

resulting from the use of celery watered with filtered sewage. Among many similar cases one was lately reported by Ferre in which an epidemic in a school followed the use of vegetables watered with the contents of a cesspool which received the evacuations of the pupils. Watercresses grown in ditches contaminated by sewage have been known to serve as the vehicle for the infectious agent. In 1895 Deshon reported several cases of typhoid, occurring at a western station, which he believed could be traced to the use of heavy, sour and indigestible bread.

Among troops in camp during warm weather the use of food contaminated with the typhoid bacillus, brought from the latrines by means of flies, to whose feet the germs readily adhere, is a factor of the greatest importance in spreading the disease. Numerous observers have detected the specific bacillus in the excrement of flies made to feed on infected material, and colonies of typhoid bacilli have been shown to develop in the tracks of these insects which had been allowed to settle on typhoid discharges and then made to walk over a suitable solid culture medium. Vaughan states that, during 1898, in some of the large military camps where lime had recently been sprinkled over the contents of the latrines, flies with their feet whitened with this substance were seen walking over the food. He also noted that officers whose mess tents were protected by means of screens suffered proportionally less from typhoid fever than did those whose tents were not so protected. When flies are numerous in camp and are constantly settling upon and contaminating all articles in common use, it is easy to see that even if the food and drink be protected from their invasion, an infection may readily be brought about by touching the lips with the fingers or other articles upon which the typhoid bacilli have been deposited. The typhoid epidemics of 1898 gradually decreased with the approach of cold weather and the disabling of the fly as a carrier of the infection. It is well to remember that when a strong wind constantly blows from the same direction, a fly-borne epidemic will extend chiefly down wind, as this insect always rises, and generally moves, in the direction of air currents. Flies lay their eggs in nearly all organic material, especially if this be in a putrid condition. Howard regards horse manure as the most favorable breeding material, but in the camps of 1898 the larvæ were often seen by thousands in illy-policed latrines. Sprinkling the latrines with earth, as ordinarily practised, did not appear to destroy them. Care with respect to preventing organic contamination of the camp space and in carrying out proper measures of latrine disinfection will do much to prevent their development. The life of the fly is short, but the cycle of development is rapid. According to Howard, under favorable conditions the egg hatches in eight hours, the larvæ pass to the pupal state in from sixty hours to three days, while from pupation to the issuing of the adult requires about five days. As the life cycle is complete in about ten days and the individual insect lays about one hundred and twenty eggs at a time, the enormous numbers in which these insects may occur in standing camps are readily accounted for.

Typhoid fever may also be transmitted by aerial infection from drains, water-closets, latrines, dust heaps, urine or fecal discharges which have been allowed to dry on the linen or person or in receptacles. In this condition the bacilli are capable of being carried considerable distances through the air to settle down on water, clothing, or food. It is not yet determined whether the disease can be contracted by breathing air containing suspended bacilli, but certainly in the case of mouth-breathers they should readily find their way to the pharynx and thence be washed into the alimentary canal by the act of deglutition. It is true that complete desiccation soon destroys the typhoid germ, but in practice it is not always completely desiccated, and Flügge and Fischer have shown that the enteric bacillus can successfully resist for a time a considerable amount of drying. Allchin, moreover, states that but a comparatively slight current of air, 4 metres per second, is sufficient to raise germs into the

atmosphere from the surface of liquids or wet ground. The dissemination of typhoid by means of dust was undoubtedly a potent factor in its spread, in 1898, in the camps at Jacksonville and Tampa. In this connection it is interesting to note that, in 1885, the British troops at certain stations in the Soudan used only distilled water, yet typhoid was very prevalent. No reason for the spread of the infection could be shown except that the excreta were dried, converted into dust, and scattered over the camp by the desert winds. In the French army, Nollet was recently able to determine the presence of the typhoid bacillus in the dust of cracks in the barracks at Cherbourg, in which garrison typhoid had prevailed epidemically.

Personal contact also does much to spread the infection, especially among raw troops. Where lack of discipline permits the pollution of the ground in the vicinity of the camps by the indiscriminate deposition of human excreta, a certain proportion of such discharges will assuredly be infected and portions may be carried into camp and tents on the shoes of incautious passers. Uncleanly seats in latrines, or the ground therein, may specifically contaminate the person, hands and clothing of those resorting to them. Where troops are detailed to do the heavier labor about hospitals, as is often the case during epidemics, the opportunity for an infection to be carried back into camp through their agency is often great. The board which investigated the occurrence of typhoid fever in 1898 was struck with the fact that men who were closely associated in the same company or tent almost simultaneously developed typhoid fever, apparently through a localized infection imparted from the same sources.

Heavy rains do much to disseminate typhoid among encamped troops, especially where there is bad sanitary police. Where sinks are dug in impervious soil and are so located as to receive surface drainage, they may be overflowed by storm waters and distribute their contents over the adjoining surface—to be later dried by the sun and scattered as dust by the feet of men and animals and the wheels of passing wagons. During the war with Spain, in camps where the tub system for the reception of excreta was in use, careless handling and transportation by the scavengers resulted in the scattering of fecal matter, much of which was infected, almost broadcast over the camp area.

A fruitful cause of the dissemination of typhoid throughout a camp lies in the fact that no small proportion of soldiers, with mild infections or with ambulant cases of typhoid, either do not go on sick report until the typhoid condition is well advanced, or not at all. In many cases, also, the nature of the comparatively slight prodromal symptoms presented are not recognized by the medical officer, and the case for a considerable period is treated in quarters as one of diarrhoea or similar trifling affection. This is particularly true in cases, noted by Allchin and others as being not infrequent, in which the individual has been exposed to great hardships, and in which the temperature is normal or sub-normal throughout the attack. As already stated, the stools in typhoid fever are probably infective even during the period of incubation, and there are probably a considerable proportion of cases in which an infection does not develop the typical disease, through either an attenuation in virulence of the specific germ or more or less marked insusceptibility on the part of the subject. The experience of French medical officers in Algiers and Tunis would seem to show that apparently healthy persons may long carry the germs of typhoid, which, later scattered under favorable circumstances, develop the disease in others. British medical officers have noted the same in India and elsewhere—particularly during the Afghanistan expedition. Many instances have been recorded also in our own service, especially in the days of Indian warfare, where outbreaks of the disease occurred among troops who had been for weeks in regions that were not known to have ever before been penetrated by man. From these facts army medical officers in all services

have, in the past, favored a theory of the *de novo* origination of typhoid, or of the metamorphosis of the specific germ from the colon bacillus under suitable conditions. It is easy to understand, however, in the light of recent investigations as to the infectiveness of typhoid urine, how the microbe of this disease can be carried with troops for long periods without its presence being suspected, and then give rise to an epidemic when favorable conditions are encountered. Since the period of incubation is twelve or fourteen days—or even in some cases as long as twenty-three days—it is obvious that infected individuals may be passed as healthy and sent to other stations, there to develop the characteristic symptoms of the disease and to serve as the starting-point for new epidemics. This was repeatedly shown to have occurred among recruits sent out from Jefferson Barracks—formerly endemically affected with typhoid fever—to western stations. Further, convalescents from typhoid, returned to duty at too early a date, may be unrecognized but potent agents in the origination of the disease in others. All these classes of cases are particularly a menace to the health of a command under canvas, since by their agency every latrine in the camp may become infected, and the probability of contamination of the camp space, and perhaps tentage, by infected urine and saliva is so great as to approach certainty.

Direct contagion from the obviously diseased to the healthy plays a strong part in the spread of enteric fever. There is no reason for positive belief that the poison is given off in the breath or the emanations from the body, but it is probably contained only in the urine, the faeces and, to some extent, the saliva. If these be properly disinfected and disposed of, if strict cleanliness be observed, and if attention be paid to the disinfection of the soiled linen, the risk of contagion may be reduced to a minimum. Nevertheless, it has not been found possible with all precautions entirely to prevent the spread of the disease to the attendants. During the typhoid epidemics of 1898 the admissions for this disease from the Medical Department and Hospital Corps amounted to 193.41 per thou-

1898 and the decade 1888-97, the rates per thousand of English troops at different stations were as follows:

Station.	YEAR 1898.			DECADE 1888-97.		
	Admissions.	Deaths.	Constantly sick.	Admissions.	Deaths.	Constantly sick.
United Kingdom	1.9	0.22	0.31	1.2	0.24	0.20
Gibraltar	4.2	1.32	.74	5.4	.95	1.05
Malta	21.2	6.38	2.44	6.6	2.48	1.15
Egypt and Cyprus	81.0	23.40	11.12	21.3	4.37	3.90
Canada .....	...	...	...	1.3	.21	.25
Bermuda	15.0	2.31	2.36	84.8	6.28	5.13
West Indies	1.1	.55	.23	9.0	2.15	1.98
South Africa	32.9	55.77	4.88	12.8	1.87	1.93
Mauritius	14.6	4.86	2.37	15.0	5.94	2.15
Ceylon	2.1	1.43	.09	6.9	2.13	.84
China	1.9	.04	.39	1.5	.50	.21
Straits Settlement .....	.7	.71	1.9	.88	.29	.29
India	36.3	10.04	4.90	21.8	5.75	3.12

On averaging together the figures for the two cold stations, the United Kingdom and Canada, for the decade 1888-97, the admissions per thousand strength are seen to be 1.25, the deaths .22, and the constantly sick .22. For the same period the average rates for the remaining stations, located in hot climates or in the tropics, were: admissions, 12.4; deaths, 2.97; constantly sick, 1.92. From these figures it appears that British soldiers in hot climates or in the tropics are almost exactly ten times as liable to contract the disease as those serving in cool climates; while the liability to death from this disease is fourteen times greater. The apparently shorter course run by typhoid in the tropics, as expressed by the rates for constant sickness, is merely due to the higher rate of mortality, by which the elevation of the former figures, through tardy convalescence, is prevented. In our own service, for the year 1898, the admissions for this disease per thousand troops

stationed in the tropical islands were 102.18 and the deaths 13.88; while of troops within the United States during the same period the admission rate was 85.46 and the death rate was 8.79. It should be remembered, however, that troops were exposed to tropical influences but a small part of that year, and that for full periods of service the difference in rates would undoubtedly have been much greater. Within the limits of the United States the influence of locality is marked. The amount of typhoid fever in the Department of Texas is almost twice as high as in any other military department. In 1890 it was more than six times as high as in the departments of the East, California, and Arizona. In 1897 it was fourteen times as high as in California, and much higher than in the other departments. Coustan states that typhoid fever is far more prevalent in Algiers and Tunis than in France.

As to season, the disease prevails especially in our army during the late summer and early autumn. For the decade 1875-84, as shown by the accompanying diagram, the disease occurred least frequently during March and April and prevailed most extensively in August and September. In the French and German armies it prevails to the greatest extent during and after the manœuvres in August and September; in the Austrian army its prevalence is greater during the July manœuvres. Certain notable outbreaks have oc-

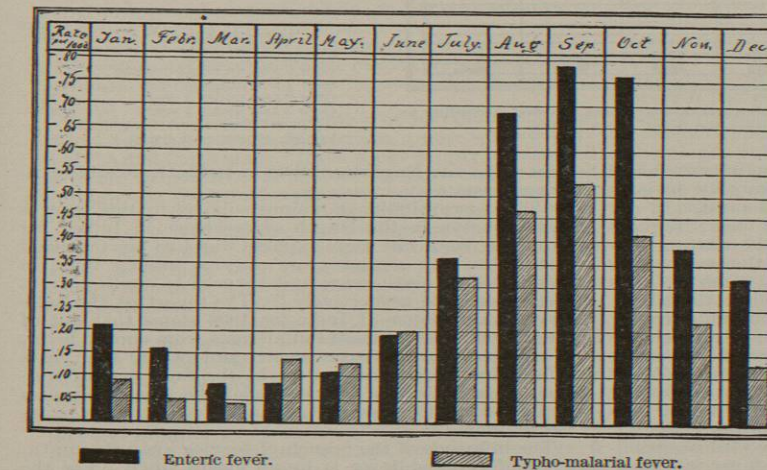


FIG. 1089.—Chart Showing the Distribution by Months, per Thousand Strength, of Cases Diagnosed as Enteric and Typho-malarial Fever, Occurring in the United States Army During the Decade 1875-84.

sand strength, when the rate for the army as a whole was 88.56. This fact specifically demonstrates the immediately transmissible character of the affection.

Causes Predisposing to Typhoid among Troops.—Typhoid fever occurs in all climates, outside the polar regions, but increases in prevalence as the equator is approached. In the British army, distributed as it is all over the world, the prevalence of typhoid varies greatly. For the year

curred in the spring, but these are invariably to be traced to a localized water-borne infection and are exceptions to the general rule.

Military experience shows that an infection of enteric fever often fixes persistently upon a single barracks, post, or district. As a rule, in those localities in which the disease is endemic, it will be found that unsanitary conditions abound; notably impure water supply, defective methods and arrangements for the disposal of excreta, and want of care in respect to preventive measures. In India, typhoid fever has been found to be a more difficult disease to eradicate from military posts than cholera, persisting with great tenacity and recurring year after year in spite of all efforts—and it has even been found necessary to abandon stations for this reason. Within these endemically infected areas newcomers are especially liable to attack, those long resident in such a zone appearing to acquire a relative immunity through repeated mild infections. Great importance was attached by Pettenkofer to the height of the ground water in endemically infected regions; a low ground water, in his opinion, always coinciding with outbreaks of the disease. This relation between the disease and ground water apparently holds true for certain localities only and need receive no serious consideration.

Negroes and other colored races undoubtedly possess an immunity, in their native countries, to typhoid fever. By some this is regarded as a racial characteristic; by others as an acquired immunity resulting from an at-

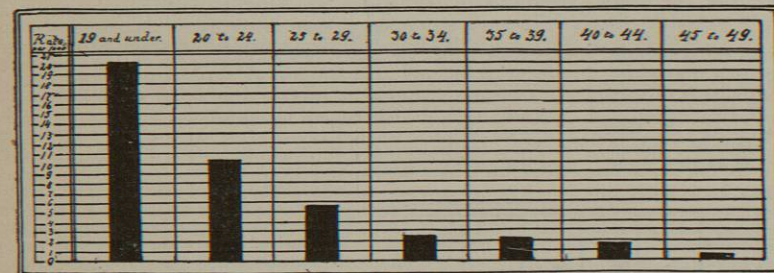


FIG. 1090.—Admissions for Typhoid Fever, per Thousand of Each Class, Divided According to Age, in the United States Army During the Seven Years 1890-96.

tack of the disease during childhood. In India the blood of the natives has been recently shown to give, in most instances, a positive reaction with Widal's test. In our own service the disease is undeniably less frequent among the negro troops than among the whites. For the period 1867-83 the admissions per thousand white soldiers, for typhoid, not counting typho-malarial fevers as then recognized, amounted to 3.58, while the admissions for colored troops were 2.59 per thousand strength. For the year 1887 the admission rate for white soldiers amounted to 4.25, and for colored soldiers .93. During the decade 1887-96 the admission rate for white soldiers amounted to 4.74, and for negroes 2.43. It is interesting to note that for our few Indian soldiers, during this period, the admission rate for typhoid was only .47. During the year of war (1898) the relative insusceptibility of negro troops as regards typhoid fever was especially noticeable, the admission rate being 93.24 per thousand white and 27.64 per thousand colored troops—this, too, in spite of the fact that as a class the negro regiments saw harder service. On the other hand, when the disease has actually occurred the case mortality has been much higher among the negroes than among the whites. Typhoid fever occurs only exceptionally among the native troops in India, and their immunity as compared with the immunity of white soldiers serving in that country has long been noted. As illustrating how great this difference in susceptibility really is, it may be stated that, in 1893, of the forces in India, typhoid fever

was responsible for 1.41 per cent. of the sickness and 42 per cent. of the mortality among the English soldiers, and for only .03 per cent. of the sickness and .4 per cent. of the mortality among the native forces. For the white race, nativity appears to be a factor of some slight importance. In the United States army, during the seven years 1890-96, the admission rate for typhoid fever from the native-born Americans, per thousand strength, was 5.69, for the soldiers of German nativity, 5.41, and for the soldiers born in Ireland, 5.02.

Typhoid fever is especially a disease of young soldiers. How much greater their susceptibility actually is can best be appreciated by reference to the accompanying diagram (Fig. 1090), in which the number of admissions are seen to decrease arithmetically by almost exactly one-half during each five-year period up to the age of thirty-five. Not only are young men more liable to contract this disease, but the mortality, also, among those affected is higher. Thus for the period 1890-96, in our army, the deaths per thousand of each class were as follows:

Age.	Death rate.
19 years and under	3.32
20 to 24	.95
25 to 29	.69
30 to 34	.23

The case mortality for this period was 16.02 per cent. for soldiers nineteen years of age or under; 9.21 per cent. for those twenty to twenty-four years of age, and 8.89 for those thirty to thirty-four years of age.

Length of service, in which factor age must of course be considered to enter, also markedly influences the occurrence of typhoid. The report of the surgeon-general for 1885 shows the relative prevalence of this disease, excluding small fractions, among men of different periods of service, to be as follows:

Length of service.	Percentage of cases.
6 months and under	48.0
Over 6 and under 12 months	16
Over 1 and under 2 years	14
Over 2 and under 3 years	5.5
Over 3 and under 4 years	4.5
All over 5 years	7
Length of service not stated	4.5

In respect to English soldiers in India, Eyre and Spottiswoode state:

"The susceptibility of young soldiers to this fever is clearly shown in the length of residence in India; for while the death rate from typhoid was 4.98 per thousand in the first and second years' service, among those in their third to sixth years and seventh to tenth years it was 1.55 and .55 respectively." The report of the Sanitary Commissioner of India for 1896 states that out of the total number of deaths at all ages from enteric fever, 78 per cent. were between twenty and twenty-four years of age and 36 per cent. were in the first year of residence. In India, the prevalence of the disease appears to depend chiefly upon the amount of susceptible material presented.

The influence of the branch of service upon the prevalence of typhoid fever is by no means small. For the period 1867-83 inclusive, the admission rates per thousand strength were as follows: cavalry, 19; infantry, 4.6; artillery, 2.5. For this period the cavalry thus suffered more than seven times as much from typhoid as did the artillery, and nearly five times as much as the infantry, while its death rate was more than three times greater than either of the others. This great difference was largely due to the active field service against Indians required at that time of mounted troops. For the seven-year period 1890-96, the admission rates per thousand strength were 8.03 for the cavalry, 5.74 for the infantry, and 4.74 for the artillery. In time of peace the personnel

of the medical department is affected less than any of the above arms of the service; but during the war with Spain it suffered more than twice as much as any of them.

Overcrowding among troops certainly predisposes to epidemic typhoid fever; Marvaud gives figures to show that in the French army the mortality from this disease bears a well-defined relationship to the number of men aggregated at a post. In camp, the effects of overcrowding are particularly noticeable. This is perhaps due in part to a lowered vital resistance in the individual, but is probably chiefly dependent on the greater intensity of the infection resulting from the rapid propagation of the typhoid bacillus on a soil more highly contaminated with organic material, on which it possibly acquires more virulent qualities.

Uncleanliness of person and surroundings is a powerful factor in the development of the disease among troops. Particularly is this the case with regard to the care and disposition of the excreta, the most important and difficult problem presented to the military sanitarian in the field. The common method of disposal of excreta and refuse in camp—by pits—offers many facilities for the development and spread of the specific micro-organisms. All collections of filth are liable to contamination and hence to become foci of infection. In garrison the accumulation of organic matter under floors, together with the seepage of moisture as a result of the use of excessive amounts of water in cleansing, affords an excellent medium for the development of the microbe.

The influence of great fatigue as a factor in the occurrence of typhoid has been particularly noted by medical officers in foreign services. The arduous and exhausting manoeuvres which take place yearly in all the larger European armies are invariably followed by outbreaks of typhoid. It is well known that by over-exertion the bactericidal power of the blood is diminished and susceptibility to disease greatly increased. Coustan mentions, as applying in this connection, the experiments of Charrin and Roger, in which rats made to turn a wheel until exhausted succumbed readily to inoculation with an attenuated culture of anthrax, while similar animals not so exhausted resisted the same inoculation.

Insufficient or improper food, through the malnutrition or digestive disturbance which results from its use, may facilitate the invasion of the organism by the typhoid bacillus.

Prophylaxis.—In the prevention of an epidemic of enteric fever among troops in garrison, a pure water supply is of the first importance. If the water supply be regarded as liable to pollution it should, in garrison, be filtered through the Berkefeld apparatus before being used for drinking purposes. In the field, and sometimes in garrison, water is best sterilized by boiling—preferably by the Forbes apparatus. If the water is originally pure, as water in springs, deep or artesian wells, or unpolluted surface waters, it will only be necessary to insure against its contamination before use. With troops in camp, while the water should be good, an early and correct diagnosis of the cases of this disease which first appeared is quite as essential. Since in camps enteric fever is more directly propagated from the sick, and the latter can through their discharges soon disseminate the disease through large bodies of troops, the prompt recognition and isolation of these cases, with the disinfection of their excreta, equipments, tentage, and surroundings, is of the greatest importance. As already intimated, the diagnosis of this disease is frequently a matter of much difficulty and may be impossible in all instances, but constant watchfulness on the part of medical officers will reduce this error to the minimum. The board investigating the typhoid epidemics prevailing during the war with Spain concluded that less than half of the cases of this disease which occurred were correctly diagnosed; but stated its opinion that, in recognizing this proportion, the army surgeon probably did better than the average physician throughout the country does in his private practice. Any such error of diagnosis, however, implies

too great reliance upon the mere clinical symptoms of enteric fever—which, it has been stated, are frequently modified or largely lacking—and a too infrequent use of modern and more precise means of diagnosis, as found in the Widal test with blood serum and the diazo reaction in the urine. It is obvious that under many conditions of military service, particularly with marching troops, the former test can scarcely be applied, but in a fixed camp or garrison it can always be carried out—and the technique of the diazo reaction is possible under any circumstances. These tests should be habitually applied to every case presenting fever the nature of which is not promptly and definitely recognized as being other than typhoid. Since the Widal and diazo reactions may not be given at certain stages of enteric fever, they should be repeated one or more times in possibly suspicious cases.

When typhoid fever is recognized as existing, the affected individual should promptly be isolated. If in garrison, the clothing and bedding of the patient, together with the water-closet or latrine used by him, should be disinfected. If the case occurs under canvas these precautions are required, and in addition the disinfection of the clothing and bedding of those sheltered with him should be sterilized. The tent itself should be disinfected. If possible the camp, or at least that of the company organization in which the case occurred, should be moved. If this be not possible, the site occupied by the infected tent should be vacated, policed and exposed to the sun. It should not again be occupied. In many instances it would, in addition, be desirable to freely scatter fresh lime over the former tent area.

Since many cases of enteric fever in camp will not be recognized, it should be the rule to regard all human excreta as infected, and, where a camp has a permanency of more than three or four days, systematically to carry out measures for the destruction of its presumably noxious qualities. The cost of an epidemic of typhoid will be many times the additional expense of these justifiable precautions. In all camps of any permanency the use of excavated latrines should be prohibited, and either the trough system or crematories, as now used in our army, provided. Under the same conditions, urine tubs should be provided for night use and their utilization enforced. Careful police of the camp, with cremation of refuse, should be carried out, to limit soil contamination and prevent the development of the fly plague. A careful sanitary police is very effective in preventing the development of these insects in very great numbers; but where the plague actually exists the only recourse is to abandon the infected area for a new site, preferably to be located to the windward and at a distance of at least two miles.

Other general methods of prophylaxis consist in the allotment of abundant space in the arrangement of the camp; the free exposure of the interior of tents—and of their contents—to sunlight and fresh air; cleanliness of person on the part of the troops; an abundance of good food and, in time of epidemic, the avoidance of exhausting drills and exercises. It is important that a presumably infected camp site should promptly be abandoned; though if troops be allowed first to become generally infected the procedure is not as efficacious in controlling typhoid fever as in some other diseases.

With respect to the measures to be applied to prevent further spread of the infection from the sick, the proper disinfection of the excreta is of the first importance. All discharges should be received in a solution of milk of lime. The nates of the patient should be cleaned with paper and afterward with a bit of compress cloth wet with a dilute disinfectant solution. The bed pan should be covered with rubber sheeting and removed at once. In garrison, the contents of the bed pan should be thoroughly mixed and allowed to stand for half an hour before pouring into the slop hopper; in the field it should be burned at once. The practice of burying typhoid discharges, after measures of disinfection by chemical means, is strongly to be deprecated. In certain instances all the bacilli undoubtedly will not be destroyed, and it

has been shown that they not only develop in organically polluted ground but may grow upward through a considerable depth of earth. Even if buried deeply there is always a possibility of their future disturbance. Whether in camp or garrison, the cloth compresses used to cleanse the patient should be destroyed by fire. The bed pan, rubber cover, and slop hopper should be cleansed with disinfectant solution, and the two former wiped dry. Both should be placed in a closed receptacle to prevent access by flies. All sputum should be received in spit cups containing a disinfectant solution. Feeding utensils should be cleansed in boiling water immediately after use, and any uneaten remnants of food at once disinfected by burning or scalding. All bed linen, body clothes, and towels soiled by discharges should be immediately rolled in a clean sheet wet in bichloride solution, and removed for appropriate disinfection. Bed spreads and blankets should be sunned and aired as often as possible. They should not be shaken any more than is absolutely necessary. Bed and body linen should be changed daily; rubber sheets should be used over the mattresses. Flies should be kept away from the patient, not only for his comfort, but to prevent the transmission of the disease to others by their agency.

After attending to the wants of a typhoid patient, the hands of the attendant in each instance should be rinsed in a disinfectant solution and then washed in warm water, using soap and a nail brush.

The urine of patients convalescent from this disease should be examined at frequent intervals for the typhoid bacillus. Return of convalescents to duty or quarters before this bacillus has been absent from the urine for at least one week should not be permitted. To effect the sterilization of the urine, where this bacillus is present, Richardson and others recommend the use of urotropin, in doses of gr. x. three times a day. Salol and other substances appear to have little value for this purpose.

Preventive Inoculation.—The problem of preventive inoculation against typhoid fever, now receiving much attention, has a special importance for the military sanitarian. Bokenham endeavored to produce a prophylactic and curative serum by the immunization of horses through the repeated injection of living and dead cultures of the bacillus; but the serum thus obtained was not of sufficiently great potency to give it a practical value, and no means could be found of precipitating or concentrating what strength the serum contained. Pfeiffer, Wright and Semple, and others, then endeavored directly to produce in man the immunity which it was shown could be created in animals. At first these investigators cultivated virulent cultures on agar, making up an emulsion of these cultures with bouillon so that each cubic centimetre contained about 2 mgm. of fresh agar growth. The microbes were then killed by exposure to a temperature of 56° C. for several hours. Of this emulsion 1 c.c. was used as a dose, the liquid being well shaken. Recently Wright has attained more satisfactory results by cultivating the bacilli directly in bouillon. After incubation at 37° C. for a period of from fourteen to twenty-one days, the culture is sterilized by exposure to a temperature of 60° C. for five minutes. This is done by drawing the emulsion into small sterile tubes, which are sealed and placed in a beaker of cold water which is gradually raised to the desired temperature, and this is maintained for the period above noted. Agar tubes are then inoculated with the material to make sure of its sterility. Before injection, .5 per cent. of lysol is sometimes added to neutralize any accidental contamination. The amount used for human inoculation is two-fifths of the minimum amount which would be fatal to a guinea-pig weighing 250 gm. The immunizing material appears to be valuable rather on account of its antimicrobial than its antitoxic properties.

While the reaction following the inoculation is usually slight, it is at times somewhat severe. Rigors, nausea, and a tendency to syncope sometimes occur. There is a well-marked local reaction, which, however, never advances to suppuration. Where the inoculation is success-

ful, the blood serum acquires the specific agglutinative property to a marked degree. Cameron found in his own case that at the end of twenty days the agglutinating power of his blood serum was increased forty times; and an increase to this extent has been shown by other observers to be a common result. In general, the agglutinating property is equal to that conferred by an attack of the disease itself. It is not known how long the influence of the inoculation persists; and when a protection lasting more than two years is desired, it is recommended to insure a good reaction by repeating the inoculation after an interval of one week.

At present, experience with these inoculations has not been sufficiently comprehensive to warrant the drawing of exact conclusions. The inoculations have been carried out on a considerable scale, however, with the sanction of the British military authorities, on soldiers voluntarily submitting to the operation before leaving for the recent scene of hostilities in South Africa. Foulerton states that reports so far received from South Africa show that typhoid fever has occurred at the rate of six to the thousand among the inoculated and nine to the thousand among the uninoculated. Figures given by Wright based upon 11,295 British soldiers in India show that .95 per cent. of the inoculated contracted the disease where 2.5 per cent. of the uninoculated were attacked. These results, while not brilliant, are certainly encouraging, and render the method well worthy of general use among young soldiers; particularly since the inoculation, when properly performed, is quite free from danger.

TYPHUS FEVER.—Occurrence.—A chapter might be devoted to the historical pathology alone of typhus or spotted fever. The disease is as old as the disputes of nations, and has prevailed in formidable epidemics among troops in the field from 400 B.C. down nearly to the present time. During peace it has always been of comparatively subordinate importance, although its occurrence in armies has given rise, from time to time, to disastrous outbreaks among the civil population. It is known to have prevailed during the Peloponnesian war; and in 1489 it destroyed 17,000 of the troops of Ferdinand at the siege of Grenada. In 1528, at the siege of Naples, over 5,000 of the French nobility lost their lives from typhus in a period of about three weeks, and the French army of 30,000 men was almost destroyed. In 1542, in the German army at Ofen, according to Hauser, typhus claimed 30,000 victims. Before Metz, in 1552, the besieging Spanish army lost 30,000 men in less than two months, compelling the abandonment of the siege. The roads taken by the retreating army were said to have been lined with the dead and dying. In 1556, it decimated the army of Maximilian II. In 1620, the Bavarian troops serving in Bohemia lost over 20,000 men from spotted fever. In 1628 and 1632 the disease ravaged the Swedish army. Both the Royal and Parliamentary armies in England, in 1643, suffered severely; in the wars of Louis XIV. it caused enormous losses in the French army. At the siege of Torgau in 1760, it is said that over 30,000 men, out of a total of 35,000, died of this disease in a few months. Typhus is reported as having been one of the great factors in the mortality of our troops during the Revolution; and in 1790 the losses among the Russians from this disease were so great that operations against the Turks had to be suspended. In 1799 typhus decimated Genoa and the French force besieging it. The greatest recorded ravages of this disease, however, occurred during the wars of the first Napoleon. At Saragossa, out of 100,000 people, 54,000 died, chiefly from epidemic typhus. At Dantzic and Wilna, in 1803, and during the retreat from Moscow, vast numbers of French troops are recorded as having perished from typhus. In May, 1812, the Bavarian allies of the French mustered 28,000 men; in February, 1813, it is said that this disease had left but 2,500 to bear arms. In August, 1813, the first Prussian army of 60,000 men had lost one-sixth of its strength from an epidemic of typhus. Murchison states that in Mayence alone, of the 60,000 French troops composing the garrison in 1813-14, no less than 25,000

died of typhus in six months. According to Rawlinson, of the French armies around Paris, after the retreat from Russia, 40,000 men are recorded as having died of typhus in six weeks, one-fifth of the remaining force being sick. This disease raged in all the contending armies during the Crimean War, particularly among the French troops. Aitken says: "In the spring of 1856 it was computed that more than 17,000 men of the French force perished in less than three months, chiefly from typhus." Baudens declared that of the typhus cases in hospital in February, 1856, two-thirds were devoted to certain death. The deaths during this outbreak among the French medical officers amounted to 48, and there was scarcely one that escaped attack.

Typhus undoubtedly did not occur during the Civil War, although there were a small number of cases diagnosed as this affection. These were undoubtedly fulminant typhoid. It prevailed among the French troops in Mexico, especially on board the ships which conveyed the colored contingent from North Africa. Coustan says that the French troops in Mexico "suffered a cruel loss." In 1862-63, and again in 1867, typhus attacked the French garrisons in Algeria; Marvaud stating that of one body of 3,500 troops, 1,200 died. Its existence during the Franco-German War in 1870-71 is disputed. During the Russo-Turkish War in 1878 it was said that at one time the cases of typhus were so numerous in the Turkish army as to threaten its disorganization, and the conditions in the Russian army were not much better. After the capture of Plevna, according to Coustan, 50,000 men out of a total of 120,000 died during the period of inactivity, and in May and June of 1879 it is stated that half the Russian forces near Constantinople were prostrated with this disease.

Typhus, in the military service, is essentially a disease of camps and sieges. Of late years typhus has lost much of its dangerous character. Its geographical distribution is not great, and at present, in time of peace, it occurs only among troops stationed in Southeastern Europe, where the disease is endemic. In the Russian army for the period 1890-97, the rates per thousand were as follows:

Year.	Admissions.	Deaths.
1890	0.6	0.04
1891 .....	.9	.07
1892	1.8	.14
1893 .....	..7	..05
1894 .....	.7	.03
1895 .....	.3	.02
1896 .....	.3	.02
1897 .....	.2	.02

In the Austrian army there were 9 cases in 1897, 4 in 1896, and 8 in 1894. There has been no well-authenticated outbreak of this disease in our army within the past half-century. A number of epidemics of typhus have, however, occurred in the civil population of the country—the infective agent being in every case imported from abroad.

Direct and Predisposing Causes.—The specific exciting cause of typhus fever has not as yet been isolated, though undoubtedly such a factor exists. Recently, in Russia, it is said that the disease has been experimentally produced by inoculation with the blood of typhus patients. It is universally admitted that the most important influences predisposing to its epidemic occurrence are want, misery, and hardship. Typhus appears to be largely favored by overcrowding and lack of proper ventilation. Cold weather, as shown in the Crimean War, indirectly promotes its occurrence among troops for these reasons. Viry notes that typhus was prevalent in public institutions in the city of Metz, in 1870, when it did not appear among the French troops living in shelter tents just outside the walls. Poor food, dampness, fatigue, and other conditions lowering the resistive powers—together with psychical depression—have much to do with epidemics of this disease.

Typhus fever is highly contagious, in the strict sense of the word; and there is probably no disease which has been proportionately more frequently contracted from the sick by their attendants. At Plevna, nearly all the medical officers were attacked; during the Crimean War 12.8 per cent. of medical officers and only .4 per cent. of line officers, among the French troops, died from typhus. The specific virus appears to be distinctly transmissible from the sick to the well through the surrounding atmosphere. While nothing is known of the causative agent, infection appears to occur by way of the air passages. The poison may be harbored by and carried from place to place in fomites. Jacquot, in speaking of typhus in the Crimea, says that "wherever troops affected with typhus have camped, the dejections and excretions which have saturated the ground are fatal to troops which follow them." The morbid agent appears to exist long in infected clothing and dwellings. The activity of the specific virus is favored by unsanitary conditions, and where the disease is introduced among troops which are poorly nourished and clothed and living under conditions implying overcrowding, there is every likelihood of an epidemic outbreak of the fever. The incubation period is variously stated at from six to fourteen days, though there appear to be some well-authenticated cases in which it was not more than from two to five days. The disease is most common during the period of youth and early maturity, as found in young soldiers; but the mortality is lower than among those of greater age.

Prevention.—It is manifest that the prophylactic measures against the disease are those that aim to prevent its introduction from without, and those that are designed to eliminate all local conditions favorable to its development. Quarantine against infected points should be rigorously maintained. When the disease occurs among troops in garrison, the sick and well should promptly be placed under canvas; for the influence of fresh air upon the virulence and vitality of this disease is undoubtedly of the highest importance. The command, if large, should be broken up into smaller bodies. Especial attention should be given to the prevention of overcrowding, to insuring the abundance and proper preparation of food, to the avoidance of fatiguing exercise, and to the maintenance of strict sanitary police. Careful watch should be kept for suspicious cases, and these should be at once isolated. It should not be forgotten that the aggregation of large numbers of the sick increases greatly their mortality, as well as the danger to the attendants. Tent hospitals should preferably be used, the supply of fresh air being unlimited and the floor space allowed to each patient being about two hundred square feet.

As the contagion is especially virulent near and about a patient, attendants should avoid inhaling the emanations or exposing themselves unnecessarily to such inhalation, unless protected by a previous attack. They should not stay in the immediate vicinity of typhus patients longer than necessary and should never sleep in a ward. They should take plenty of sleep and good food, and should frequently employ disinfectant solutions on the face and hands. The attendants, like the sick, should of course be quarantined. Careful disinfection of bed and body clothing and excreta is always called for. The barracks or wards, as well as all articles of furniture, clothing, or equipment contained in it, should be disinfected and thoroughly aired after removal of the patient.

YELLOW FEVER.—Occurrence.—Yellow fever is essentially a disease of tropical and sub-tropical countries, and is ordinarily restricted to well-defined geographical limits. Bodies of troops serving within these limits for any length of time have uniformly been more or less affected by it. In 1648, "there occurred in Havana, and in the fleet of Don Juan Pujados, a great pest of putrid fevers which remained in the port almost all summer. A third part of the garrison and a larger part of the crews and passengers of the vessels died." The disease was extremely fatal among the British troops which subsequently captured Havana; and it is interesting to note