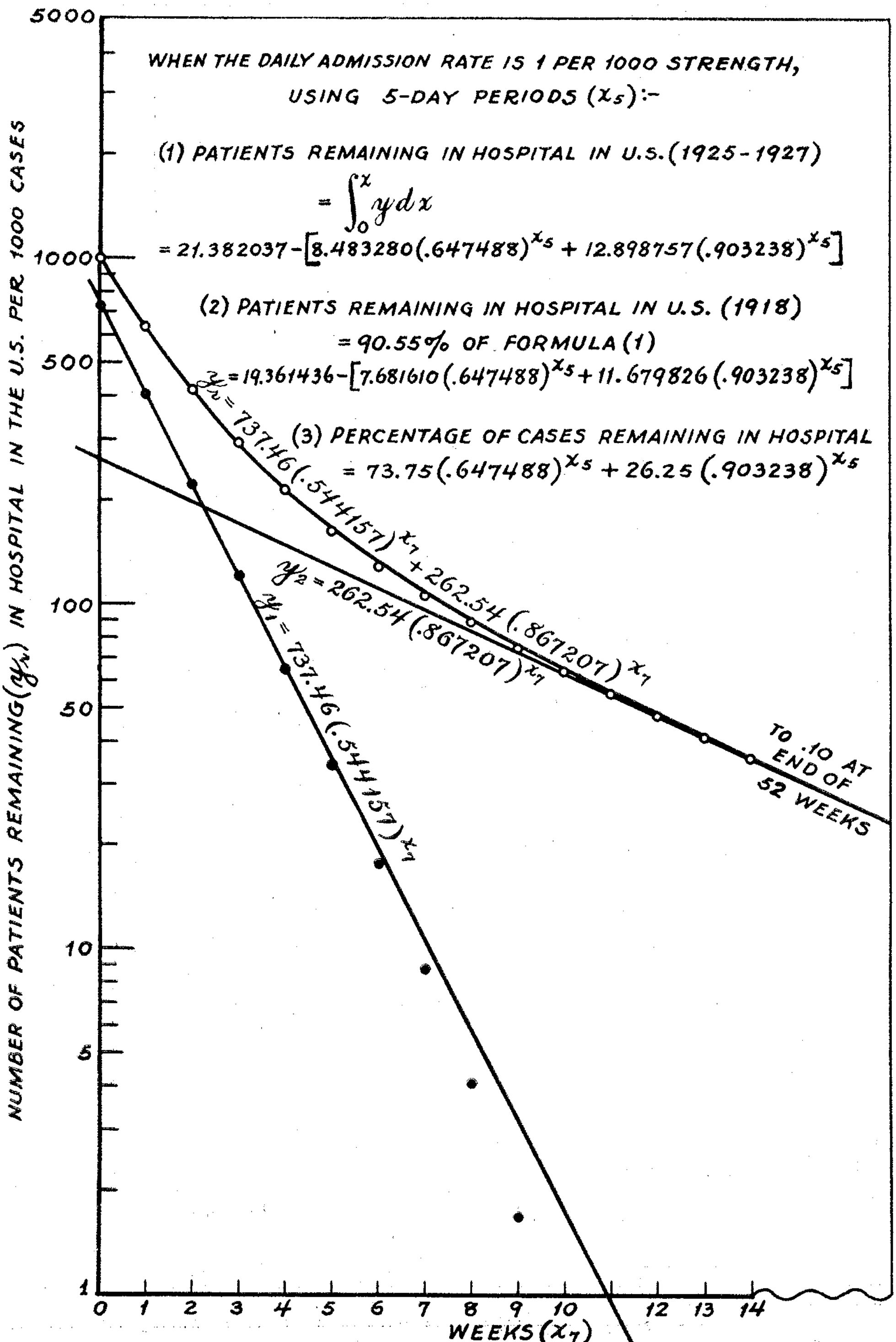


Fig. 82.—Duration of treatment (remaining in hospital) of disease and nonbattle injury cases as they occur in the United States.

NOTE: Observed points from data as graduated by Fig. 81.

(1) From integration of formula for curve.

(2) 20.36 (19.36 + 1.00) was the estimated average number of days lost per hospital case in the U. S. in 1918 (Fig. 3, p. 7).

Multiply (1) by 90.55% to reduce it to (2).

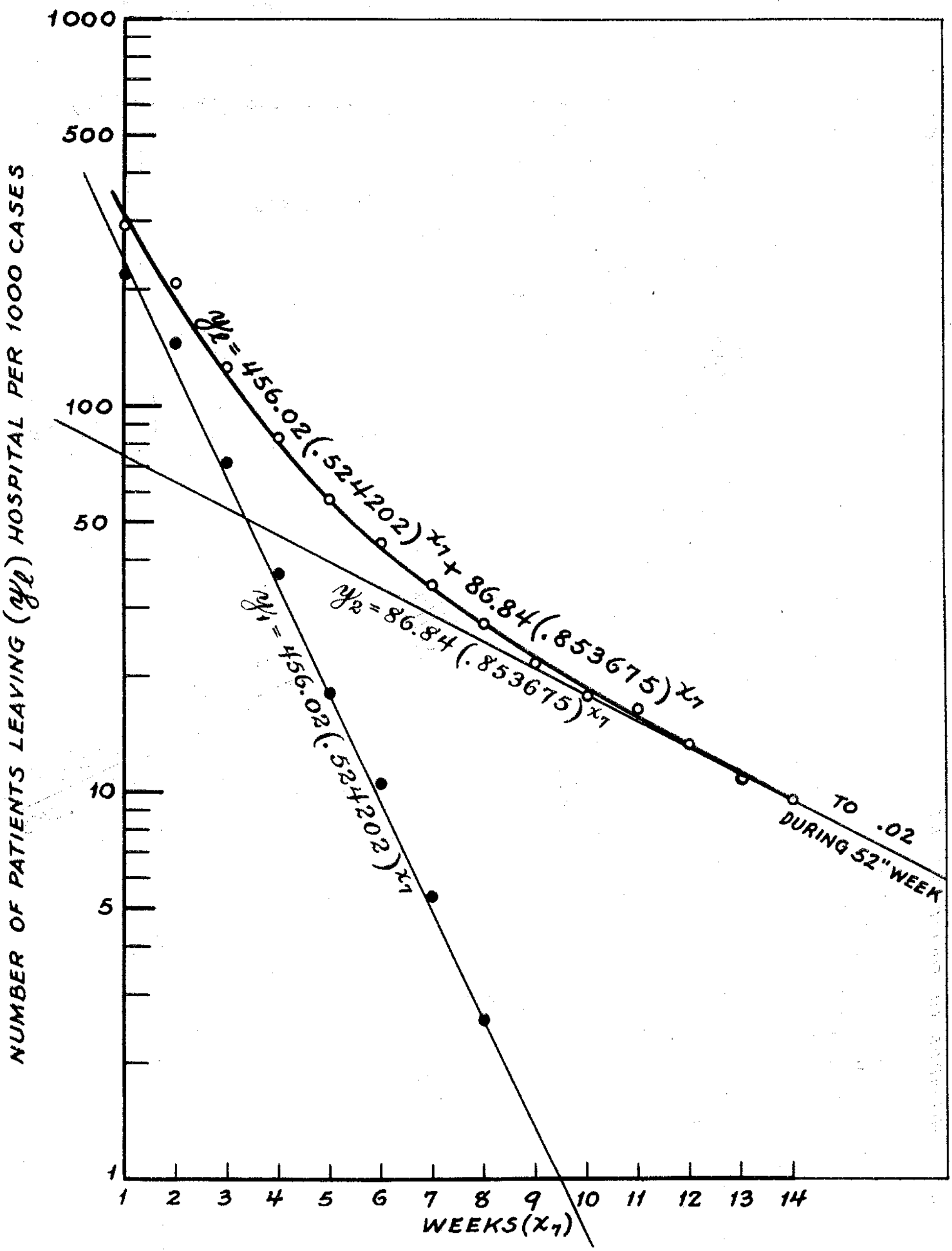


Fig. 83.—Duration of treatment (leaving hospital) of disease and nonbattle injury cases which occurred in the American Expeditionary Forces in 1918 while in the A. E. F. and later in the U. S.

NOTE: Observed points from experience with A. E. F. cases during the last six months of 1918. [1]

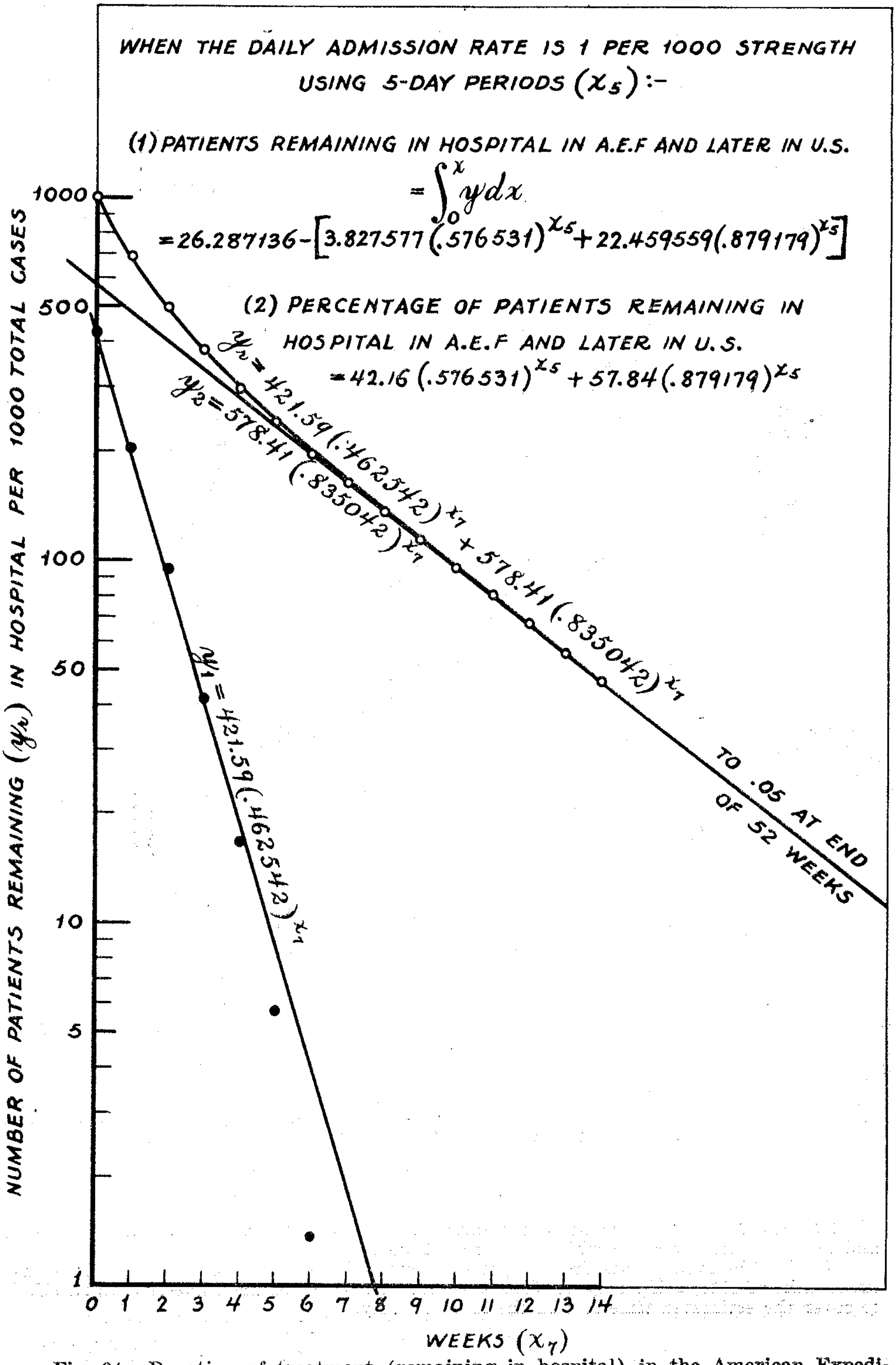


Fig. 84.—Duration of treatment (remaining in hospital) in the American Expeditionary Forces and later in the U. S. of disease and nonbattle injury cases which occurred in the A. E. F. in 1918.

NOTE: Observed points from data as graduated by Fig. 83.

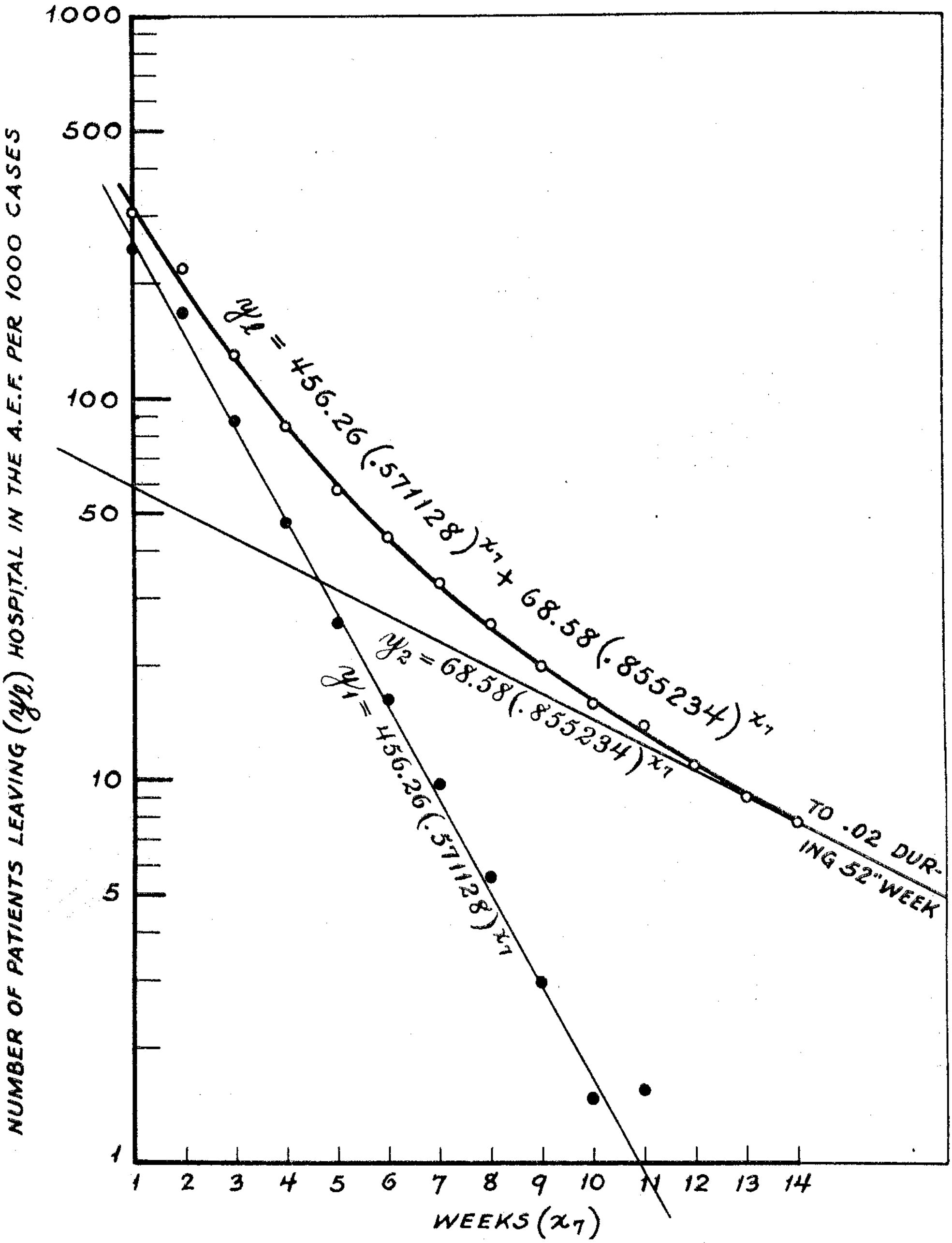


Fig. 85.—Duration of treatment (leaving hospital) in the A. E. F. only of disease and nonbattle injury cases which occurred there in 1918.

NOTE: Observed points from experience with the A. E. F. cases during the last six months of 1918, using only duty cases, deaths, and 40% of the cases sent to the U. S. to cover the estimated time lost in the A. E. F. only. 1

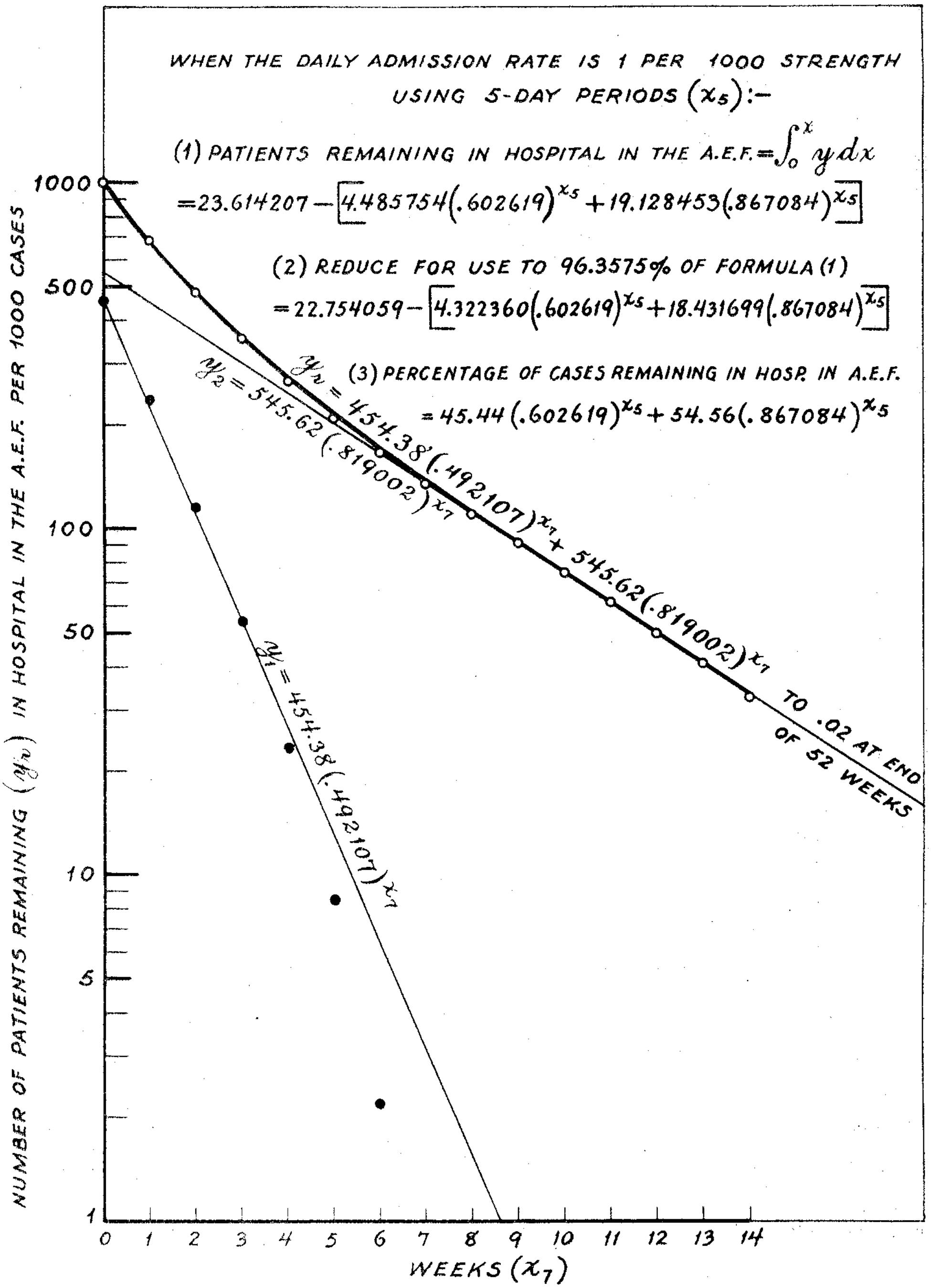


Fig. 86.—Duration of treatment (remaining in hospital) in the A. E. F. only of disease and nonbattle injury cases which occurred there in 1918. [1]

NOTE: Observed points from data as graduated by Fig. 85.

(1) From integration of formula of curve.

(2) It is estimated that the average days lost per case in the A. E. F. only was 23.75 (22.75 + 1.00). Multiply (1) by 96.575% to reduce it to (2).

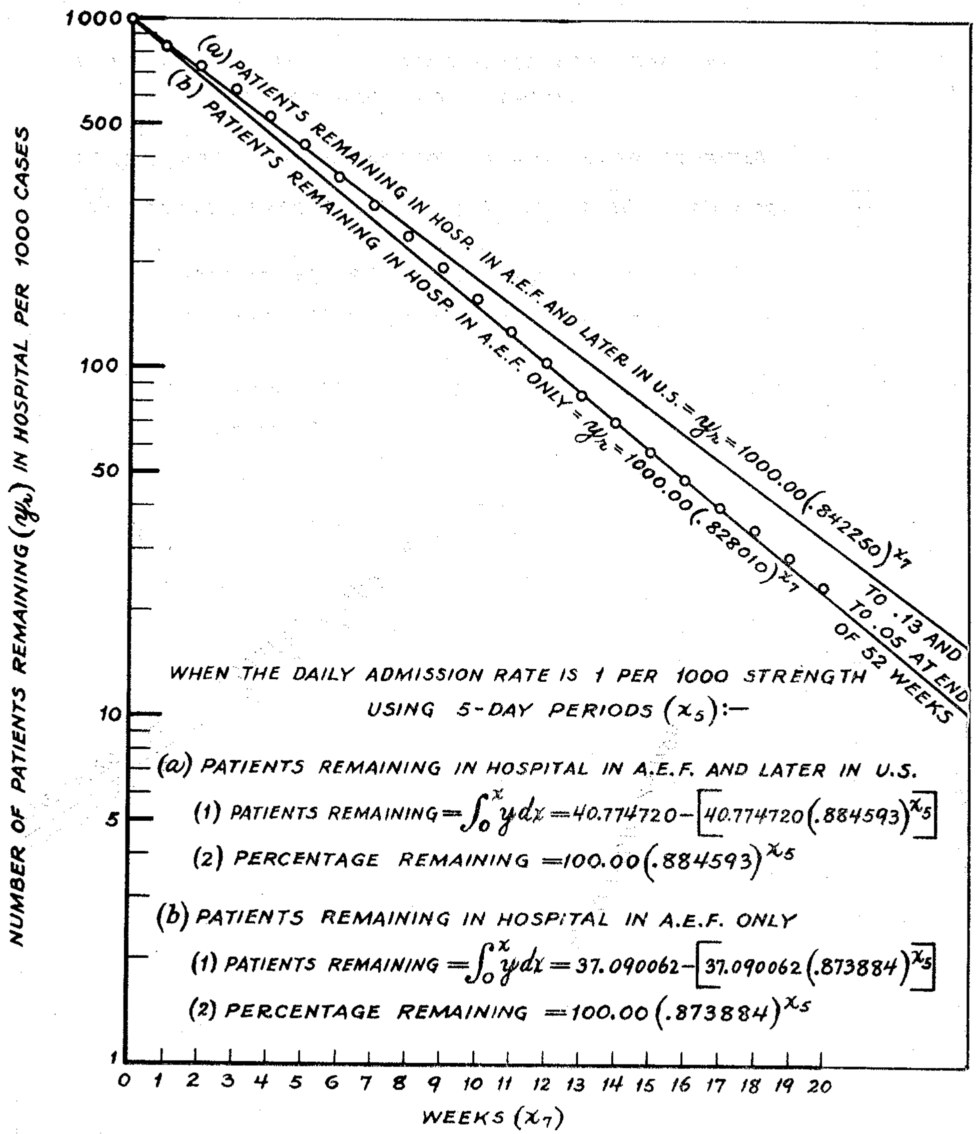


Fig. 87.—Duration of treatment of GAS cases which occurred in the A. E. F. in 1918. [1]

NOTE: The observed points include practically only the time lost by cases while in the A. E. F. The lower curve (b) is sloped so as to include only that much time; while the upper one (a) covers all time lost including that after transfer from the A. E. F. The upper curve is obviously a poor fit of the observed points, but it is as good a one as is practicable with the available data.

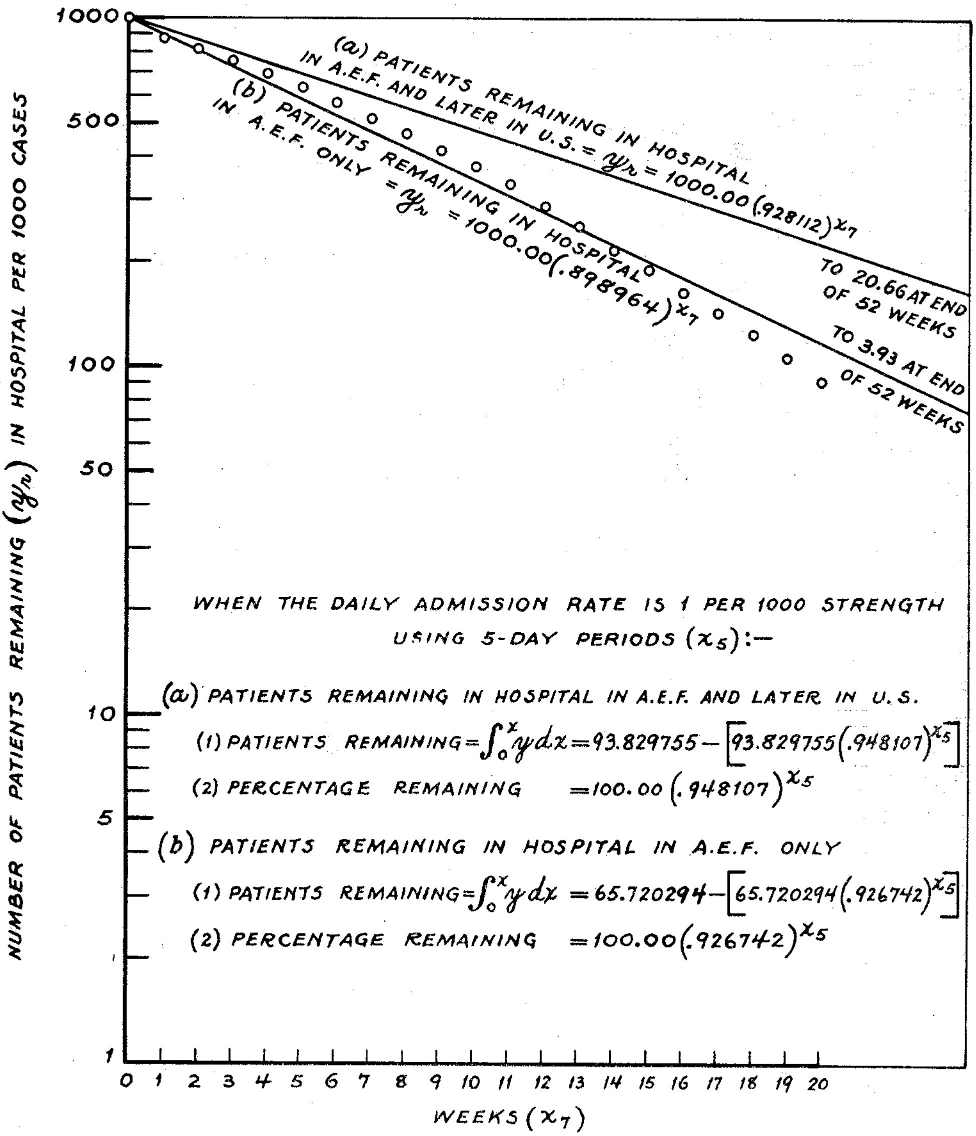


Fig. 88.—Duration of treatment of GUNSHOT cases which occurred in the A. E. F. in 1918. [1]

NOTE: See Note on Fig. 87.

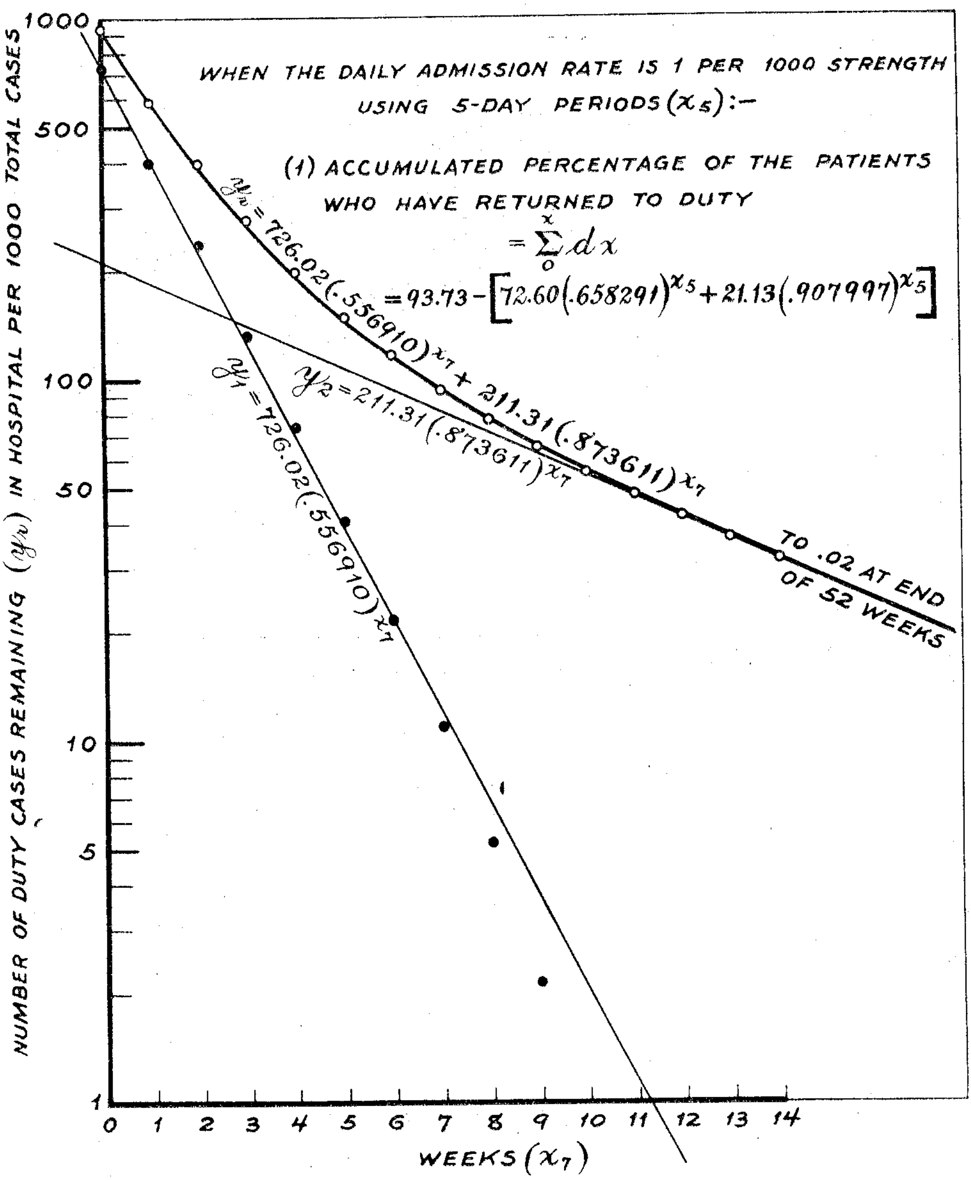


Fig. 89.—Duration of treatment of disease and non-battle injury cases who were admitted to hospital in the United States in 1918 and returned to duty.

NOTE: Observed points based upon experience with U. S. cases 1925 - 1927, modified to conform to 1918 experience. [1 2]

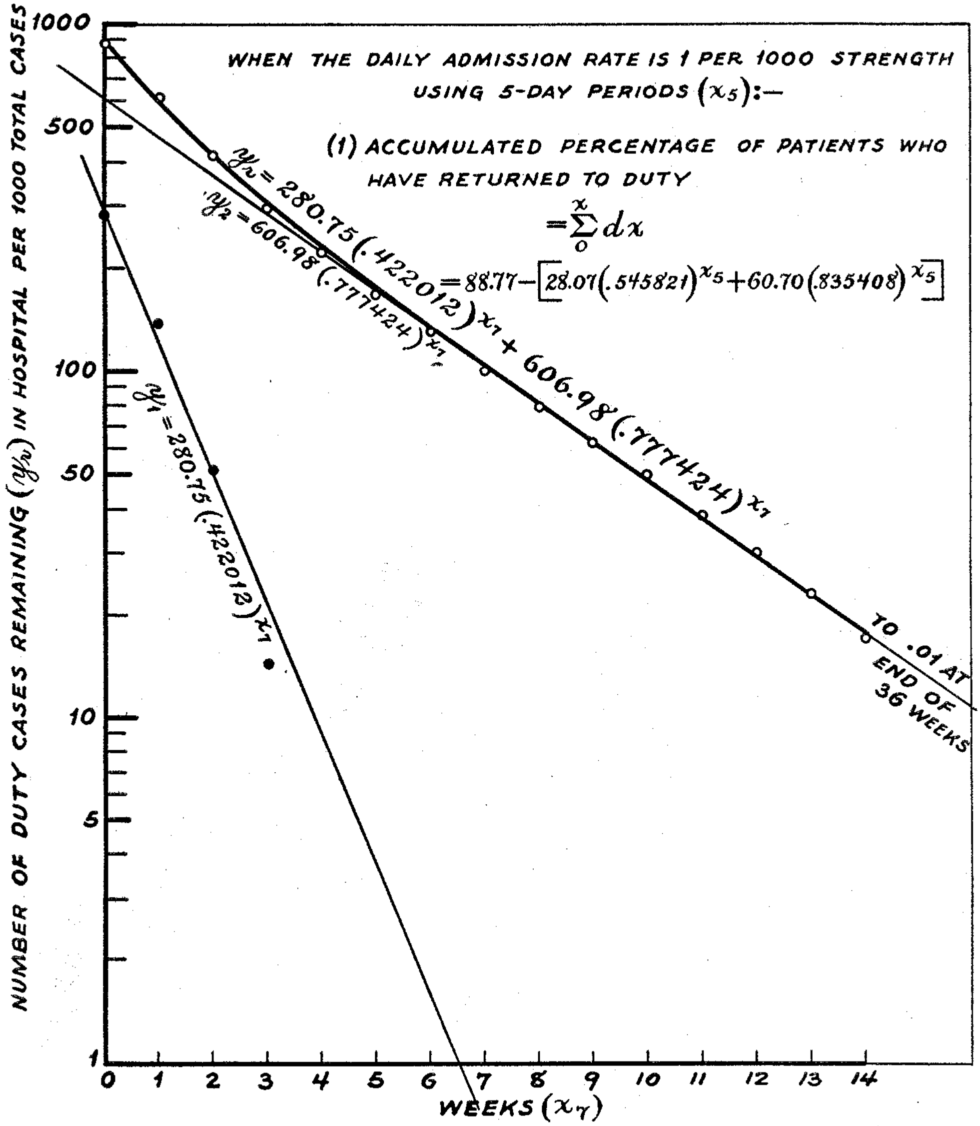


Fig. 90.—Duration of treatment of disease and nonbattle injury cases which returned to duty while in the A. E. F. in 1918.

NOTE: Observed points based upon experience with duty cases in the A. E. F. during the last six months of 1918. 1

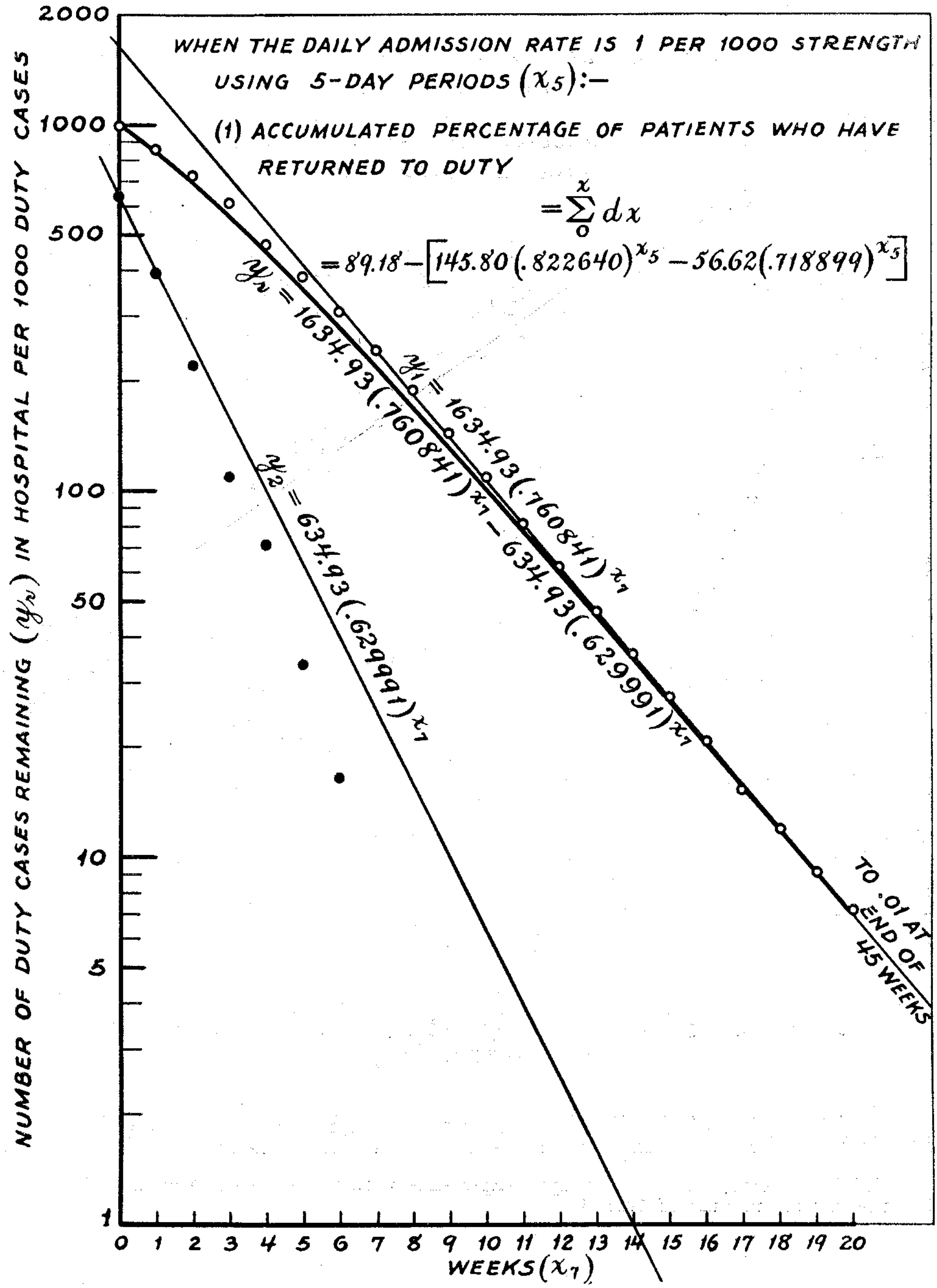


Fig. 91.—Duration of treatment of GAS cases which returned to duty in the A. E. F. in 1918.

NOTE: Observed points based upon experience with duty cases in the A. E. F. during the last six months of 1918. 1

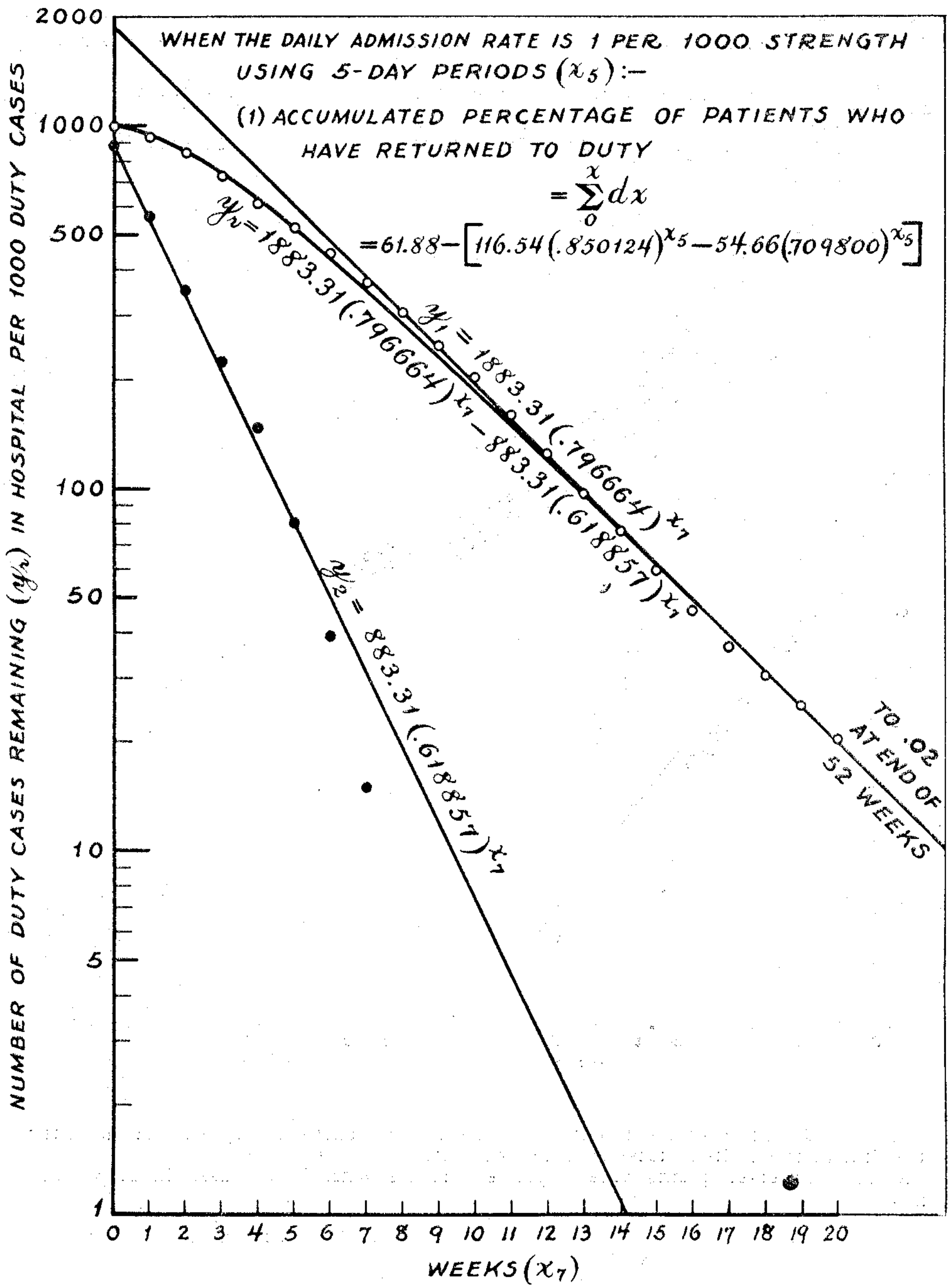


Fig. 92.—Duration of treatment of GUNSHOT cases which returned to duty in the A. E. F. in 1918.

NOTE: Observed points based upon experience with duty cases in the A. E. F. during the last six months of 1918.[1]

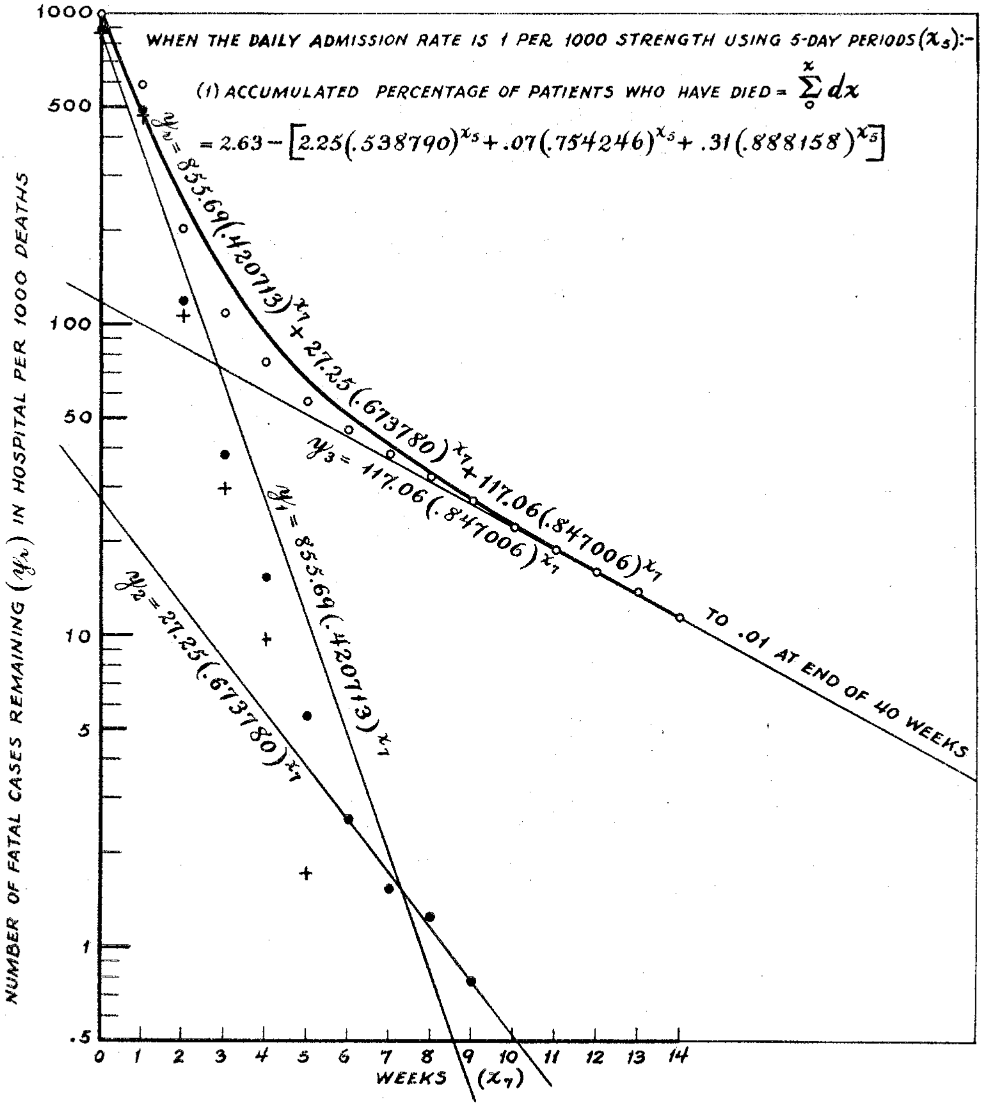


Fig. 93.—Duration of treatment of disease and nonbattle injury patients admitted to hospital in the United States in 1918, who ultimately died.

NOTE: Observed points based upon experience with U. S. cases in 1918 which died.[1]

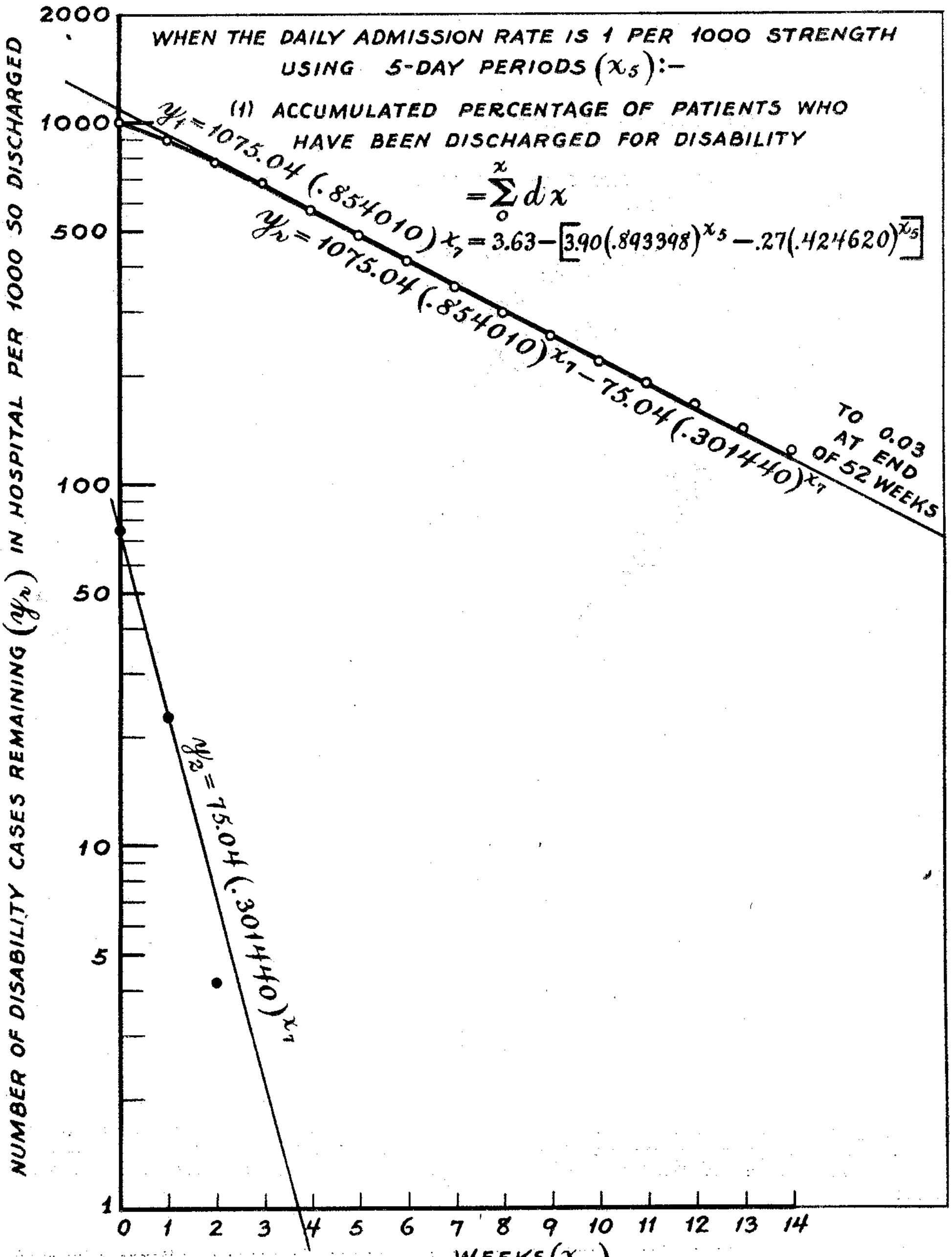


Fig. 94.—Duration of treatment of disease and nonbattle injury patients admitted to hospital in the United States in 1918, who were ultimately discharged for disability.

NOTE: Observed points based upon experience with U. S. cases in 1918 which were discharged as physically disabled. [1]

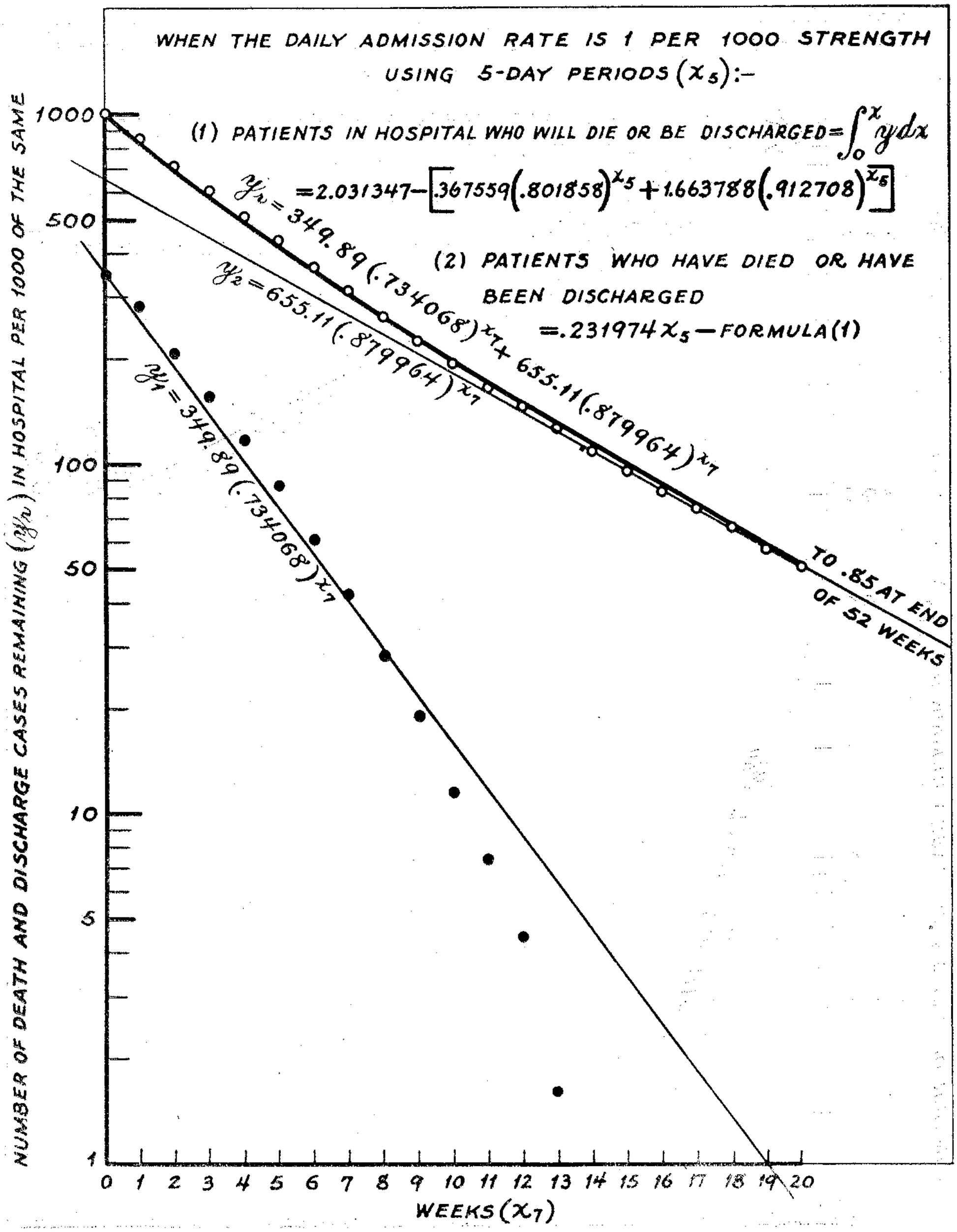


Fig. 95.—Duration of treatment of disease and nonbattle injury patients admitted to hospital in the United States in 1918, who ultimately died or were discharged for disability.

NOTE: Observed points based upon experience with U. S. cases in 1918 who died (using only one tenth of deaths from influenza and pneumonia) or were discharged as physically disabled.[1]

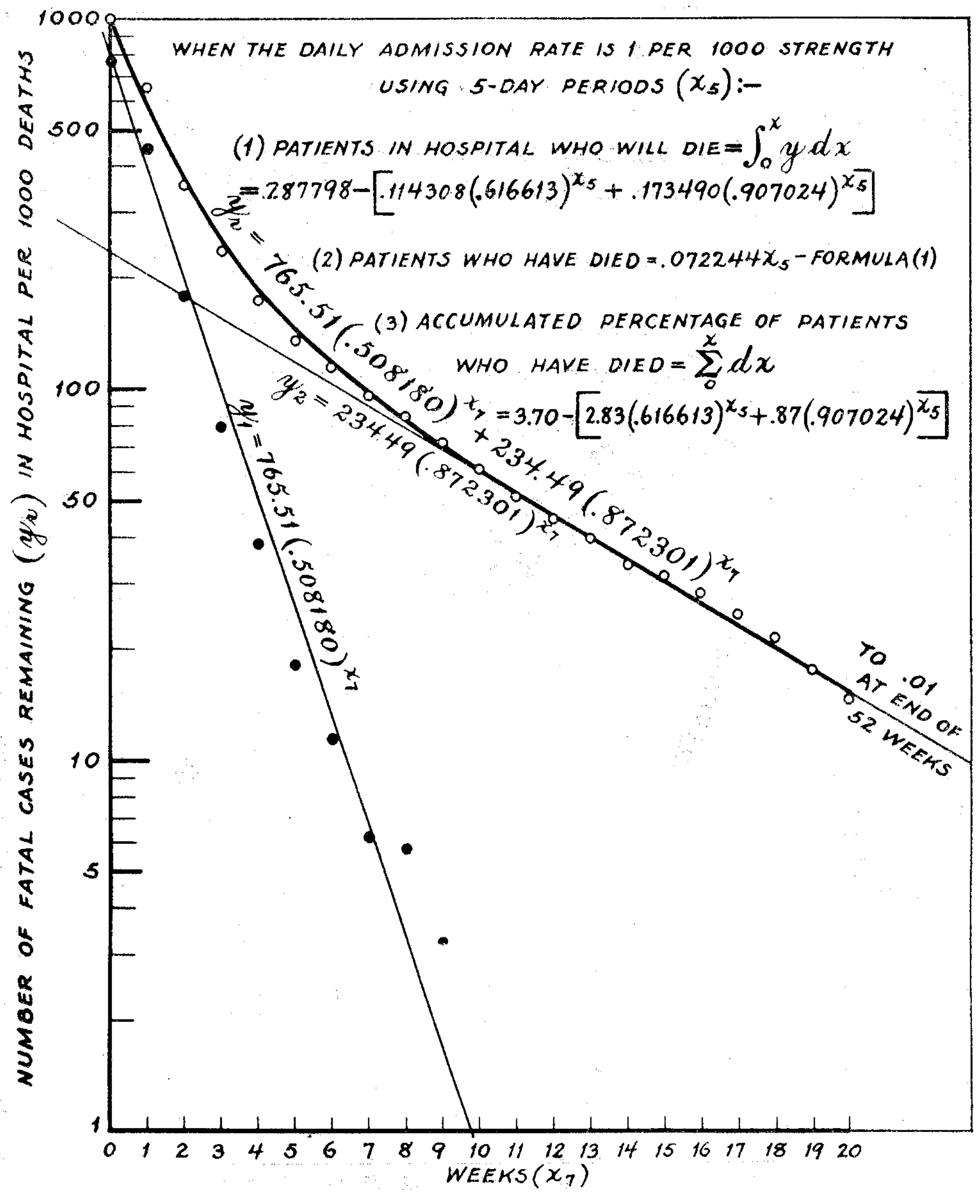


Fig. 96—Duration of treatment of disease and nonbattle injury patients admitted to hospital in the A. E. F. in, 1918, who ultimately died.

NOTE: Observed points based upon experience with A. E. F. disease and nonbattle injury cases during the last six months of 1918, who died. [1]

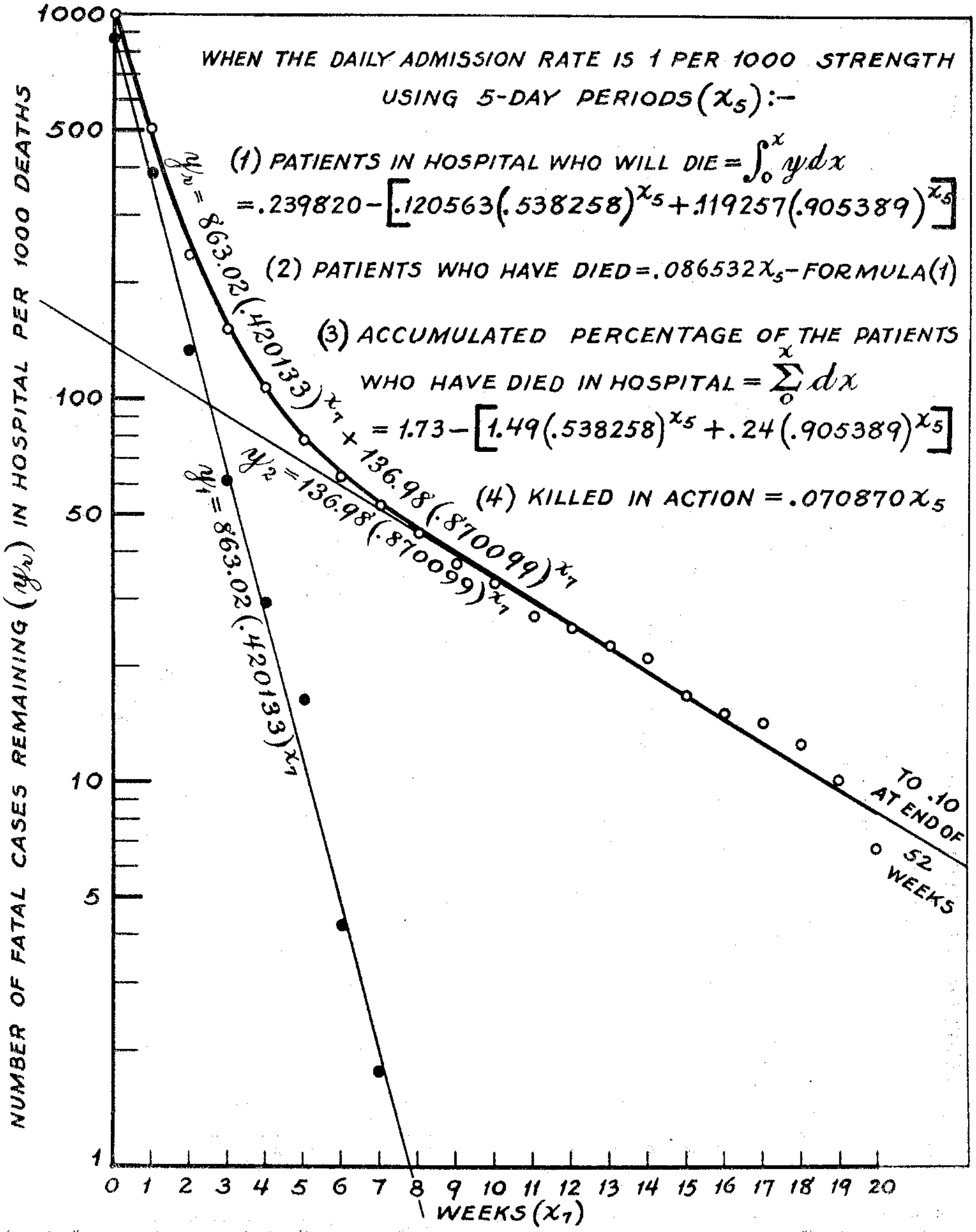


Fig. 97.—Duration of treatment of gas patients admitted to hospital in the A. E. F. in 1918, who ultimately died.

NOTE: Observed points based upon experience with the patients wounded by poisonous gases in the A. E. F. in 1918, who died. 1

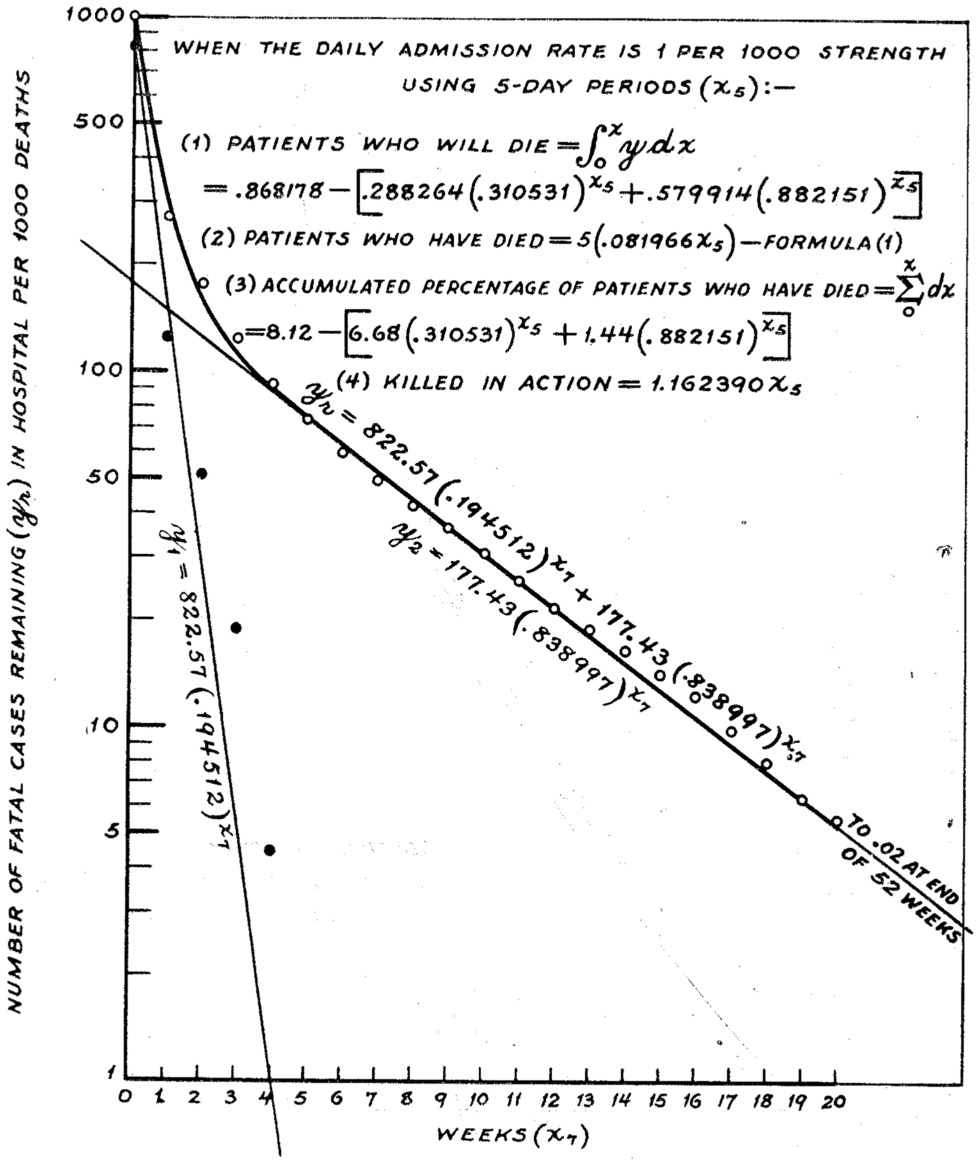


Fig. 98.—Duration of treatment of GUNSHOT patients admitted to hospital in the A. E. F. in 1918 who ultimately died.

NOTE: Observed points based upon experience with the patients wounded by gunshot missiles in the A. E. F. in 1918, who died.[1]

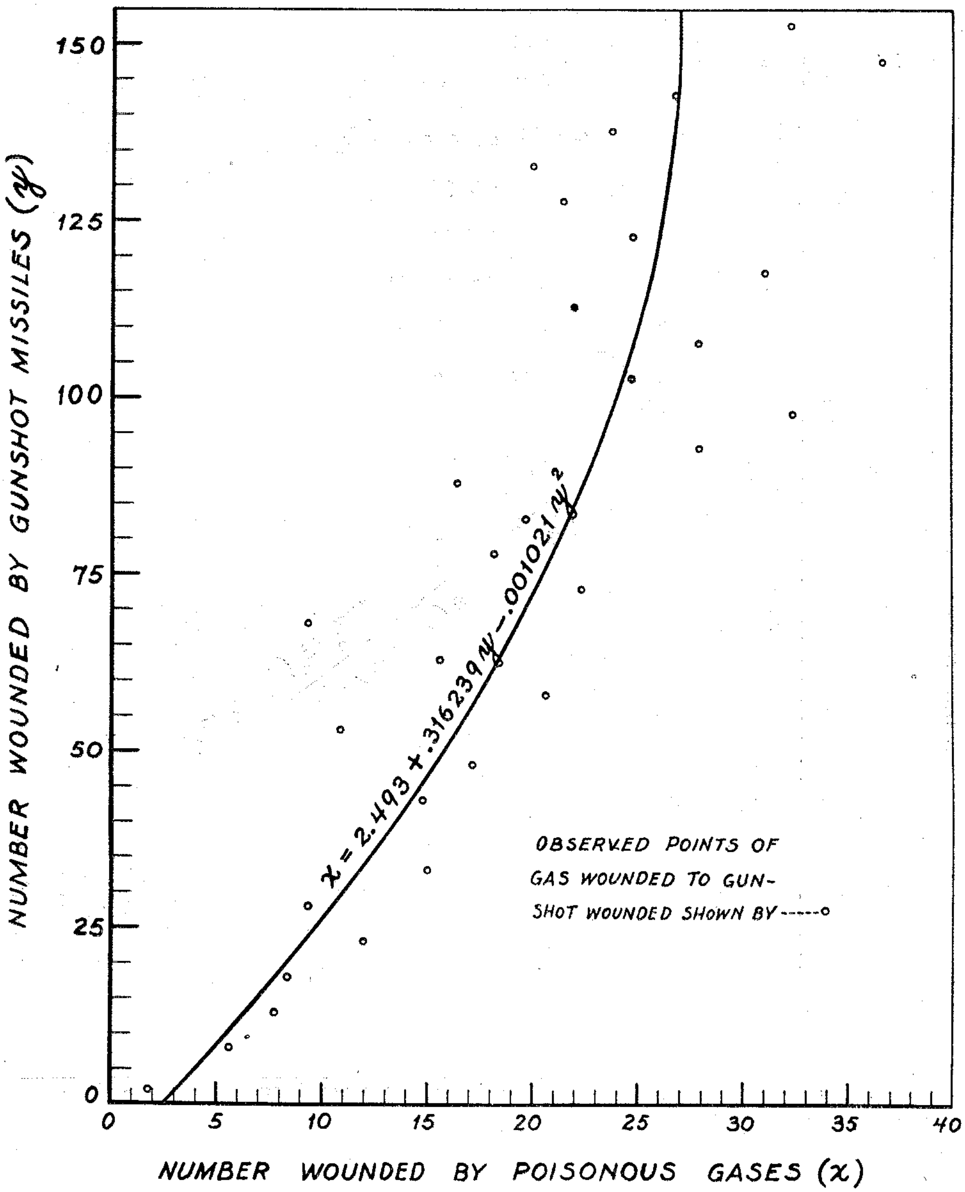


Fig. 99.—Relationship of the number wounded by poisonous gases to those wounded **by gunshot missiles.** [3]

NOTE: The same infantry regiment battle days were used as per Fig. 100. As shown by the graph the number of men wounded by war gases increased at a slower rate than those wounded by gunshot missiles, actually causing a gradual decrease in the number of gas cases per one gunshot case as the latter increases in number. Thus the number wounded by poisonous gases to each one wounded by gunshot missiles was 1.14 when there were 3 of the latter, but only .18 to each one when there was 153.

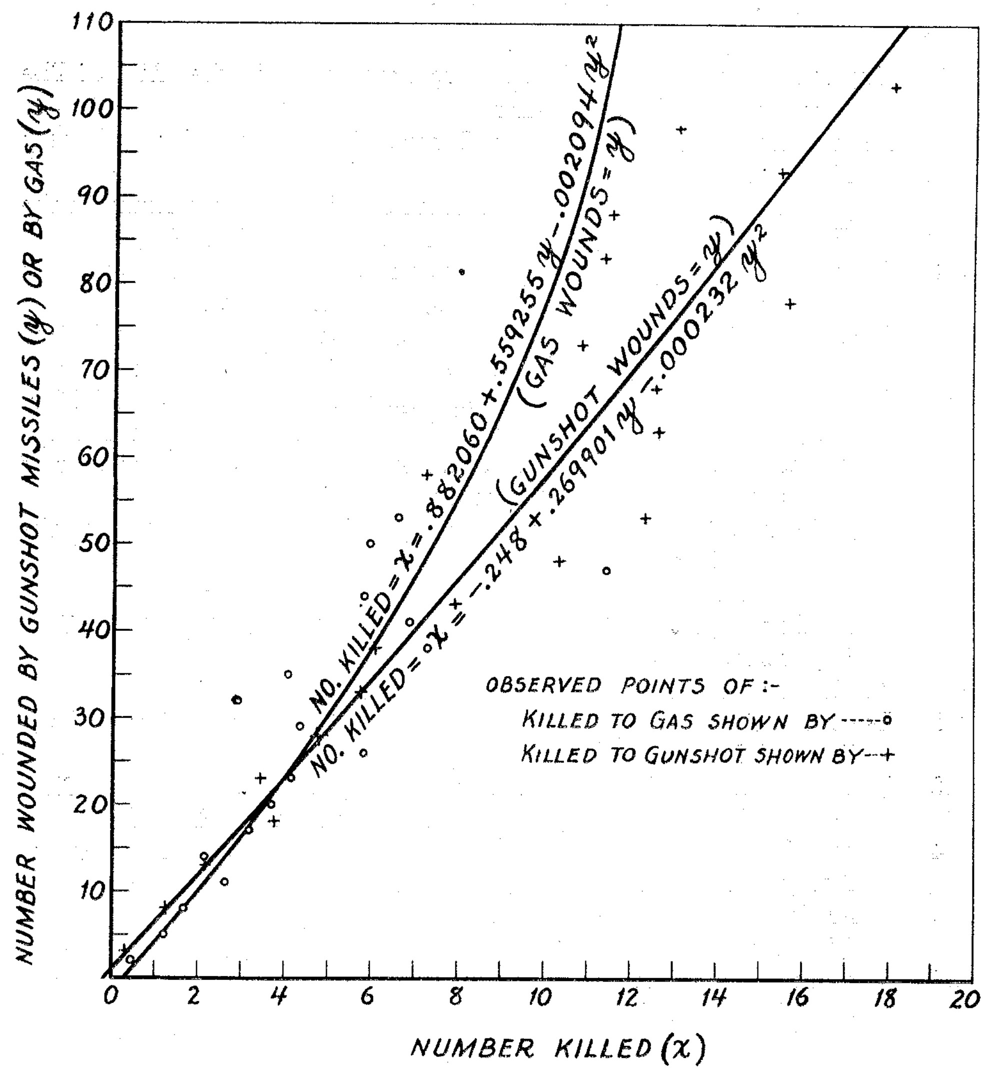


Fig. 100.—Relationship of the number killed by all causes to those wounded by gunshot missiles or by poisonous gases in 6,022 battle days for infantry regiments from Jan. 1 - Nov. 11, 1918. 3

NOTE: The infantry regiments used were those of the following Divisions:- 1st, 2nd, 3rd, rth, 26th, 27th, 35th, 42nd, 78th, 79th, and 80th.

The graduated and ungraduated data for those killed in relation to the number wounded by gunshot missiles were reduced to 68.52% of the total killed, and to those wounded by poisonous gases to 31.48%, which was the same percentage that gunshot and gas wounds were of the total.

The relative number killed decreased 43% as the number wounded by poisonous gases increased from 10 to 100 per infantry regiment battle day; while on the other hand the relative number killed to those wounded by gunshot missiles remained practically constant as the latter increased from 10 to 100.

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Zone of the Interior (See headings for troops in Z. of I., i. e., in U. S.).

ABBREVIATIONS:

A. E. F., for American Expeditionary Forces.
T. of O. for Theater of Operations.
Z. of I. for Zone of the Interior.

Carlisle Barracks, Pa., 11-1-30—2500.