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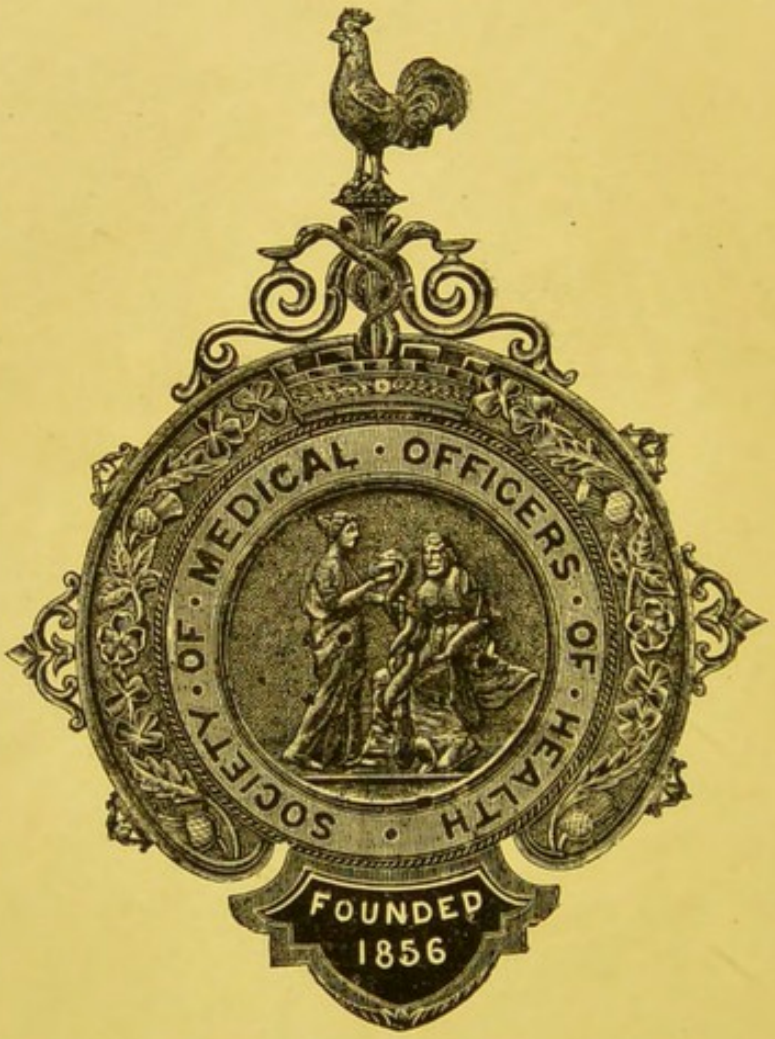

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ON THE

SANITATION OF ARMIES

ON ACTIVE SERVICE

IN THE FIELD.

BY

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NOTE.

THE subject matter of this essay, so far as it embodies personal investigation, is based upon experience, partly in the combatant ranks and partly in the medical service, in the recent war in South Africa. The delay in its preparation has been particularly due to the mass of material bearing upon the medical aspects of that war which has demanded consideration and review; to the rapid progress which has of late been made in the investigation and in the knowledge of those diseases which are the scourges of armies on field service, attaining on campaign an epidemic prevalence never now exhibited in civilised countries in times of peace; and to the facts that the statistics of disease and mortality in the Anglo-Boer War are only now (and as yet but partially) available, that very recently there have been published the sanitary records of the Spanish-American War of 1898—a most valuable contribution to the subject—and that an object lesson illustrative of the most perfect methods of military hygiene has been furnished by the war between Russia and Japan in Eastern Asia.

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CHAPTER I.

INTRODUCTION.

IT is a commonplace of history, corroborated and confirmed by the experience of almost every campaign, alike in civilized and uncivilized countries, no less in modern than in ancient times, that disease is a more potent element in warfare than the weapons of the enemy.

In every war—save only two—of which authentic and accurate records have been preserved, it has been found that the cases of death and disablement caused by disease have far outnumbered those due to lance or bayonet, shot or shell. As a factor in the success or failure of military operations, it has ever proved that the germ is mightier than the sword.

Innumerable are the proofs of the enormous influence exerted by disease upon military history; it will be sufficient to select for purposes of illustration a few instances from among the most famous or from those which were fraught with the most far-reaching consequences.

Clearly of the nature of epidemic pestilence was the calamity which overtook the Assyrian army under Sennacherib, when 185,000 were estimated to have perished within a brief period, so that the projected invasion of the cities of Judah had to be abandoned (1).* Xenophon has graphically told of the ravages of dysentery and allied maladies in the army of Xerxes in the fifth century B C. and of the political results which followed (2). The long struggle for supremacy between Rome and Carthage was interrupted again and again by epidemic illness so extensive as to cause a temporary cessation of hostilities (3). In our own country, the defeat of the Roman expedition into Caledonia under Septimius Severus, A.D. 208, was brought about far more by outbreaks of fever among the troops than by the physical difficulties of the country or the resistance of the natives, 50,000 out of a total of 80,000 men falling victims to disease (4). Later, it was the Romans who were befriended by the occurrence of pestilence, the conquest of their capital being averted and their empire saved by a widespread epidemic of malaria among the invading Gauls under Brennus (5). Before the battle of Agincourt, the English army in France had been reduced by the effects of illness, and particularly of dysentery, to one-fourth of

*Numbers within brackets indicate the authorities referred to. See list, page 80.

its original strength (6). Doubtless it was the conviction that only a victory could save the remainder that prompted King Harry to engage the enemy with such a meagre and disproportionate force and so to win for his country its most remarkable success in arms. As factors in the fate of nations, turning the tide of history and arresting its current, all these instances yield in importance to the brief campaign between the Prussian army and the Revolutionary troops of France which culminated in the battle of La Lune and the victory of the forces of the New Republic in 1792. Here the invading force had every advantage of numbers, enthusiasm, morale, and training. Opposed to it was a rabble, undisciplined, ill-assorted and incoordinate, without experience and without much stomach for a fray. All these disadvantages, however, were outweighed by the possession of health. The Prussians were decimated by disease, and even those who were exempt were exhausted and debilitated by rain and cold and hunger, broken by hardship and privation. The battle was decisive; the campaign was ended; the reign of the guillotine was assured! (7, 8).

These catastrophes of war impress us by their magnitude; but it is only within the last hundred years that observation has become so generally minute, reports so precise, and statistics so reliable that we have been enabled to grasp and to study the figures of campaign mortality with any degree of accuracy or numerical perspective.

Fortunately for the welfare of the British nation, the death-rate from disease in the Walcheren expedition of 1809 has never been exceeded. In this notorious campaign, 347 per 1000 died of illness while only 17 per 1000 died of wounds. In the Peninsular War, despite the terrible slaughter at the storming of Badajos, at Ciudad Rodrigo, and elsewhere, the deaths from disease were three times more numerous than those from injury inflicted by the foe. Despite the vigour of the troops, the annual number admitted to hospital was twice as great as the total number in the field! In the Russo-Turkish war of 1828, 80,000 died of disease as opposed to 20,000 of wounds. In General Scott's campaign in Mexico, one-third of the total force engaged perished of epidemic illness; while later, in the French war in Mexico, the deaths from disease outnumbered the deaths in battle in the proportion of 29 to 10.

In the Crimea, among the British troops, those who succumbed to disease were one and a half times as many as those who were killed in action. Among the French troops, out of a total of 301,000 engaged, 75,000 died of disease, and only 20,000 of wounds. Disease claimed more than one-fourth of all the French medical officers who served in the war. In the same campaign,

during a period of six months, the Allies lost 52,000 men, of which only 2000 were killed by the weapons of the enemy! In the Civil War in the United States, with its enormous mortality of over 500,000 men in five years, the disease death-rate shows a similar preponderance. The ratio borne by the number of those fatally injured to the total death-rate being only one-fourth among the Confederate troops—less than one-third in the army of the North. In the war between Austria and Prussia in 1866, the numbers were less disproportionate, owing chiefly to the brief and decisive character of the contest. The Prussian army lost 4450 in battle and as the result of wounds therein sustained, 6400 from disease; and it is noteworthy that the mortality from wounds was exceeded by the number of deaths due to cholera alone. In the Russo-Turkish war of 1878, the losses were respectively 16,000 from wounds and 86,000 from disease. In the Spanish-American war of 1898, during a short campaign of only five months, out of 275,000 men enrolled in the United States forces, fully 2,500 fell victims to disease, while only 345 were slain. In the French expedition to Madagascar in 1895, only seven men were slain, while no less than 7500 out of 23,000 engaged (almost 33 per cent.) succumbed to maladies contracted on service (9, 10, 11, &c.)

The figures quoted above refer invariably to the average of armies. It is impossible to refer at any length to the statistics, remarkable though they may be, of particular regiments and units. As an example there may be mentioned the fate of the Cameronian regiment which, in the first Chinese war, lost one-half its total number from sickness chiefly of a preventable nature (12).

The figures of mortality and morbidity in the South African war of 1899-1902 demand special consideration. The campaign embraced a period of thirty-three months. Precise figures are not yet available, but with close approximation to accuracy, it may be said that the death-rate from disease was 69 per 1000 of total engaged, while that from wounds was 42 per 1000. Excluding the cases of immediately fatal wounds, we find that the cases admitted to hospital from sickness outnumbered those admitted with wounds by 20 to 1 (450,000 and 22,000 respectively). Of those admitted to hospital on account of disease, 74,000 were cases of either Enteric Fever or Dysentery; while of the total number of 14,800 deaths from disease, 9246 were ascribed to one or other of these causes (12). Thus are brought out the remarkable facts that one-sixth of the total admissions to hospital on account of disease and two-thirds of the total numbers of death from disease were ascribed to maladies which are all but entirely due to defective sanitation, and that the cases of death from these

diseases considerably outnumbered the total killed by the fire of the enemy.

I have referred above to the two exceptional campaigns in which the disease-death-rate was lower than the wound-death-rate. The first of these was the Franco-Prussian war of 1870-71. In that conflict the deaths from disease were 18·6 per thousand, the deaths from wounds 33·7 per thousand. Various factors combined to bring about this unprecedented result. The campaign was of very short duration; the troops were, for the most part, in continuous and rapid movement; the season of the year was favourable. There is no doubt, however, that to an excellent and efficiently administered scheme of sanitation, no small part of the creditable result must be ascribed. The other case of exceptional statistics of campaign mortality is that of the recent war between Russia and Japan. Exact figures cannot be expected yet awhile; but the Japanese estimate of 15,300 deaths from sickness against 57,150 killed in battle or subsequently dead of injury may be accepted as not far from the truth. In this case there were no advantages derived from a short campaign, favourable weather conditions or rapid movements of troops; all these elements, indeed, were conspicuously absent; so that the remarkable triumph of sanitary methods on the part of the Japanese army gains in interest, in importance, and in hopefulness for the health of armies in future encounters, the more earnestly and carefully it is studied (13).

In civil life under ordinary conditions the offices and efforts of the sanitarian may be regarded from two standpoints. They may be viewed from the practical and utilitarian aspect of the economist who recognizes that disease and death are ruinously wasteful and that, other things being equal or even approximately so, the healthiest is also the wealthiest community; or alternately, they may be regarded from the point of view of the philanthropist—a sentimental point of view, it may be, but identified with the highest sentiment in human nature—who would attack and resist disease and death because they are inevitably accompanied by suffering and grief.

In war, also, the work of the Sanitary Staff may be regarded from two very diverse points of view; but, in view of the nature and the object of warfare, it will be universally conceded that the humanitarian aspect must take a secondary place. The very existence of a sanitary staff, the importance of an efficient sanitary administration, is based upon the urgent need of maintaining armies and their individual components in the best condition for the performance of the special work for which troops are raised and trained. It must be a satisfaction to the military sanitarian that pain, anxiety, and sorrow are diminished

in proportion to the success of his labours; but it should be kept in mind that such happy issues are not the objects for whose attainment he exists. It can never, indeed, be wisely or logically forgotten that he exists primarily for a strategic and not a philanthropic purpose.

It is from the strategical point of view, therefore, that in this essay the question of the Sanitation of Armies on Active Service will be considered.

Among the elements tending to the successful administration of a military force and to the due, speedy, and economical accomplishment of its object, the first place must be unhesitatingly awarded to an able strategy and skilful tactics; only second in importance is an efficient drill and discipline of the elements of which such a force is comprised; the third place must be given to an adequate and provident commisariat. The function of the sanitarian, though of no mean importance, cannot claim to take precedence over any of these.

Only by a frank recognition of the relatively subservient place of sanitary affairs in general military matters can there be brought about any real or lasting improvement in the conduct of campaign hygiene or, as a result, in the health, well-being, and physical efficiency of troops on active service in the field. He who advises the application of theoretically perfect methods of isolation, disinfection, and refuse-destruction to the procedure of actual warfare will never be listened to by the experienced. He who does not admit that in warfare all other needs must yield to strictly military needs will never be heard by the soldier. "Sometimes the prevention of disease in the army and the care of the wounded are written about as if they were the objects for which the whole military service existed" (14). Such writers fail to recognize that "the main object of a General in the field is to conquer the enemy" (15). They urge counsels of perfection, making no allowance for human nature, human indifference, human fatigue; saying in effect, "Boil, filter, bury, and sterilize whether the war goes on or not." They forget that "it may be the duty of a good General to undertake operations which involve the sacrifice of a portion of his force to disease if the object he has in view cannot be otherwise accomplished, just as he necessarily loses men in taking a position from the enemy" (14). But while it is true that there may be, that there have been, occasions when sanitary precautions must be disregarded or at least relegated to a very subsidiary place, it is no less true that there have been (and doubtless will again be) critical periods when the whole aspect of a campaign, the whole result of a war, has depended less upon the general plan, the bravery and steadiness of the troops or even upon their pre-

ponderance in numbers or advantage of position than upon a well-organised and well-administered scheme of sanitation.

A general prevalence of sickness among troops affects their efficiency (and thus the whole conduct, course, and outcome of the conflict) in three ways, in each case by causing absence from duty. It should be noted, however, that the reduction of efficiency is not proportionate to the reduction in numbers; thus a force of which one-tenth part is incapacitated by illness is by much more than one-tenth part reduced in value to its commander. Such reduction of strength of an army or regiment is due in part to death, in part to unfitness for duty resulting from present or past sickness, and in part to the necessity for detaching a number of men from strictly military duty that they may undertake sick nursing and sick transport.

As regards reduction of efficiency by death, its effects, especially upon armies on active service and far from their base of operations, are much more severe than if the dead had never existed. Thus there is absolute loss of the money, time, and effort expended upon their training in arms, their preparation for warfare, and their transport, it may be a great distance, to the area of campaign. Their loss may occur at an inopportune time when their places can only be filled with much difficulty and after disastrous delays. Further, the occurrence of fatal illness is not without injuriously depressing effect upon the survivors; and not infrequently—especially with cases of such zymotic disease as abounds on field service—the dead have been a source of very real danger to the living.

Despite what has just been written, absence from duty from disease is of considerably more serious import as regards military efficiency than absence owing to death. Strategically, the sick are a serious source of embarrassment since they cumber transport and hinder progress. From the point of view of supply, the presence of sick on campaign is a yet more serious factor. Apart from drugs and appliances, they require more (and more varied) rations and more clothing than the healthy and their requirements are more urgent. In times of strain upon the machinery of transport and supply it is a question whether one sick man or five sound shall have to put up with a diminished ration. The places of the sick in battery, company or squadron must be kept open although the prospect of recovery and the duration alike of illness and of convalescence may be extremely uncertain. Further, the zymotic sick are a source of danger from dissemination of infection not merely during illness but for a long and ill-defined period thereafter. Thus apart from all question of sentiment and finance (matters neither of which is intrinsically unimportant), and from the merely tactical point of

view, sudden deaths, as from gunshot or cholera, are much less disconcerting than slow, even if not fatal, attacks of dysentery or enteric fever.

The third factor through which epidemic disease militates against the effectiveness of troops is by causing the detachment of healthy men to guard and tend the sick and to convey them to hospital. That these men are, in most modern armies, specially enlisted, that they are not drawn to any great extent from the fighting strength, does not concern us. Equally do they require to be supplied with rations, with shelter, with kit, with fuel, with water, and with transport for their own impedimenta; thus mobility is hindered and celerity of movement, so ardently desired by Commanders-in-Chief, is rendered impossible.

Sufficient has been said by way of preamble. It has been shown by overwhelming evidence that in almost every campaign, great or small, short or protracted, the mortality from disease which theoretically can be, and in practice has been to no small extent, prevented, exceeds the mortality from wounds which is an essential, an intrinsic element of combat. It has been shown that disease is important as destructive of military efficiency apart from and far beyond the actual number of the deaths which it entails; and that, as a factor in determining the results of hostile operations, disease, and particularly infectious disease, transcends all other factors in potency. How, therefore, to prevent and control such campaign sickness is obviously a study worthy the most earnest attention and labour of the sanitarians of every country; but most of our own country, whose great possessions, colonies and dependencies, in every quarter of the globe and not least in those tropical lands whose conditions favour the rapid extension of zymotic maladies, render it supremely essential that we should never cease to elaborate and perfect our preparations for warfare so that, when need arises, our troops may fight under the most healthy, which are also the most successful, conditions.

Chapter II.

THE DISEASES OF CAMPAIGN.

"Know how the diseases" (of campaign) "are produced, and you will know how to prevent them" (9).

As in the hygiene of the household and of the community under ordinary conditions, so with the sanitation of war; methods may be divided into those which are calculated to prevent the occurrence of disease and those which are devised to check the prevalence and hinder the extension of disease which has occurred. Ventilation and drainage belong to the former class, disinfection and isolation to the latter. Frequently the measures projected to achieve these separate purposes will be identical, precautionary in the one case, obligatory in the other; nevertheless, the division of the groups as regards intention is not only convenient but sound.

Before proceeding to discuss what is possible, what is effective, and what is essential, in the way of preventive procedure under campaign conditions, it will be requisite to consider with some fulness the actual diseases of armies on active service; to consider especially such aspects of their natural history as are associated with their excessive prevalence in time of war, and such features in their epidemiology as may be turned to advantage by those who would combat their ravages and restrict their dissemination.

I propose, then, to discuss in the first place the diseases which are especially prone to attack troops and thereby diminish their efficiency under the conditions of warfare; thereafter to study the measures of disease prevention which have proved and are likely to prove effective and practicable on active service; and finally to consider the procedure which seems best calculated to prevent the extension of disease which, having run the gauntlet of preventive methods, has actually invaded a campaigning army.

"There are no diseases peculiar to the soldier" (10). It will be necessary, later, to investigate the truth of this assertion somewhat fully; meanwhile, it may be confidently asserted that the maladies of troops are those which are found in civil life among men of the military age and class. The diseases affecting

the efficiency of a fighting force may be divided into seven classes, of which the first far outweighs in gravity all the other six combined. These are :—

1. Diseases of the zymotic type.
2. Diseases due to vicious habits.
3. Diseases due to atmospheric conditions or associated therewith.
4. Diseases due to defective or unsuitable food.
5. Diseases due to the conditions of military service.
6. Diseases due to parasites.
7. Diseases secondary to wounds.

It will be necessary to pass each of these classes in brief review.

Generally speaking, all the conditions which determine the occurrence or incidence of infectious, preventable, or epidemic illness in civil life prevail also among campaigning troops. In addition there are other factors worthy of careful consideration which are not found in a state of peace.

First: there is a gathering together in close proximity of men who are of the age specially susceptible to the specific fevers. These men are ignorant and careless by training, brought into close personal contact, and frequently overcrowded.

Second: these men are inevitably in a state of mind which fosters their natural carelessness and indifference. They have taken their lives in their hands. Their expectation of life is very uncertain. At any hour they may be called upon to face great danger. It is only to be expected that they will not greatly bestir themselves to guard against the remoter risks of infection. (20). I have heard officers of education and experience confess considerable sympathy with this mood; that it permeates the ranks and is a trait of no small significance is not to be denied.

Third: these men are subject to exhausting conditions of life. Exposure, hardship, and fatigue are their daily portion. The food is monotonous, frequently of poor quality, often deficient in amount. These depressing conditions not only lower the physical resistance of the body to the entrance of pathogenic germs, but also increase the mental indifference above referred to.

Fourth: these men dwell perforce amid specially insanitary surroundings, under conditions which would not be tolerated in an enlightened country in peace time. Camps hastily pitched and destined for residence for but a few hours or days are, through unforeseen military necessities, occupied for protracted periods. In the full expectation of but a brief stay, neither is the camp site carefully chosen nor its soil protected from pollution. When a prolonged detention is seen to be inevitable it is too late to remedy the evil. Further, the risks of warfare and the need

of economising effort equally urge that the camp be compact. Latrines, therefore, (privies of most primitive type), slaughtering-places, and cooking-places have all to be within a moderate compass, certainly within easy flight of the common house fly and green-bottle fly. Yet again, in the camps of cavalry and mounted infantry, military exigencies make it essential that the men of each squadron should camp or bivouac in close proximity to their horse lines. With these difficulties to encounter it is impossible to reach a high standard of sanitation. He who, in such matters, preaches counsels of perfection helps no one; he who recognises the impossibility of achieving ideals is alone qualified to give practical, valuable help.

Fifth: even where the sites of camps are deliberately chosen with a view to the possibility of prolonged occupation, tactical necessities often preclude the selection of the healthiest or even of a moderately healthy situation. Marshy areas may be deliberately fixed upon, the risks of malaria being preferred to the risks of shell-fire on a more exposed position. Frequently, and especially with mobile columns and troops in contact with the enemy, all choice of site is precluded. In an arid country, like the western Transvaal, the provision of water supply for men and animals may compel a force to select for its bivouac the situation which has been utilised for the same purpose on many previous occasions.

Sixth: there is the additional difficulty of diagnosis to complicate the conditions under which illness must be dealt with on active service. Unless in general hospitals and the like (wherein all these problems are greatly simplified), all diagnostic processes which require care, time, delicate observation, or delicate apparatus are impossible in the field. The alternative is to consider all doubtful cases as definite cases of the malady suspected; but such a method is apt to leave officers commanding units hopelessly undermanned, and to lay an intolerable amount of duty on the healthy.

Seventh: even when men are indubitably sick with serious illness, there is great difficulty in getting them removed from the front to hospital. "Such cases should be removed to Field Hospital at once," say the visionaries of Pall Mall. No doubt. But the convoy whose escort these sick men may be assisting to provide may be several days' trek from any hospital or village. Thus, even if they could be spared, they must move on.

Eighth: they cannot be spared. The officer commanding an outpost camp in an infected district is perpetually on the defensive with the Medical Officer. "I trust you won't take any more of my men, doctor; we are very short." In common humanity, it is urged in answer, the sick should be sent where

there are beds and comforts. "What," is the reply, "what will common humanity do for the men who are left? Already they have less than each alternate night in bed." Such difficulties are inevitable in war. No doubt there are those who would have it smoothed so as to be a suitable game for a luxurious nation to indulge in. When those days come, everybody will easily conquer everybody else.

Ninth: yet another difficulty is the inadequate means of disinfection at the front. Even when certain cases of sick are diagnosed as infectious and isolated so far as may be, excreta cannot be disinfected for want of material. Inevitably, therefore, either soil or water or both become polluted. Thus, not infrequently, even when there is the fullest knowledge and the best will in the world, evil must be permitted for want of the wherewithal to cope with it.

The diseases of military life produced by vicious habits require but the briefest notice. All the other classes of illness to which the soldier is subject are increased and aggravated by campaign conditions. This class, including venereal disease and alcoholism, is enormously reduced. Even in civilised countries where prostitution prevails and alcoholic liquors can be purchased, it is an unimportant factor in warfare. By strict elimination of those affected by such illnesses when troops are passed for service in the field, and by the thorough surveillance which is subsequently rendered possible by military rule, they can be reduced in the field to a negligible quantity.

The military diseases due to or predisposed to by atmospheric conditions, and particularly by wet and damp and extremes of heat and cold, are bronchitis, and the various forms of inflammation of the throat, rheumatism of several varieties, and sunstroke. Save heatstroke under very exceptional conditions, none of these ailments have much influence in raising the death-rate; but all occasionally prove important from the strategical point of view by temporarily incapacitating large numbers of men. To tell the soldier to avoid exposure to cold and wet is to tell him not to enlist; but by the provision of suitable and sufficient clothing for troops in the field, by the elimination of mouth-breathers among recruits, and by convincing officers commanding units that over-exertion and fatigue are always more important in the production of sun-stroke than either exposure to the sun's rays or a high temperature of the air, much can be done, and has been done, in the way of reducing these illnesses to a minimum.

Of the diseases due to improper feeding, two only need concern us. Scurvy has disappeared from campaigning armies, one hopes and believes for ever, and this by the adoption of very

simple expedients. Only under conditions of siege or of expeditions in very remote and virgin country need it be feared. Regarding the dyspepsia of field service opinions are very much in conflict. Caldwell (9) refers to two forms: one, a flatulent form frequently associated with diarrhœa, ascribed by him to the prolonged use of biscuit. This, in my opinion, is simply due to defective mastication, the stomach being expected to perform what is really the duty of the teeth. This view of its nature is apparently that also of Surgeon-General Wilson, Principal Medical Officer in the Anglo-Boer war (16). Another form of dyspepsia, characterised by marked anorexia, is attributed by Caldwell to monotony of diet (9). This he has noticed "to be the precursor of Enteric Fever." It seems possible that this was really the initial stage of the fever itself. It is true that my own experience was chiefly with mobile columns who, so far as edible matters were concerned, honoured the regulations regarding looting chiefly in the breach; but certainly neither I nor medical officers with whom I had the opportunity of comparing observations were familiar with this form of dyspepsia, appetite among the men under our charge being invariably in excess of supply. Occasional cases of acute indigestion ascribable to some form of ptomaine poisoning were met with in South Africa, but not more frequently than might be expected to occur in a population necessarily subsisting to a considerable extent upon tinned articles of food.

Apart from mere predisposition through lowered resistance, a group of diseases is *directly* ascribed to the privations and exhausting conditions of campaign. These include such widely different ailments as footsoreness, temporary heart failure, and a degree of mental depression approaching insanity. The first of these, especially among raw and unseasoned troops, becomes, owing to the number affected, a very serious cause of inefficiency from the strictly military point of view (16). Much may be done to diminish this by means of preliminary preparation for active service. In the case of a war waged at a distance from the home country, the sickness from causes of this nature is inevitably increased by the prolonged period of comparative inactivity on board the transports.

Cases of disease due to parasites are not likely ever to be sufficiently numerous to militate against the efficiency of troops to any important extent. Those due to external parasites are apt to become very widespread, it is true; but the evil can scarcely exceed mere inconvenience. Those, on the other hand, which are due to intestinal worms, bilharzia, and the like, while intrinsically more serious, are rarely frequent enough seriously to impair the effective strength of troops.

Second only in gravity to the great group of infectious diseases (still taking the strictly military point of view) are the maladies associated with sepsis, the wound infections. Until very recently the writers on the hygiene of war have paid singularly little attention to sickness of this type and to the prevention thereof. Consideration of the matter has been left to the surgeon rather than to the sanitarian. The recent war in Manchuria has shown, however, that for the maintenance of a force in its maximum possible vigour, aseptic and antiseptic methods rank next in value to the measures intended to prevent extension of sickness of a zymotic nature. By a carefully carried out system of aseptic and antiseptic hygiene not only will the average wounded man be enabled to return to duty at a much earlier date, but the risks of death and of permanent disablement will be enormously reduced. Further, the necessity of transport for the injured will by such means be considerably reduced; and by the knowledge of the diminished risk, the morale of a force will be improved.

In summary and recapitulation of the above, the words of Firth (12) may be quoted:

"Although most of the disease occurring commonly among soldiers during peace are met with in war time, still there is a marked tendency for some to predominate, notably those dependent upon such influences as exposure to climate, pollution of soil or water, and indifferent food. The influence of hostilities shows itself mainly in increased incidence and mortality from respiratory and digestive troubles, malaria, diarrhœa, dysentery, enteric fever, and cholera. The precise degree of increased incidence which these diseases display naturally varies according to the climatic and other circumstances under which any particular campaign is prosecuted. This is particularly the case in our own army which serves all the world over; but in general terms it may be said that war conditions usually mean a six-fold increase of such diseases as diarrhœa, dysentery, and enteric fever, as compared with peace time incidence; malarial fevers are increased about one-fifth; venereal diseases in camp-life drop to about one-fourth of the number in ordinary garrison or cantonment; respiratory and digestive affections generally show a slight increase; while injuries, other than those received in action, together with other common disabilities, do not as a rule prevail more than under circumstances of peace."

Before proceeding to the particular discussion of the more outstanding campaign diseases, it is necessary to consider somewhat fully the question of the possible modification or evolution of disease types under the conditions of field service. There has been a tendency to believe that, under such circumstances, the actual nature, pedigree, and history of the infections illnesses were

otherwise than identical with their features as presented in peace time and in settled countries. There seems to be a lingering opinion that, amid such surroundings, diseases, whose stability and individuality are not ordinarily to be called in question, may become profoundly modified, may be hastily re-evolved from allied forms, or may actually be re-originated (21). In other words, the theories of epidemic sickness which held sway half-a-century ago are not yet quite extinct as regards diseases of campaign. In the course of the widespread maladies of war, the mysterious, the unexpected, the inexplicable, is so much more frequent than in settled communities that these old-world theories are still convenient and by many adhered to.

Thus Caldwell: (9)

"Any theory which assumes the possibility of the transformation of the colon or other bacillus into the *bacillus typhosus* is particularly convenient, as it not only fits in with facts which are too well known to admit of discussion, but it also does away with the necessity for admitting the existence of an antecedent case of enteric fever as requisite for an outbreak of the same disease."

Again:

"There is evidence to show that the essential cause of dysentery is a free living organism of both soil and water, and that . . . it possesses remarkable powers of disseminating itself throughout communities into which it has been introduced, or in which it has of itself sprung into existence. . . . There is strong reason to believe, without in any way vitiating previous statements, that the essential cause of this disease may, under certain morbid conditions, have its origin in the intestinal tract of man. . . . Cases are of constant occurrence on the line of march, when there has been no question of infection from a previous case, and in localities where the disease is unknown."

Yet again:

"The occurrence of enteric in old-standing camps is generally preceded by an anomalous form of fever accompanied by diarrhœa. . . . Taking the effect of apparent similarity of origin into careful consideration, it does not seem unlikely that this form of diarrhœa may be pathologically associated with true enteric fever, being possibly an attenuated form of the last-named disease. The theory of 'the progressive development of the property of infectiveness' might well apply here."

A similar suggestion is made by Notter, Firth, and Horrocks (18), who write:

"Besides the presence of undoubted infection in primary dysentery, there is also a probable acquired infection developed from primary diarrhœa, just as there is a probable occurrence of

a progressive development of the property of infectiveness in simple sore throat up to a condition of diphtheria. The gradually developed infection of dysentery grafted on diarrhœa is nowhere better seen than in the experience of military campaigns." (19).

But surely, as I have attempted to show, the conditions of active service are so different from those prevailing anywhere else, in any time or country, that we need not express surprise nor resort to improbable hypotheses if the unusual or the unprecedented should manifest itself in connection with the natural history of disease. There is surely no need to assume any new laws to explain such unwonted developments. Here we have a large nomadic population, comprised of men of susceptible age, untrained to a nomadic life. The individuals composing this community are, with continual activity, crossing and recrossing each other's tracks like bees in a hive but with paths relatively far more extended. If we keep in mind, also, the long duration of the infectivity of such diseases as enteric fever, its early infectivity, the capacity of its micro-organism to survive for long periods in suitable media outside the body, and the difficulty or even, occasionally, the impossibility of diagnosing mild or early cases, we shall surely admit that we have a variety, a multiplicity of actual or potential factors sufficient to account for even the most puzzling, even the most unlikely, of all the many recorded anomalies of campaign disease.

Thus there is clearly no need to invoke a theory of the mutability of bacteria. For all we know, the typhoid bacillus may, under certain conditions, be evolved from the bacillus coli and thus enteric fever generated anew (21). But such a theory is neither necessary to explain the facts nor inherently probable, and the whole experience of sanitarians in this country, in America, and in Germany, is opposed to it. "There is so far no evidence that either the ordinary bacillus coli communis can be converted into the typhoid bacillus, or that the reverse is possible. The species are absolutely distinct." (17).

For the same reasons which lead us to reject the views which postulate an evolution of disease germs anew or even an essential modification of these, we may discard as neither likely nor requisite the suggestion that simple diarrhœa is the precursor (other than as a predisposing factor), or an attenuated form of either enteric fever or dysentery. True, epidemics of these more serious illnesses have very often supervened on epidemics of simple diarrhœa; but, on the other hand, during the South African war, there occurred several epidemics of diarrhœa of a severe type in which there was no suspicion of the existence of enteric fever or true dysentery. For example, the regiments of yeomanry encamped at Stellenbosch in the spring of 1900

suffered much from epidemic diarrhœa. In the battalion of which I had at the time medical charge, I saw in one day over fifty cases of this sickness out of a total of five hundred men; and doubtless at least as great a number of milder cases were not reported to me. Many of these cases were of a very serious degree, causing prolonged incapacity; yet there was no indication that cases of real dysentery were simultaneously occurring, and enteric fever did not make its appearance among the men of this battalion until nearly three months later.

The question is not merely an academic one, devoid of practical importance. If we must admit that the infection of dysentery is occasionally "probably developed from primary diarrhœa;" that simple diarrhœa may be "possibly an attenuated form of enteric fever;" that the essential cause of dysentery may, under certain conditions, "have its origin in the intestinal tract of man;" and if we are to accept any hypothesis of the evolution of bacillus typhosus from allied forms which "does away with the necessity for admitting the existence of an antecedent case of enteric fever as requisite for an outbreak of the same disease;" then it is obvious that mere sanitation, no matter how well devised or how rigorously carried out, can never secure absolute immunity from infectious disease either to troops or to any other aggregation of humanity, and that further investigation is wanted before the Sanitary Officer in the field can apply himself to his task with any confidence or with any zeal. The fact that micro-organisms, alike those causing fermentation and those causing disease, are, by the conditions of their environment, modifiable in activity and virulence through successive generations, is as well known as any thing in the whole science of bacteriology; but so far as is known such modifications are in degree, not in essential nature A belief in the "progressive development of the property of infectivity" cannot be legitimately invoked to explain the occasionally observed sequence of diarrhœa and enteric fever and dysentery. In all likelihood the real explanation is a simpler one: that to a community rendered unusually susceptible by exhausting illness, specific maladies were imported and rapidly seized the occasion. No one doubts that enteric fever, as it occurs in Britain and in Europe generally, is a definite entity. Doubtless if the enteric fever and dysentery of war and campaign could be as well and minutely studied as these illnesses have been under peace conditions at home, the theories of progressive severity, increasing infectivity, and subsequent attenuation would be found to be superfluous as well as incorrect.

Chapter III.

SPECIAL CONSIDERATION OF THE DISEASES WHICH PARTICULARLY AFFECT THE EFFICIENCY OF ARMIES IN THE FIELD.

AMONG the diseases of troops on active service which demand special consideration, the first place must unhesitatingly be given to ENTERIC FEVER; and this for several reasons: it is not only the typical campaign disease, the malady which has wrought the greatest havoc among fighting troops in Africa, Asia, and America during the last decade, so that it has recently been very much in evidence, much before the public mind; but further, it is, next to cholera, the most preventable of its class. ("There is no epidemic or endemic disease, except cholera, which can be more easily controlled and prevented than typhoid fever" (17); finally, the hygienic methods which must be put in force against it are also to a large extent those applicable to the restraint and extinction of other diseases of the group.

Enteric fever must be classed with the filth diseases, and is the most ubiquitous of its class. Even under the best social and sanitary conditions, if it has proved easy to check, it has proved very hard to exterminate (48). Especially "in warfare typhoid fever has always to be reckoned as a deadly enemy. All authorities agree that it dogs the steps of armies in campaigning" (49).

In the second and third year of the American War of Secession, there occurred among the Federal troops (880,000 in number) over 53,000 cases of enteric fever of which 16,000 were fatal. There is also good reason to believe that during the same war, more than one-half of the deaths attributed to malaria were actually due to enteric fever (57, 39). In the Volunteer camps in the war between Spain and America in 1898, there were over 20,000 cases of enteric fever—about one-fifth of the total force. The deaths were 1580 in number or 7·61 per cent. (44). Further, enteric fever caused 86 per cent. of the total deaths in the army. Again, the enteric death-rate in the U.S. army for the year ending April 1899 was 123·7 per 10,000 of mean

strength (as against 197·1 per 10,000 in the civil war), twenty-two times as great as the average enteric death-rate in the army in the previous decade of peace (48).

In the British campaign in the Soudan in 1898 a similar elevation of enteric death-rate occurred, that for the year of hostilities being 11 to 12 times as high as in the years 1897 and 1899 (50). The figures for the South African war are very striking. More than five per cent. of the troops suffered from enteric fever and more than half the deaths were attributable to this one cause. During the war, 450,000 were admitted to hospital suffering from illness (as opposed to wounds); of these cases nearly 43,000 proved to be enteric fever; and 8,000 of these cases were fatal (11, 50, 46, 12).

Regarding the natural history of enteric fever (and of such other specific ailments as demand particular discussion subsequently) there need only be considered such characteristics as have special bearing on the subject under review.

As to the essential etiology of enteric fever there is now no division of opinion. The bacillus Eberth-Gaffky is universally conceded to be the cause of the disease. Investigations as to its habits and life-history have been very numerous but the results are not quite in agreement nor, upon all points, decisive. It is a human parasite, capable of *surviving* for long periods under certain conditions outwith the body and also, under narrowly restricted conditions, of a saprophytic growth (55). Except under these (artificial) conditions, there is no proof that it can *multiply* outside the body. It forms no spores, it has no resting stage. It has not been proved that any other animal is susceptible to its attack (17). The very general belief is that it gains access to the body through the mouth and stomach. It lives and multiplies in the intestinal canal, apparently without necessarily giving rise to the disease; and thence, if successful in overcoming individual resistance, it invades the intestinal mucous membrane and afterwards the blood and the tissues of the spleen and many other organs. It is excreted by the fæces and the urine; thus these, if unsterilised and permitted to pollute food or water supply, lead to the dissemination of the infection. This infectious property of the excreta begins very early and lasts very long. "The stools of a man in the incubation period of typhoid fever may be laden with the bacilli of this disease" (44, 28).

There is ample evidence that the bacilli may continue to live in the body for long periods, apparently many years, after the occurrence of the disease (17). Their presence in the urine is an accidental, not an invariable feature, happening only in about 25 per cent. of the cases. When bacilluria is present it is very persistent, having been found five years after the illness (55).

The bacilli are present in the fæces for a much shorter time, probably not beyond convalescence (35).

Regarding the survival of the bacilli outside the body, many valuable investigations have recently been published. Their long survival in soils of various natures has been frequently demonstrated (23, 24, 25). It has been thought that soil in which fæcal or other organic matter had been converted into basic nitrates by oxidation was specially favourable to their life (9); but the researches of Firth and Horrocks (see below) indicate that their viability is not enhanced by the presence of sewage or other organic pollution in such soil (34). They have been found to survive from one summer to another (26). The labours of Martin showed that they lived for 404 days in sterile soil, survived a much shorter period in virgin soils, and in soil abounding in other bacteria (bacilli also) they died within a few weeks (36).

The following table epitomises the various investigations regarding their viability:—

In moist soil, - -	up to 74 days.	(34)
Dry sand, - - - -	24	,,
Moist sand, - - - -	12	,,
Soil wet with rain water, -	67	,,
,, with dilute sewage, -	54	,,
,, with dilute sterile sewage,	74	,,
Dust, - - - - - - -	25	(42)
Sun-exposed dust, - - -	14	,,
Urine-infected dust (India), - -	9	,,
Air dried fabrics (clothing), - -	74-84	(34)
Dry soil (dust), - - - -	24	,,
Clothing, - - - - -	30	(32)
Fabrics, - - - - -	60	(46)
Street dust, - - - -	30	,,
Dry earth, - - - - -	21	,,
Filter sand, - - - -	82	,,
Dry pulverised soil, - - -	25	(48)
Enteric excreta, - - - -	90	,,
Earth infected from culture, -	5 to 5½ months	,,

As regards the survival of the bacillus in fluids, there is some discrepancy of result. In natural waters, its life is apparently very brief (5-8 days) (17, 31, 46, 50), though certain ill-ascertained conditions permit its viability for much longer periods. There is abundant confirmation of the view, inherently probable, that polluted water *per se* cannot cause it (23). In sterilised water to which it has been added it has been found after 28 days (48); in aerated waters it disappears under 14 days (33). In liquid fæces it has survived 30 days (50); in urine 41 days (53). In

sewage it was found to have perished in 14 days, but to survive considerably longer if nitrate of potash were added (18).

The information summarised above leads us to draw most important conclusions and inferences.

1. There is no proof that the B. Typhi can *grow* (but merely survive) in soil (34, 17).
2. In no natural medium (as opposed to specially prepared culture media) can it survive indefinitely; so that it is, to this extent, an obligatory human parasite (50).
3. If the infection is water-borne (as has often proved to be the case), the pollution must have been recent (50).
4. Its survival in soil depends upon the amount of moisture present (either extreme being disadvantageous to its life) rather than upon pollution (34).
5. Burial of enteric excreta is, therefore, a dangerous method of disposal. To secure safety, soils must be kept free from contamination.
6. The existence of the germ outside the body is rendered very precarious by the many influences which threaten it with injury: extremes of moisture and dryness, the presence of other bacilli, chiefly of the putrefactive order, and, as we shall see, sunlight, high temperature, and innumerable chemical substances even in very dilute solution. The species probably owes the fact of its survival despite all these hostile agents to its faculty of retaining its vitality for very long periods within the human body.

It is unnecessary to revert at any length to the question of the specific identity of enteric fever or to investigate the view that, under circumstances rare in civil life but frequently present in warfare, the bacillus of enteric fever may be evolved from allied forms (18). So far as our present knowledge goes there is nothing impossible in such a view; but it is far from being proven or even probable; the epidemic manifestations of the malady may be very well explained without it; and it is calculated to discourage the preventive methods which have been partially and increasingly successful in the past. Roux and Rodet (21) formed the opinion that the bacillus coli communis acquired specific virulence by growth in sewage. This is not now generally held. At the most it seems possible that a disease analogous to enteric fever in many of its features may, under certain circumstances, be caused by the bacillus coli (23, 29, 60).

Our knowledge of the factors which predispose to enteric fever, which increase the vulnerability of the individual by lowering his resistance, is necessarily vague, necessarily founded upon

impression and general observation rather than upon statistics or verifiable facts.

With regard to one element, that of age, there is abundant and precise information. Unhappily, under a short service system, the military age and the enteric fever age coincide. In each successive period of five years after the age of enlistment, the average enteric-rate is diminished by one half (20, 10, $5\frac{1}{2}$, and $2\frac{1}{2}$ per 1000). Not only are soldiers between 18 and 25 most susceptible; but the mortality, also, among those affected, is higher (10).

All the debilitating conditions which conspire on campaign to lower the physique (as opposed to the health) of troops have been believed to increase individual susceptibility to enteric fever. Surgeon-General Sternberg (U.S. Army) and Wilson (British Army) are inclined to attach great importance to these predisposing causes (16, 48). Particularly do they make mention of privation, of exposure, especially to the cold of the night, of men used to comfortable quarters at home, of fatigue and exhaustion from excessive exertion, of hard work implying insufficiency of sleep and rest, of indifferent rations and an impure water supply. They point out that new drafts and levies suffer most from "fever," and ascribe this to the susceptibility of youth, to want of discipline (by which lack sanitary regulations are made much more difficult to enforce), to personal imprudence in eating and drinking, to the abrupt change in mode of life, and to the necessity of acquiring new habits of cleanliness and carefulness in a country where there are no sinks and no closets.

It must be admitted that the potency of fatigue as a predisposing factor has been called in question (43). It is pointed out that it was the almost invariable experience of the South African war that trekking troops were less affected than stationary troops (9). This happened despite the fact that weather conditions, fatigue, clothing, and impure water were all against the mobile troops. Of course, it must be granted that the trekking troops, in the earlier period of the war, rarely had occasion to occupy foul sites and were less exposed to infection generally. The influence of exhaustion in lowering disease resistance must therefore be left an open question (17, 23, 61, 10).

A similar effect is ascribed to alcoholism and the debility due to severe hæmorrhage. These possible predisposing causes are relatively too infrequent to have any appreciable effect in raising the morbidity of an army.

Second only to age, in my opinion, as a predisposing factor, is the condition of the gastro-intestinal mucous membrane (16, 41, 54). Many authorities have considered dyspepsia, diarrhœa, and the states of gastric and intestinal catarrh of which they are

the manifestations, as powerful factors in allowing the entrance of enteric fever into the body. I think there is much evidence of the truth of this. During the South African War I had practically no experience of dyspepsia except occasional acute cases; but even after such transient attacks, men who had long resisted enteric fever, who had lived amidst it in safety for months, developed the illness at last. On the other hand, I had much to do with campaign diarrhœa, and I feel very confident that men depressed by continued attacks of simple catarrh of the intestine are invaded by the enteric bacilli which, otherwise, in their normal health, they would easily repel. I emphatically endorse the words of Tooth: "I cannot help thinking that diarrhœa affords a delicate index of the sanitary state of the force, and more, that it is the stormy petrel of enteric fever, and that as such it requires the gravest attention of the sanitary authorities" (54).

It cannot, however, be claimed that the increase on active service of the elements which predispose to enteric fever is a sufficient explanation of the great and rapidly spreading epidemics which have affected troops in almost all recent wars, alike in south and west and east. Rather must we look to the channels by which the disease is conveyed, in other words, to an increased accessibility (50). Such channels of dissemination are direct or indirect. The former method can only give rise to isolated, sporadic cases. The indirect method, as the more important, demands prior, and the very gravest, attention.

That water is the common vehicle of infection in settled countries there is no doubt. Of 638 epidemics in civilised countries referred to by Davies (46) 70 per cent. were water-borne. The fact that the specific bacillus is rarely found in water cannot be weighed against the overwhelming evidence that enteric fever is more usually conveyed by water than by any other medium. Even on campaign it is highly probable that its presence in epidemic form always originates *primarily* through infection of drinking-water. To the pollution of the Modder by the Boers at Jacobsdal, Tooth is inclined to attribute the introduction of enteric fever into the British army in South Africa. Thus forcibly does he describe the situation:

"There was enteric fever at Jacobsdal, ten miles above. The problem is to supply, say, 50,000 thirsty men with pure water from the moment they arrive, heated with battle and a semi-tropical sun. They must lead their horses to the water but must withstand the temptation to drink themselves. The proposed Water Company must either have in reserve a sufficient supply to meet this demand, or they must have been at the river long enough to have boiled and filtered enough for the purpose,

manifestly impossible on the occasion referred to. It is the first drink that costs" (54).

It is, then, certain that on field service in any country, the risks of water-borne infection can never be disregarded with safety. But it is no less certain that a pure water supply is not an absolute protection and that there are other important means of infection. Probably after the outbreak of an epidemic in an army, water carriage ceases to be an important means of dissemination. In India, it is urged in proof of its conveyance otherwise than by water that while the general introduction of pure water supplies into garrisons has greatly diminished the incidence of cholera and dysentery, enteric not only holds its own in the army but has, of late years, tended to increase (42, 39).

To soil pollution we should probably look as the most serious channel of communication in warfare *after* the disease has been introduced. Soil pollution is not in itself harmful without some means of introducing it within the susceptible individual; but once it has occurred, water (secondarily infected), food, dust, and flies all become potential carriers of the virus (9, 35, 48, 50, 23, 53, 54). Undoubtedly, mere polluted soil, like polluted water, will not convey the disease unless the specific germ forms part of the pollution; but the researches of Firth & Horrocks have not quite disproved the general belief that organically polluted soil is a more suitable nidus for the life of the bacillus than soil free from recent contamination. The specific contamination may reach the soil either in fæces or in urine. There is much and increasing evidence that infection by urine is the more common means. The bacilli are liberated by the urine in enormous numbers (58); this germ dissemination goes on for an indefinite but certainly a very protracted time; and owing to its nature, infection by urine is much more likely to be overlooked than infection by fæcal matter (9, 22, 23, 35, 41, 48, 50, 53, 58).

In favour of the dissemination of enteric fever by dust there is a great concurrence of authorities (9, 22, 27, 44, 42, 50, 53, 48, &c.) This cumulative evidence is of various sorts: the probability of dust infection has been proved in Egypt, India, Virginia, Florida, and South Africa; epidemics have been reported in India and elsewhere when all other channels were eliminated; and Firth and Horrocks have experimentally demonstrated the possibility of the process (34).

The evidence concerning the conveyance of enteric infection by flies is no less conclusive (42, 44, 37, 57, 9, 64, 23, &c). One who has spent the hot season in South Africa in charge of enteric fever wards cannot but be convinced by daily observation of the possibility and even the likelihood of the carriage of infected matter, from latrines and refuse to foodstuffs, on the heads and

legs of flies. There is plentiful confirmation of the belief. Firth and Horrocks have also investigated this question experimentally and again with positive results (34). Vaughan, Reed, and Shakespeare, in their classical report upon enteric fever in American camps in 1898, look upon fly-conveyance as probably a very important means of disease diffusion (44). Similar evidence comes from France (40) and from Egypt (50). The view is greatly strengthened by the knowledge that wherever enteric fever prevails it is most common in the warm season when flies are most numerous, and its epidemic extension receives a sudden check when the first cold weather of the autumnal nights causes a rapid diminution in the number of the flies (57). Various species are supposed to take part in this distribution of the disease, particularly the common house-fly and closely allied forms, and the green-bottle latrine fly which, in tropical and sub-tropical countries, takes the place of our blue-bottle fly. I think it extremely likely that the fly will eventually prove to be only second to the water supply as an agent in spreading the enteric infection in hot countries.

It is to be feared that dust and flies would not become innocuous even if soil pollution were strictly prevented. In hot countries, latrines are very difficult to keep in good condition, even when dry earth and disinfectants are freely used. There is ever the risk of fæcal matter and urine being rapidly dried, pulverised, and scattered by winds, so as to reach the food supplies while the bacilli are still alive.

Dissemination of the disease by infection of the fabrics of clothing, tents, &c., has been proved to be possible, and is probably of occasional occurrence. I do not think that it can rank in importance with the other channels already considered (50, 23).

I think that the risks of infection while bathing should not be overlooked (54). I have known men who were scrupulously observant of all the precautions regarding boiling of drinking-water, admit that from accident or forgetfulness they had, while swimming, swallowed large gulps of water filthy and infected beyond all suspicion. One civil surgeon who spoke to this effect died of enteric fever five weeks afterwards, although he had had charge of enteric wards in Kroonstad for fully five months before.

Direct infection must be briefly noticed. The phrase "infection by personal contact" is somewhat vague: it would seem to imply infection from mere proximity; yet in hospitals where enteric fever is admitted to the general wards, it is not the patient in the adjoining bed who contracts the disease, but the nurse. Moreover, even the nursing staff can diminish their risk

by increased carefulness. Doubtless, then, "infection by personal contact" really means by spoons or fingers, or by movements of the bedclothes scattering infected dust. This form of infection is just as likely to occur in a bell-tent as in a hospital marquee; much more so indeed, particularly if fourteen men are sharing the one confined space alike as living room, bedroom, and dining room!

Nevertheless the conditions of infection within hospital are worthy of special discussion. Therein, the conditions should make infection as difficult as possible, and every channel by which the disease can extend should be capable of being watched. Yet it was a very general experience in South Africa (9, 27, 17) that men who were admitted to hospital with minor ailments, or with wounds, developed enteric fever during or just after their sojourn. During their stay they had drunk only tea, coffee, soup, or sterilised water. They had been as much as possible protected from dust, and their food from flies. Yet during the period when I had charge of enteric and general medical wards simultaneously, I on several occasions dismissed a patient from the latter only to receive him into the former six or eight days later.

The hygienic management of enteric fever is complicated by the difficulty of diagnosis under any conditions; on active service the difficulty is tenfold intensified. The onset of symptoms is so insidious and indefinite that neither can a diagnosis be made with confidence in the early stage nor can the date of attack be accurately fixed. As a rule, in warfare, cases are reported to a medical officer about 7-10 days after the commencement of pyrexia. The part played by the name "Simple Continued Fever" in the British army has its counterpart in the "Malaria" and "Typho-malaria" of the United States. The report on the U.S. Volunteer Camps of 1898 contains the statement that one-half of the cases of enteric fever were incorrectly diagnosed (44). During the early phase of a campaign, the mild cases of enteric fever are unrecognised; later, the opposite (but safer) course is taken, and all doubtful cases are called enteric (16). Under the conditions of active service (save in the general hospitals) diagnostic methods, whether by agglutination or by bacteriological examination of blood, are quite impracticable. Thus clinical methods of differentiation have to be resorted to; and these are necessarily often of the most perfunctory nature,

The consideration of the prevention of the *occurrence* of enteric fever (prophylaxis proper) and the prevention of its *extension* when already present (disinfection, &c.,) may advisably be postponed till these matters are submitted from a general point of view in the latter part of this essay. Meantime only a few special features require notice.

If they were possible, the preventive methods which are successful at home should be best in the field; alas, they are but partially possible. The primary essentials are to secure a pure water supply at almost any cost; to maintain its purity during distribution; and rigorously to prohibit drinking from all other sources. Convalescent enteric patients should be strictly kept away from the water supply and not permitted (still less required) to perform any duties in connection therewith. Sterilisation of water by heat is the only method of purification which is absolutely reliable. No method of filtration is uniformly satisfactory (56). Chemical methods of purification are only to be regarded as makeshifts when other means are not available. After purification, water must be distributed in clean and covered vessels to keep out dust and flies. All excreta must be disinfected *at once*. When pulverisation or access of flies has been permitted, disinfection is too late. In addition to these steps, the strictest personal cleanliness on the part of the soldier is to be zealously inculcated as a second line of defence. This is admittedly more easy to preach than to practise. In the western Transvaal, in May 1900, four squadrons of irregular cavalry, chiefly composed of men trained to clean habits from infancy, had to perform their grooming and eat their food with their fingers without the opportunity of washing even their hands, for four consecutive days.

Inoculation of protective serum is still upon its trial. Though apparently of considerable benefit, it does not sufficiently confer exemption to allow of sanitary vigilance being in the slightest degree relaxed. In South Africa, it is reported that while nine per thousand of the uninoculated took enteric fever during a fixed period, only six per thousand of the inoculated became infected. It would thus seem that about one third of those inoculated derived immunity from the process.

In every phase of an epidemic but particularly at its first outbreak, isolation of those affected is of supreme importance. We have seen that enteric bacilli survive long in soil, so that boiling or burning is essential before enteric excreta can be safely deposited therein. Neither of these processes is possible on the march; thus isolation of the sick is imperative. The mild cases, diagnosed as simple continued fever or mere diarrhœa, and cases of the ambulant type are, from the sanitarian's point of view, the most dangerous. All men suffering from febrile headache or febrile diarrhœa must be regarded with suspicion. Convalescent patients must be regarded as unsafe until the temperature has been normal for a fortnight and all cloudiness of the urine (indicating bacilluria) has disappeared. Till then isolation and disinfection of excreta are essential.

The disinfection of enteric dejecta will be considered fully in connection with the disinfection of infected excreta generally. The germ of enteric fever is readily killed by a temperature of 167° Fahr. for a few minutes, by direct sunlight, and by many chemical substances even in dilute solution (17, 10, 27, 26, 41, 53, &c.) Its destruction is thus theoretically easy. Practically, and especially with rapidly moving troops, it is far otherwise.

Methods involving the use of heat by boiling or burning are the most satisfactory. The chief essential is that it should be prompt. The sterilisation of utensils is more difficult and, for that very reason, more important.

The disinfection of the persons of the sick is as necessary as the disinfection of their excreta. As a preventive method the administration of urotropin (one gram twice daily) through the whole period of convalescence is advised and seems to have proved effective (41). It is expensive; but its cost is trifling compared with that entailed by the disease which it is administered to prevent.

(Other authorities referred to: 15, 19, 20, 30, 38, 45, 47, 51, 52, 59, 62, 63, 65, &c., &c.)

The diseases termed "simple continued fever," "typhomalarial fever," and "paratyphoid fever" require but brief discussion. The name "simple continued fever" should be abandoned. It is no longer believed to indicate a specific entity; it is no longer even convenient, "fever undiagnosed" being preferable by reason of its candour. Cases of malaria, of mild enteric fever, of Malta fever, of paratyphoid fever, of transient heatstroke, and of simple diarrhœa with pyrexia have all been grouped under this misleading title.

Much the same may be said of the "typhomalarial fever" of the French and American armies. The term is no longer officially recognised. It seems to have been almost invariably applied to cases of veritable enteric fever of a more or less abnormal type (75).

Paratyphoid fever is of a very different nature. The belief is apparently gaining ground that there is a definite and specific fever with gastro-enteric symptoms which resembles true enteric fever in many respects yet is distinct from it and which is due to infection by bacillus coli (9, 60, 67). Even if this be true, its occurrence is so exceptional (only a few hundred cases having been recorded), and its manifestations so closely resembling those of enteric fever that it is sufficient for medico-military (if not for scientific) purposes to class both as "typhoid" and to treat them alike both clinically and hygienically.

"There has been hardly a single war of long duration, hardly a single siege protracted over several months, in which dysentery

and diarrhœa have not broken out in the hostile armies in the field, or among the besiegers and the besieged. Among *war pestilences*, alongside of typhus and typhoid, these diseases have always taken a foremost place" (57). DYSENTERY has wrought terrible havoc in armies in the past. In the Napoleonic wars, in the Crimea, in the Franco-German war, it greatly increased the mortality. In the American civil war, among the deaths from disease in the army of the North, over 44,000 (nearly one-fourth of the total) were ascribed to "dysentery and diarrhœa" (48). In the campaigns of European troops in tropical countries the deaths from dysentery have equalled and occasionally out-numbered the deaths from enteric fever. In the first year of the recent South African war, over 12,000 cases were recorded with a mortality of 5 per cent. (69). Yet it is an eminently preventable disease otherwise than in mere theory. In the wars of the last three decades its prevalence has been steadily reduced. In view of the fact that it is endemic and frequently epidemic in Japan, the comparative immunity of the Japanese troops in the recent war in Manchuria has triumphantly proved the excellence of their sanitary methods in the field (70).

Regarding its essential nature our knowledge is far from clear and precise. The general opinion is that it presents three or four varieties of which the amœbic and the bacillary are the most frequent and most severe (69). The preponderance of evidence is that the bacillus discovered by Shiga is mainly responsible for the epidemic dysentery of war (71, 72). This bacillus survives for several months in moist and shaded soil, quickly perishes in natural waters, and succumbs to drying more quickly than the enteric bacillus of Eberth (72, 31). It is destroyed by a temperature of 140° Fahr. in an hour, and by a solution of carbolic acid (1-20) or of corrosive sublimate (1-20,000) in a few minutes (68). Caldwell believes that the germ of dysentery is more tenacious of life than that of enteric fever and that, consequently, in camps where both have occurred, dysentery is more difficult to stamp out (9). The etiological relation of dysentery to diarrhœa has been already and sufficiently discussed. From much experience of dysentery in the field one endorses the view of Faichnie who writes: "Dysentery may supervene on simple diarrhœa; but as this is the exception and not the rule, I think we may take it that when this occurs a fresh infection is the cause" (70).

In dysentery the predisposing factors play a relatively more important part than in enteric fever. Insanitary surroundings furnish the chief elements which conspire to promote the diffusion of enteric fever. In dysentery these are secondary in potency to conditions which depress individual vitality. In

other words, while unhealthy environment promotes the spread of disease (a) by lowering resistance and (b) by supplying means of infection conveyance, in enteric fever the latter is the essential factor, in dysentery, the former. Dysentery is the disease of war and of famine and for the same reason. Overcrowding in tents and quarters, scarce and unwholesome food, impure water (apart from actual infection), and depressing conditions generally prepare the way for its ravages (69, 10). It is particularly prone to attack those who have a disorder of the alimentary canal (9).

The channels by which it is conveyed from man to man are believed to be the same as in enteric fever. First in frequency comes dissemination by water-carriage. Certainly this is not the only route; for many contracted it in South Africa who only drank tea and boiled water; and when, as in Natal, the British troops occupied the sites of previous Boer camps, careful sterilisation of water did not prevent its epidemic outbreak. In the spread of dysentery, as of other diseases of the class, dust and flies probably play no small part (70, 72).

The prophylactic measures to be taken in its resistance are very similar to those enumerated as applicable to the prevention of enteric fever. Men suffering from diarrhœa of any type should be ordered to report sick at once. Cases of dysentery should be isolated and sent to the base or to general hospital if intractable. Camp sites should be kept free from pollution. Excreta should be disinfected, preferably by heat. Water should be boiled, food stuffs protected from pollution by flies. Fæcal matter in latrines should be covered with earth or chloride of lime. Latrine paper should be prevented from being blown about. Hands and clothing should be kept as clean as the conditions permit. Finally, convalescents should be disinfected, alike their bodies and their clothing, before they are permitted to rejoin their unit (69, 70, &c.)

By "SIMPLE DIARRHŒA" is meant any form of intestinal catarrh other than those due to active irritants such as drugs or ptomaines on the one hand, or associated with the specific infection of cholera, dysentery, or enteric fever on the other. This form of sickness may become a serious influence on active service in three ways. First, it may prevail so extensively and so severely as to interfere with the efficiency of troops; and this, even though its mortality rate is very low. In the Anglo-Boer war illustrations of this were abundant. When the Scottish Yeomanry were encamped at Stellenbosch in April 1900, I estimated that one-fourth of the total number (500) were affected with some form of intestinal derangement. This caused much incapacity for duty; although most of the cases were mild and none were fatal. In the second place, there is, as has been said,

an almost unanimous opinion that such disordered states of the intestinal mucous membrane as are indicated by diarrhœa enormously increase the liability to infection by enteric fever, dysentery (and also cholera), provided, of course, that the specific organism is introduced (9, 10, 18, 57). Thirdly, it is alleged by some (9, 18), though far from generally accepted, that diarrhœa and dysentery have a common origin and that every case of simple diarrhœa is a source from which the infection of true dysentery may develop. This hypothesis has already been considered at length in this paper.

The diarrhœa of troops in the field is of chemical, mechanical, or bacterial origin. Its ascription to "chill" is surely no longer reasonable (except so far as pneumonia and peritonitis may be similarly ascribed). The chemical causes are too personal and exceptional to be fitly discussed here. The mechanical causes, on the other hand, are vastly important because of the lowered vitality resulting from the diarrhœa which they induce. Intestinal catarrh of such mechanical origin is associated either with food or with water supply. In the case of the former, the food is either unsuitable in its nature (as when hard biscuit and tough meat prove too much for the masticating or peptic powers of the soldier) or it is contaminated by dust. A turbid water supply is a frequent cause of such illness, the diarrhœa being the indication of nature's efforts to remove the irritating sand or earthy particles. Prior to and immediately after the relief of Mafeking (and doubtless subsequently) the troops in the western Transvaal and Bechuanaland had frequently to accept as their only available supply a water which deposited about one-fourth of its height of sediment. With mounted troops advancing with celerity there was no time for filtration. Moreover the water was so turbid that filtration through a Berkefeld filter without previous sedimentation would have been impracticable. Such water was never, or very rarely, consumed untreated but always as "tea" or as a liquid facetiously entitled "thick soup;" nevertheless, it was not surprising that ailments of the gastro-intestinal tract were plentiful.

Diarrhœa of bacterial origin is quite certainly due to several distinct micro-organisms. One of these, indeed, is the *bacillus dysenteriæ* of Shiga; but obviously diarrhœa of this nature is not a "simple diarrhœa," but a mild dysentery (73). Doubtless bacterial diarrhœa is the real diarrhœa of war and armies. It is indubitably infectious: it is spread by water-infection, by dust, and by flies. There is evidence that the camps of mounted troops are specially liable (62). This may be due to the fact that one of the germs which cause it is capable of living a saprophytic life in horse-dung; or, alternatively, to the agency of flies which find in the excreta of horses a suitable breeding-

ground. The fact that the seasonal curve of diarrhœa coincides with the life history of the commoner flies goes to support the latter view (74). The various conditions of warfare which lower the vital resistance of the soldier all predispose to diarrhœa, which itself predisposes to the more serious maladies which are apt to follow in its wake. As a warning and as a precursor of graver evils, the significance of diarrhœa on campaign is far more important than its direct effects.

CHOLERA is a new disease. Only within the last century has it affected the troops of civilised nations; yet during that period it has proved a most dangerous enemy. In the Crimean war, among the French and British troops, there were almost 20,000 cases and over 10,000 deaths. In the American civil war during the two years 1866 and 1867, there were 3,317 cases of which 1,499 were fatal. In the contemporaneous war between Austria and Prussia, out of a total mortality of 10,850, no less than 5,000 deaths were due to Cholera alone!

That its essential cause is the comma bacillus of Koch is undoubted. This organism is capable of saprophytic growth in moist and otherwise suitable soils. It is quickly killed by desiccation, by heat (140° Fahr.), and by acidulated solutions in extreme dilution. It lives from a few days to several weeks in water, foul or sterilised. It can live and multiply in the human bowel without causing the disease. The conditions which predispose to cholera are similar to those already mentioned in connection with other maladies of the class; and particularly, all depressing influences, mental and bodily, fatigue, dyspepsia, and intestinal catarrh. It is chiefly a water-borne disease; but it is also conveyed by dust, flies, soiled rags and clothing, and infected food. Cholera yields so readily to sanitary measures that its occurrence in an army whose commanders are awake to the possibilities of modern hygiene need no longer be dreaded. The measures referred to may be briefly summarised as follows: a system of quarantine; isolation of all suspicious cases; prevention of soil and water pollution; sterilisation of drinking water or the substitution of tea or acidulated drinks; total abstinence from alcoholic beverages; supply of sound and suitable rations; disinfection of excreta (as for enteric fever); avoidance of unnecessary exposure to extremes of heat and cold and to fatigue; prevention of the access of flies to food; personal cleanliness; and preventive inoculation (9, 10, 48, 57, 71, 75).

While the various forms of MALARIAL FEVER are prominent among the diseases of troops, it cannot be alleged that they are particularly prevalent on active service (12), except in so far as warfare occasions the sending of white troops in large numbers into malarial countries. Further, the methods to be taken in

order to guard against its occurrence are somewhat similar in war and in peace. In the present connection, therefore, only a few points demand consideration. In the recent troubles of Spain in Cuba and the French expedition to Madagascar ten years ago, malarial affections were more numerous than any other. In the American civil war there were over a million and a quarter of cases on the Union side alone; and though the death-rate was low (less than one per cent.) yet the diminution of efficiency was enormous and those discharged from the effects of the fever were very numerous.

It is to be noted that malaria affects officers in a smaller proportion than men; that a certain percentage of individuals seem to possess an innate immunity; and that an attack, instead of protecting more or less from subsequent attacks, renders the affected person more liable to contract the disease in future.

The flood of light that has been recently shed upon the nature of the malarial poison has indicated also what is right and necessary by way of prophylaxis. In addition to the ordinary processes of approved field sanitation, it is important during warfare in malarial districts:

1. To avoid camping in marshy places or beside sluggish streams or stagnant pools.
2. To avoid localities where the presence of Anopheles has been observed.
3. To fill up or drain all collections of stagnant water, or cover their surfaces with kerosene or petroleum.
4. That men sleeping in the open air should wear head-nets and gloves, and should apply some volatile oil to face, neck, and hands on lying down.
5. That quinine should be administered (half a gram, or less, daily, per man), and hot coffee supplied to those going on guard (10, 76, 57, &c.)

From the point of view of the military sanitarian, YELLOW FEVER is to be classed with malaria; for while neither disease is specially fostered by the circumstances of life on field service, yet both are accidentally associated with war through the presence of armies in countries to whose climate they are unused and ill-adapted. In wars waged in tropical America, yellow fever has proved a serious feature. To avoid it troops should be forbidden to enter infected towns, strict quarantine should be observed, mosquito bites should be guarded against by all known means, and white troops despatched to engage in hostilities in the yellow fever areas and during the fever season only on the most urgent need. For the rest, the prophylactic methods for yellow fever are similar to those applicable to cholera (10, 57, 71, &c.)

So far as can be foreseen, the chance of BERI-BERI breaking out as an epidemic among the troops of a white race is extremely slight. It is not so with the armies of coloured peoples; for in the recent war in eastern Asia, deaths from this disease bulked largely in the disease-mortality rate in the Japanese army. Unfortunately, even if it did occur in a European army, our knowledge of its nature is too slight to indicate any special methods of prevention beyond the usual processes of sanitation (57, 75, 77).

In the armies of all the civilised nations, vaccination and revaccination is now efficiently carried out. That being so, SMALLPOX is not likely ever again to prove a grave campaign disease. Nevertheless, in times of national emergency, there is a risk of troops being hurriedly raised and sent to the front without adequate attention to vaccination. This occurred in Great Britain in December-January 1899-1900 without untoward result; but the experience of the United States eighteen months previous was less happy, their volunteers in the Philippines (in touch with an unvaccinated native population) taking smallpox in twice as great a proportion as did their regular troops. When smallpox does occur in an army, the most rigorous measures of isolation and disinfection are, of course, indispensable.

With modern ideas of cleanliness and hygiene, PLAGUE, which is one of the grosser filth diseases, is not likely ever to affect armies to a formidable extent. A pure water-supply, prevention of soil-pollution, and the maintenance of the highest standard of personal health are the general measures calculated to make its invasion of troops impossible. Inoculation, careful surgical attention to wounds and abrasions however slight, and extermination of rats are the special points to be observed.

DENGUE is neither important as interfering with the efficiency of troops nor has it any special etiological relation to military service.

If we may hope that plague and smallpox are no longer likely to threaten the health of campaigning armies, with still more confidence may we expect that TYPHUS and RELAPSING FEVERS will never again decimate the ranks of a military force. It was otherwise, however, in the very recent past, typhus being the "war fever" *par excellence* in the Crimean campaign and the Russo-Turkish conflict of 1879. Only by a combination of the very grossest neglect of sanitary rules with the most extreme hardship and privation could it ever secure a foothold in an army.

Scurvy, the parasitic diseases (other than those of the zymotic class), and the wound-infections (other than plague) remain to be referred to. SCURVY has wrought havoc among troops within the memory of those still living; but its nature is now so well under-

stood that it has become, alike on hostile and pacific expeditions, an occurrence of great rarity, and in the warfare of the last decade has scarcely been recorded. Its appearance is invariably associated with the lack of fresh vegetables and fruit and is due to the want of the organic salts which these articles of diet contain. Predisposing causes, however, are not without importance, since it appears that when the general condition of the body is lowered from any reason,—and particularly from want of exercise, extreme cold, or depression of spirits (as in sieges),—a scorbutic diet is much more likely to originate symtoms of illness than when the food supply alone is faulty and all other circumstances favourable. It is therefore to be prevented by an avoidance of these conditions so far as possible; by the issue of fresh fruit and vegetables as a ration, or of jam and preserved vegetables in their default; by a regular issue of lime juice (or of citric acid solution) when fresh vegetables are scanty; and when they cannot be procured at all, by insisting that flesh meats of all sorts be eaten partly or entirely uncooked.

The PARASITIC DISEASES liable to be contracted on campaign are the several varieties of filariasis, bilharzia, and the different species of intestinal worms. Except possibly through the occurrence of bilharzia (which was fairly prevalent in South Africa towards the end of the war), these are not likely to interfere to any serious extent with the efficiency of troops. They are to be guarded against by ordinary measures; but specially by sufficient cooking of meat and vegetables, by purification of drinking water (which is the main channel by which animal parasites gain admittance to their host), and by cleansing the hands, if practicable, before taking food.

It has long seemed to me a matter of surprise that the subject of the prevention of WOUND INFECTION has received so little attention from writers on military hygiene. This is doubtless due to its having surgical rather than medical associations. But, while the wound and its treatment in other respects are matters for the surgeon alone, the prevention of the occurrence of all septic processes, from the merest superficial suppuration to the most rapidly fatal pyæmia, is as truly the function of the sanitary officer as the prevention of smallpox or dysentery. Moreover, as has already been urged, the maintenance of the maximum fighting efficiency of the troops under its care should be the pre-eminent aim of the field sanitary administration; and, to this end, second only to the exclusion of the zymotic diseases, is the importance of keeping the wounds sustained on the battlefield free from the complications of sepsis.

To say nothing of pain (since it is alien to our topic) the introduction of sepsis into wounds sustained on active service is,

in the aggregate, of strategic importance, (1) because it causes an increased mortality (wounds proving fatal which would quickly have recovered could they have been kept aseptic); (2) because it largely increases the risks and proportion of long standing or permanent disablement (wounds which would normally have healed without interference with function causing contraction, ankylosis, or extensive cicatrisation owing to the introduction of infective organisms); and (3) because it prolongs the period of healing even by eight to twelve times and so delays the man's return to duty. Injurious effects of the class last-mentioned are most important from the military (though least from the individual) point of view. Serious injuries, as of the great organs of the head and trunk or of the main arteries, are to a moderate extent aggravated by the occurrence of any form of wound infection; slight injuries are but slightly aggravated thereby; but wounds of moderate degree, comprising the great majority of all, have their course vastly modified according to whether they are shielded from septic infection or can resist it, or, on the other hand, yield to the infection.

The last thirty or forty years have witnessed a remarkable improvement in this respect. Quite apart from their numbers, the wounds in the American civil war and Franco-Prussian war were terrible in their effects, septicæmia, pyæmia, erysipelas, and gangrene occurring in a very high proportion of the injuries, far beyond what was usual at the time in civil and peaceful life. In marked contrast is the high ratio of wounds healing without suppuration or other infection in the Spanish-American and Anglo-Boer wars, the results being more excellent (proportionately) than those ever attained under civil conditions at home. This excellent standard has been maintained by the Japanese troops in their recent conflict, it being reported that one month after the battle of Türentschen, 30 per cent. of the wounded had returned to their duties. This great improvement is attributable to several causes, particularly to the rifle of small bore and high muzzle velocity, and (in South Africa at least) to the sparsity of population and the resulting absence of infective micrococci; in a less degree to the use of the first field dressing and the disuse of the probe (16, 10, 83, 82, &c.)

Chapter IV.

SANITARY PREPARATION FOR FIELD SERVICE.

HAVING reviewed the diseases of active military service historically, etiologically, and in their practical aspect, we are now in a position to apply the knowledge so gained to the detailed elaboration of sanitary administration in the field. During the past ten years, six great peoples have tried vital conclusions in three far-sundered quarters of the globe. Thus has been afforded singular opportunity of putting to the test the newer sanitary methods based upon recent access of knowledge as to the nature of the zymotic and the wound diseases. Thus, also, it is possible, at this date, to take a very wide survey of comparative methods of military hygiene. By such a comparison it is certain that any insular bias, or any prepossession in favour of the merely time-honoured, will be effectively corrected.

Before proceeding to discuss with some care and fulness the minutiæ of campaign sanitation, there are a few general matters that require notice.

First, a word in anticipation of criticism. The critics of the methods of military hygiene (apart from those whose criticism is encouraging or helpful) are of two sorts: those who say that prevention of epidemic disease in warfare is easy; and those who say it is impossible. The former urge "efficiency" without knowing how hard of achievement it may be, they offer counsels of perfection based upon ignorance, they would have bodies of mounted troops, pressing forward by forced marches, to carry out the processes of sterilisation, filtration, and disinfection, which they are used to in urban areas in Britain. Others, again, assert that the morbidity-rate of fighting armies must ever be high, that it is as inevitable a feature of hostilities as is a wound-mortality, and that enlightened methods of sanitation are, on field service, impracticable. That they are wrong is shown by the steadily diminishing disease-death-rate in armies from the Napoleonic wars to those of the last decade; and especially by the marvellous results of Japanese military hygiene. "In the Japanese army in Manchuria only 1 per cent. of the deaths is due to disease, so scientific and perfect is their system" (84).

"Prevention is better than cure." Never more so than when an army in a hostile country and far from its base of operations

is threatened with an invasion of infectious disease. The transport required by ten cases of sick will convey material enough to prevent the infection of many hundreds. It cannot be too emphatically proclaimed that, if assuredly in civil life, much more in active military life, good sanitation will *pay;* it will ensure saving in cost, in life, and in suffering; above all (from the standpoint of the strategist) that army will maintain the highest efficiency from whose ranks, by means of a successful sanitary regime, epidemic or extensively disseminated disease is excluded.

The questions of weight and bulk, however (and especially the former), are not on the same footing as the question of cost. A nation must afford to buy materials for disease prevention because it cannot afford to lose its men. But the carriage of cumbrous apparatus, however desirable, is prohibitive with mobile columns. If they cannot go light they cannot go at all. As a result of this, the hygienic methods obligatory in a general hospital would be impossible on the march, especially with cavalry. Other and simpler methods, therefore, must be devised.

Amidst all the preventive processes about to be discussed, two essentials are supreme. The first is the provision of a pure or a purified water supply, by which the *outbreak* of disease may be forbidden; the second is the prompt disinfection of excreta, so that the *extension* of sickness may be arrested. All other procedures are either subsidiary or are but means towards the attainment of one or other of these ends.

NEED OF A SPECIAL SANITARY STAFF.

An army on campaign—and no less an army in peace time, since it exists but to prepare for war—should have a special sanitary staff.

No authority who has written upon this subject has expressed himself with any dubiety. More than a century ago Jackson wrote: "As the health of troops is a matter of the greatest importance to the success of a war, health officers may be justly considered to be an important part of the army" (11). Parkes emphatically urged the value of such a provision (76). In his report upon the medical arrangements in the South African war, Surgeon-General Wilson wrote: "It would be far better to have a special sanitary staff;" and again, "It appears to be advisable to attach . . . an officer whose sole duty shall be to deal with sanitary matters. The duties . . . can only be successfully carried out by an officer who has no other duties to perform." Leigh Canney writes: "If it is necessary in civil life

to separate medical work into practice and prevention, it is far more so in actual war." Treves (85), Tooth (54), Firth (12), Simpson (11), Caldwell (9), and others, writing in the same connection, have all concluded in the same opinion. In the German and Japanese armies a special sanitary service exists (86). In the United States a similar need is recognised (44, 10).

The reasons for the necessity of this separation of function are not far to seek. Not only are the requisite training and the objects aimed at quite different, but the duties are often incompatible and the very mental attitude or point of view is quite dissimilar. It is by a mere accident of medical evolution that the two branches have been associated ; by an accident similar to that which in former times combined the physician and the apothecary, the barber and the surgeon. As now-a-days no one can be a good physician and a successful surgeon, so the duties and aims of the "medical officer" and the "sanitary officer" have become so far sundered that they cannot be successfully conjoined. The responsibilities inherently appertaining to the two functions cannot well be undertaken by one individual. Firth writes recently (12) : "I think it very necessary that we should recognize at the outset that it is desirable that the scheme of disease prevention should be kept distinct from that of disease treatment, and the administration necessary to organize and render effective the cure and care of the sick. . . . Let us candidly admit that the preventive side of medicine, in its practical working, needs to be considered separately from the therapeutic or curative."

It is for the specialists to elaborate a scheme for the arrangement of a sanitary personnel ; but the model of modern civil usage may advisably be followed ; where no health officer of a large community is either permitted or fitted to treat the sick or operate upon the wounded, and only the subordinates (comparable to the medical officers attached to military units) are expected to combine, so far as may be, two functions so little related.

In addition to sanitary officers, sanitary companies, with non-commissioned officers and men in the usual proportions, are imperatively required. The former will demand a careful training, similar to that of sanitary inspectors of burghs or counties, and may, indeed, hope to be chosen for such appointments when their term of military service has expired.

The duties of the non-commissioned officers and men of such a "sanitary corps" would be the guarding of water supplies, the purification of water by boiling or filtration, the cleansing of water-carts and water-bottles, the general sanitary supervision of camps, the construction of latrines (aiding the pioneers in this

work) and their maintenance in wholesome condition, refuse destruction, disinfection, and the prevention of soil-pollution; particularly would it be their duty to report cases of suspicious sickness such as diarrhœa and "fever."

In order that they may enjoy the full benefits of the Geneva Convention, the men of the "sanitary corps" should never carry rifles (except in savage warfare) and should wear the red cross. They should go on piquet, on reconnaissance, and into action, carrying stretchers and dressings instead of arms. Thus, when engagements occurred their duties would become identical with those of men of the bearer companies who, under the modern conditions of long range weapons and a widely extended front, are far too few in numbers. Such a corps should possess, control, and be responsible for, its own transport; which could be used for the carriage of sanitary appliances on the march or for the conveyance of sick or wounded as necessity arose.

NEED OF SPECIAL SANITARY INSTRUCTION OF OFFICERS AND MEN.

In order that the health of troops in the field may be preserved, special sanitary instruction of officers and men is imperatively essential.

In all the works upon military hygiene and in the writings of medico-military critics of recent wars we read disparagement of the soldier's intellect and character. "Soldiers are like children." "Thomas Atkins will drink anything." "The soldier's carelessness is appalling." Well, if the soldier exhibits these traits of ignorance and thoughtlessness in a greater degree than is usual in the class of the population from which he is drawn, it is obviously due to his training; and that he *does* exhibit them to this phenomenal extent is the conclusion of all who have studied the ways of troops in the field with unbiassed mind. Many years ago Parkes wrote: "If the English soldier, when placed in unaccustomed circumstances, can do nothing for himself and is helpless, it is not the fault of the man but of the system which reduces him to such a state. That it is not the fault of the man is shown by the fact that however helpless the English soldier may be in the first campaign, he subsequently becomes as clever in providing for himself as any man" (76).

How then is this training, this system, to be rectified? In two ways; by education of the soldier's mind, and by the cultivation of sound habits of life. The latter will be referred to later (see remarks on the training of the soldier, p. 44); only with

the question of the soldier's instruction are we at present concerned.

Besides the association of troops on active service with epidemic sickness, which has been shown to be almost invariable, besides the proved apathy towards any form of evil which does not menace him visibly and immediately, there is yet a third reason which makes it a matter of urgent importance that every soldier, of whatever rank, should have a sound training in the elements of military hygiene. In a country like Great Britain, with an old civilisation and a dense population, the soldier is so used to efficient sanitation that on campaign, suddenly brought under new and widely different conditions of life, he does not know how to act. In his home, pure water is supplied and excreta removed by simple mechanical processes; the domestic refuse of his household is taken away with almost mechanical regularity. When, without any intervening instruction, the man so accustomed is sent to a distant country where sanitary engineering is unheard of, and where he has to look after water-supply and refuse removal for himself, he is not unnaturally in a somewhat grave predicament.

With troops marching and occupying positions in very extended order, supervision of each individual is impossible. Men may be forbidden to drink water from indiscriminate sources, but such an order cannot be enforced. Only by education and discipline can the result be achieved. Similarly with such laborious operations as digging latrines and burying of dead animals in hard ground. The night, it may be, is cold and dark, the men are wet and hungry. Edicts of Commanders-in-Chief and orders of company officers are alike futile. Unless the men can be shown that it is to their advantage, that it is worth their while, to perform such irksome duties, they will be disregarded.

Such a course of instruction in military hygiene, including the essentials of ambulance and first aid, should be in part theoretical and in part practical. Subalterns are educated and recruits enlisted at an age when the mind is very receptive, yet very retentive of impressions formed and conclusions accepted. The foundation of the instruction should be laid in a series of lectures. In such lectures, three subjects should be discussed with special fulness and emphasis: the need of a pure water supply and the reasons for that need, with methods of water purification comparatively reviewed; the methods of disposal of excreta and refuse and the ills which neglect of this will, or may, entail; and the importance of first aid in the field, with explanations as to the germ origin of diseases and of the action of antiseptics. Besides these three essential matters, there are many others worthy of a place in such a lecture-syllabus; such

as personal hygiene and cleanliness, the cooking of rations in the field, the evils of over-fatigue, of exposure to extremes of temperature, and the means which may be taken by the soldier, within the limits of his choice, to guard himself against these.

It may be thought that first aid and elementary ambulance is out of place in such a scheme of instruction. I do not think so. With the widely extended front of these later days, the wounded soldier must have the first field dressing applied by himself or by his comrade. By the time that skilled help arrives, the opportune moment will have passed and, moreover, other and more elaborate dressings will be available. From ample evidence in South Africa I am convinced that the "first field dressing," despite its great potential value, will be of but little practical use until the soldier has learned that suppuration is not due to "cold," or "thinness of blood," or any vague cause, but that it is a process well understood and capable of being prevented. A widely diffused knowledge of elementary ambulance will secure for the wounded soldier, in most cases, the inestimable advantage of being treated where he falls; and the fact of this advantage and the reason therefor would be a salient point in such an ambulance training.

The information acquired in such a course of teaching must be put in practice in peace time, else it is liable to be but imperfectly learned and quickly forgotten (118). I have thought it matter of deep regret that in our camps of manœuvre and exercise, where water is supplied in mains, and latrines constructed and refuse regularly removed by the camp contractor, there is no opportunity of rehearsing, as it were, the procedure of camp sanitation on active service abroad. It may be that the Japanese practice is extreme and superfluously accurate; where the make-believe wounded are supplied with meat extracts and hot milk and the area of their imaginary injuries carefully treated with antiseptics while the instruments are actually sterilised for the operation that might have been required (91). But there is no doubt that without a reasonable amount of practice in peace time sanitary methods will occasionally break down in war. Parkes writes: "The camp life of campaign should be closely imitated, and the rules of conservancy most strictly carried out as a means simply of teaching what will be of such importance in war" (76). And Firth: "Sanitary effort is like every other act of offence or defence on the part of the soldier: it is an act that needs to be carried out in peace to be effectively executed in war."

Hitherto we have considered an instruction in hygiene applicable to officer and to man alike. But the officer requires further sanitary education of quite a different nature, from a different

motive, and for a different purpose. As an individual he has the same responsibility as his men ; as a commander, responsibilities much wider. The officer must be convinced not merely that sanitation is in itself a good thing, of benefits indubitable, but also that it is a military necessity. He will have learned that by observance of sanitary law he and his men will keep well; he must further be shown that health in his ranks will assist his tactics, expedite his movements, possibly turn the scale between failure and success; while sickness among his unit will be "worth many squadrons to the other side." It was abundantly seen in South Africa that sanitary indifference was not confined to the men. Moreover the apathy of the officer was most difficult to deal with because it was based less upon ignorance than upon contempt. Junior officers, particularly, seemed to think that sanitary precautions were unworthy of a soldier's countenance. "There was a certain feeling that it was unmanly to be afraid of drinking any water, that the possibility of contracting disease was one of the chances of war, and should not be shirked. The obvious remedy is a little instruction in elementary hygiene." "Until the junior officers have some real knowledge of the subject (of sanitation) and are induced to believe that these matters are of vital importance, the details will always be slurred over" (16). Individual officers must "recognize that sanitary prevision is as much one of the duties of a staff officer as signalling or knowledge of methods of supply" (12). Sir Redvers Buller writes: "I believe the remedy for sickness, when it can humanly speaking be prevented, is to make regimental officers take more interest in sanitation." The company officer must be made to see that zymotic disease among his men is a reproach to himself and raises a doubt as to his fitness for his position. The Japanese success in maintaining a low rate of sickness in the field (while the Russian force in the same country was suffering severely from dysentery) was largely due to the fact that some knowlege of field hygiene permeates through all ranks of their army (69). "I have no hesitation in stating that were the principles of disease prevention more fully appreciated by the army and their practical application made a matter of organised administration and effort, as much as is the supply of ammunition and food, the cost in money and the loss in military efficiency by disease incidence alone in time of war might be reduced to at least a third, possibly more" (12,117).

Chapter V.

SANITARY CONSIDERATIONS AFFECTING THE INDIVIDUAL.

[In the following section of this essay, the "Sanitary Considerations affecting the Individual" have been somewhat arbitrarily defined. Thus I have treated of water-supply as a general matter (as it must be), while the question of rations I have considered as concerning the individual, though this is only partially true.]

IN previous pages the factors predisposing to the various forms of zymotic malady have been somewhat fully dealt with. These (as opposed to the exciting factors which are more generally diffused) are for the most part of an individual nature. Thus the part of the subject presently before us deals chiefly with the elements predisposing to sickness, with the maintenance of the soldier in a state of maximum resistance, and with the removal of debilitating conditions from his environment.

Insufficiency of exercise and inadequate ventilation are not likely ever to occur during active service in the field. Other conditions, such as dampness of ground and atmosphere and temperature of the air, are outwith our consideration because they are beyond the soldier's control.

It is certain that if adolescents ranging from 18 to 21 years of age are sent to wage war in foreign countries, especially if these are tropical or sub-tropical countries, there will be an enhanced risk of the outbreak of epidemic disease, and, if such should occur, a grave morbidity-rate and a very high relative death-rate. This is particularly the case with regard to the risk of enteric fever, to which the susceptibility in the three-year periods 18-21 and 21-24 is as 100 to 74. 27 per cent. of all cases occur between 15 and 19 years of age (102).

Immaturity of troops is also productive of inefficiency apart altogether from the occurence of actual disease. "Men under 21 cannot bear the fatigue of war" (76). Despite Lord Wolseley who, recognising the more ready adaptibility of youth, has said, "Give me young men" (90), this view is all but universal, and was endorsed by Napoleon in his famous dispatch: "I must have grown men; boys serve only to encumber the hospitals" (92).

The inference from this is of the gravest import. The British possess a large part of the tropical regions of the world; yet they enlist recruits at an age much lower than in any other

European army (86, &c.) Doubtless the age is fixed in part by political and economic necessities; but viewing the question from the standpoint that alone concerns us, the physiological, which is also the military, standpoint, recruits should not be raised for foreign service under the age of 20 years, nor passed for active service, unless in case of national emergency, until they have attained the age of 21.

Under the head of training I would include both physical training, in the sense used by the athlete, and moral training, training in temperance, self-control, and sane habits generally. Admittedly, of course, these qualities have little in common except their name. It is a grevious feature of our military life at home in time of peace that it is an indolent life, to a large extent desultory and without motive. Apart from drills and parades, garrison duties and fatigues, the soldier's life is one of leisure. This does not apply to smiths, cooks, and the like; and to but a small extent in the artillery and cavalry, the medical and the service corps. But with the average infantryman (and these comprise the great majority) the life is full of ennui, an ill preparation for active service. This state of things is not only injurious in itself but very directly fosters intemperance and the contraction of venereal disease. To alter it radically is not easy, since it is associated with our whole system of enlistment and military service; but much might be done by furnishing attractive voluntary tasks for the soldier in his leisure, by the establishment of workshops, whereby their usefulness on their return to civil life would be increased, and of schools wherein they could be trained to cook and bake, to repair clothing and arms, and by the hearty encouragement of all active outdoor amusements and games of agility and strength. Thus might our troops emulate the Roman soldiers, "who were trained so severely in peace that war was a relief." Further (and this is increasingly done), they should spend a considerable portion of the year in camp and under canvas, so that they may become inured to cold and to vicissitudes of weather under conditions less trying than those of actual war.

Still more important is moral training, acquisition of the habit of self-control. The recent recruit, newly arrived on active service, is prone to empty his water-bottle in the first hour of a march and to consume his emergency ration on very slight occasion. Later he learns the unwisdom of this at bitter cost. He should have learned it before.

The question of thirst demands special consideration. At home, under the conditions of garrison life, the soldier suffers from an artificial, an acquired, thirst. He drinks at first because it is the wont of his class, drinks indiscriminately and often

immoderately. In time the habit becomes second nature; and if it is his fortune to go on active service in a warm country he has to pass through a protracted and painful experience before the habit is effectually broken. "There is no doubt that the soldier drinks more water than he needs; this is a matter of education and custom. He drinks oftener and more largely than his officer, and the man who drinks least is he who is accustomed to hard outdoor work in a hot climate" (16). My own experience when camping in Syria and Tunisia as well as when marching in the South African summer is the experience of all: that by resisting the desire to drink on every opportunity the self-denial soon becomes easy; while those who yield to it merely increase their thirst and aggravate the privation (118, &c.)

This difficulty of the soldier's exaggerated desire for liquids can only be dealt with indirectly; temperance and still less total abstinence cannot be made compulsory without so far diminishing the soldier's freedom that recruiting would be checked. But indirectly, by the provision of recreation halls and playing grounds and by offering every inducement of encouragement, promotion, and increased pay to those who exhibit self-restraint, much may doubtless be achieved.

The questions of rations and their preparation lie on the frontier of my theme; being partly matters of commissariat, that is, of supply, yet having a very direct bearing upon individual health. From the latter point of view, there are three points to be considered: first, the prevention of any scorbutic tendency; second, digestibility, since we have seen that an irritable and catarrhal state of the gastro-intestinal mucous membrane is the most serious of all the factors predisposing to those campaign diseases which enter by and have their local manifestations in the alimentary canal; and, third, the combination of the greatest amount of nutrient value with the least bulk and weight.

The scale of rations issued to British troops on active service leaves nothing essential to be desired. For troops engaged in fighting or in marching against an enemy or in a hostile country, tinned beef or mutton with occasional variation in the way of tinned stew of the "Maconochie" type or of the German "Erbswurst," and hard biscuit must be the staple diet, since monotony of food is less of a hardship than the imposition of extra duty in the way of its preparation upon men already exhausted by the more primary duties of their calling. A supply of prepared and cooked foods lessens the transport and saves the labour of the soldier (76). To issue flour and fresh meat to tired men is neither kind nor politic; but whenever the exigencies of the service and the possibilities of supply render it feasible, these should have a place by way of addition and variety.

As a change from tinned meat when fresh supplies are not available, cheese is to be recommended and has scarcely received the place to which its convenience and nutritive value entitle it. The Japanese, who ascribe much of their health on campaign to their choice of rations, use peas, haricot beans, and lentils in considerable quantities. These with rice, oatmeal, and wheat, are all eminently well adapted for use on campaign and, under certain conditions, particularly in warm weather, might well supplant the issue of flesh meats altogether.

The ration of tea should be increased to half-an-ounce daily. Tea, with coffee and cocoa as alternatives or partial substitutes, should be generously issued, since apart from any value as nourishment and as serving to increase the well-being of troops, their use tends to diminish and discourage the drinking of unsterilised water. The observation was made many times in South Africa that the colonial troops who were the greatest consumers of tea were the least subject to enteric fever. With the same object the issue of salt rations in any form is absolutely to be condemned.

For its virtue as an antiscorbutic a regular issue of jam is of great value. Dried vegetables make but a poor substitute, and the ration of lime juice raises the difficulty of its dilution. It cannot be drunk pure, and is not agreeable in tea or coffee. The subject of lime juice will later be referred to in connection with the sterilisation of water for drinking. A sufficiency of sugar is very important. Its absence we found a great privation. It is cheap, easily conveyed, of high food value, and acceptable to almost all. When from any cause it is not forthcoming, saccharin should be issued, as it at least supplies the desired flavour. The most conspicuous lack in the field service ration of our army is chocolate. It is a food of the highest order, and appreciated by troops. It keeps well, is easily conveyed, and can be used alternately as a food or as a beverage. It is relatively costly, but this is a matter of minor importance when such an expensive process as war is concerned. A daily ration of two ounces of chocolate would well repay the government which issued it to its troops.

The questions of the preparation of rations and of the provision of apparatus and fuel therefor opens a field too extensive to be adequately discussed here. The issue of uncooked rations (as fresh meat and flour) without an issue of fuel is to be deprecated, since poor and partial cooking and resulting indigestion accrue. Every soldier, since he is liable to periods of detached duty at a distance from his unit, should learn the elements of field cookery; yet when men are in camp or bivouac in full companies, one cooking for the unit is probably the

cleanest, the safest, and the most conducive to good hygiene generally.

A portable cooking apparatus, on wheels, is in use in several continental armies (116). By means of such an appliance soup or tea is prepared while on the march and is ready for the men on their arrival in camp. This would be a great boon to all, but especially to men ordered on immediate guard or piquet. The wheeled field bakery of the French army is on similar lines but more cumbrous and less necessary. The ideal to be striven for is an army wherein no liquids are consumed except in the form of tea, soup, or the like; where cookery of food and sterilisation of water are, therefore, one combined process. Under the latter heading the subject will be further considered.

The issue of a spirit ration to troops in the field is surely a survival from a less enlightened age. Surgeon-General Wilson reports: "The spirit ration is not necessary and the men are just as well without it"; and from the physiological point of view there can be no doubt of the truth of this; although in the Japanese army, where everything is based on scientific grounds, a moderate allowance of "saki" is issued to the men. In the British army an alcoholic ration necessarily takes the form of spirits, usually rum. Not only has it to be taken undiluted but the recipient has usually to drink it while fasting (contrary to all wise physiological rule) that the mess tin may be available for the ensuing meal of tea or soup. Personally I found the rum ration very grateful and such was, I believe, the general opinion. But I am no less certain that it is injurious and would be markedly so did the one sixty-fourth of a gallon not dwindle to much less before it reaches the private soldier. Rosse, reporting on the Ashanti war of thirty years ago, wrote: "Alcoholic drinks are hurtful. The men who did not touch the supplementary ration of rum presented a mortality and a morbidity inferior to the other soldiers" (120).

It is quite otherwise with a ration of tobacco. I feel sure that an issue of tobacco (2-3 ounces a week) would promote the comfort of the troops without injury to their health. From the inability to purchase what they are used to and what only the government can supply they are subjected to a hardship without compensating advantage. Such a supply of tobacco might be used either for smoking or chewing, preferably the latter. There is no doubt that, so used, it alleviates hunger and, by promoting salivary secretion, diminishes thirst or makes it more tolerable. In the Japanese army, an issue of tobacco was made throughout the recent war.

The daily problem, alike with an army as with an individual, is how to perform the maximum of work with the least expenditure of energy. A wise commander, whether of a troop or of an

army corps, will endeavour to save his men all unnecessary fatigue and to allow them a sufficiency of sleep, the want of which quickly impairs both mental and bodily fitness. The question of what shall be carried *by* the soldier and what carried *for* him has been debated by military authorities for centuries, all recognising that the weight carried in marching order is a most potent factor in determining the soldier's fitness to perform the other duties of campaign. On the one hand there is the fear of separating the soldier from the essentials of life; on the other, of so overloading him that he becomes tired, dispirited, a prey to minor ailments and unfitted to cope either with an enemy or with disease infection. The wise solution, as always, is a mean between the two extremes; but it should be borne in mind that it is easier to carry greatcoats and surplus ammunition than to carry sick, and easier, if they are lost, to replace them. Lord Wolseley, aware of the importance of keeping troops in the highest physical condition alike for their health's sake and for the success of the campaign, says in effect, Reduce the number of sentries so far as may be. Attend to general cleanliness of the men. Issue hot meals before starting. Diminish the weight carried on the march. Do not keep the men standing. Save the men as you save the horses. Keep up the interest of all. Let the men have enough sleep (90).

The subject of the soldier's clothing is a vast one. In connection with the present theme only a few points require reference. The first essential is to have it adapted to the night rather than to the day. In tropical countries the evenings get rapidly cold, and the diurnal variation of temperature is much greater than is usual in Britain; in hot countries, therefore, both tunic and underclothing should be of thick woollen material. The weight of the clothing should be supported from the shoulders rather than by a belt. The kilt of the Highland regiments is an almost ideal campaign dress, suitable equally in the tropics and amid the rigorous severities of the Peninsula.

Except in camps of some permanence and under very unusual conditions, the bell-tent is unsuitable for warfare. It is bulky, cumbrous, heavy for transport, and toilsome to pitch and strike. An exhausted man will rather lie in the open air than commence to hammer 22 pegs into hard ground. The simple shelter-tent with a ridge pole, though less effective in protection, is eminently better, simpler, and lighter. In wet weather, when transport is in difficulties (and shelter most necessary), the bell-tents are often many miles behind. It is evidently better to have a light protection which can be brought along with the column than a thorough protection which is apt to be absent when most required.

Associated with the subject of the maintenance of the health of the individual is the matter of the first treatment of wounds which, as I have already indicated, is of enormous importance as affecting the efficiency of troops as well as the cost of war, measured in terms of the permanent disability of the wounded.

It may be accepted that the condition of a wound as regards sepsis is determined within a few hours, it may be a few minutes, of its receipt; that the bullets of all modern rifles reach their objective in an aseptic state; and that first field dressings are useless as antiseptics and can only be of benefit by keeping out septic organisms, not by destroying them after they have entered a wound.

The percentage of wounds healing without suppuration in the Anglo-Boer war was much commented upon by all the surgeons engaged (113, &c.), but was looked upon as adventitious and unexpected if not undeserved. The Japanese, however, have achieved a similar or even a lower percentage of wound-infections by deliberate methods of asepsis.

To secure a similar happy result in future campaigns, the strict observance of four rules is essential.

First, there must be maintained the greatest personal cleanliness. Obviously the conditions required to render this possible can be commanded neither by general nor by private soldier. In South Africa, except in certain districts, already mentioned, where there was no water available for ablution, the troops generally were able to maintain a standard of cleanliness beyond what is usual in the middle class in civil life at home. Doubtless this contributed to the rapid healing of wounds.

The second essential is cleanliness of underclothing. This is more difficult of attainment, and one cannot but fear that the Japanese instruction to troops to put on clean underclothing before hostilities or when engagement is impending, is only under exceptional circumstances feasible (78, 81). Recognition of the benefit, however, and of the fact that rifle wounds may be infected by the introduction with the bullet of fragments of septic underclothing at least indicates the course which ought to be followed by all practicable means.

As a third essential, the first field dressing must be applied at once and on the spot. From Cuba, from Manchuria, and from Natal, there is a consensus of opinion that rifle and, to a less extent, shell wounds are not best treated by immediate removal to hospital. On the other hand the exclusion of sepsis by the application of a first field dressing, by interposing an antiseptic barrier between the wound and the outside air must be done speedily if it is to be done successfully. This implies that, in the great majority of cases, it must be applied by the wounded

man himself or by his neighbour; and, to this end, the procedure must be a simple one.

The fourth requirement is the simplicity and suitability of the first field dressing itself. It must neither be moist nor require moisture in its application. Under the circumstances of its need and use no solutions can be made. Further, the waterproof element is undesirable. The dressing should be such that if suppurative germs have entered the wound, the ill effect resulting will not be increased as it would be were a waterproof covering to convert the whole dressing into a poultice. Above all the process of application must be very simple. The dressing will have to be applied in times of haste and excitement; and if simple means fail to secure the exclusion of septic infection, assuredly complicated methods will not succeed.

The actual materials of the first field dressing is the least important consideration. The gauze, charpie and bandage of the British army has proved satisfactory. The antiseptic dressing packets of the army in Manchuria, containing a ten per cent. ethereal solution of creosote, is perhaps unduly complex though it has the advantage that flies are repelled by it. Simple sterilised wool and gauze, well dusted with salicylic or boric acid powder, with a sterile gauze bandage, the whole being enclosed in an air-tight cover, probably fulfil all requirements. The essential points are its application over the whole area of wound, before the patient has been moved, and as quickly as possible after the injury has been sustained.

The present position of the dressing in the skirt of the tunic is not satisfactory. Its presence there is inconvenient, it is apt to become loosened or soiled, and in action in warm weather the tunic is apt to be taken off and left some distance in the rear. Its attachment to the bandolier—thus invariably associating it with the supply of ammunition—is probably preferable. It must be firmly fixed so as never to be loosened unless by intention. Its removal or use save for necessity should render the defaulter liable to severe penalty. Every soldier, of every rank, should be carefully taught its object, its importance, and the method of its employment. Particularly must he be cautioned what not to do; and shown that preliminary touching of the wound with fingers, handkerchiefs, or any unsterilised matter, may completely defeat the object for which the first field dressing is intended (16, 78, 80, 81, 87, 88, 79, 82, 83, 119, &c.).

Chapter VI.

PREVENTIVE SANITARY MEASURES IN THE FIELD.

PREVENTIVE sanitary measures in the field (no specific disease being present and its exclusion the object of those measures) are directed towards two aims: the provision of a pure or a purified water supply, and the prevention of pollution of soil, of water (directly, or through the soil), and of food, by foul organic matter which, given the risk of the importation of disease, may at any time become laden with specific infection.

As a preliminary to both these divisions of the subject there must be considered, since it has a bearing upon both, the selection of a camp site.

In making such a selection tactical necessities must be accorded the first place. These, indeed, may overrule all others, since it is obviously better to occupy a site which is hygienically bad than to expose troops to an increased risk of fire from the enemy or to select a position which it may be difficult to defend.

Accepting such limitations, the Sanitary Officer should advise in the selection of a situation, neither too damp—muddy or marshy—on the one hand nor dry and dusty on the other. The enforced acceptance of either extreme will render camp sanitation extremely difficult, since either the flow of water or the blowing about of dust will tend to disseminate organic impurity. Close proximity to a road is inadvisable since the presence of horse-droppings attracts the visits of flies and in dry weather traffic produces and raises dust.

Above all, the sites of previous camps should be avoided. Such previous occupation may be indicated by the existence of actual refuse or inferred from the presence of flies in unusual numbers. Columns composed of cavalry and other mobile units often find it difficult to leave their camping grounds in good condition; they may march off in darkness when it is impossible. They, also, are liable to the experience of a converse difficulty since they occasionally do not reach their destined camping ground till after dusk when they are apt inadvertently to occupy a recently polluted site. A particular instance of this may be mentioned. On one occasion the force commanded by the late Col. Le Gallais arrived at Vredefort long after darkness had set

in, and had perforce to bivouac where they could. All through the night an intolerably unpleasant odour permeated the camp, and this was explained the following morning when it was found that the putrid body of a horse lay in the middle of the lines. In every direction were indications of previous and recent occupation, so that, in place of enjoying an expected rest, an immediate movement had to be made.

WATER SUPPLY AND WATER PURIFICATION.

It will be abundantly manifest from a perusal of the preceding pages that the provision of a safe water supply to troops in the field is a matter to which all other concerns are secondary alike in time and in importance. The other rules of campaign sanitation can never without grave risk be neglected; but with the acquisition of a pure water supply the ideal of a disease-free army may be attained; without it, the hope of such a successful result is slender and liable at any moment to be defeated.

For the absolute exclusion of water-borne disease from an army, four factors are essential.

1. The water must be free from specific infection and kept so.
2. Unless this can be secured with certainty (and such security and certainty are impossible in warfare) the water must be sterilised.
3. After sterilisation it must be kept pure and distributed so.
4. No unapproved water must be drunk by any soldier.

No matter what processes of sterilisation are to be put in force, no matter how reliably they are wont to be performed, the purest possible source of water supply is to be selected in every case; with columns marching in tropical countries the choice is usually rather of the least foul. A pollution of a chosen or an inevitable water supply by a force itself is very reprehensible; from the first moment of arrival, a routine system of water-conservancy should be adopted. This may not indeed be invariably successful, for after an arid march in hot climates horses are not easily restrained from plunging into streams or pools, rendering a large extent of water turbid and muddy for a considerable time.

In the case of every camp water-supply on active service, but especially when the source is a running stream, the Sanitary Officer should select the spots for drawing drinking and cooking water, for the watering of animals, for ablution, and for washing of clothes. These various positions should be in the order mentioned from above downwards, the site for clothes washing

being lowest as most liable to infection-pollution. Sentries should be posted as waterguard alike to prevent drinking below the animals' watering-place or bathing above it.

The question has been much debated whether with an apparently pure water, presenting neither evidence, nor *a priori* probability, of contamination, methods of purification may advisably or safely be omitted. For several reasons I think the answer is unquestionably, No. In the first place, an appearance of purity is not reliable; it is notorious that a water may be dangerously polluted although showing all the outward physical characters of excellence; in the second place, there is neither time nor opportunity (in the case of marching or fighting troops) for any investigation, either bacteriological or chemical; yet again, such an analysis is not to be trusted, since a water-supply may be pure one day and polluted the next, with no obvious sign of the change; and lastly, under campaign conditions sterilisation of water must be a matter of routine; if it is to be omitted at the discretion of the Sanitary Officer, he is sure, sooner or later, to commit an error of judgment, when all the benefits of months of precaution may be hazarded. It is to be admitted that any process of purification implies considerable manipulation of the water, a manipulation which in itself is fraught with danger; nevertheless, this danger can be minimised by adequate care and, at the worst, is much less than the danger which it is the object of sterilisation to avert.

In examining a water-supply proposed for camp use, an endeavour to discover the presence of enteric bacilli is not to be advocated. Its difficulty, the difficulty of identifying the species, is well known; a negative result is only calculated to produce a false confidence; and the risk of infection by the germs of other water-borne diseases must not be overlooked. Investigation as to the presence of bacillus coli (as indicating general sewage pollution) is more likely to be successful and of value. But even this examination is all but impossible under the conditions of field service; and where it is most practicable (as in standing camps and general hospitals) the arrangements for water sterilisation are so much facilitated and so supremely essential that such procedure should never be omitted. The usefulness of a simple estimation of chlorine has been urged; but even if a titration indicated with great certainty the absence of animal pollution, yet the risk of subsequent infection can never be disregarded. And doubtless in warfare the only safe course is to regard every position as possibly held by the enemy, and every water-supply as liable to contamination.

It has to be remembered that, apart from the existence of pathogenic organisms, the presence of a considerable amount of

animal matter in water may be injurious to the health of those who consume it. Any process of purification, therefore, should aim not merely at the destruction of all bacteria, but also the conversion of other animal impurity into an innocuous or the least injurious form.

Effective water purification implies the removal of gross impurity such as mud, sand, and visible organic matter, as well as, and as a preliminary to, the more important matter of disinfection proper. If possible, a turbid or cloudy water should be clarified. This may be done by sedimentation by means of alum, by filtering through sterilised cloth, or by the use of a Maignen's filter, which acts both with simplicity and speed. It is, however, essential to recognise that such filtration serves at best but a subsidiary purpose, and is never to be used as a substitute for some form of reliable sterilisation.

Innumerable methods for the sterilisation of drinking water for the use of troops on active service have been suggested. These are divided into three classes according to whether the essential principle depends upon the use of (1) heat, (2) filtration, or (3) chemical reactions. Before these can be compared and contrasted, it is necessary to discuss each in some detail; and not merely the three essential procedures, but also the many several methods which have been devised, suggested, and tried for the effective performance of each.

Sterilisation of drinking water by heat is either accomplished by actual boiling, whether associated with cooking or separately, or by raising the water to a temperature which, though considerably under that of ebullition, is yet higher than is consistent with the survival of pathogenic bacteria.

Actual boiling, as opposed to sterilisation at a lower temperature, is the simpler to perform, requires less elaborate apparatus, and affords the greater security; it has the disadvantages that much more fuel is required, and that the subsequent cooling of the water necessary before it can be used takes longer time.

Under the conditions of active service, heat sterilisation of water is effected either by ordinary camp kettles, by improvised apparatus, or by adaptation of a heating apparatus such as Soyer's stove, to this particular purpose; or, on the other hand, in an appliance specially designed for the purpose. Several of these sterilisers devised for military use deserve notice in this context.

The feature of Griffith's steriliser is that the water is not boiled but merely heated to a temperature of approximately 160° (Fahr.) The water after sterilisation is from 48° to 88° (Fahr.) higher than before. The apparatus weighs 120lbs., and provides 60 gallons per hour, with a consumption of 24 oz. of oil, if that is available, or rather less than half that quantity of water if wood

fuel is used instead. The Lawrence steriliser is comparatively heavy, weighing over 180 lbs. It furnishes a supply of 25 gallons of water per hour, with a consumption of 1 oz. of oil per gallon of water treated. In this apparatus the water is actually boiled and issues 20° higher in temperature than it entered. Its weight is its chief disadvantage.

The Forbes-Waterhouse steriliser, with a weight of 74 lbs., supplies 25 gallons per hour. The water is boiled, but is cooled by conveyance through the cold water entering the apparatus, and is discharged only 10°-20° higher than before treatment. Kerosene is used as fuel, only 8 oz. being consumed in an hour. It possesses the great advantage of continuity of action, being able to be used for 24 hours consecutively. Further, it is economical of fuel and easily portable, while the water issued is but little deprived of its natural gases, and is not too hot for immediate use. Its disadvantages are its cost, its weight, and the need of shelter from wind to ensure its satisfactory action. The Forbes-Waterhouse steriliser has been very thoroughly investigated in the U.S. army, especially as to its primary quality of disinfection, and the reports are very satisfactory.

The apparatus designed by Leigh Canney to meet the requirements of the troops in South Africa produces about 30 gallons of water per hour, with a consumption of two pints of oil as fuel, or 8 oz. of petroleum. Subsequent cooling of the water is no part of his process. His appliance is cheap and light, easy to work, and easily repaired. On the other hand it is relatively wasteful of fuel, its action is not continuous, but is a series of separate boilings, and the sterilised water takes from 15 to 30 minutes to cool to potable temperature, according to the heat of the surrounding air. Its weight scarcely exceeds 60 lbs., but this great advantage is somewhat discounted by the greater weight of fuel which has to be carried for its supply. Leigh Canney claims for his apparatus that it will provide the soldier with one quart of boiled water daily for a year, with the use of 2 gallons of petroleum, costing 6d. and weighing only 8 lbs.

While there is no doubt that the Forbes-Waterhouse steriliser and that of Leigh Canney are absolutely trustworthy and fitted to solve the problem of water supply alike in stationary camp, on lines of communication, in hospital, and with large columns moving deliberately and well equipped with transport, it must be admitted that no apparatus comparatively heavy, comparatively cumbrous, or comparatively complicated will be serviceable with mobile columns actually at the front. Troops moving rapidly in unfamiliar and hostile country, such as cavalry on extended reconnaissance, cannot take with them a heavy steriliser, and are too dispersed to use it even if they could. For such as these

boiling in the camp kettle, or even in mess tins over individual fires, is the only solution; but, fortunately, unless there is want of fuel or tactical considerations forbid a fire less the enemy should gather information which it is essential to withhold, such a process is always feasible, quite as effective as a disinfectant as boiling in more elaborate apparatus, and, by the addition of tea, the water so treated can be drunk while still warm, and the want of aeration is unnoticed by the palate.

The difficulty of boiling water for drinking purposes on active service is closely associated with the difficulty of procuring or supplying fuel. In South Africa six years ago, fuel was never supplied to marching columns, and the search for it was often arduous and the work of collecting it a severe addition to the toils of the day. The South African plateau is for the most part devoid of trees or brushwood; to collect a sufficiency of dried ox-dung took a long period. If men are to be forbidden the consumption of unsterilised water and heat is to be the means of sterilisation, fuel must be carried. Coal is much too heavy and inconvenient; petroleum or kerosene is probably the fuel best adapted for the purpose. To carry a supply for possibly a month is no small undertaking; but it is certainly better to transport a considerable weight of fuel than to lose time, men, and military advantage from excessive sickness.

It is obvious that unsatisfactory boiling (and no less the imperfect performance of any of the methods of sterilisation) is worse than none; since a sense of security is created which is not justified. In an outpost camp with which I was familiar I used to see water taken from a polluted source and added to the contents of the boiler at any time; sometimes a supply was drawn off within a few minutes! The risk of contamination after boiling is much increased by the fact that the water needs both to be cooled and aerated to make it agreeable and palatable. I have frequently seen water just issued from the steriliser put into dirty canvas bags to cool, or strained through a rag (which was doubtless originally clean) for the same purpose (17, 22, 83, 124, 54, &c.)

Filtration was practised as a means of purifying water supplies for military use long before the nature of infection was understood. Now it has been established by a large number of experiments that only two species of filters are reliable sterilisers and even these within closely restricted limits. They are the filters composed of diatomaceous earth of which the Berkefeld filter may be taken as a type, and the porcelain filter of which the Pasteur-Chamberland filter is the best known. Each of these materials is fashioned into hollow cylinders for most convenient use. Filters of both types were extensively used in the Anglo-

Boer war so that all medical officers therein engaged had an opportunity of studying their action.

The Berkefeld filter constructed of a cylinder or "candle" of hardened infusorial earth is more rapid in action though less efficient and less durable than the Pasteur filter with porcelain for its medium. Berkefeld filters require to be frequently cleansed and sterilised—at least every second or third day—else they cease to be bacteriologically safe. Such repeated sterilisation tends in time also to impair their efficiency. The candles must be absolutely without flaw. They are very fragile so that on the march it is necessary to carry a large supply very carefully packed. When mud or fine sand is present in the water previous clarification is necessary as they speedily become clogged and cease to act. Thus there are numerous difficulties in the way of their use, the most serious, on field service, being their need of constant attention.

The Pasteur-Chamberland filter is much slower in action. It is less fragile than the Berkefeld filter, however, and much more trustworthy, bacteria which passed the infusorial filter after several days being effectively retained by the porcelain filter for several weeks. Thus sterilisation and cleansing once a week is sufficient.

The chief advantage of filtration under campaign conditions is the small bulk and small weight of the apparatus as compared with the size and weight of a heat-steriliser with its necessary fuel. The objections to filtration, on the other hand, are many. The apparatus is extremely fragile. A minute defect renders it useless. Reliable filters cannot purify a muddy or turbid water until it has been strained. Their action is slow, even the large "Field Service Filter" only furnishing 30 to 40 gallons of previously clarified water per hour. Lastly, they require skilled supervision. The men in charge of them must be clean; they must be careful, since otherwise the object of the process is defeated; they must be intelligent, especially in regard to the sterilisation of the candles; and above all they must be honest since there is a constant temptation to diminish the very irksome labour by perfunctory performance. The conclusion is forced upon all who have had experience of such filters that while they are eminently suitable and valuable in garrison and standing camp, they are impracticable for trekking and fighting troops.

Filters made of asbestos or similar material of the Maignen type have been previously referred to. They are durable, light, and portable and suitable for work in the field; but they are in no sense sterilisers but merely clarifiers of water, and their value is merely as adjuncts to sterilising processes proper (45, 17, 83, 122, 130, 131, 129, 53).

A vast amount of ingenuity and research has been expended

upon the effort to discover a means whereby water may be chemically sterilised for troops without impairing its potability in other respects. A statement, in tabular form, of the results of many investigations made with this object is appended (p. 79). It may at once be admitted that no method yet devised seems perfectly adapted to the circumstances of warfare and at the same time sufficiently to be relied upon as a germicide; and it is certain that no method has been subjected to such severe tests in the laboratory or in manœuvres under peace conditions at home as to warrant an experimental test on active service in the field. Several processes, however, and notably the Bromine, the Copper, the Bisulphate of Soda, and the Citric (or other vegetable) Acid methods, seem to afford fair promise that the problem of water purification by chemical means may yet be practically solved.

The Bromine process of Schumburg complies with the requirements of an ideal method in several respects. It is not unduly complicated. The apparatus is very portable; so much so that a weight of 4 lbs. will provide 1000 men with one gallon of sterile water each. The resulting taste is slight and not disagreeable, somewhat resembling extremely dilute solution of potassium hydrate. The process has been submitted to very searching tests by the German military authorities and their reports are on the whole, though not unanimously, favourable as to its efficacy. With water-bottles of glass or enamel, the Bisulphate of Soda process seems free from objection and is well spoken of in a recent report to the U.S. War Department. The Metallic Copper process has only very lately been suggested. If further tests should confirm the statements of its germicidal power, its simplicity should make it specially serviceable to military needs. The many advantages of Citric Acid are obvious. Not only is the reagent cheap and the process mere solution, but the result is palatable and slightly antiscorbutic. A $\frac{1}{2}$ per cent. solution is fatal to pathogenic organisms in five hours. The taste of such a solution is barely appreciable and it imparts a piquancy to recently boiled or "flat" water. The only practical disadvantage is the time required. This, however, may be overcome by adding citric acid to the water for morning issue on the previous night and by carrying the evening supply (say a quart per man) on the march, the acid being added before setting out.

With the various chemical processes, as with filtration, previous clarification is necessary. In this respect either is inferior to heat-sterilisation (48, 53, 44, 83, 133-139, 145-148, &c., &c.)

Experience has shown that for troops on campaign the daily

allowance of water per man should be 2 to 3 gallons according to the nature of the work performed and of the weather. Half of this or about one gallon is for drinking and cooking; and only from necessity should the minimum be reduced to three quarts. There can be no thought of the issue of two separate qualities of water. The problem, then, is to supply this daily gallon per head in such a condition that it can under no circumstances be the means of conveying disease.

From a comparative review of the methods of water purification, it is evident that no one method is invariably the best; that the process most suited to certain conditions is impracticable under others. Bacteriological reliability is the first requirement of any process and simplicity and portability of appliances are important factors; initial expense is a matter of but small concern when such a costly thing as war is involved and where lives are at stake. It is undoubted that among the several methods of sterilisation those by the use of heat are the best and the most reliable. In the agitation of some years ago it seemed as if many thought the process (as applied to this purpose) was a new one, and the error of thinking that it was an easy process was still more general. It must also be borne in mind that though water-purification is far beyond all other methods of disease prevention in importance, it is not itself an absolute barrier to the introduction of infectious disease as is proved by its presence in the cities of England, Europe, and America, where a pure quality of water is alone supplied. The fact remains that a regular and unremitting system of heat sterilisation of water is the first hygienic essential for an army on campaign.

Filtration, especially with turbid waters, is unsatisfactory. The time required, the fragility of the necessary appliances, the need of skilled and faithful supervision, all militate against its use on field service. This is the more unfortunate since it is particularly under the conditions when a light and compact apparatus is most desirable that filtration is unreliable. To put it otherwise, when boiling is difficult, filtration is more so; when boiling is easy, it is safer, and preferable generally.

The purification of water by chemical processes is still on trial; so far no reagent has been discovered which fulfils all the requirements, namely, rapid action as a disinfectant, moderate cost, convenience in use and portability, stability of composition, and the leaving the treated water in such a condition that it is neither unwholesome nor unpalatable. Such a substance has still to be found; but the results of many investigations, particularly those of Moore in America, Schumburg and Pfuhl in Germany, Vaillard in France, and Parkes and Rideal in England, seem to indicate the probable evolution of some practicable process

adaptable to the needs of mobile troops and isolated posts on active service.

It is almost certain that in standing camps and camps at the base and on lines of communication, and also, probably, in the case of columns of some magnitude making deliberate advance through an invaded country, water is best sterilised by heat, and preferably by such an apparatus as the Forbes-Waterhouse steriliser where fuel is economised and the issuing water cooled, such treated water being aerated before use. On the other hand, with troops in rapid movement and in close touch with the enemy, no system of purification which involves the transport of elaborate or special apparatus is possible. Under such conditions, the men should have tea or soup at night in ample quantity, even if weak, and coffee or tea in the morning. The camp kettles, after the distribution of evening tea, should be again filled and boiled, so that a quart of sterile water is available for the filling of each man's water-bottle in the morning. The addition of oatmeal to this water before boiling, or of lime-juice or citric acid subsequently, is well worthy of consideration and extended trial. If the supply of fuel is defective, what is available must be used for boiling water rather than for cooking; and with this in view the waggons should carry at least one prepared ration per man (in addition to the "emergency ration" carried by himself), and at least one day's supply of fuel (petroleum or kerosene) for the boiling of water. In addition, a number of Berkefeld filters should be carried, with a carefully packed reserve of candles, to tide the column over a day of emergency should the boiling arrangements fail from any cause. Chemical methods (except the addition of ½ per cent. of Citric Acid to the contents of water-bottles) are not yet ripe for trial. With all this, the men should be trained out of their thirsty habits, and shown that the less they drink the less they will suffer from thirst. Finally, the system should be a matter of invariable routine, with no allowance for discrimination or judgment in the selection of a purification method. If such a choice is possible or permissible, all the most elaborate endeavours of the careful will go for naught.

Without the greatest vigilance in regard to water *distribution* the aim of all the cares expended upon water purification is liable to be frustrated. The hands of those engaged in the work must be clean and the vessels employed no less so, desiderata by no means easy to secure amidst the stress and pressure of hostilities. "Dipping" in any form must be prohibited; all vessels for water-carriage must be closed with tight-fitting lids to exclude dust and insects, and with faucets and taps for the issue of water as required and to permit complete emptying. Water carts for use before and after sterilisation must be kept separate. All

water carts must be scrupulously clean. To this end those made of wood should be abandoned and replaced by circular tanks constructed of iron, treated by Barff's process, and with a tap at the lowest part. If there is the least suspicion of accidental pollution they must be thoroughly disinfected, otherwise further supplies are liable to contamination. All receptacles for water storage should be of metal, situated at a distance from rubbish heaps, latrines, and transport lines, regularly cleansed, and not handled except by those detailed for the purpose. Boilers and tanks alike should be frequently cleansed with chemical disinfectants and sterilised cloths. Water-bottles should be made of glass or enamelled, and should contain one quart.

There remains yet to ensure that troops are restrained from imbibing "unapproved" water or water from a prohibited source. Breach of regulation in this respect should be visited by sharp punishment. But neither to penalty nor to supervision should we look for a radical removal of this difficulty. The soldier, as has been said, must be trained to an understanding of the urgent need of care in this respect. He would not wittingly drink of water poisoned by strychnine or arsenic. He must be shown that the danger of drinking polluted water is just as imminent and quite as grave. Nevertheless, the existence on campaign of an unwonted indifference to fate is a formidable factor which must be reckoned with. "One cannot expect a body of men, some of whom will meet with a violent death on the morrow, to take much trouble to guard against the remoter consequences of infection" (39). This apathy can only be met by proving equally to officers and men that to expose oneself (or one's comrade) to unnecessary risk of infection is as foolish, as unsoldierlike, as to expose oneself needlessly to the enemy's fire, and for the same reason. The temptation to use untreated water is diminished by ensuring the palatability of that issued in its stead; and is therefore increased by the employment of those chemical means of purification which affect the flavour of the water so dealt with.

The restriction must apply also to fresh milk and to "unapproved" lemonade or aerated waters. On active service milk is not essential and only the use of condensed and sterilised forms should be allowed.

In recapitulation, the following conclusions may be stated:

1. The provision of a sterile water supply is the prime essential for the health of a campaigning army.
2. Any process of sterilisation, to be reliable, needs care and constant skilled supervision. This the men of the Sanitary Corps previously referred to would alone be qualified to render.

3. Ineffectual purification is dangerous since—
   (a) It may spread disease.
   (b) It may beget false confidence and neglect of other precautions.
   (c) It may lead to loss of faith in sanitary measures and so dishearten troops.
4. Only the simplest methods are applicable to the conditions of marching and fighting troops; such as the issue of water in the form of soup or tea, or boiled and acidulated for the filling of water bottles.
5. Officers and men must appreciate the importance of the subject; they must know that it is as necessary to detail men to obtain, purify and distribute water as to detail cooks; and, in short, that the maintenance of the health of troops is as essential to military success as wise strategy, clever tactics, good discipline or straight shooting.

PREVENTION OF SOIL-POLLUTION.

The pollution of soil (and thereby of water and food) is a secondary and indirect, though far from an unimportant, factor in determining the prevalence of illness among troops. The men, set amidst novel surroundings, unused to a nomadic life, and unaware of the dangers eventually accruing from a polluted soil, throw upon the ground refuse which they would never think of depositing upon the floor of a dwelling-house; oblivious or ignorant of the fact that while the latter can be cleansed with comparative ease, a soil once befouled can never be purified save by the slow processes of nature.

It is not, of course, contended that a polluted soil, *per se*, can originate illness of a grave or infectious type. But it is undoubted that such contamination, besides tending to lower individual vigour and therefore individual resistance, offers every facility for the establishment and diffusion of zymotic affections. "There is little doubt, according to the experience of those acquainted with the conditions of active service, that a large proportion of the diseases to which the soldier is peculiarly liable while engaged in the field result directly from the faulty disposal of the organic matter which must of necessity collect about the habitations of man." Despite the most careful methods of conservancy, the sites of encampments become polluted sooner or later, the length of time being determined by the efficiency of the camp police. Cooking-places, rubbish heaps, and horse lines are necessarily

within the precincts of a camp; and slaughtering-places, though they should be without the boundary, must yet be in close proximity. If the soil is originally dry and permeable and the climate warm and moist, admirable media for the existence or even the propagation of pathogenic bacteria are thereby provided. The truth of this is indicated by the experience of the army in South Africa, where, as already mentioned, trekking troops, occupying fresh ground from day to day, were comparatively exempt from the illness which was simultaneously abundant in standing camps; indeed the diminution of this immunity of the marching columns towards the latter stages of the war tends still further to corroborate this view. The evidence submitted to, and the report issued by, the U.S. Commission investigating the occurrence of typhoid fever in the Spanish-American war is very strong and indeed conclusive on this point.

How is such soil-pollution to be avoided? Many precautions are necessary, and those which deal with matters of minutiæ are not the least important, but two of these claim precedence over all others and demand special consideration; they are the collection and destruction of all organic refuse, and the construction, use, and care of latrines in accordance with sanitary regulation and experience.

To prevent soil-pollution (and thus to prevent one of the factors conducive to campaign disease), the routine performance of approved methods of refuse disposal is the first essential.

As with methods of water purification, so with those under review; the procedures to be adopted vary both with the necessities and with the possibilities of the situation. Nothing but discomfiture awaits the attempt to apply precise garrison methods to the rough conditions of field service. Incinerators and refuse destructors, for example, whose use is obligatory in general hospital and standing camp, are useless for mobile units, since they could neither be carried nor, were that difficulty overcome, could they be successfully employed.

In camps of some permanence, kitchen garbage should be collected as carefully as in civil life; it should never be allowed to touch the ground nor be buried within the camp area. All such refuse should be taken to a place set apart for its destruction. Such a site should be well without the camp, should be to leeward (the prevailing wind being known), and at a safe distance from the water source. Even here rubbish should not be carelessly deposited or thrown about, but unloaded directly into the trench or destructor. In such camps destruction by fire is the only method whose results are ultimately satisfactory. Refuse of every sort should thus be dealt with, kitchen garbage, stable manure, dead animals and slaughter-house offal, straw, empty

tins, rags, and bones. What is incombustible should be subsequently buried. A number of camp crematories have been devised and several forms have been ingeniously adapted for convenience of transport. But a destructor of simple type can be readily improvised provided materials are available.

If filth trenches are in use in standing camps for temporary reception of refuse, they require very careful attention. Especially must flies be excluded ; this is best secured by free use of chloride of lime or crude petroleum.

With marching troops other and less ambitious methods only are feasible. Here also the use of fire is to be regarded as safer than burial. Kitchen garbage is not to be thrown upon the ground. What cannot be burned at once in the kitchen fire is to be collected in a suitable receptacle, covered, and preferably of metal. This should be emptied daily. Much of the kitchen refuse is too moist to be easily burned. In camps of more than one day's occupancy, greasy and soapy liquids from kitchens and wash places should be thrown over heaps of grass, thorns, or twigs, whereon the fatty matters are deposited. The grass or brushwood so used is afterwards to be burned. All material not capable of being directly consumed should be taken to a place selected and there mixed with straw and manure and set fire to, crude petroleum being added if required. Such combustion is greatly facilitated by forming a pile of old tins as the centre of the heap. These allow of the entrance of air, and, by promoting draught, make the process more thorough and more rapid. If the force is stationary for some days, such tins can be used for this purpose again and again. When such burning is done on the surface of the ground, a cover of wire netting prevents the scattering of dirty and partially consumed fragments in windy weather. When it is done in a pit, a final covering of earth should be added as the force moves off.

With artillery, cavalry, and other mounted troops, military exigencies require that horses and men be closely associated in camp. From a sanitary point of view this is unfortunate, since horse-dung, especially in accumulated heaps, provides a very suitable breeding-ground for flies of several species. It is recommended that it be spread out to dry for a short time each day and burnt thereafter. This, of course, is only feasible in a warm country and in dry weather. In standing camps it must be removed daily and destroyed by heat. In camps of rapidly moving troops, no means of dealing with it are practicable.

Dead animals should, if possible, be buried. This is a matter of great practical difficulty since it requires much labour. If from this reason or the nature of the ground or otherwise, burial is impossible, the animal (unless death is due to anthrax) should

have the abdomen freely opened. By this means the offensive period of putrefaction is hastened and considerably diminished.

Slaughtering-places should be at a moderate distance beyond the boundaries of the camp. All offal should be promptly burned, or, though less advisably, buried (9, 128, 16, 10, 113, 117, 118, 124, 44, &c.)

As bearing on the subject of soil-pollution the question of latrines is scarcely less important than that of refuse disposal. As before, what is to be attempted is decided by what is practicable. The several requirements of standing camps, of camps of 2-10 days' occupancy and of the hasty camps and bivouacs of moving commands may be separately noticed.

In camps of some permanency, the evil effects of soil-pollution are most to be dreaded. Further, infected men are probably present; flies, if the country and season be warm, are to be expected; and the occurrence of dust storms is to be anticipated. Trench latrines, therefore, are unsafe. Buckets must be substituted. These should contain dilute carbolic acid in place of earth, and their contents should be invariably disinfected and afterwards buried. The management of latrines in camps where specific infectious disease is present must be subsequently discussed in connection with the disinfection of dangerous excreta. Latrines in camps of this nature should be protected by screens so as to prevent dust and paper from being blown about.

In encampments intended for a medium duration of stay, trenches not less than four and preferably six or even eight feet deep should be dug. Accommodation for from 5-10 per cent. of the men should be provided and such pits should serve for from 10 to 14 days. Their situation depends upon the position of the water-source and of the kitchens, upon the duration of stay anticipated, upon the slope (as determining water-flow after rains) and upon the direction of the prevailing winds. They should not be within 100 yards of the nearest tents. Undue proximity and undue distance are each, for obvious reasons, harmful. If from the hardness of the ground, as in Lord Methuen's camp at the Modder, shallow latrines only can be dug, either there is too little earth available for covering excreta or too much labour is required in the frequent digging of new trenches. The former permits the diffusion of foul odours and attracts the presence of flies. By the multiplication of latrines also the freedom of the camp is contracted.

Excreta should be covered by the individual. Toilet paper, which for sanitary reasons should be issued to men on campaign, must be covered with a sufficiency of earth; otherwise it is liable to be blown about and possibly may even reach the food stores and the water-supply. The direction of such latrines should be

indicated by white stones and their position by a lamp at night if necessary.

In addition to the use of dry earth by the individual, the men in charge of such latrines should add a more plentiful covering three or four times daily. The trench should be entirely filled in when three-fourths full and the site so marked that it will not be inadvertently reopened.

In suitable weather dry earth not only acts well as a deodorant but effectually prevents the scattering of filth by flies or the blowing about of papers. Fresh chloride of lime may advantageously be used in addition. Lime and all disinfecting powders are not merely useless but even dangerous owing to erroneous notions of their value.

Pending the construction of latrines, some surface pollution is unavoidable. This should only be permitted at a selected site at some distance from the camp and the area carefully attended to when the latrines are ready.

In the case of camps of very brief occupation, latrine trenches are the only possible latrines and prove quite satisfactory. They should be shallow, not exceeding one to two feet in depth. In the case of mobile columns no disinfection of latrines is, as a rule, either requisite or practicable. If there is reason to suspect the presence of infectious disease, and particularly if flies are numerous, an effort towards disinfection should, however, be made. The use of chloride of lime or combustion aided by the addition of petroleum are the most feasible methods. Such trenches should be covered in on leaving but not so carefully that their existence can be overlooked Instead of covering with earth or lime, the addition of dry grass or straw or the more inflammable kitchen refuse, afterwards burned, leaves a visible and disinfected covering of ashes.

As a practical matter in the administration of camps either in peace or war, the disposal of urine is much more difficult than that of other excreta. Still more so is this the case with its regulation because of the simplicity of the process, the difficulty of detecting offenders, and of the conviction of its harmlessness in the minds of all soldiers. Contamination of this nature is more likely to occur in wet weather and at night; experience shows that men will not go far to urinate at night. Those with experience of the cold of the South African winter nights will readily comprehend if they do not even sympathise with the objection.

The remedies are to prohibit indiscriminate micturition and sharply to punish breach of the rule; to have buckets for urine beside the trench latrines, and these emptied twice daily or as required; to have places for urination specially designated; and

to have tubs filled with sawdust (if available) in such places in the lines at night, the sawdust to be afterwards burnt. The use of suitable vessels such as empty biscuit tins placed just outside the tents, may be permitted during the night, but these must be removed (and disinfected if necessary) at reveille. But, as has been admitted, no military regulations are harder to enforce than these. So that we must rather look for safety to the absence of the infectious sick from moving forces, to their early isolation, and to the sanitary administration of urotropine till infection has ceased.

To regulations enforcing the use of latrines it is less difficult but no less essential to secure obedience. Offenders should receive exemplary punishment. In addition it should be endeavoured to make latrines so comfortable and inoffensive that men will have but little inducement to go elsewhere.

Latrines of medium depth are less safe than those of either greater (6 ft.) or lesser depth (1-2 ft.) The former have the security due to remoteness from the surface ; the latter are more accessible to the nitrifying organisms in the soil. The simpler the system in use the more easily can it be carried out. For this reason the pail system, if ill regulated, is much more dangerous than the use of simple trenches. It is most important, especially in wet weather, that the immediate surroundings of latrines should be kept clean ; if this is not done a difficulty arises which increases every hour. Whatever type of latrines are in vogue, careful and regular supervision and attention by men of the Sanitary Corps or men specially detailed for the purpose is absolutely essential (10, 111, 13, 113, 135, 117, 118, 16, 9, &c.)

The potency of flies as factors in disease conveyance is now so generally credited that the means for their prevention demand special discussion. All good methods of refuse destruction and excreta-disposal check the numbers of flies. With the hastily pitched and speedily struck encampments of cavalry, they are not a formidable evil. In permanent camps, where flies are apt to collect in enormous numbers, latrines should be enclosed. Milk of lime or crude petroleum should be freely sprinkled over latrine trenches. Such trenches should be burned on the surface and covered up after use. From built kitchens or meat safes flies must be excluded by gauze. Refuse should be so dealt with (by collection in close receptacles and by burning) that flies are provided with no suitable breeding-place. At the worst a selection of a new site one or two miles to windward may have to be made.

Towards the same object, the avoidance of soil-pollution, general cleanliness must prevail in the tents and in the lines. The latter should be kept clean, the turf, if turf there be, un-

broken, and no traffic permitted except on the streets and roads of the camp. The tent areas are to be kept as clean as possible. Food fragments are to be removed (and empty tins serve well for this purpose), so that neither floors nor unused food are fouled.

Urination within tents is not permissible on active service. Refuse from the men's tents is to be collected daily. When strictly military duties permit, tents should be cleaned and inspected daily, and so far as possible exposed to sunlight. Every man must learn that ground once befouled can never be restored to purity by sweeping or the use of disinfectants.

All duties of camp conservancy should be performed under and to the satisfaction of Officers or N.C.O.'s of the Sanitary Corps. The actual work can be done by prisoners, by fatigues, by natives (in certain countries), or, occasionally, by civilians for pay.

It may be asked, What are the essential minima which must never be omitted even in the hasty encampments or bivouacs of forced march, pursuit, or retirement? As the absence of infection is to be presumed under such circumstances, it is sufficient to keep the water-source as clean as possible, to prevent fouling of the ground actually occupied, to dig a latrine trench and rubbish pit, to cover the former and set fire to the latter on departing, and to leave indubitable signs of previous occupation.

It should be remembered that the fact that a force intends to move on the morrow does not justify the pollution of the site. Military conditions may prevent the intended advance. The pollution cannot then be rectified. On the other hand, only from inadvertence (as in darkness) or from urgent military necessity should a force be located on a camp site recently vacated by another (9, 113, 16, 10, 117).

Chapter VII.

METHODS TO BE ADOPTED UNDER THE CONDITIONS OF FIELD SERVICE TO PREVENT THE EXTENSION OF DISEASE THAT IS ALREADY PRESENT.

THE remaining division of the subject relates to the measures of sanitation which are applicable to armies in the field when preventive methods proper have failed; when, despite all endeavours, infectious illness has invaded a campaigning force.

As a preliminary to the consideration of isolation, notification and disinfection, the all-important matter of early and accurate diagnosis must be noticed.

When it is remembered that the infectivity of enteric fever commences prior to the manifestation of any symptom, and occasionally occurs without there being any other indication of the presence of the bacillus within its host; when the insidious nature and protracted duration of urine infection is borne in mind, and since it is known that a considerable proportion of cases of enteric are never unfitted for duty and remain "ambulant" in type throughout, the need of the greatest care in diagnosis and of the prompt isolation of all mild and dubious cases must be evident (44, 60, &c.)

In the Grüber-Widal test we have a method, neither very uncertain nor unduly complex, of verifying the diagnosis of enteric fever in the uninoculated. It, however, is not available till the disease is well established, and so is of but little use to the military sanitarian. According to Cole and Schottmueller, the diagnostic value of blood examination is greater than that of the Widal test, since, by the former, definite conclusions can be formed much sooner than by the latter (60, 149, 150).

It is impossible, however, to do bacteriological work or laboratory work of any sort in the field. It is at the actual front where such aids are most urgently required that they are unavailable. So that, just as all waters should be regarded as liable to contamination, so every case resembling enteric fever must be looked upon as a definite case of the disease. A large number of cases of "Simple Continued Fever," possibly the larger number, are really aberrant cases of enteric fever. All cases so named, therefore, and all cases of "Diarrhœa with Pyrexia," are to be considered as distinct cases of enteric fever from the Sanitary Officer's point of view. The experience alike of war and of civil life is that early and mild cases of enteric fever are the most dangerous as possible agents in disseminating the disease. From another aspect, that of the clinician (which is also, in this matter, that of the philanthropist and the ratepayer), it is advisable to get cases of enteric fever and dysentery to hospital at an early stage. The severity, and, therefore, the duration, of the illness and the risk of death increase when reception in hospital is delayed. Therefore, sick men, especially those suffering from diarrhœa, "fever," or persistent headache, should be encouraged to report sick, and to apply for treatment as soon as possible, instead of being urged by company officers and colour-sergeants, as too usually happens, to "fight on a bit," or "try what another day will do." At present the ailing man on active service is between two fires; he would fain have help, but he dreads the disapproval of the N.C.O.'s and the sarcasm of his companions. Quite an opposite state of things should be reached when it is a breach alike of honour and of regulation for a man

not to report sick when he feels so. The risk of malingering may be discounted, since neither diarrhœa nor pyrexia can be counterfeited. It would be one of the duties of N.C.O.'s and men of the Sanitary Corps to report all cases of suspicious sickness to the Sanitary Officer of the camp (46, 60, 44, 19, &c.)

As has been said, hand in hand with early diagnosis (which in itself is, of course, of no benefit) must go the isolation of early and suspicious cases of zymotic disease. "If the sick, and particularly the infectious sick, should be removed from the healthy in civil life at home, much more urgently necessary is it in campaign life abroad" (9). Without doubt the extension of epidemic sickness in the field is largely due to the presence amidst the troops or in the field hospitals of men suffering from communicable disease. Cases of enteric fever, diagnosed, very probably, as "S.C.F.," or of dysentery in an initial stage, when diarrhœa is the only symptom, share a bell-tent with other cases, or with the healthy, with blankets and utensils in common use. The increasing debility of the patient renders numerous and hasty visits to the latrines impossible. From this cause and by urine pollution, tents, and the soil of floors, clothing, and blankets become infected. Flies and dust do the work of diffusion. The sick rate is increased tenfold within a fortnight.

It may be urged that the isolation of all cases of suspicious illness will seriously cripple the strength and so impair the efficiency of a force. This is no doubt true. The step is not proposed to be taken or regarded as essential in a disease-free army; and if infectious illness has been declared to be present, the number of doubtful and suspected cases will probably be considerable. On the other hand, the very object of the step is to prevent a much graver risk, to avert a threatened disability on a much larger scale. Apart from all questions of humanity and therapeutic expediency, such prompt isolation of all actual and suspected cases is to be regarded as an insurance, and to be defended on this principle.

Further, the isolation of the infected soldier must be very complete, since the omission of one detail of prophylaxis may defeat the object of all. His reception and retention in hospital may be taken to imply such thoroughness of isolation. His return to duty must not take place till infectivity has ceased: and this must be determined not by any fixed rule or period of days but on special consideration of each individual case. In the case of war in a foreign country, it is probably inadvisable to pass men for active service within three or four months of an attack of enteric fever. And the issue of infected material for use in the field would imply negligence so gross that it surely need not be feared. When a large proportion of the men of a

unit are affected with communicable disease, the question of the isolation of the whole of such a unit may demand consideration. But, since it is probably the condition of the site that has determined the outbreak, the abandonment of the position, if compatible with military needs, is probably the best solution of such a problem (9, 10, 117, 44, 68, &c.)

In a war of any magnitude when sanitary and medical officers are in great demand and each is doing, or marching in readiness to do, the work of two, no duties are more irksome than those connected with reports, returns, and the compilation of statistics. Thus it is most desirable to diminish the number of these reports and of such duties so far as permissible. Yet without regular and accurate statistical tables of the incidence of infectious disease, all efforts towards its diminution are greatly handicapped. The medical officers in charge of troops whether in stationary camps or on the march should furnish to the P.M.O. or to the Sanitary Officer of each division or district a daily sick report with the actual number of sick under his charge, the proportion of sick to strength, and with a special statement regarding the numbers affected with zymotic illness. On the basis of this daily return the Sanitary Officer should make a weekly report to headquarters, with such comments as he thinks fit. When epidemic or other grave disease is unusually prevalent, the Sanitary Officer should make special effort to ascertain and remove the cause, and the nature and results of such efforts should be included in his weekly report. To the bureau of the Principal Sanitary Officer at headquarters there would thus come weekly statistical returns and sanitary reports from all parts of the theatre of war. These, translated into map form, would allow him to form a most clear and accurate view of the disease prevalence throughout the area of campaign. With such information before him he would be enabled to issue appropriate instructions to all his subordinate Sanitary Officers and at the close of hostilities, to compile, tabulate, and publish a very accurate, reliable, and valuable survey of the sanitary history of the war. It is undesirable to elaborate such a scheme of returns too minutely; but it is contended that the extra labour involved would not be intolerable, that its value would be enormous, and that thereby a comprehensive survey of the health of the army at frequent intervals would be possible. On the basis of the information thereby afforded, extensive measures for disease control could be initiated, even, if necessary and possible, to the evacuation of posts or garrisons where the wastage from sickness was so great as to outweigh the tactical advantage of holding them. The recently published reports on the disease incidence and mortality of the Spanish-American and South African wars

go far to show that preventive measures on the basis of such weekly returns would procure results not to be achieved when each sanitary officer is working individually and to a large extent in the dark.

The process known as "direct contagion" really implies either air-conveyance or the immediate passage of germ-laden material from patients to attendants or comrades in a tent. Such infection is to be prevented (as we have seen) by the early discovery and transference to hospital of all infected persons and (as has yet to be noticed) by prompt disinfection and removal of all excreta. But for the certain prevention of infection by contact, yet other measures require observance. All possible steps conducive to personal cleanliness and personal hygiene should be taken. Flies are to be excluded from tents, and to this end meals should be taken in special marquees in standing camps, in the open air if weather conditions permit, and only from necessity in the living tents. If the latter is obligatory, all food debris should be collected and removed after each meal, while supplies and surplus should be closely covered. Over-crowding is most injurious, not merely from the interference with ventilation and the resulting depression of health and increased susceptibility to catarrhal conditions of throat, of respiratory mucous membrane, and of the alimentary canal, but from the impossibility of nice methods of eating and storing food when men are closely packed together. For these reasons, eight is the largest number which should occupy a bell tent, and six should be the maximum if there is no special feeding-place. Hygienically, the simplest bivouac or no protection at all is better than the joint occupancy of one tent by 12 to 16 men.

As the provision of a purified water supply was regarded as the primary essential for the prevention of disease among campaigning troops, so we may regard methods of disinfection (and particularly of excreta, since they are the source of all infection) as the primary and most essential means of arresting its spread. It may even be said that efficient and, particularly, *prompt* disinfection of dejecta affords the only hope of checking the general diffusion of zymotic disease once it has got a foothold in an army.

It is desirable first to consider the various methods of dealing with infected, presumably infected, or possibly infected excreta, and afterwards the adaptability of such methods to the varying circumstances and needs of warfare.

Four such processes require to be specially noticed; they are:

(1) Simple burial.
(2) Destruction by fire.
(3) Chemical disinfection with subsequent burial.
(4) Sterilisation by moist heat, that is, by boiling.

The first of these, burial without previous treatment, is only to be regarded as a makeshift to be followed when infectious disease makes a sudden and unexpected appearance in a marching force. In other words, burial of the excreta of patients suffering from dysentery, cholera, or enteric fever without previous sterilisation is only perforce and with the greatest reluctance to be adopted.

Burning or incineration is simple and effective but wasteful of fuel. The addition of paraffin and afterwards of sawdust to the contents of bedpans insures thorough combustion; but the manipulation involved is both disagreeable and dangerous, and after the bedpans are emptied they require cleansing by some other process. Incineration has this benefit, that no subsequent burial is required, the ashes being alike innocuous and inoffensive. Where incineration of excreta is employed all camp refuse can be similarly treated. But the process is not well adapted to the disinfection of liquids, whether infected discharges or the ablution water used in hospital wards.

Chemical disinfection is, on the whole, less simple and less reliable. The micro-organisms of cholera, dysentery, and enteric fever and other pathogenic microbes are, it is true, readily destroyed by chemical disinfectants such as carbolic acid (5 per cent.), chloride of lime (4 per cent.), lysol and creolin (2 per cent.), and formaldehyd (1 per cent.), provided the quantity of solution equals the quantity of matter to be treated and a period of two hours is allowed. Lime, from its cheapness and convenience, is in general use in the armies of the continent. Sinhuher found that enteric bacilli in fæces were rapidly destroyed by quicklime, a 6 per cent. admixture causing their disappearance within an hour. He therefore advises for military use a combination of 10 per cent. of quicklime in garden mould. This, however, is scarcely suited to the conditions of active service. Chlorinated lime has the advantage that it may either be used in solution or as a powder. Eminently the best of all the germicidal agents is corrosive sublimate. Chantemesse found that perchloride of mercury in solution of 1 in 20,000 was more quickly fatal to enteric bacilli than a $2\frac{1}{2}$ per cent. solution of carbolic acid. Its price, its convenience, its solubility, and this high potency place it easily at the head of field disinfectants. Its only notable defect is the want of markedly distinguishing characters. Where a more obvious and odoriferous disinfectant is desirable, izal, creolin, or, best of all, tricresol, of which a 1 per cent. solution is fatal to all pathogenic microbes within a few minutes, fulfils all requirements.

The disadvantages of all methods of chemical disinfection are very apparent. No matter how powerful the germicide the process involves time and this necessitates the retention of the

excreta in an offensive state. For the process to be thoroughly carried out the solid excreta require to be intermingled with the disinfectant, whereby new risks arise. Yet again, it is difficult to make solutions of carefully graduated strength in the field; while, with all the more effective germicides, cost, while not a vital, is yet not an inconsiderable, feature.

The method of disinfection by boiling remains to be noticed. Its efficacy is undoubted, for all the pathogenic microbes that have practically to be dealt with are killed by a temperature lower than that of boiling water. This process is applicable not merely to excreta but to infected articles of almost every sort. Its great advantage (after its certainty) is its rapidity, five to fifteen minutes sufficing for the destruction even of spore-bearing organisms in semi-solid dejecta. As opposed to these merits, the consumption of fuel is considerable and the disinfected material has afterwards to be dealt with by burial or otherwise.

The apparatus devised by Cummins (27, 141), in which the benefits of boiling and chemical disinfection are combined, though quite unsuitable for the use of mobile troops, has proved most effective in standing camp and garrison alike in South Africa and in India. A 5 per cent. solution of carbolic acid is kept boiling in two iron vessels. Into one of these excreta are emptied, while bedpans and other utensils are cleaned by immersion in the other. The process is quite inoffensive, the carbolic acid acting as a quick deodorant. It is also fairly cheap, very simple, and, within certain evident limits, of general applicability. It is pointed out that the disinfecting power of the carbolic acid is increased by the heat, while the presence of the disinfectant lowers the thermal death-point of the various micro-organisms. Thus by the combination of phenol and ebullition the potency of each is mutually increased, the necessary duration is cut short, or, conversely, a given time is more absolutely fatal to all bacterial life. A few minutes' boiling in such a solution (and a period of fifteen is recommended) undoubtedly secures the death of the most persistent microbes and spores.

Another dual method is recommended by Wilson (16), a combined steriliser for liquid excreta, with an incinerator in which dry refuse, dressings, infected clothing, and the like are consumed. By this means fuel is much economised, the conversion of water into steam (as a preliminary to incineration) being very wasteful when moist excreta are to be converted into ashes.

As with water sterilisation and the other processes of the hygiene of war, so with the disinfection of excreta: no one method is invariably the best; indeed no one method is always possible. The questions demanding solution are: Where all

methods are available, which is the most reliable ? and, Where all methods are difficult (as during rapid movements), which method is the least so ?

In hospitals wherein infectious patients are received, and in isolated posts and besieged garrisons where the retention of undoubtedly infectious cases is inevitable, the following regime may be taken as that which should be followed so far as circumstances permit.

The dejecta, advisably from all cases of sickness, but certainly from all suspicious cases or those presenting febrile or intestinal symptoms, are to be received in a bedpan in which solution of corrosive sublimate, izal, or tricresol has previously been placed. Immediately after use these are to be placed in a covered box while the patient is cleansed and locally disinfected. All cloths or rags used for this purpose are to be immediately burned. Such bedpans are then to be conveyed in a tin receptacle, provided with a lid, and either emptied direct into the incinerator or steriliser or into pails coloured red, marked with the letter "E," and used for no other purpose. The bedpan is then to be disinfected in perchloride solution and washed, and finally the hands of the attendant are to be cleansed. The working of the steriliser or alternative appliance is to be supervised by a non-commissioned officer of the Sanitary Corps.

All these processes and especially the cleansing of the utensils is to be done *at once*, since drying (particularly liable to occur in the case of the bedpan with a large infected surface) or accession of flies is a source of danger.

Sputum must be similarly dealt with and all spit-vessels and feeding cups are to be carefully and promptly disinfected and cleaned after use.

Urine is to be treated with no less, if possible with greater, care. On account of its less obvious, less offensive nature, urine pollution and urine infection are more to be dreaded than the fæcal dissemination of disease. The ward urinal should contain tricresol or perchloride solution and be dealt with as indicated for bedpans. In addition, urotropine is to be administered to enteric patients and convalescents in doses of from one to two grams daily for several weeks or until discharge to duty which should not take place until the urine is no longer cloudy. It produces no ill effects and its cost, as compared with that of an epidemic, is not to be considered.

In camps of prolonged occupation, at the base, on lines of communication, or elsewhere, the regulations for disinfection in hospital are to be carried out as far as possible. The procedure advisable in all cases must be considered obligatory whenever there is a suspicion of the occurrence of infectious disease.

In camps of brief occupancy, less elaborate methods must necessarily suffice. It is under such circumstances that chemical disinfection is most applicable. All suspected excreta should be at once treated with izal, tricresol or corrosive sublimate solution. After a sufficient time (not less than two hours) they should be buried in a deep trench save in the case of actual enteric excreta which should be subjected to the action of fire if this is at all possible.

With mobile columns, when time, apparatus, and fuel are alike wanting, neither burning nor boiling is possible. Thus only simple burial is available. This, as has already been urged, indicates the importance of the removal of all febrile cases of uncertain nature from the fighting line at the earliest opportunity. Partial or careless burning, with the chance of some unburned residue being blown about or visited by flies after it has cooled, is only an added danger. Imperfect boiling is even more hazardous. Deep burial, after chemical treatment if such is available, and the burning of straw or petroleum above the dejecta before the earth is filled into the pit is probably the safest process which is feasible.

It may be permissible to recapitulate the chief features of such an essential procedure as the disinfection of suspected or infected excreta. Such disinfection, whatever be the means employed, must be done immediately. Drying must be prevented by promptitude and the use of liquid germicides. Flies must be excluded. Disinfecting powders are of very limited value. Cold chemical disinfectants without time and intimate admixture are not effective with solid excreta, and serve chiefly as deodorants, to keep off flies, and to indicate by their odour the presence of organic impurity. Fæcal excreta are less dangerous than urine. All methods of disinfection require skilled supervision. With recent knowledge widely diffused and modern appliances it should be possible to conduct a hospital in wartime without infection either of members of the staff or of men admitted with wounds or illness of simple type (9, 113, 48, 46, 141, 142, 117, 118, 53, 10, 123, 16, 143, 27)

The disinfection of clothing, tents, and the like, presents a considerably less complex problem. Methods involving the use of steam, so familiar and serviceable in civil life, are out of the question in warfare. Such an appliance as Thresh's portable disinfector may be valuable, indeed, on the lines of communication, but it is impossible of utilisation with an actual fighting force. The processes of boiling and chemical disinfection, however, fulfil all needs. Infected fabrics which may permissibly be burned should be so dealt with. Clothes soiled by blood or fæcal matter should be first cleansed by warm

soap and water, since immediate boiling or immersion in solution of perchloride of mercury fixes the stains. Thereafter prolonged boiling in water or in 2 per cent. solution of creolin or immersion for several hours in solution of corrosive sublimate (1 to 1000) or carbolic acid (4 per cent.) is sufficient.

Bedclothes, personal clothing, towels, and the like, infected by the urine or fæces of patients suffering from any of the zymotic forms of campaign disease, or worn or used by such patients should be immediately rolled up in a sheet or similar covering soaked in a 1-1000 solution of perchloride of mercury, and removed for disinfection without being permitted to dry. Waterproof sheets which are specially liable to contamination and cannot be subjected to the action of heat should be immersed for at least an hour in a mercurial bath. In hospital at least, vessels painted red and marked with a distinctive "E" should alone be used for such purposes. Vessels and utensils of every sort, if their size permits, should be boiled. Tents which have been used for infected patients whether soiled or not should be completely emptied, sponged or sprayed with formalin (1 per cent.) or tricresol (2 per cent.) while still *in situ*. On such tents being struck, the area should be treated with quicklime (afterwards hydrated) or chlorinated lime and subsequently exposed for a prolonged period to air and sunlight (9, 123, 48, 16, 10, 53, &c.)

The processes which have been described and selected as most efficacious and most practicable—especially in regard to water purification, camp conservancy, and sterilisation of infected matter,—are based upon the methods of which I have personal experience in South Africa in 1900-1901, modified in respect of certain details in the light of conclusions arrived at by other observers, of more recent researches—especially regarding the viability of the bacilli of enteric fever and dysentery,—and of personal experiments upon the potability of waters treated by certain chemical reagents. Apart from the later modifications, which affect minutiæ rather than general principles, it is contended that the methods adopted in the Anglo-Boer campaign, and particularly in its later stages, were reliable and sufficient; and that the failure to secure and maintain a disease-free army must be attributed in the main to deficiencies of material and to the lack of generally diffused knowledge regarding the vital importance of field sanitation.

CONCLUSION.

I HAVE endeavoured to outline a scheme of sanitation feasible under the conditions of active service in the field. Provided the execution of such measures is supervised by officers and men trained to such special duty; provided their performance is carried out wholeheartedly by each individual as the result of individual enlightenment and training; provided all necessary appliances are generously furnished: I do not think it utopian to believe that the disease-rate and the disease death-rate in our army might be reduced to a fraction of what has been experienced in the past in the several campaigns in Egypt, in South Africa, and on the Indian frontier. Were such precautions adopted as an invariable routine and furthered by each man's personal efforts, our army, like that of Japan in Manchuria, would achieve results beyond what can ever be secured by mere courage and discipline on the one hand, mere leadership and strategy on the other. We might send our men on foreign expeditions confident that none would suffer from remediable evils in his environment; we might safely reduce our hospital accommodation and our provision for sick transport, thereby securing to the wounded an increase of comfort and attention. The protection of our own shores and of our colonies would be facilitated. "We might even smile at the thought of an invasion of India, secure in the knowledge that while the health of our army was maintained by an efficient sanitary corps, that of the enemy would be decimated by water-borne disease" (144).

As was granted at the outset, the military sanitarian must base his proposals on practical and tactical considerations. But, as was shown, philanthropic objects are achieved by the same means. The success of the combatant branches must usually be bought by bloodshed, must ever be proportioned to the loss inflicted upon the foe. With the efforts of the military sanitarian it is far otherwise. In so far as he is successful, death and suffering are diminished. As contrasted with the heroic death in battle, the futile loss of life from inglorious disease is saved. "Sanity" and humanity go hand in hand; what secures the one secures the other.

TABULAR STATEMENT OF THE RESULTS OF INVESTIGATIONS REGARDING THE STERILISATION OF WATER FOR DRINKING PURPOSES BY CHEMICAL MEANS.

A. Alum. Addition of gr. 6 to the gallon. This is useful as clarifying the water, and is to some extent germicidal.

B. Pot. Permanganate. This is added until a faint pink colour remains. Objectionable since the taste and colour persist.

C. Chlorine. Afterwards neutralised. The taste and smell remain. Transport and storage difficult.

D. Bisulphate of Soda. Gr. 100 will sterilise one gallon. It is afterwards neutralised by Bicarbonate of Soda. Objectionable since the iron of water-bottles is corroded.

E. Bromine. Schumburg's process. Free Bromine is added, and, after a time, neutralised. A slight taste remains.

F. Iodine. Vaillard's method. Sterilisation complete in 10 minutes. Tabloids of (*a*) Potassium and Sodium Iodate, (2) Tartaric Acid, and (3), Sodium Hyposulphite are coloured blue, red, and white respectively. One each of (*a*) and (*b*) are first added. After ten minutes one of (*c*). It is claimed that smell, taste, and appearance are ultimately normal.

G. Peroxide of Hydrogen. Slow and expensive.

H. Siemen's "Water-improver." Too slow. (Takes 22 hours.)

I. Formalin and combinations thereof. Resulting flavour disagreeable and effect upon digestion doubtful.

J. Chloride of Sodium. Sterilisation only effected by strong solution.

K. Tea and Coffee (without heat). Effect inappreciable.

L. Brandy and Wine. Slow and unreliable.

M. Permanganate of Lime. Effective but difficult to get rid of. Sedimentation slow.

N. Ferric Chloride and Bicarbonate of Soda. The quantity required is too large.

O. Precipitated Chalk and Sulphuric Acid. Unsatisfactory.

P. Lime. Process too complicated for field service, and organisms found alive in the precipitate.

Q. Citric Acid. 5 per cent. solution. Requires 5 hours.

R. Caustic Soda. 1 per cent. solution in salt solution. Rapidly germicidal, but doubtfully innocuous to the consumer.

S. Copper Sulphate. Moore's method. Still under investigation, and the results with the various pathogenic organisms are not uniform.

T. Copper Chloride. Kröhnke's method. Uncertain, very slow, and requires subsequent filtration.

U. Copper. Probably useful, but requires further elaboration.

V. Chlorine (as Sodium Hypochlorite). Hünermann's process. Apparently not quite reliable.

W. Chloride of Lime. Traube's process. Unfavourably reported upon.

X. Oxonised Air. Not applicable to small quantities of water. Apparently valuable municipally, but not for military purposes.

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THE FEEDING OF THE SOLDIER IN BARRACKS, IN HOSPITAL, AND IN WAR.

Wherefore it appears to me necessary to every physician to be skilled in nature, and to strive to know, if he would wish to perform his duties, what man is in relation to the articles of food and drink.—HIPPOCRATES, 460 B.C.

FREDERICK THE GREAT is reputed to have said that "an army fights on its belly," and if this trite saying of one of the greatest of the world's captains be accepted as a maxim of war, it must be admitted that the question of feeding the soldier is one of supreme importance to every officer of the army, and most of all to the members of the corps which has been created, not merely to heal the wounds and allay the sufferings of the stricken defenders of our country, but to advise fighting men of every rank on all points connected with the physical well-being of the soldier.

The subject has received a considerable amount of attention from such pioneers of military hygiene as Parkes and de Chaumont and their successors Davies and Firth, but generally speaking has been rather shunned by what may be called the sanitary section of the officers of the corps, as may be gathered from the fact that very few special articles on the subject have appeared in our corps *Journal* since its inception. It would appear, therefore, that the military sanitarian shares with his civilian brethren a certain amount of apathy towards questions of dietary.

In his Presidential Address to the Southern Branch of the Society of Medical Officers of Health, Dr. Stott made a strong appeal to the members of the branches not to consider the question of dietary beneath their dignity. He said:

I think dietaries for all periods of life as important as for the early period of life.

Not many years ago it was considered beneath the dignity of a doctor to refer to the infant's food; now it is an all-important factor. Each medical officer of health runs his own little book or card on how to feed infants. Why not diets for all ages,

pointing out the danger of eating too much proteid matter and drinking too much alcohol?

Are we not indolent (he continued) on this matter of dietary, and ready to believe any experiment or take the results as granted of another person's work rather than take the pains to work out results for ourselves? Should not the medical officer of health start a crusade against eating and drinking, as was started against tuberculosis?[21]

Why not, indeed; and if these remarks apply to city and borough medical advisers, are they not doubly applicable to the military medical advisers of the Crown?

Sir James Crichton-Browne told the Royal Institute of Public Health two years ago that much had been done by preventive medicine for children but mighty little for grown-ups, and although this remark certainly does not apply to the army, and one is far from desiring to belittle the influence of other branches of preventive medicine in military practice, I feel certain that a more correct knowledge of the laws of diet in not only the barrack room but in the officers' and sergeants' messes, would lead to improvement in the general health of the soldier, diminished invaliding, and greater economy in the upkeep of the great fighting machine of this country. Let us first consider the soldier's diet generally.

The foodstuffs used by the soldier in various parts of the world are legion, but, as any detailed account of individual articles of diet is beyond the scope of this paper, it will be sufficient to say that all the important constituents of them fall under one of the following five headings: 1. Nitrogenous compounds, including proteids and albuminoids. 2. Fats. 3. Carbohydrates, including sugar, starches, gums, and cellulose. 4. Salts. 5. Water. The functions of nitrogenous foods are threefold—namely:

(*a*) To build up the tissues and repair the results of the wear and tear in the body. (*b*) To regulate oxidation. (*c*) To be used as heat producers.

Fats are chiefly valuable as heat producers. They also develope visible movements and other forms of vital energy.

Carbohydrates act in a very similar way to fats, and to a certain extent they are interchangeable with them.

It is generally taught that in cold climates the fats should be increased, and in warm the carbohydrates, but Dr. Hutchison,[13] who has done me the honour of reading over the MS. of this paper, disputes this statement, and considers that the amount of food of all varieties is much the same in all latitudes.

The salts necessary for the preservation of health are many. Common salt is an imperative necessity of life and health. It supplies the soda necessary for salivary digestion and the chlorine for the hydrochloric acid of the gastric juice. Salts of the vegetable acids are essential in the soldier's dietary or scurvy will ensue, while phosphates are specially needful for the growing lads which form the bulk of our modern army.

Water to the extent of 2½ to 4 pints daily is, of course, an absolute necessity of life.

The nutritive constituents of food, in accordance with their functions in the body, may, therefore, be classified as follows:

Tissue Formers.	Work and Heat Producers.
Proteids.	Proteids.
Mineral Substances.	Albuminoids.
Water.	Carbohydrates.
—	Fats.

The Soldier's Food in Barracks.

Our first consideration in dealing with the soldier's dietary must be the amount of food necessary to keep the body in health and vigour, and here we find ourselves confronted with the difficulty that it is by no means an easy matter to pronounce an opinion on the amount of any variety of food actually required by the living organism, as the accepted notions on the subject have been entirely upset within the past couple of years by the labours of an American physiologist; I refer, of course, to Professor Chittenden's original investigations on physiological economy in nutrition.[7]

This work has only been before the public for a comparatively short time, and is still, so to speak, *sub judice*, but is so important that it deserves to be carefully studied not only by medical officers but also by their regimental comrades, as this question of the amount of food necessary for the maintenance of health must interest every one, whether he be a leader of men or a simple citizen. Prior to Chittenden's research, diets had been drawn up by many learned hygienists as the results of their observations on the diets of people of many nationalities, but none of these authorities had definitely proved that the amounts so laboriously calculated were really necessary for the requirements of the body.

The attached Table No. II, adapted from Munson,[18] shows the typical working dietaries which were universally accepted up till 1905. The fourth column of this table may need a word of explanation. It will be observed that the fuel value of each diet is shown in "calories."

This is a convenient method used in expressing the value of diets which enables us, instead of saying we need so much proteids, starch and fat, to say we want so much heat.

The heat produced by the proteid, fat and so on, is a better indication of correct quantities than the actual amount of proteid and fat used, because the value of these constituents to each individual body is different and the food materials also differ in quality.

The calorie, or heat standard, I need scarcely remind my readers, is the amount of heat required to raise 1 kilogram 1° C., or 1 lb. of water 4° F. When we thus express the potential energy of food we do not mean that

all this energy takes the form of heat, but that *if it were* converted into heat a certain number of calories would be the result.

Professor Chittenden was induced to undertake his remarkable series of experiments by a Mr. Horace Fletcher, who for five years practised economy in diet associated with elaborate mastication. He was found at the end of this period to be able to perform the trying and arduous work of a university oarsman on a dietary possessing about 40 per cent. of the proteid food, and not more than half the fuel value in calories of the standards fixed by most authorities, and yet to compare favourably with individuals receiving double his amount of food.

Experiment showed that nitrogenous equilibrium was maintained, and that therefore his food was sufficient.

Dr. Anderson, the Director of the Yale Gymnasium, said:

> My conclusion, given in condensed form, is this: Mr. Fletcher performed his work with greater ease and with fewer noticeable bad results than any man of his age and condition I have ever worked with.

Chittenden, before describing his experiments in detail, points out that it is

> obviously of primary importance that we should know quite definitely what the minimal proteid requirements of the healthy man really are, and the experimental work to be detailed has aimed especially to determine whether it is possible to materially lower the amount of daily proteid food without detriment to the bodily health and with maintenance of physical and mental vigour.[7]

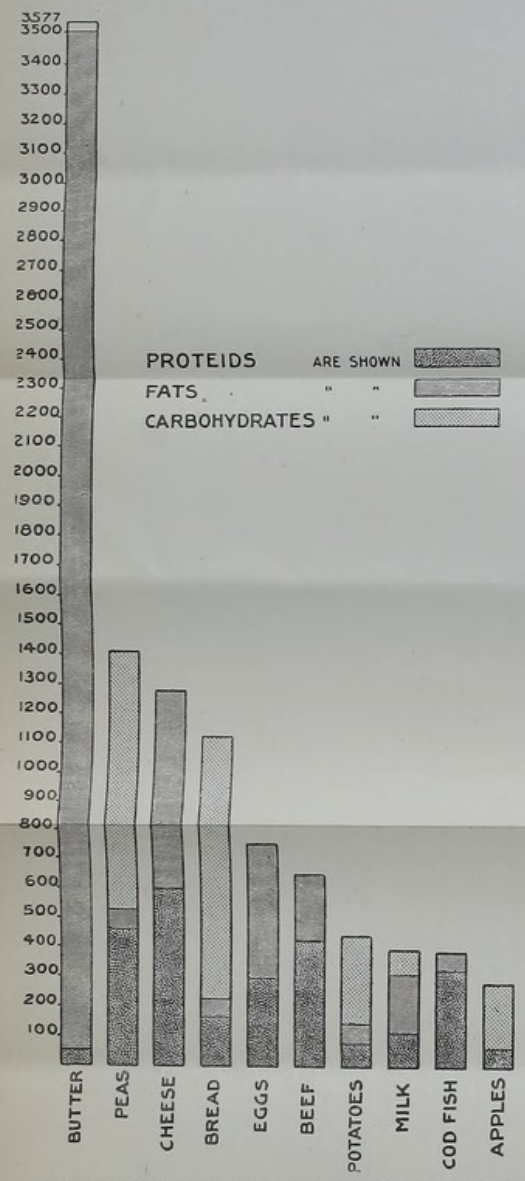
Like most really keen investigators, Chittenden commenced by experimenting on himself, and started by reducing his proteids to one-third, and the fuel value of his food to one-half that given in the standard dietaries. He tells us that:

> At first the change to a smaller amount of daily food was attended with some discomfort, but this soon passed away, and the writer's interest in the subject was augmented by the discovery that he was unquestionably improved in physical condition. A rheumatic trouble in the knee-joint, which had persisted for a year and a half, and which only partially responded to treatment, entirely disappeared (it has never recurred since). Minor troubles, such as "sick headaches" and billious attacks, no longer appeared periodically as before. There was greater appreciation of such food as was eaten; a keener appetite and a more acute taste seemed to be developed, with more liking for simple foods. Indeed the writer is disposed to maintain that he has done more work and led a more active life in every way during the period of this experiment, and with greater comfort and less fatigue than usual. His health has certainly been of the best during this period.[7]

Chittenden's further experiments were conducted, with, of course, their own consent, on three groups of individuals, namely:

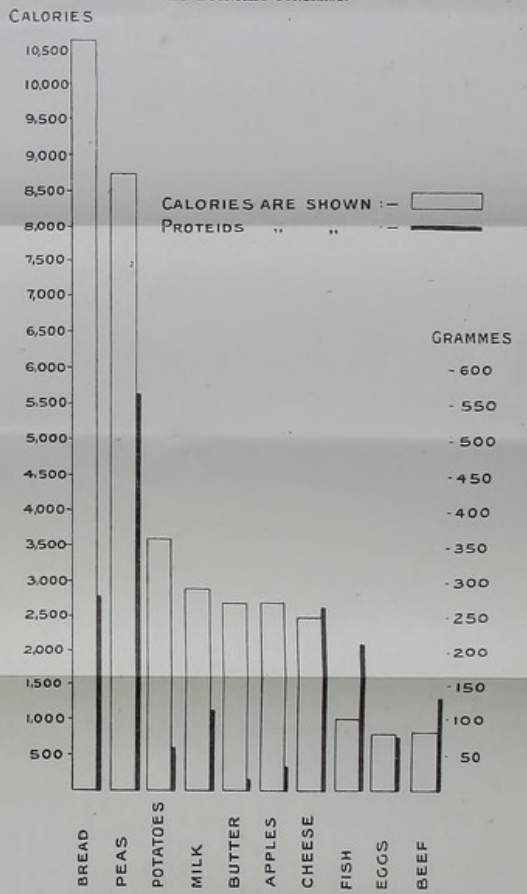
1. Five professors and instructors of Yale University.
2. Eight undergraduates of the university who were all athletes in training.
3. Thirteen men of the Hospital Corps of the United States Army.

FUEL VALUE OF ONE POUND OF SOME TYPICAL FOODS.



The diagram represents the relative number of calories obtained from each food, and also the relative proportions of proteids, fats, and carbohydrates. The total fuel value of a meal consisting of bread and cheese will be found to be nearly double that of one composed of beef and potatoes. (From Dr. Robert Hutchison's *Food and Dietetics*, reproduced by permission.)

AN ECONOMIC CONTRAST.



The amounts of energy (calories) and building material (grams of proteid) to be obtained for one shilling from some typical foods are graphically shown. The value of cheese as a cheap form of proteid food is well demonstrated. (From Dr. Robert Hutchison's *Food and Dietetics*, reproduced by permission.)

No restriction was placed on the articles of food consumed by these men, but the amount of flesh food was greatly decreased.

The experiments were of two varieties, namely :

1. Those in which the body weight was taken and the urine analysed for long periods of four, five, and six months.

2. Others in which the exact amount of nitrogen in the food and excreta was accurately estimated daily.

Speaking generally, the observations show that proteid food was reduced from Atwater's standard of a daily allowance of 143 grams to 36–54 amongst the professional men, 62 amongst the student athletes, and 55 amongst the soldiers.

Dr. Anderson, the expert in physical training above referred to, found the physical condition of the soldiers and athletes very satisfactory at the end of the period of dieting. Measured by strength tests it was actually found the soldiers and athletes had gained greatly in strength.

Chittenden claims that the gain in strength of these athletes and soldiers cannot be assigned to systematic training. The only change in their mode of living which can in any sense be responsible for the improvement is the change in diet. The main fact to be emphasized is that these men—trained athletes accustomed to live on large amounts of proteid food—for a period of five months reduced their intake of proteid food more than 50 per cent. without loss of bodily weight and with a marked improvement in muscular power.

To sum up briefly, Chittenden's experiments on several groups of individuals extending over some months tend to show that men may, without any increase of non-nitrogenous food, live in good health and gain in strength and activity on one-third to one-half the amount of the nitrogenous food usually considered essential. These facts are matters of supreme importance to military commanders, as in time of siege or during expeditions, where the amount of proteid food is limited, a knowledge of these important experiments might enable the medical officers to suggest a dietary which would economize the supplies available without any deterioration of the strength and activity of the troops.

I have dwelt at some length on these experiments, as the research work of Professor Chittenden is the most laborious, long-continued, and exact of any investigations into the dietary of healthy men which have been reported of recent years. His results have, however, been adversely criticized by Professor Halliburton and Dr. Robert Hutchison in this country, by a brother professor in America,[4] and by several other physiologists in various parts of the world.

The English critics propose to maintain the present standard of dietary, so as to have a reserve of proteid which may assist in enabling the organism to resist disease; but Professor Benedict, of the Wesleyan University, Connecticut, has gone in for a much more searching criticism of Chittenden's work.[1] He has prepared from European and American sources, the average

dietaries shown in Table IV, and he claims that these amounts represent the actual requirements of the classes using them. He admits the accuracy of Chittenden's experiments, but doubts if he has proved that the restricted nitrogen diets can be maintained permanently. He thinks that the improvement in health in all the subjects may have been due to the simple regulated mode of life and not necessarily to the restricted proteid diet, and he particularly instances the immense physical and moral improvement which a more liberal proteid dietary has produced in some races, such as peasants of Southern Italy and the negroes of the Southern American States.

In his work entitled *The Nutrition of Man*, published last year, Chittenden replies to some of his numerous critics. He shows by experiments extending over a year that dogs can live on quantities of proteid food far below the standards set by other investigators, and ascribes the unfavourable results attained in the experiments of others with these animals to unhygienic surroundings or unsuitable dietaries. Chittenden quotes the case of a German physician who lived and thrived on 66 to 76 grams of proteid for a period of twenty months with either maintenance, or slight increase of body weight. His work is supported by some experiments of Professor Irving Fisher, of Yale University, which were published last year under the title *The Effect of Diet on Endurance.*

This investigation, which was carried out on nine students, all working hard in the university, showed that, in eight of the nine cases, reduced proteid, combined with effective mastication, produced no ill effects. The body weight was, it is true, slightly diminished, but was compensated for by remarkable increase of endurance.

It will be seen from the foregoing that the results of Chittenden have received considerable hostile criticism, but it seems to me that none of his critics have as yet adduced evidence, in the form of carefully conducted experiments, to disprove the results of his painstaking research. I therefore venture to indicate that this is a line of study in which military physicians might do some epoch-making work. It might be difficult, but I cannot think it would be impossible, to induce groups of soldiers in different parts of the Empire to adopt a modified dietary under the supervision of officers of the corps, and the results of such investigations might go far to settle this very important question.

The matter is one of supreme national importance, as, if it could be finally proved that the amount of proteid estimated by Chittenden, and not that estimated by Voit and Atwater, satisfies the physiological requirements of man in these latitudes, our present ideas of poverty will have to be rewritten, and some of the work of Mr. Seebohm Rowntree on "Poverty" will become almost valueless. From an economic point of view, as I shall indicate, the acceptance of Chittenden's new standards of dietary would involve an enormous saving of public money.

TABLE I.—*Showing the Rations in Peace and War of the Six Great European Powers and Japan.*

Power.	Meat.	Bread, Biscuits, or Flour.	Vegetables.	Potatoes.	Milk.	Sugar.	Salt.	Coffee.	Tea.	Butter or other Fat.	Lime-juice or Jam.	Wine or Spirits.	Oatmeal or Groats.	Peas or Beans.	Rice.	Soup, Condensed.	Tobacco.	Remarks.
ENGLAND:	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	
Peace	12 Portion may be bacon, liver, or fish	16	4	12	5	2	½	—		1	1	—	—	1½, or green vegetables	—	—	—	Roughly estimated, as the actual amounts which each soldier receives must vary somewhat under restaurant system.
War—South Africa	16 to 20 fresh, 16 preserved; cheese, 2 to 4 occasionally	20 bread, or 16 biscuits or flour	16, or 1 oz. compressed or dried onions	—	—	3	½ and pepper ⅛th	½ or cocoa paste 1	½	—	1 occasionally	2½ rum when certified as necessary by S.M.O.	—	3, or vegetables and lentils 1	2	Pickles occasionally	—	Allowance Regulations for the Army, para. 35 and 36, lays down a scale which has not been adopted of recent years.
FRANCE:																		
Peace	10.5	26.25, or 21 biscuits	3.5	—	—	—	—	—	—	2.1	—	—	—	—	—	—	—	From Munson.
War	14.0	26.25, or 21 biscuits	1.05	—	—	0.73	0.7	0.56	—	1.05	—	8.75 wine in Algiers	—	—	2.2 in lieu of vegetables	¼	—	Laveran estimated that ordinary peace ration gave 124 grams of proteid and 760 grams of carbohydrate. France is only country issuing soup in war ration.
GERMANY:																		
Peace—A. Garrison	5.30, or bacon 4.41	26.47	—	53	—	—	—	—	—	—	—	—	4.24	—	3.18	—	—	Germany and Japan are the only Powers issuing tobacco as a ration. Note large potato ration and complete absence of sugar.
B. Field ...	17.65, or bacon 6	35.30	—	71, or groats, or peas, or rice	—	—	0.88	1.41	—	1.76	—	3.53 brandy or 35.30 beer, or 17.65 wine	6.6, or peas, or rice, or potatoes	12, or potatoes, or rice, or groats	6.0, or peas, or groats, or potatoes	—	1.41	
War	13.25, or sausage 8.8	26.50	6, potatoes or rice, etc.	53, or rice, or beans, or flour.	—	—	0.9	0.9	—	—	—	—	—	—	4.4, or ground barley	—	—	
AUSTRIA HUNGARY:																		
Peace	6.71	30.88 or biscuits 17.63, and flour 6.57, or groats, or millet, or barley, or potatoes, or rice	Sauer-kraut 5.54 and 2.47, or flour, etc.	19.77, or flour, etc.	—	—	—	—	—	0.62	—	—	—	—	3.71, or flour, etc.	—	—	
War	9.8 fresh, or 6 bacon, or 6 salt meat	3.5 biscuit and 25.2 flour	4.9	8.9, or peas, or groats	—	*0.87	*1.05	*0.87	—	1.6	—	—	—	5.29, or groats or potatoes	—	—	—	* Sugar, salt, coffee, and spirits are not given by Firth, 1908 edition.
RUSSIA:																		
Peace[1]	7.1	26 flour or biscuits	Variable	—	—	—	—	—	—	—	—	—	—	—	—	—	—	One quarter pound of groats may be exchanged for 0.9 peas or beans, 1.7 potatoes 2.2 turnips or carrots, 3.2 cabbage. The peace ration is from Munson; war ration from Firth. Note smallness of sugar ration.
War	7½ or 3½ ham	29 flour	—	—	—	0.25	0.8	—	0.25	0.73	—	5.4	4.8	4.9	—	—	—	

TABLE I (*continued*).—*Showing the Rations in Peace and War of the Six Great European Powers and Japan.*

Power.	Meat.	Bread, Biscuits, or Flour.	Vegetables.	Potatoes.	Milk.	Sugar.	Salt.	Coffee.	Tea.	Butter, or other Fat.	Lime-juice or Jam.	Wine or Spirits.	Oatmeal or Groats.	Peas or Beans.	Rice.	Soup, Condensed.	To-bacco.	Remarks.
ITALY:	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	
Peace	7.06 to 10.59	32.48	—	—	—	0.71	0.53	0.53	—	0.53 as bacon	—	8.82	—	—	5.3	—	—	
War[2]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
JAPAN:																		
Peace[3]...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36	—	—	
War—1. Daily ...	—	—	4	—	—	½	½	—	½	—	—	—	—	Pickles, fruit, or vegetables, 2	36	Sauces, 2	—	Japan is the only Power issuing fruit and cake in the field. Note that meat is only a periodic issue.
2. Periodic ...	16	—	—	—	—	—	—	—	—	—	—	6.3 sake	—	—	—	—	20 cigarettes	
3, Irregular[4]..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

[1] Money allowance for purchase of vegetables and condiments. Tea, although national beverage, is purchased by the soldier himself.

[2] The writer has been unable to ascertain the scale of rations for the Italian Army in the field.

[3] Daily issue, a money allowance of 6 sen for the purchase of all other necessaries.

[4] Japanese cake, 8 oz.; fresh fruit, 20 oz.; 3 peaches, apples, or oranges.

TABLE II.—*Typical Dietaries for Persons performing Hard Work.*

	Proteid.	Fats.	Carbo-hydrates.	Fuel Value.
	Grams.	Grams.	Grams.	Calories.
ENGLAND: Royal Engineers doing active work (Playfair).	144	83	631	3,950
SWEDEN: Mechanics (Hultgren and Landergren).	189	110	714	4,725
RUSSIA: Factory operatives (Erismann).	132	80	584	3,680
GERMANY: Machinists, Krupp's Gun Works (Prausnitz).	139	113	677	4,395
SOUTHERN AUSTRIA: Farm labourers at harvesting (Ohlmüller).	159	62	977	5,235
UNITED STATES: Mechanics (Atwater). ...	154	227	636	5,275
UNITED STATES: Navy ration (Atwater) ...	143	184	520	5,000
UNITED STATES: Army ration	164.2	97.8	600	4,061
Average	152	119.5	665	4,540

TABLE III.—*Diet Return of the 2nd Battalion Devonshire Regiment for the Week ending December 9th, 1907.*

Date.	Meal.	Diet.
Tuesday, Dec. 3, 1907	Breakfast	Coffee, bread, butter, and fresh fish.
	Dinner	Roast beef, Irish stew, boiled and baked potatoes, peas.
	Tea	Tea, bread and butter.
Wednesday, Dec. 4, 1907	Breakfast	Tea, bread, butter, pies, meat, and pickles.
	Dinner	Roast beef, hot pot, boiled and baked potatoes, cabbage, plain pudding.
	Tea	Tea, bread and butter.
Thursday, Dec. 5, 1907	Breakfast	Coffee, bread, butter, liver, and potatoes.
	Dinner	Baked meat pies, sea pies, boiled potatoes, haricot beans.
	Tea	Tea, bread and butter.
Friday, Dec. 6, 1907	Breakfast	Tea, bread, butter, and fish cakes.
	Dinner	Roast beef, baked curry, baked and boiled potatoes, rice, and peas.
	Tea	Tea, bread and marmalade.
Saturday, Dec. 7, 1907	Breakfast	Tea, bread and butter.
	Dinner	Roast beef, brown stew, potatoes, butter beans, plain pudding.
	Tea	Tea, bread and butter.
Sunday, Dec. 8, 1907	Breakfast	Coffee, bread, butter, and kippers.
	Dinner	Roast beef and baked potatoes, boiled beet and carrots, boiled potatoes, cabbage, plain pudding.
	Tea	Tea, bread and butter.
Monday, Dec. 9, 1907	Breakfast	Tea, bread, butter, sausages and potatoes.
	Dinner	Roast mutton, steamed mutton, boiled and baked potatoes, peas, and plain pudding.
	Tea	Tea, bread and marmalade.

(Signed) H. S. L. RAVENSHAW,
Major Commanding 2nd Devon Regiment.

December 1st, 1907.

Passing from the subject of the quantity of food required for the soldier, we come to the question of the best methods of cooking it and placing it before him in the most economical and attractive manner. In this relation great improvements have taken place during the last few years, and there is now very little for the reformer to suggest except that general messes, or the so-called "restaurant system," should be compulsory throughout the army.

The waste under older methods of feeding was simply enormous, as Woodruff estimated that the value of waste in a post at Montana was actually £200 per annum,[16] but under the new scheme this waste is reduced to a minimum. There is economy in staff, cooking, fuel, and clerical labour, and as the result of the system the soldier lives nowadays in a simple form of club.

I have had an opportunity of studying the working of the general mess in the 2nd Battalion of the Devonshire Regiment at Devonport, and, through the courtesy of the adjutant, am able to subjoin a copy of an actual week's dietary, which speaks for itself (Table III.) It will be seen that the food is excellently varied, and, as the results of visits to the kitchen and dining halls, I can assert that it is well cooked and served in a manner superior to that of the restaurants which would be patronized by men of the station in life from which the soldiers of our country are usually recruited. From an economic point of view our present system leaves, perhaps, something to be desired, as, if we estimate the value of rations, cooking, and mess allowance at the rate of 1s. per day per man, the total cost of feeding a battalion 1,000 strong amounts to the enormous total of £18,250 per annum. It is because this single item in the cost of an army is so heavy that the work of Chittenden commands our special attention, as if we could, as the result of further experiments, advise a modification of the soldier's ration the nation might have to thank us for a reduction in the Army Estimates.

The Soldier's Food in Hospital.

In the feeding of the soldier in hospital great reforms have recently been adopted. Up till a couple of years ago the soldier often remained on the same diet for days, and even weeks together, and had roast chop or convalescent diet served up day after day until he asked the medical officer for a change. With the introduction of "ordinary diet" this has been completely changed, and the diet is now automatically varied. I would, however, suggest a further improvement, namely, the introduction of a fish or rabbit diet once a week. In military families' hospitals the dietary is constructed so as to admit of this arrangement, and the fish or rabbit diet is stated to be much liked and appreciated as a change from the meat diets of the other days of the week.

I would, moreover, suggest the abolition of chicken diet from the scale of diets of military hospitals. Its existence

in the scale is merely a trap for the unwary, and often leads thoughtless junior officers to order a costly diet when ordinary diet would meet the case quite well. In cases where chicken is desired it could easily be ordered as an extra in the same way as fish is frequently prescribed. The difference in cost between "chicken" and "ordinary diet" is about 1s., so that an extra charge to the public of £100 is involved by every 2,000 chicken diets ordered.

Let us now contrast our "ordinary" hospital diet with an accepted standard dietary. Hutchison[12] says: A good standard diet adapted to English habits, and suitable for a man doing a moderate amount of muscular work, is thus constituted:

Foundation.—1 lb. bread, ½ lb. meat, ¼ lb. fat.

Accessories.—1 lb. potatoes, ½ pint milk, ¼ lb. eggs, ⅛ lb. cheese.

In order to realize more clearly what a diet like this means, its constituents may be divided into meals, which would work out as follows:

Breakfast	Two slices of bread and butter. Two eggs.
Dinner	One plateful of potato soup. A large helping of meat with some fat. Four moderate-sized potatoes. One slice bread and butter.
Tea	A glass of milk and two slices of bread and butter.
Supper	Two slices of bread and butter and 2 oz. of cheese.

On reference to paragraph 54 of the Allowance Regulations we find that the "ordinary" hospital diet contains the same amount of meat, but 4 oz. less vegetables (which are, however, almost made up for by 1½ oz. of sugar) and 2 oz. more bread, but no eggs or cheese. It includes salt, which is omitted from Waller's dietary,[12] and also the important food accessory—tea. Practically, therefore, the diet only contains two eggs and 2 oz. cheese less than what Dr. Hutchison considers a rather liberal diet for a man doing a moderate amount of muscular work.[12]

I consider, therefore, that, as the soldier in hospital is not doing any work, the ordinary diet is too liberal, while if we accept the results of Chittenden, it is excessive. Moreover, as a matter of routine, we find that the soldiers are by no means restricted to their bare diets in hospital, and that many cases of comparatively trivial disease or accident have eggs, milk puddings, and other extras ordered for them, which, as will be seen, bring their dietaries beyond all apparent requirements. This seems to be a matter which might well receive the consideration of all officers of the corps, as the study of every detail of hospital economics is essentially the speciality of the military medical officer.

Medicine and surgery, and their special branches, are highly important subjects, but, whereas physicians and surgeons trained in every speciality can be obtained by

the War Office in the open market with comparative ease, physicians who are skilled in hospital management are scarcely to be found in the Empire, except in the ranks of our own corps.

The Soldier's Food in the Field.

Passing to the final division of our subject, on reference to Table I the reader is at once struck by the fact that meat and bread, or biscuit, constitute the staple articles of nitrogenous diet of troops in the field in all the armies of Europe. With the single exception of occasional issues in South Africa, little or no attempt has been made to supply such cheap and excellent forms of food as cheese or oatmeal, although these articles would undoubtedly, form excellent means of supplying a pleasant change from the everlasting "bully beef" and biscuits.

Cheese, indeed, does not receive the amount of consideration it deserves in military dietaries. It will be observed by a reference to Diagram 1 that it possesses higher fuel value than beef, yet it will be noticed that it finds no place in the diet table of the Devon Regiment, which may be taken as a type of the most recent dietary of the soldier in barracks. Dr. Newman[19] says of cheese that

> It is much better as a food than beef, and weight for weight yields three times more calories than lean beef, and equal nourishment can be obtained from cheese as from beef at one-sixth the cost (vide Diagram 2). On the whole, cheese is one of the very best of all our common articles of food.

The cheaper cheeses, such as Canadian and Dutch, are often more nourishing than the expensive ones such as Gruyère, Stilton, and Gorgonzola, which are purchased chiefly for their flavour.

Oatmeal forms a part of the peace ration of the Russian soldier and of the service ration of the German. It is occasionally issued to the Austrian soldier in barracks, but is not in favour in any other European army. Hutchison[14] describes it as the most nutritious of all cereals. It is very rich in fat so would be a useful addition to the soldier's ration in the field, which is notably deficient in this relation. Oats prepared by rolling instead of grinding and heated during the rolling process, are much more digestible and easily cooked than ordinary oatmeal. Prepared in this way the cereal constitutes the much advertised preparations of oats which, under various fancy names, are now so deservedly popular. The value of sugar in the field ration of the soldier is another matter which is not appreciated as fully as it might be in Continental armies. Several French military physicians[2, 3, 8] have given special attention to the subject; and although their opinions are somewhat conflicting, the evidence of M. Joly[15] in experiments with the 94th Infantry suggests that sugar may replace a portion of the meat ration on field manœuvres or on service. He goes so far as to suggest that the emergency ration should consist entirely

of carbohydrate material, as it is generally accepted that this type of food is chiefly concerned in producing muscular energy. The dynamic properties of such food being superior to those of meat, a carbohydrate ration might rightly claim the title of a fighting ration, or *vivre-de-combat.*

This contention, though no novelty to the hygienist, rather upsets the popular British notion that the "roast beef of old England" is the foundation on which our solid British pluck is built. With troops in the field, where food is occasionally limited and frequently tough and uninteresting, it is especially important that officers and soldiers should be instructed in the importance of perfect mastication and insalivation of food. Sir Michael Foster, who made elaborate experiments on the subject, said: "The adoption of the habit of thorough insalivation of the food was found to have a remarkable and striking effect upon appetite, making this more discriminating, and leading to the choice of a more simple dietary, and in particular in reducing the craving for flesh food."

TABLE IV.—*Benedict's Dietaries: The most recent Average of many Dietaries prepared to refute Chittenden's advocacy of Diminished Proteid for all Persons.*

Subjects.	Fuel Value, Calories.	Proteids.	
		Total Grams.	Digestible Grams.
People with active muscular work—lumbermen, athletes, etc.	5,500	175	160
People with ordinary muscular work—carpenters, farmers, etc.	3,300	115	105
People with light muscular work—professional and business men, clerks, etc.	2,700	100	92

From the *American Journal of Physiology*, August, 1906.

The appetite, too, is beyond all question fully satisfied with a dietary considerably less than with ordinary habits is demanded. Sir Michael Foster's experiments[23] showed clearly that perfect mastication produces great economy in nutrition and a remarkable improvement in the condition of the whole gastro-intestinal tract. The waste products of the bowel were not only markedly reduced in amount, but actually became odourless and inoffensive. I think these striking results of perfect mastication should be more widely known than they are. The teeth of the soldier are, of course, of first importance in this relation. We find that men in South Africa constantly complained of the effect of biscuit on their teeth; and, indeed, as Lieutenant-Colonel Caldwell has pointed out,[5] the soldier who develops defective teeth during a campaign has before him "a long and dismal vista of intestinal

troubles." Wherever possible, therefore, flour should be issued as a ration instead of biscuit, and bread be made in field ovens. It will be found that, as soldiers are not expert bakers, it is preferable to issue baking powders for use in the field instead of yeast cake, which requires considerable skill for its proper manipulation.[5]

Of necessity a large amount of the food of troops on service must be supplied in tins, and this brings us to a question which has attracted a vast amount of attention during the past couple of years. In view of the message to Congress by the President of the United States on June 4th 1906, and the opinion of a well-known Liverpool merchant personally acquainted with the conditions of the trade in Chicago, quoted in the *Times* of June 1st, there appears to be little room for doubt that the conditions under which animals were slaughtered, and tinned or canned foods prepared in America, were, and possibly still may be, filthy and disgusting, and that consequently grave dangers to health may ensue from their consumption. This danger, as the Professor of Hygiene at the Royal Army Medical College points out, may operate in one of two ways, namely:

1. Through food poisoning due to the filthy conditions under which the canning has been carried out, or
2. Through transmission of disease from the use of the flesh of animals which had suffered from tuberculous or other diseases.[9]

Although it will generally be admitted that the tinned meat issued to troops is, ordinarily, of good quality, it is necessary, in view of the evils which are known to have existed, to endeavour to guard the soldier against any possibility of food poisoning or infection by tubercle or animal parasites through tinned food.

We should, I think, recommend that the requirements enunciated by Dr. George Newman should be insisted on in the case of all goods for military consumption. These requirements are that:

1. The manufacturer's name and place and date of canning should be impressed on each can.
2. Food intended for canning should be inspected at the factory, and be derived from animals that have already been inspected.
3. Premises and apparatus used in preparation processes, or for storage, should be regularly inspected and kept in good sanitary condition.
4. Imported canned goods should have a certificate that they have been produced and prepared under administration control and inspection.
5. The "detective" system of inspection, as now practised, should be much more thorough.[20]

For officers actually serving with the troops in the field the instructions laid down for the examination of tinned articles in the official Supply Handbook are practically sufficient.[22] Lieutenant-Colonel A. M. Davies adds to them three useful practical hints—namely:

1. Always look for the date stamp.
2. If there is a faint suspicion of a tympanitic note on tapping

the tin, a suspicion not strong enough to warrant condemnation, put aside the tin in a warm place for twenty-four hours, and test again by tapping; if gas formation is going on, the tympanitic note will be more marked.

3. A most convenient way of testing for the presence of gas is to place a good-sized drop of water at one end of the tin, and to puncture the tin sharply through the drop; if there is a partial vacuum in the interior, the water will be sucked in; while if there is formation of gas, bubbles will escape, forming a froth with the water.[9]

Every effort should be made to vary the rations of soldiers in the field, as monotony of diet produces a condition of gastric disorder which appears to predispose to enteric fever and dysentery.

We now come to the discussion of a question which is of the greatest importance, and may fittingly close our brief review of an important subject—namely, the advisability or otherwise of issuing alcohol to troops in the field. I have not referred to the subject under the previous divisions of the subject, as, although I hold no brief for total abstinence in a general sense, my experiences at home and abroad convince me that alcohol in every form is best avoided by the soldier in barracks. In hospital it should be used as a powerful drug, and not as a food; and I am strongly of opinion that the ordering of expensive wines in the treatment of disease in military hospitals is rarely if ever justifiable on scientific grounds. Lieutenant-Colonel Caldwell[6] calls special attention to the extremely common error that alcohol is a safeguard against cold.

Military physicians should educate their comrades as to the effect of alcohol in producing a loss of body heat, and point out that the issue of "tots" of rum on cold nights is not only undesirable but actually pernicious. Parkes speaks out on the subject with no uncertain voice. He says:

When debarred from spirits and fermented liquors men are not only better, but far more cheerful, are less irritable, and endure better the hardships and perils of war. The courage and endurance of a drunkard are always lessened, but, in a degree far short of drunkenness, spirits lower, while temperance raises, the boldness and cheerfulness of spirit which a true soldier should possess. If spirits neither give strength nor sustain against disease, are not protective against cold and wet, and aggravate rather than mitigate the effects of heat—if their use, even in moderation, increases crime, injures discipline, and impairs hope and cheerfulness; if the severest trials of war have not been merely borne, but most easily borne, without them; if there is no evidence that they are protective against malaria and other diseases, then the medical officer will not be justified in sanctioning their issue, or their use, under any circumstances.[17]

To this indictment of alcohol Munson adds his quota as follows:

That there are rare emergencies in which alcohol might possess a certain value either to supplement an insufficient issue of food or gain a temporary stimulus at the expense of subsequent depression may, perhaps, be admitted. It is certain, however, that under nearly all conditions of military service alcohol in any of its forms is only pernicious to the soldier.[17]

It is evident from the foregoing that the medical officer has the support of every military hygienist in condemning the issue of a spirit ration to troops in the field, except in some exceptional circumstances where, under the stress of war, it may be necessary to compel the soldier to draw an over-draft on the Bank of Life, well knowing that the action will render him physiologically bankrupt for some time to come. In conclusion, I need scarcely point out that in the space at my disposal it has only been possible to touch on the fringe of a great subject. I will be satisfied, however, if I have brought out the great interest which this branch of Public Health must command from every officer of the corps.

The whole question of food values is, so to speak, in the melting-pot, and the Nation as well as the Army may well look to us for a solution of a problem which involves such enormous interests. This is no mere professional or class question, but a matter of supreme economic importance to every nation on the globe, but especially so to this great Island Kingdom, where the food supply of the people, in peace and war, is the burning question of the hour.

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[Editorial Comment.]

THE FEEDING OF THE SOLDIER.

There can be no doubt that the problems surrounding the feeding of the soldier, either in barracks, in hospital, or in war, afford a field for observation which is second to none in interest and to which the attention of scientifically-minded officers of the Royal Army Medical Corps has always been, and we hope always will be, directed. The subject was admirably placed before the Navy, Army and Ambulance Section by Major Blackham (*vide supra*). The enormous importance of the question from an economic point of view is apparent when he tells us that the cost of feeding a battalion 1,000 strong amounts to £18,250 per annum. A great improvement has followed the adoption in certain regiments of what is called the "restaurant "system," which allows the soldier to purchase a variety of food at cheap rates, and it seems desirable to make the system general throughout the army.

From Major Blackham's tables it is evident that the quantities of food issued err on the side of excess, and he quotes Chittenden's experiments to support his belief that a perfectly satisfactory dietary might be devised on a scale containing less protein. The question is still *sub judice*, but experiments resembling those of Chittenden might be undertaken by volunteer groups of soldiers in different parts of the Empire, who should adopt a modified dietary under the supervision of officers of their corps. Many readers may be surprised to hear that until lately it was impossible for the soldier to obtain anything to drink with his dinner (except, perhaps, water), so that it was their custom to go to the canteen to drink beer beforehand, a custom injurious alike to the digestion and to the pocket. Lieutenant-Colonel A. M. Davies says that he urged the adoption of this reasonable reform many years ago in India, but was told it was impracticable owing to the difficulty in keeping accounts, but this difficulty, like others, has not proved insuperable. Cheese does not appear to form any part of the diet of the soldier in barracks, although

there can be no doubt of its high food value; but, as Lieutenant-Colonel Wrench said in the course of the discussion, the choice of food by the soldier is largely the result of fashion, custom, and convention, so that he associates meat with wealth, cheese and oatmeal with poverty, and bread and water with the treatment of criminals.

The diet of the soldier in hospital is also excessive, and Major Blackham tells us that it is in a great number of instances increased by extras which are ordered, as was pointed out in the discussion, "more "to please patients than from real necessity," and maintained right up to the time of their discharge. This extravagance in dealing with extras is by no means confined to military hospitals, and means to check this abuse are frequently discussed by those interested in hospital management.

But the soldier's diet in the field is perhaps of all the most important, for it is there he has his hardest work to do, while it is there also that his food is most likely to be defective. The British soldier's war diet consists mainly of "bully beef" and biscuits, to which Major Blackham urges the addition of cheese and of oatmeal, and he asks whether sugar in some form could not also be given. Biscuits are uninteresting and often hard, so that where possible flour should be issued and bread made in field ovens, its baking being facilitated by using baking-powders instead of yeast cake. With respect to tinned foods he urges the adoption of Dr. George Newman's list of requirements.[1]

Finally, Major Blackham refers to the important subject of issuing alcohol to troops in the field, and adds his own testimony to that of most of his colleagues in condemning its use except on rare occasions, where, "under circumstances of war, it "may be necessary to compel the soldier to draw an "overdraft on the bank of life." In connexion with this subject it is asserted that the effect of abolishing the canteens in the United States Army under the influence of the political pressure exercised by the temperance party has not been satisfactory, the general opinion being that it has been followed by an increase in the number of military offences, of alcoholism, and of venereal disease, and a multiplication of places where intoxicants are sold in the neigh-

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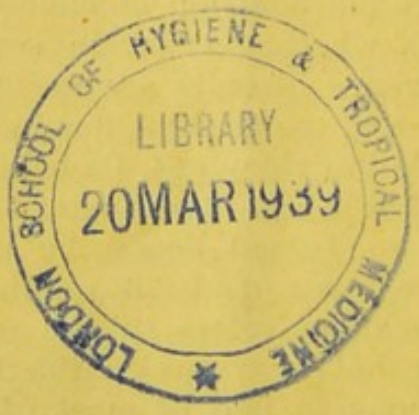
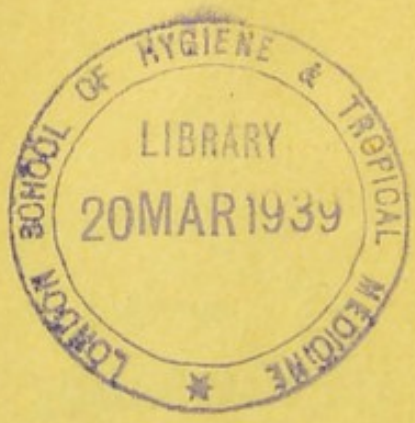
[1] *Public Health*, November, 1906.

bourhood of military posts. The admission rate for alcoholism in the United States Army for 1906 reached the appalling figure of 30.58 per 1,000, while in the British Army it was 1.1, and for the preceding ten years an average of 2.1, while none of the Continental armies showed an admission-rate so high as 0.5 per 1,000; it must be remembered that the short service system in Continental armies affords less time for habits of alcoholism to develop amongst the healthy young men who form their rank and file, a large proportion of whom are well educated, and are less open to the temptation to drink for mere amusement which besets the average British soldier.

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