Typhoid, the destroyer of armies, and its abolition ; The theory of air-borne typhoid in armies / by Leigh Canney.

TYPHOID
THE DESTROYER OF ARMIES
AND
ITS ABOLITION

THE THEORY OF AIR-BORNE TYPHOID IN ARMIES

[Read before the British Medical Association at Cheltenham, Aug., 1901]

BY

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TYPHOID, THE DESTROYER OF ARMIES, AND ITS ABOLITION

THE recent experiences in South Africa as regards the partial destruction and the more extensive paralyzing of our armies by preventable disease suggest certain inquiries to the medical mind. They reveal a condition of want of foresight and indifference to hygiene on the part of those at the head of the War Office when this war broke out that would have been discreditable in civil life in the administration of the remotest village of England or Scotland.

How long will the theory I have termed *laissez-boire*, so strongly held by the War Office, that in war the men will drink and must be allowed to drink where they like, hold good?

The three great destroyers of life in war are water-borne—typhoid,* dysentery, and cholera. They often paralyze the army's movements and

* The terms 'typhoid fever' and 'enteric fever' are synonymous.

embarrass the transport. They inflict enormous suffering, vast numbers continuing to march with the greatest distress, until they fall out and are left by the roadside, often absolutely devoid of assistance or food, as happened in Madagascar. All victims of these diseases require careful food and nursing, but they can get next to nothing suitable in war. These diseases are all water-borne in origin. All are entirely preventable during war by various methods known to medical science, and yet the death-rate in war from these diseases is far larger than from all other causes put together. It is stated in Parkes' 'Hygiene': 'The ravages of enteric fever, malaria, and dysentery ought to be trifling and easily prevented. Enteric fever and contagious dysentery ought with certainty to be prevented in a camp.'

The suggestion arises, The war is over and the diseases may not happen again. We shall now review the incidence of typhoid in civil and military life to see if this supposition is justified.

Typhoid has afflicted all countries and races, though chiefly white races. It has at times removed whole races of men; it has decimated cities and villages in Europe, often annually, throughout history. Livy records fifteen 'plagues' of typhoid up to 459 B.C., then Rome practically passed its Public Health Act by constructing drains and sewers and securing a good water-supply, with the result that the 'plagues' disappeared until the pure water-supply was broken up later. It can be traced in its epidemic form through all English history, known

loosely at times as 'plague,' and later, even up to 1865, as 'autumnal' fever, and referred to in that year by Dr. Harley as 'that form of enteric fever which prevails continually in London.' In that 'autumnal' epidemic form it was decimating all towns and villages. At least 200 years of epidemics can be absolutely defined, and between 1841-46 France alone had 106 epidemics, and whole cities had been nearly wiped out. But the light was dawning, and the idea of the causation of the 'plague,' or typhoid, had passed in the ages from the 'anger of the gods,' through the mystic medieval 'blue mist' of autumn, through 'humid exhalations,' to the more definitely 'polluted water,' until in 1880 to Eberth the enemy is unmasked, and four years later is isolated and growing in the laboratory on a 'potato culture.'

The rôle of typhoid in armies on active service has been, and still remains, a far more serious affair than in civil life. It is serious because it is the very time when the men who have trained for years are most wanted.

The army of a conqueror has often been destroyed by typhoid. It is the disease which especially dogs armies, and has even attained the name of 'camp' fever, from its usual occurrence in war. It is traceable through nearly all wars; in Roman times it was very frequent. The gigantic first Crusade was largely destroyed by it before reaching Constantinople. Henry V. lost four-fifths of his army in France by it. It decimated the Royalist and Parliamentarian armies, and had the same action throughout the wars in the Netherlands.

Take the Civil War in England (1642-43); the Royalist and Parliamentarian armies were both close to Reading, and, as Dr. Willis (then at Christchurch, Oxford), relates, 'both sides could not fight for many months. Although close to each other, either side left off, and from that time for many months fought, not with the enemy, but with the disease.' Essex moved to Thame, where he lost a great part of his army. The King and the royal army went to Oxford, taking typhoid with them; the troops, crowded together, 'fell sick by troops, and, as it were, by squadrons. Now disease invaded the unarmed and peaceable troops, the entertainers of the soldiers, and all others'; they were 'beset with a heavy and long languishment.'

Take, again, the Walcheren Expedition (1747). In fourteen days there were 12,086 in hospital with typhoid fever, and it was found that the natives there had this fever every autumn. One regiment had only four men left well, another only one in seven. The expedition was abandoned.

In every campaign in Dutch Brabant between 1743 and 1748 our army was annually decimated by typhoid; in the latter year 'half the regiments and all the common people' were suffering, and in the former year one physician had 700 cases to look after!

Napoleon complained of the sick from this disease 'encumbering the hospitals and roadsides' (!) In the Peninsular War there were always 12 per cent. down from this cause and other water-borne diseases, and sometimes 20 per cent. and 25 per cent.

In the Crimea in the first seven months 60 per cent. died, a mortality exceeding the Great Plague

of London, and in the whole war nine times as many from preventable disease as from wounds. The mortality from the same cause was equally terrible among the French, who actually lost over 8,000 before landing and at least 50,000 in all from water-borne and preventable diseases, including 58 per cent. of their surgeons. Sir Thomas Longmore, M.D., on the subject of the Crimean War, says: 'Nothing was ready for a state of war . . . the neglect of the sanitary department of the military service and the subordinate position assigned to it recoiled on the heads of the Government and the people by leading to a frightful amount of sickness and expenditure of life in the ranks of the army, and ultimately to the enforced abandonment of part of the enterprise the army was designed to accomplish.' With the exception of the last few words of the sentence it will be seen that this criticism from so high an authority may be applied with equal truth to the French war in Madagascar, to the Spanish-American, and the present South African Wars.

In the Civil War in America (1862-63) over 200,000 died from disease, being more than twice the number dying from wounds, the immense proportion of these deaths being from water-borne diseases.

There is now a pause for a moment in this terrific destruction by bacilli as we consider the Abyssinian campaign (1867-68), composed of 4,000 British and 8,000 native troops. There was very little illness, beyond some cases of dysentery and malaria acquired in India. And how was this result attained? By distilled water, which had been

supplied freely to the base, and strict attention to the advice of the principal medical officer.

In the Franco-Prussian War (1870) it is stated in the German report that typhoid fever outside Metz proved a worse enemy than the besieged French army. Their losses on an army of about 150,000 in two months amounted to over 2,000 from water-borne diseases, and this must be multiplied by at least five to obtain the total probable number for many weeks down with these serious diseases.

We next come to Ashanti (1873-74). The drinking-water was filtered through various substances, then boiled, and served often as cold tea or cocoa, and was innocuous. Out of 2,554 officers and men there were fifteen killed by the enemy's fire and 48 by disease, or in all something less than the London death-rate. These figures are sufficiently eloquent in favour of the sanitary measures adopted.

In Afghanistan (1878-79) the death-rate was brought up to the heavy figure of 89 per 1,000 by the outbreak of water-borne disease (cholera).

In Egypt (1882) there were four times as many cases of dysentery as wounded.

In 1885, in the Suakim Expedition of over 7,000 men, the death-rate was scarcely equal to that of the United Kingdom. This result was attained on distilled water, 150 tons being produced daily at Suakim.

In Ashanti (1895-96) boiled water was used and Pasteur filters, with good results.

In the Nile Expedition (1898) Surgeon-General Taylor states: 'Typhoid fever was responsible for half the mortality of the campaign, and caused more than double the deaths of both battles put together.'

Lastly, the century closes with the South African

War. A careful study of the official casualty lists to January 31, 1901,* shows that the total casualties, including killed, deaths by wounds or disease, returned invalided to England (those invalided to the Colonies or to South Africa have not been officially stated, but are here estimated at 5,000), and those still (on December 28, 1900) in South African hospitals, amounted in all to over 70,000. Further study of these figures makes it probable that at least 51,000 of these casualties (including over 7,000 deaths) may be attributed to disease originating in contaminated water. This cause has claimed twice the number of deaths caused by the enemy's fire, and prevented over 50,000 trained soldiers taking further part in the war—at least, for many months. In addition, this cause has probably throughout the war sent into hospital for one, two, or more weeks, an even larger number of sufferers from mild attacks, thereby severely reducing the effective strength of the army, embarrassing the hospitals, and requiring tons upon tons of transport daily. Such are the results to the end of January, 1901.

Now glance at the French experience of colonial wars. In Cochin China (1858-61), the decimation by cholera and other water-borne disease necessitated the home Government advising abandoning the war. In three years, by these diseases chiefly, over 2,000 had died out of an effective strength of 7,000. In Tonkin (1886-88), the army was again decimated by cholera. Finally, in Madagascar, the French lost 30 per cent. of their European army

* Subsequent returns do not substantially alter the figures here given.

(and for one death there are at least four or five cases of most severe illness) almost entirely by typhoid and dysentery. The sufferings the remainder went through on account of these diseases baffles description, and will never be known. Their preventable mortality was sixteen times greater than ours in Ashanti twenty-two years before. There was no opposition, only thirteen being killed by the enemy's fire. The men drank the water as they found it, contaminated by the natives above. Here are a few of the important remarks by Dr. Reynaud, Principal Medical Officer for the Colonies, on colonial wars: 'L'expérience chèrement acquise á Madagascar, a démontré la nécessité d'avoir un service de santé largement doté en personnel . . . il est indispensable que le service de santé possède des moyens de transport lui appartenant en propre.' Finally, he adds: 'Ce sont des guerres de médecins, d'ingénieurs et d'intendants.' He concludes by stating that the disasters were the result of the gravest sanitary errors; that the medical department was considered only an auxiliary service, though in these wars auxiliary services are chief, the difficulties before them being far greater than those before the strategists.

In the Spanish-American War (1898-99), Surgeon-General Sternberg, of the United States Army, in his 'Lessons of the War,' points out that there were six times as many deaths from diseases, mostly water-borne, as from killed or wounded. He adds: 'It is well known to sanitarians and military surgeons that, as a general rule, more soldiers succumb to disease than are killed by the bullets of the enemy,

and our recent war has not been an exception in this regard.'

Such are the catastrophes brought about by the *laissez-boire* theory on service.

A very brief review of the progress of sanitation and prevention of disease at stations in peace will give some idea of what the Medical Corps can do, and has done, when unhampered by the fear of 'cutting' or delay of their transport, and when the apathy of combatant officers has been a negligible quantity.

Between 1826-46 it was twice as deadly to serve in the home army as for men of the same age in civil life; but in the period 1861-70 the death-rate per thousand in the home army fell to 9·45, and in 1898 to 3·59, much of the improvement being due to the medical recommendations urged upon the Royal Commission following the Crimean War.

The average mortality on home service from typhoid between 1837-46 was seventeen times greater than in 1898 (excluding the cases arriving from Khartoum). A similar improvement has been attained by their exertions at many of our foreign stations, notably at Gibraltar, where the incidence of typhoid was eighteen times greater in the period 1837-46 than now. At Malta the incidence of water-borne disease was formerly forty times greater than in England; it is now approaching the condition of Gibraltar. In Canada stations are nearly as healthy as at home. In Bermuda, which long had an evil reputation, great progress has been made by the R.A.M.C.

What has the Medical Corps done to stamp out typhoid in India? They have done a great deal, but the results of their work are not yet in view, and there seems a tendency to discouragement amongst the corps in consequence. They have done splendid work in establishing at some stations pure water supply, and at others pure milk, at others again incinerators of refuse, and at some dairies. But there are very few stations that can boast of having carried out all these things thoroughly.

Reverting to the consideration of the facts of the chief wars since the Crimea, we see that there are only three in the terrible list with any satisfactory preventive results—Abyssinia, Suakim, and Ashanti —and it is to be noted that in these cases boiled or distilled water formed a prominent feature of at least part of the campaign. The death-rate was about the ordinary home death-rate, and the need for hospital transport very limited. In the remainder of the wars the *laissez-boire* theory has been in force, and the men have drunk the water as they found it, with the result that the casualty lists have been enormous and without intermission in any war.

It has been rightly said by an authority: 'The amount of illness varies with the genius of the Commander.' The Commander-in-Chief at the War Office when this war broke out is responsible. The danger was known and calculated upon; he made no adequate provision to meet it. The danger is always foreseen by the Medical Department, and too often it is considered that their 'recommenda-

tions' may be ignored. At the outset of the war with Spain, Surgeon-General Sternberg issued the following circular: 'In time of war a great responsibility rests upon medical officers of the army, for the result of a campaign may depend upon the sanitary measures adopted or neglected by commanding generals of armies in the field. . . . The medical officer is responsible for proper recommendations relating to the protection of the health of troops in camp or in garrison. . . . Serious results infallibly follow a neglect of these rules.' Then followed recommendations which, if carried out, would have prevented all the typhoid and most of the diarrhœa and dysentery from which the American army suffered so severely.

A little later he issued Circular No. 5: 'The extensive prevalence of typhoid fever in camps of instruction indicates that the sanitary recommendations made in this circular have not been carried out. . . . If the recommendations have been made and not acted upon by those having authority in the various camps, the responsibility is not with the Medical Department, but these recommendations should be repeated, and commanding officers urged.' The word 'court-martialled' would have been better than 'urged.'

The questions arise, How much destruction of life by preventable disease in war is necessary before general officers will take up this problem seriously? How many years must pass between established scientific work and the adoption by the War Office

of its practical applications? The preventability of typhoid (enteric fever) has been established at least a quarter of a century, yet the immense casualty lists from this and other preventable water-borne diseases all over South Africa in this war reveal a state of things as regards the supply of pure water little in advance of the first year of the Crimean War, or even of the Crusades. Miss Nightingale, in her evidence before the Royal Commissioners appointed to inquire into the sanitary state of the army after its almost complete destruction by disease in the first year of the Crimean War, said: 'Is not this the most complete experiment in army hygiene? We cannot try this experiment over again for the benefit of inquiries at home, like a chemical experiment. It must be brought forward as an historical example.' The War Office, in the face of the most complete scientific facts established since the time referred to, have thought fit to 'repeat the experiment.' The next summer manœuvres will reveal if it is their intention to put the nation yet again through this distress and suffering.

Steps are taken in peace, to some extent, to prevent disease in the army. In war, on a moderately large scale, and in the face of disease, there is no organization at all adequate to prevent the soldier being absolutely useless to the nation, after years of training, in the very hour of danger. In this war, up to January 31, 1901, some 50,000 men have been deprived, on account of preventable disease, of further participation in the campaign; together with these a very large number have temporarily blocked the hospitals at some stage of the war, resulting in great hampering of the army move-

ments, and greatly increasing the transport necessary.

Is the limit of the War Office's power of prevention reached in such campaigns as Abyssinia (4,000 Europeans, 8,000 natives), Ashanti (2,500), Suakim (7,200)? Was it impossible to have extended a partial system of prevention, and so have turned the war in South Africa into a healthy recreation, with a death-rate equal to that of London? If the Army Medical Department had gone through their surgical work without adopting the teaching of Lord Lister, returning a death-rate from wounds of 15 per cent., instead of their excellent 5 per cent., would nothing have been said? If the Commissariat Department had supplied poisonous food, causing a thousandth part of this damage, would nothing also have been said? How, then, can a general officer conduct a campaign on contaminated water, and the public remain apathetic?

There are two enemies in every war drawn up as armies against you—men and bacilli. The bacilli have beaten the men in the victims they have secured from remote ages till to-day. If it be true that the first object of war is to destroy your enemy, surely the second must be to save your own army from destruction. If combatant officers find it difficult to retain the two ideas at once, and to conduct the two campaigns simultaneously, why not give the R.A.M.C. carte-blanche to see the bacillary campaign through, giving them also full

responsibility and disciplinary assistance in carrying it out ?

I shall show directly how a minute army, fashioned to deal with the bacillary enemy, can form an integral part of the vastly larger army it is protecting from their attacks, and I venture to think that the plan of this bacillary campaign, which will be discussed later, would be immeasurably superior to the *laissez-boire* theory lately seen in South Africa and in all previous large campaigns.

We must get rid of the notion that general measures will suffice to secure success; it is not a dustman's question of general cleanliness pursued at odd times, it is a campaign which is to be fought *pari passu* with every movement of every unit of the army from first to last, a campaign within a campaign. Some might think a plan of being careful, but not 'fussy,' the best; if so, they would fail utterly. We have seen that that which has happened in South Africa is quite the usual thing in war—nay, even was calculated upon before the war, and it would have been regarded by the medical profession as most strange, and nothing short of a miracle, if it had not happened. The sad part of it is that it was not a crusade, where those dying in the war were the envy of their kinsfolk and friends. Many did not wish to die by the bacilli, nevertheless ignorance and underrating of their power, and the apathy of generals responsible for the quixotic exposure of their men alike to bacilli and, in the early stages of the war, to the Mauser sleet, have taken them to the grave. We pitied the Dervishes rushing against the storm of lead; what will they think fifty years hence of the picture of 45,000

Englishmen drinking unaltered the polluted Paardeberg River?

In order to convey some clear idea to the lay reader of the subject before us, we will very briefly review the progress of work on this subject in the past century, touching only on the facts bearing on our present view of the subject, viz., prevention.

Typhoid (or enteric) fever is an epidemic disease, in consequence of its being water-borne. It is taken in by the mouth in contaminated water. Dirty water does not necessarily convey typhoid. The well of a farm may have the clearest or the dirtiest water, but there will be no typhoid fever until the typhoid bacillus enters the water, generally by a minute leakage of sewage. The people at the farm will only get typhoid if they drink this water; hence the infant and the beer-drinking father may escape. Sometimes the water-works or reservoir supplying a town many miles off may be infected even minutely by a person having typhoid fever, and then there is a vast epidemic in the distant town, as happened at Caterham, Maidstone, and Worthing recently, and now at Bloemfontein. Such, in outline, are broadly the facts on which every epidemic of typhoid fever is easily explained. The scientific work which culminates in this simple statement is vast, and includes years of labour of very many distinguished men throughout the nineteenth century.

After 1860, England was leading prominently in the new sanitary science, and consequently the improved drainage and water-supply resulted in marked reduction of typhoid, abolition of cholera, and almost of typhus. In 1880-84 the specific

bacillus of typhoid fever was discovered, and grown on cultures outside the body. Later work, in which the great influence of Pasteur and Lord Lister is seen, brings us to the present position, viz.:

1. The bacillus is conveyed from a previous case of typhoid, usually by contaminated water, and thus may occur in drinking-water, aerated waters, milk, salad, river shell-fish, butter and cream, etc.

2. In peculiarly neglected and unsanitary surroundings, as in some armies and camps; flies may convey it, or, rarely, dust.* Though the latter agency is not proved, the agency of flies is more possible. Both these agencies can only act where no proper sanitary precautions are taken.

3. The bacilli are destroyed by various methods known to science, of which, for practical purposes, the most reliable is by boiling, when they cease to be harmful.

4. The bacilli have no geographical limits.

For practical purposes, it is universally admitted that the best effective means to protect against typhoid in civil life is the maintenance of a pure and protected water-supply. In war such protection is manifestly impossible, and it is necessary to seek protection by other methods.

It has been asked, 'How can you tell when the water is contaminated?' You cannot always do so, and therefore in war all water is to be considered contaminated. 'How can you tell where your communications will be cut?' You cannot, and therefore you guard the whole extent. It must be remembered that the preventive measures against

* The author proposes to consider technically elsewhere the question of the supposed influence of dust as a carrier of typhoid.

typhoid, at the same time, will abolish the great majority of cases of the remaining water-borne diseases—dysentery, diarrhœa, and cholera—which double the sick-lists, swell the lists of invalided, block the hospitals, embarrass the march, and reduce the fighting strength. At the same time, they consume supplies, increase the transport, and occupy the surgeons' and nurses' time that should be devoted to the wounded.

In the face of these facts, we ask, How long is the theory that we have turned *laissez-boire* to hold good, the theory that the soldier will drink, and must be allowed to drink, where he likes in war? So apathetic is the War Office on this subject, that the Professor of Military Hygiene at Netley, though elsewhere fully alive to the advantages of prevention by boiling, etc., states hopelessly in his work on hygiene, 'Soldiers should be cautioned not to drink turbid water, and the reason for not doing so should be explained to them. He should be taught to fill his water-bottle with pure water whenever practicable.' If in any war it could be shown that the water naturally available was pure, the advice might stand; but as all water in war must be regarded as contaminated, the position thus assumed represents scientifically such a surrender to the *laissez-boire* theory, that it would have been better to have declared at once that water-borne typhoid in war is inevitable.

I have shown how wide is the scope of action in the future for the Army Medical Corps in all armies on service, and it can be shown how much still remains to be done, especially in India, South

Africa, Malta, and other stations in times of peace. Our immediate concern is the practical problem of protecting an army in the field from typhoid and the allied water-borne diseases.

I am convinced, in order to effect this, that during war it is absolutely necessary, and in times of peace most desirable, that the R.A.M.C. shall have a section of its officers and men, known as the Royal Water Corps, set apart with the special charge to prevent water-borne disease. This body must receive from combatant officers and men absolute attention to all rules laid down by them either in war or peace. The chronic state in which the R.A.M.C. finds itself, of being greatly below its normal strength, makes it utterly impossible in war for the wounded to be attended to properly, if the same officer is attending to sanitary orders being carried out. If it is necessary in civil life to separate medical work into practice and prevention, it is far more so in actual war.

It has been seen that nearly all cases of disease on service are water-borne. Of the various preventive methods, we have stated that the method of protection by boiling is practically the best. Now, to supply boiled water to an army through a long campaign may appear a herculean task; that such is not the case will be demonstrated. I will justify, however, the demand for the adoption of this scheme (or a better) by the weight of evidence.

Professor Notter (Military Hygiene, Netley) states: 'To destroy any organic poison in water, it is of the

greatest importance that all suspicious water should be boiled before use.'

Surgeon-General Taylor, M.D., Principal Medical Officer in the Nile Expedition (1898), states: 'Greater facilities should be given to regiments and corps for the carriage of necessary kettles and fuel. There is no doubt if boiling were strictly carried out, it would prevent water being a source of enteric (typhoid) and dysentery.'

Dr. Renaud, Principal Medical Officer in France for the Colonies, states: 'L'eau potable, d'après les instructions, devait être soigneusement filtrée ou bouillie.'

Surgeon-General Sternberg, in medical command of the United States army during the Spanish-American War, states: 'Troops should drink only boiled or filtered water.'

Add to this evidence the success of distilled water long since established in the small campaigns, Abyssinia, Ashanti, Suakim, and Crete (before the introduction of the Nile cases), and one is at a complete loss to understand the action of the War Office and of generals who dared to lead a large army into Ladysmith, which had maintained its evil reputation for epidemics of typhoid even to a few months before, totally unprepared to prevent the inevitable results. That the siege was raised only to reveal 800 cases of typhoid in the starving garrison, and that subsequently there were many more cases was not surprising. To have led armies totally unprotected against disease through the country around Bloemfontein, notoriously the most persistent typhoid area in South Africa, is nothing short of amazing. If there be the shadow of excuse

in the latter case, by way of 'single lines of railway,' 'transport,' etc., which I shall question directly, there can have been none for the Ladysmith case. It was known months before that Ladysmith would be a base in a then almost inevitable war. Boiling apparatus and a few tons of petroleum could have gone there a year before without offending the most sensitive Boer. That filters were recommended, ordered, and arrived in South Africa only after the war had been raging for months is hardly a palliation for the catastrophe that has resulted, seeing that they would be useless unless in the hands of a specially trained corps.

Let us now consider the scheme I propose, and then the objections or difficulties in the way of its adoption.

My letter to the *Standard*, September 10, 1900, states: 'The water for 45,000 men should have been boiling thirty-five minutes after the arrival of the army at Paardeberg.'* I shall take Paardeberg as a test case, because, as I have said, it 'will have to be handed down in the annals of military medical literature as a byword for retribution for neglect of sanitary laws,' and I am taking it because on leaving the Modder River Camp in the general advance, Lord Kitchener has said (in the telegraphed report) before the Hospital Commission, 'everything was cut down.' Now, as the scheme to be suggested will have the result of reducing transport in an

* Later experiments show that this could have been done in twelve minutes instead of thirty-five minutes.

advance, Paardeberg must be taken as a test case, from the transport point of view, in favour of the adoption of such a scheme.

Let us take the present war in South Africa, and assuming that the mean strength for the year has been 200,000 men, to give every man four pints of boiled water daily would require 273,000 gallons* of petroleum for the year's war. This would cost about £6,600, and would weigh about 1,000 tons. The general transport required for this army daily is 2,000 tons, if advancing in a body. This fuel would therefore add daily only about $2\frac{3}{4}$ tons to this 2,000 tons, or an increase of $\frac{1}{750}$th.

Next as to the machines required; these would be made in two parts, a reservoir above and a petroleum stove below, each constructed to supply fifty men in twelve minutes with fifty pints of boiling water. Each machine weighing about 60 lb., and one mule carrying easily 200 lb. weight, it follows, therefore, that one mule attached to each unit of 100 men could convey the following supplies:

Two machines, fitted in boxes, with cooling apparatus	140 lb.
12 pints of petroleum (sufficing for 4 pints of boiled water daily for each of the 100 men for four days) ... ... about	15 lb.
Extras: Sugar, tea, meat extract, cocoa, vegetable powder, tabloids of antiseptics (to be used in washing up) ... ... total	20 lb.

leaving a balance of 25 lb. for saddle and some other articles. The mule would have two men of the

* Experiments carried out recently under my supervision have shown the possibility of boiling 100 pints of water (at 55° F.) with three-quarters of a pint of petroleum in twelve minutes.

Water Corps section of the R.A.M.C. in charge. The mule must be able to keep up with the most rapid cavalry march, and in this case the Water Corps men would be mounted. It must not be overburdened, as the men in charge will have to advance on foot at a trot towards the end of a march in order to arrive behind the scouts, but fifteen minutes before the army, and have the water boiled and cooled on or directly after the arrival of the army, if desired, and served as tea, coffee, or soup. By experiments I have carried out, the water can be cooled for all the men in five minutes. If the enemy are expected in front at the close of the march, the officers of the Water Corps would have retained enough water in the carts to be partly served out, if necessary, before the action.

Each mule would also carry ropes and a collapsible bucket for wells, etc., also a pickaxe and shovel to erect earthworks rapidly, if required to protect the mule and apparatus. The corps would be supplied with cloths to filter the mud from the water, as the dirtiest water might be employed with safety, no other filtration being allowed either before or after boiling. The machines and fuel would be used for no other purpose but providing fluids for the army.

It is considered of the highest importance to keep the men in the firing line supplied with water. It must be understood that the *mussuck* (goat's skin) carried by the faithful *bhisti* (Indian water-carrier) must be seen no more as a utensil to convey boiled water or tea, etc., to the firing line.

It has been customary to parade these men and 'carefully inspect' their *mussucks;* no member of the

R.A.M.C. should take part in such a farce. You might look at a *mussuck* for a hundred years, but it could never be passed as clean; between the boiled water and the soldier's mouth it is impossible.

Mules have been chosen as transport for the reason that the Water Corps is to march with the regiment over hill and dale. In fact, wherever the men can march it must never be separated from them. The advantage to the men of being able to get rapidly tea, cocoa, or soup four times a day with their dry biscuits when the transport is miles behind is something which, if once established, the men would never give up.

In Lord Roberts' march to Paardeberg, for 45,000 men 450 mules could have taken the whole apparatus for boiling, including tea, sugar, cocoa, etc., as we have sketched, and enough fuel for twelve days. Lord Kitchener states that by the 'cutting down' he left behind 502 mules and 416 oxen. I can see no reason why these animals do not represent the carrying power asked, including transport for sufficient fodder to have covered the march.

The transport of this Water Corps could be made, and would have to be made, very independent of the general transport. If a regiment is likely to be cut off from its own transport for a given time—I have supposed that time usually not to exceed four days—for that time the Water Corps transport must be absolutely independent and accompany the regiment. The transport of fuel required daily by the Water Corps, minute as it is, representing only $\frac{1}{750}$th of the total tonnage required daily (Lord Roberts' army of

45,000 men required 500 tons of transport daily; the reserve fuel, therefore, would have only added two-thirds of a ton), would have to take precedence of all transport except that day's ammunition. In other words, the transport of the Water Corps would have to be sacred; the amount telegraphed for would have to be sent instantly. No general could stop it or 'cut it down' on any account whatever. It must be remembered what this 'fuel' is. In peace you have water-engines to put out fire; this fuel is the fire which is going to put out water-borne disease and empty the hospitals. The mules could not be used to 'save the guns,' a proceeding only necessary through the ignorance or mistake of some artillery officer in putting them in the wrong place. It would be better that a regiment were entirely wiped out than that the Water Corps system should be discredited. There were dozens of hospitals in South Africa filled with water-borne disease, as is the rule in war; the transport for one of these alone (the Portland) occupied fifty tons in sixteen waggons with sixteen oxen each. If one such hospital had been left behind, its waggons could have carried all the fuel required for the whole army for fifteen days, together with the forage for the 500 mules of the supposed Water Corps for the same time; and if any further transport had been required, another hospital could have been left, for if a smart Water Corps had gone these hospitals would all have been practically empty.

If anyone has any lingering doubt of the influence of the scheme in diminishing transport, let him consider what it means to be without this Water Corps. You would have the picture of the famous 'single

line of rail,' and you would have to take up to Bloemfontein and Kroonstad some 10,000 men (part of your army of 45,000), who are now in bed, or worse, being conveyed in open trucks to the base to their hurt. Up this 'single line' you would have to bring all their food and medical requirements and nursing staff; you would have to feed and house this vast army of sick, and it would not be anything unexpected, because the Medical Department would have calculated upon it and sent equipment for it; you would have, in addition, great difficulty in marching the remaining men, as they are suffering in great numbers from either water-borne diarrhœa or mild typhoid. Surely this picture decides the case from the transport point of view.

Now, someone has remarked, 'Supposing the mules were shot?' They would be replaced; it does not affect the value of the scheme at all. Supposing you lose your artillery? Artillery is still a useful thing, you get new artillery. In emergency the two boiling machines and fuel could be carried by the two men of the Water Corps.

Now, the greatest difficulty, perhaps, that will be felt by the R.A.M.C. in recommending or urging such a scheme is its possible partial application, and so the inability to promise complete success. The fear of the partial application is founded on the ignorance and reckless indifference of the men. 'Tommy will drink where he likes.' The *laissez-boire* theory is so deep-rooted in both officers' and men's minds that it is regarded as a very difficult thing to teach and to restrain the men. The

R.A.M.C. may freely admit that theoretically the scheme is absolutely sound, but to apply it *in toto* is difficult. The watchword of the Water Corps would be 'Boiled water or nothing' on a campaign. Not a drop of water to be drunk unless approved by the Water Corps. In cases of extreme emergency, such as destruction of the water apparatus or failure of fuel, officers would inform their men in the presence of the Water Corps that the Water Corps had given permission for the polluted water to be drunk unboiled; without this permission it could not be done. A list of the men thus drinking, with the circumstances and date, would be sent into the corps. The men, on entering the army, would have a pamphlet on the destructive effects of, and sufferings that have been caused by, the *laissez-boire* theory, explaining also that on active service no water will be used for drinking except that supplied by the Water Corps.

This Water Corps should be in action on all stations outside the British Isles in times of peace, on all active service at home or abroad, on all manœuvres or marches, and should equally affect volunteers at manœuvres. All officers of the army should be examined in the rudiments of hygiene as it bears on water-borne disease, and also in the modern military history of outbreaks of these diseases, and they must understand the scope and uses of the Water Corps. All men in the army should be taught by their officers that in war and peace it is dishonourable to drink unapproved water, and liable to bring discredit on their regiment, as it most certainly would. Nothing more need be said as to restraining the men, as it is probable that this

corps would supply the men quicker with approved water than the men could obtain for themselves unapproved water.

Young, able, general sanitary officers of high rank must be appointed in addition from the officers of the R.A.M.C.; their duties would be to inspect the various camps in war, attended by the officer commanding. They would inspect the sanitary work of the officers of the regiment, of the Water Corps, and of the hospitals. The officers of a regiment should be made responsible for the ordinary sanitary arrangements of their own regiments in war and in peace, but subject to inspection by the R.A.M.C.

The Water Corps would be responsible for the disinfection of all salads after they have been washed in ordinary water, and for the boiling of all milk used.

It will thus be seen that the entry of water-borne disease can be prevented, and the concentrated attention of the R.A.M.C. on any suspicious solitary case would close the door effectually to any possible germs borne by flies or wind affecting the army. The army starts free, and remains so. The Water Corps will be effective also on every transport in war or in peace, and be absolutely responsible. In times of peace the corps will concentrate on foreign stations where preventable disease occurs so largely at present, notably India, Malta, and South Africa. They will devise what may be considered an ideal station from the point of view of prevention of water-borne disease, which accounts for half the deaths at stations in India. They will swoop down

on station after station in India and South Africa with their system till not a case remains. They will compel municipal authorities to assist, and if necessary apply for powers to the central Government. Only certain streets and houses in bazaars must be accessible to soldiers for drinking purposes, and these houses must be forced to sell only the soda-water supplied to them by the Government at cost price or water approved by the corps. If these houses do not conform, they will be closed. Men and officers dining out in India and other unhealthy stations must refuse salads and unboiled milk, and the Government soda-water must be sent for them to drink. The corps will boil every drop of milk used in India and certain other stations either by officers or men. All market salads or unboiled vegetables the corps will receive first, and will wash in boracic or other suitable solution, and then in water that has been boiled. Butter, milk, and salads would be better provided by Government under the control of this corps. Boiled water will be stored in vessels inaccessible to flies. The same early isolation of any supposed case of water-borne disease as in war will be necessary. There is no station in the world, however bad its reputation at present, that could possibly retain its character in face of these measures and this corps.

The personnel of this corps must have the responsibility very clearly thrown upon them; the occurrence of a single case of typhoid would need an inquiry by a general sanitary inspecting officer. The duties are responsible; men would have to be well paid, and officers given high distinctions in addition.

In conclusion, the scheme involves:

1. A Royal Water Corps, to be devoted to this work, linked to the regiments and to the R.A.M.C.

2. The transport of this corps to be absolutely sacred, to be used for no other purpose whatever, and to be independent of all other transport. The reserve fuel, however, adding $\frac{1}{750}$th to the army's transport, is to take precedence, as required, of everything except one day's ammunition.

3. Education of officers and men in the hygienic advantages to be gained thereby.

4. The regarding it dishonourable and a crime to use a drop of any water on a campaign not approved or allowed by this corps.

The advantages to be gained are:

1. Total immunity from water-borne disease, which amounts to four-fifths of the mortality of armies.

2. Absence of discomfort on the march by minor illness.

3. Diminishing of thirst and discomfort by accessible tea, cocoa, and meat-extract soup at least four times a day, in place of nothing but dirty water, a biscuit and late transport food.

4. Enormous reduction of transport by its adoption.

5. Immense increase of effectivity on the march and in the fighting strength.

6. Liberation of the R.A.M.C. officers and men for care of the wounded by emptying the typhoid hospitals.

7. Acceleration of the war and saving of enormous expense.

8. Abolition of preventable water-borne disease

(half the death-rate) in India and many foreign stations in times of peace.

9. Lastly, the adoption of the scheme can at least do no harm, and 100 years of the *laissez-boire* theory has seen nothing but the most terrible results.

The R.A.M.C. has more than the capacity required to carry it out, and should be able to promise complete success, provided that the men and officers of the whole army will assist their efforts by compliance with rules laid down, and in this matter the public, the House of Commons, and administrators have an evident duty.

If men, officers, and country refuse it, then let them accept in future, without complaint against the Medical Corps, and without the paltry subterfuges of 'hospital commissions,' or 'medical scandals,' the inevitable result in store for them. Let them remember they may lay down future typhoid hospitals, provide armies of nurses, beds innumerable, independent transport, and yet they will not make typhoid fever and dysentery comfortable diseases in war.

The Commission lately appointed by the House of Commons has been altogether 'off the lines,' and it has been put 'off the lines' by men like Mr. Asquith and Mr. Burdett-Coutts, amateurs, who entirely under-estimated the value of medical men on the Commission, and finally sent these able Commissioners up and down South Africa to ask questions about whether men were comfortable with their typhoid and dysentery at Bloemfontein. Speaking professionally, was anything ever done more con-

temptibly inadequate and irrelevant to the main issue? We leave this Commission, which can afford no ray of comfort for the future, and turn, full of hope, to the scientific professional Commission which the R.A.M.C. has despatched to South Africa. Adopt such a scheme of prevention as I have sketched in all deference to the able advisers to the army in the R.A.M.C., and with the additional preventability of malaria in sight, the profession of the soldier in peace and war, at home and in India, cannot but become the healthiest occupation of the community.

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THE THEORY OF AIR-BORNE TYPHOID IN ARMIES

BY

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THE THEORY OF AIR-BORNE TYPHOID IN ARMIES

The importance of a study of the action of typhoid on armies in the field, and of the methods best adapted to meet what is undoubtedly the greatest scourge in war, and a grave national danger to any State unprepared to cope with it in any great military struggle, is undeniable. The conclusions arrived at by the author are set forth in a work which has just been published,* which deals with the question of prevention in armies on active service only. At the close of this paper I propose to consider the methods and scope of such a Royal Water Corps, as I have there proposed, in times of peace chiefly concentrated on foreign stations. This corps is to be charged with the responsibility in war and at stations in peace for the occurrence of water-borne disease. Though I shall limit the discussion in this paper to enteric fever, yet the province of this corps will be equally the prevention of dysentery, diarrhœa, and cholera—diseases water-borne in origin which fill so largely the military hospitals in war and in peace.

* 'Typhoid, the Destroyer of Armies and its Abolition.' Baillière, Tindall and Cox. London, 1901.

In the study of the methods suitable to meet these scourges, one was at once met with a new theory which threatened to destroy the value or usefulness of any methods based on the theory that these diseases are at least in origin, if not in spreading power, chiefly water-borne. This theory assumes that typhoid fever and presumably dysentery, diarrhœa, and cholera are largely spread by flies and dust through the air. Outside a few laboratory experiments, the great natural experiments upon which military medical authorities rely for demonstration of this theory are to be found amongst the outbreaks of enteric at stations in India, South Africa, and Egypt.

I propose therefore in this paper to consider:

1. The conditions under which typhoid originates and spreads in armies in India, South Africa, and Egypt, with a detailed review of the conditions present in those special cases where dust or flies have been supposed to be the main agents in the origin or spread of this disease.
2. The original scientific work bearing on this question.

The principal instances of air-borne typhoid in military experience are recorded in the army medical reports from 1897-99 in the case of India and South Africa, and in the case of Egypt in those of 1884-87, 1898-99.

At the outset I would wish it to be understood that if I am critical of the methods pursued or of the conclusions arrived at in particular cases, it is in order to test the foundations upon which this theory has been built. I am fully aware of the difficulties before a scientific department which has only the power to 'recommend' or advise on the most serious matters of health, and which too often sees its recommendations postponed or entirely neglected. Under such circumstances, it is not surprising that the methods are imperfect or incom-

plete, and this I find freely acknowledged in numerous places in these reports.

INDIA.

The strength of the British army in India averages about 66,000.

The admissions and deaths from enteric for the years 1896, 1897, and 1898 are progressively worse, being far larger than in all previous years, the average annual admissions for these three years being 2,073, compared with 1,476 for the previous biennial period.

Enteric during this period caused every second death amongst soldiers in India instead of every $\frac{1}{120}$, as at home.

In 1899, to compensate somewhat for the evils suffered in this respect in South Africa, there was a considerable improvement in India. Unfortunately, the two great causes which led mainly to this improvement, viz., the absence of field service and the absence of reliefs during the last three months of the year, are not likely to occur again in the future.

In 1897 enteric occurred in every district except Aden, and in all but seventeen stations.

The Typhoid Avenues in India.

1. Water.

The general water-supplies of India in nearly every case are open to suspicion of contamination or pollution. Many actually contain the typhoid bacillus. The natives are subjects of typhoid fever to a larger extent than was formerly supposed. Most of the rivers are polluted by man. The Principal Medical Officer reports in 1898:

'The extensive fouling of the banks of all Indian rivers by human excreta.'

Take the river Jumna as an example. This is con-

taminated by melon-growing manured with human excreta, the rising river sweeping everything into the municipal supplies taken from below.

STATIONS WHERE THE TYPHOID BACILLUS HAS BEEN FOUND.

Agra is one of the chief cities affected by this pollution of the Jumna, and the typhoid bacillus has been found in numerous examinations of the municipal water-supply, and occasionally at the barracks (1898). This station headed the list for enteric in 1897.

The typhoid bacillus, besides being found at Agra, was found also, in 1897, in the filtered municipal water at **Lucknow**. The Government analyst 'assumes that it is always present.'

At **Meerut**, in a well in the Royal Horse Artillery lines.

At **Cherat**, in the tank used to adulterate the milk in the regimental dairies under native control.

At **Dagshai**, in the drinking water of the bazaars.

At **Quetta** (1896), where a big epidemic occurred the same year, in the station's water-supply and in recently-made soda-water.

This station was the scene two years later of a large epidemic, which was attributed largely to dust, and must be considered in detail later.

Contamination.—Human excrement contaminates the municipal water at **Agra, Mhow, Dagshai,** and **Nasirabad.** At **Lucknow** the banks were 'defiled with fæcal deposit for two miles above the intake, and sand was taken 800 yards above the intake from a place used as a native latrine for years, to be used in the filter-beds of the water-supply. At **Peshawar** "the iron pipes often pass through foul irrigation streams." But the water is described as "good and satisfactory," although a bacillus resembling enteric was found in a tap used by the Royal Inniskilling Fusiliers.'

At **Umballa, Poona, Secunderabad, Cherat, Ahmednagar, Jhansi,** and **Ranikhet,** the water-supply was contaminated.

At all the above stations epidemics varying from 30 to 230 cases occur year after year. The defects in municipal water-supplies still continue, and pollution goes on. If the defect is within the lines of a station it is corrected, but if beyond it seems that no pressure is brought to bear to remedy these defects.

Mussacks and Pakhals.—Although they have been condemned, these filthy leathern vessels were the supposed cause, at least, of the Cherat epidemic in 1898.

2. Milk.

Milk adulterated by natives in the regimental dairies with foul water caused the **Cherat** epidemic in 1897, as we have seen. To a like cause the **Peshawar** epidemic is attributed in 1898. From **Mhow** in 1898 it is reported that 'the milk and butter almost entirely from the bazaars should be condemned as unfit.'

The **Kasauli, Subathu,** and **Intogh** epidemics of 1899 are attributed to native-supplied milk, also **Rawal Pindi** (1899), and **Lucknow** (1898). I will quote the words of the report in the case of Lucknow, as it is an instance of the urgent need of a responsible corps with full power to act at once.

'The milk-supply for the Soldiers' Institute in the bazaar is chiefly obtained from a village which is in a very insanitary condition, being situated close to the filth pits where all the night-soil from the bazaar is buried. It is *hoped* the sale of this milk in the bazaar will soon be abolished. The establishment of a station dairy similar to the one at Allahabad, which has proved such a success, is *now under consideration*.'

The report for the following year states that the sale of this milk was stopped in that year.

3. Bazaars.

The bazaars are stated to be the cause of the epidemics at **Rawal Pindi, Dagshai, Quetta,** and **Ahmednagar** in 1897, and fifteen stations attribute their epidemics in 1898 to the same cause in whole or in part.

Epidemics are occasionally reduced by placing the bazaars out of bounds.

These bazaars are in a very insanitary condition; they supply filthy aerated waters, known largely to contain typhoid, made without the slightest regard to purification or cleanliness. Their milk, butter, and fresh vegetables are all infected, and sold largely to regiments or

individual soldiers. These bazaars are much frequented day and night by the men.

4. Native Cooks.

Native cooks, often working with impure water, and introducing filthy methods, are an admitted avenue of enteric.

5. Other Avenues.

The following avenues have been drawn attention to for the first time in the 1899 report:

(1) Salads, watercress, tomatoes, etc., eaten uncooked, washed in filthy irrigation channels, causing or assisting in epidemics at **Peshawar** and **Dalhousie.**

(2) Lucerne.—At Bangalore the lucerne-gardens cultivated for the mounted corps were irrigated with liquid sewage. It is not surprising that the men handling this in the horse lines should have directly afterwards contaminated with their hands the water-chatty in their lines, and so caused the epidemic of this and the previous year.

(3) Shell-fish, one station, 1899.

6. Flies and Dust.

The following stations attributed their epidemics in whole or in part to air-borne typhoid: **Kailana, Quetta, Khyber, Chakrata, Bangalore, Mhow,** and **Poona.**

Kailana, 1897.

The medical officer states: (*a*) 'With regard to dust infection, five cases of enteric fever occurred in one barrack-room. In two the onset began within three weeks of arrival, and, therefore, the infection may have taken place on the line of march, and in three the onset was from twenty-six days to two months after arrival. (*b*) Three cases also arose in one of the barrack-rooms where men were being treated for venereal disease after eighteen, twenty-five, and fifty-one days in ward.' The floor was taken up, and there were no more cases. (*c*) In September, 1899, the cases were 'confined to five barracks near some latrines which had been disinfected, the use of which had been abandoned earlier in the year owing to their proximity to cookhouses.' The barracks were vacated, and the epidemic subsided. Considered by the medical officer as afurther proof of the important part played by flies and dust in India.

The report continues: 'The water-supply is obtained from fenced-in springs, abundant and good, but its distribution by pakhals is considered objectionable.'

'Funds for the extension of the water-supply to Kailana, which is considered an urgent need, are not available.'

In the Kailana epidemics we note:

1. The water-supplies are condemned by the use of the pakhal, which is practically the home of the bacillus, and the **urgent need** for a new supply, inferring that the present supply is unsatisfactory.
2. Butter, salads, etc., supplied by the hospital, or surreptitiously by hospital orderlies (as at Jhansi, 1897), direct infection, medicines made with unboiled water, direct bazaar infection in the case of two out of the three venereal cases, are all points overlooked in favour of the more difficult dust infection.
3. Major Davies, R.A.M.C., reported that some at least of the cases (the Northamptons) may be possibly due to drinking tank-water outside the lines known to be polluted and condemned.

At Kailana we must conclude that the avenues for water-borne typhoid were easier for the typhoid bacillus han those by dust and flies from faulty latrines. That bazaar infection and direct contact will explain equally well the facts.

Quetta.

We must consider the three epidemics of 1896, 1897, and 1898. That of 1898 forms the principal instance in India of the supposed dust-borne theory of typhoid. The epidemics of 1896 and 1897 have bearings on this point.

The onset of **the 1896 epidemic** was gradual—1 case in April, 3 in May, 29 in June, 24 in July, 33 in August, 18 in September, 25 in October, 6 in November, and 1 in December—in all 140 cases, not confined to any corps or barracks. The medical officer, after a searching inquiry, reported: 'Barrack surroundings in good sanitary state; the water-supply as perfect as possible to conceive, being brought in pipes a distance of thirteen miles from uninhabited mountains 1,400 feet above the station, and any idea that the drinking water could be the cause

*

may be put out of court.' He adds: 'The most likely cause of all, and the cause to which the disease has been attributed, is the native city of Quetta. It is full of brothels, drinking-shops, etc., many of which are in a most insanitary condition. The soldiers frequent these places in great numbers.' He also states other possible causes of the spread of the disease are:

(1) The smuggling of milk and butter from native villages.
(2) Native attendants who are not clean handling or preparing food.
(3) Drinking water from surface irrigation channels of doubtful purity on field-days when the drinking water has run out.
(4) Ambulant cases sleeping in barracks and fouling the latrines.
(5) Flies, fouling food, etc.

Samples of water from various places and of recently-made soda-water were examined, and the typhoid bacillus was discovered in some. He continues: 'It is strange that in two samples of water coming from the same source, but from different taps, it should be found in one and not in the other.'

The epidemic began in April. On June 6 all water vessels ordered to be washed weekly with 6 per cent. solution of permanganate of potash, the drinking water to be faintly tinged with the same. June 24, mussacks and pakhals, the leather homes of the typhoid bacilli, were ordered to be cleaned with a strong solution of this agent. July 23 (a month later), all drinking water was ordered to be boiled. August 5, the milk also.

The preventive measures were incomplete in theory, dilatory and ineffective in practice.

In the appendix of the report for 1897 is found the report of the fuller inquiry of the same epidemic. It states:

1. The year 1896 was a hard one for manœuvring. 'The men fell out of the ranks in large numbers, and drank any water they could get, principally from irrigation channels.'
2. 'Though the water-supply is almost as perfect as it is possible to conceive, yet its contamination

was the direct cause of the outbreak. That it was contaminated by natives is, of course, possible. In samples from different sources Mr. Hankin found the enteric bacillus.'

3. 'The Artillery suffered most in proportion to strength. This is easily accounted for, as Mr. Hankin found large numbers of enteric bacilli in the soda-water drawn from the Royal Artillery Mineral Water Factory.'

In 1897 the epidemic was less severe (52 cases).

In 1898 the epidemic was very severe (232 cases, or 108·2 per 1,000 of strength).

The epidemic began on May 13. There were 2 cases in May; in June, 4; in July, 41; in August, 52; in September, 49; in October, 62; in November, 10; in December, 1. The epidemic of 1896 practically was the same period (April 3 to December 1).

The women and children suffered in proportion, which is not the rule in India, indicating some cause in the barracks, or milk, butter, vegetables, etc., from the outside.

Major Davies, R.A.M.C., was commissioned to conduct a special inquiry, and the epidemic was ascribed to dust and flies as the principal channel of conveyance, for the following reasons:

1. Immunity till May, when the dust-storms begin.
2. Dust-storms were very prevalent from May 2 to May 13.
3. Outbreak preceded by an epidemic of sore throat, possibly from contaminated dust.
4. The filth pits were to windward of the barracks, and the epidemic was especially severe in the lines nearest the filth pits (Left Infantry and Royal Artillery Barracks).

Let us inquire what water-borne avenues were open to the bacillus at the same time.

The following avenues open in 1896 were still available:

1. The **water-supply** in which the bacillus had been found in 1896 may have contained the bacillus again from its previous undiscovered source, although it may not have been present late in the epidemic, when it was first looked for, or it may have been actually present, but not isolated.

2. The same **insanitary condition of the bazaars**, and therefore of the milk and butter, soda-water and vegetables. The Royal Artillery soda-water factory supplied the bacillus in 1896; may it not have supplied it in this case? The **dairy supplies**, Major Davies reports, were only 'fairly satisfactory'; hence an avenue to the women and children as well as the men.

Vegetables and salads washed possibly in foul irrigation water are not referred to at all.

3. The **condemned pakhals and mussacks** were still in use as in 1896.*

4. On **field-days the foul irrigation channels** were still open to the men freely.

5. **Lucerne**, or green food for horses, is not referred to, being a cause of typhoid thought of for the first time two years later, and this may have come in soaked from the fields, polluted with human excrement and foul irrigation water. This would go largely to the Royal Artillery lines, and the men handling this would be subject to a higher incidence than the infantry lines. These men might with their wet hands easily have polluted the water-supplies near, and so have distributed it to the infantry in the adjacent lines; or if engaged, as in 1896, in the manufacture of soda-water, the pollution may have arisen in this way on both occasions. Major Davies was not satisfied with the state of the regimental soda-water factories.

* These appear to have been given up shortly before the epidemic of 1898.

The increased incidence amongst the 1st Battalion Wiltshire Regiment, which occupied with the Royal Artillery the Left British Infantry lines in the track of dust from the filth trenches, as compared with the incidence in the 2nd Battalion Border Regiment, may also receive another explanation apparently overlooked. The Wiltshire Regiment arrived in India in 1895, the Borderers in 1890. According to the tables of incidence per 1,000 in the various years of service in India, the Wiltshires should have an incidence twice as great as that in the Borderers. We find they had 136 cases to 47 in the Borderers. The balance in the Wiltshires might be accounted for by possible direct infection from the Royal Artillery cases, or from the proximity of polluted water or food of the horses or mules, or the pollution of the local drinking-water by the Artillerymen's hands, etc. Thus the incidence, which was the main argument of the dust-borne or air-borne theory in this case is capable of quite a different explanation, and one which is in conformity with previous experience.

The remaining reasons the Commission found for concluding in favour of dust must be considered:

1. **'Storms of wind and clouds of dust from May 2 to May 13.'** The first case was on May 13, and was probably contracted about April 22—that is, eleven days before the winds began. If these storms of wind carried the bacilli to food and drink and to the air breathed by 2,138 men and their quota of women and children, we should expect a large number of cases between May 23 and June 3, but there were only two cases in the whole of May, and four in June. After June 3 the wind-borne cases would largely cease, whereas in each of the months July to October we have sixteen times as many cases. Moreover, if we take the whole Bombay command, in which the Quetta outbreak is included, we find that for the months of July, August, and September there was the same general increased prevalence as at Quetta. The main cause in the rest of the command is admitted to be water-borne typhoid.

2. **'The outbreak was preceded by an epidemic of sore throat.'**

The outbreak was on May 13, so the epidemic of sore throat preceded that date. Up to forty-seven days after

the sore throats only six cases of typhoid had developed in 2,138 men, but in the five months following these forty-seven days 214 cases develop. This perhaps is the strongest argument against the theory.

I am not assuming that the carrying of typhoid bacilli by flies and dust did not exist, nor that the sanitary condition or site of the trenches was what should be demanded, but what I think I have shown is that the data on which the preference is given to the theory of air-borne rather than to water-borne typhoid in this case are altogether insufficient, and that the balance of evidence is much stronger in favour of the water-borne theory.

Khyber Epidemic, 1898.

Strength, 1,483 ; 238 cases—the largest outbreak in 1898. Report states:

'Considered likely that infection was carried by dust-laden winds. Towards the end of July arrangements were completed for removal of the night-soil to 1½ miles from the camp. Pakhals were discarded, and galvanized-iron tanks provided for the drinking water.'

The subsidence of the epidemic followed the ordinary subsidence observed in other epidemics in the same command, and was not necessarily the result of the improvements. The discarding of the pakhals and the improved water-tanks may have been equally or wholly as efficient in reducing the epidemic. The state of the bazaars or camps supplying butter, milk, vegetables, green cattle-food, soda-water, etc., are all omitted in the report. We should not feel justified in drawing any conclusions from this epidemic.

Chakrata, 1898.

Half the cases were imported; the remainder were put down to dust and flies. There was no inquiry. Most of the ordinary avenues of typhoid are not referred to.

Bangalore, 1898.

At Bangalore liquid sewage was used to irrigate the lucerne gardens cultivated for the mounted corps. A chatty in the horse lines used for drinking water became infected with the bacillus. The effect of the Quetta theory is seen in the Principal Medical Officer's report. He states:

'The bacilli are almost of universal prevalence, and food and drink are liable to be affected by them, and, given the liability by means of youth, depression of health or vitality from any cause, the occurrence of the disease is probable.'

Here again the other avenues are not excluded, and the actual presence of the bacillus in the drinking water must exclude this epidemic from being considered air-borne, in spite of the reference to dust and flies.

Mhow, 1898.

The milk, butter, aerated waters and bazaars were all condemned. In 1899 the water, milk and butter are said to be protected, and fæcal dust is referred to as a cause. Aerated waters, lucerne, salads and vegetables washed in infected water and the unboiled water previously shown to contain typhoid bacilli and used probably for washing salads, watering cattle, horses, etc., are all neither excluded nor referred to.

Poona, 1899.

Major Davies reported on investigation: 'Water-supply open to pollution throughout its course.' The Principal Medical Officer, however, thinks:

'The proximity of the city filth pits right to windward of these barracks and military prison has been overlooked;'

and

'The disease may have been air-borne, as seems to have been the case at Quetta.'

It seems curious that this Quetta theory should be considered the more likely in face of the obvious fact of

'The water-supply being polluted throughout its course.'

In each of these seven epidemics the obvious avenues of water-borne typhoid are so numerous and often neither mentioned nor excluded in any reports of the epidemics that we must conclude that the proof of the air-borne theory from these epidemics does not exist in any one of them. The balance of evidence, and certainly of theory, is strongly in favour of a water-borne origin.

With regard to the present system of boiling the water used for drinking at stations in India, the medical officer at Barrackpore reports:

'It is a question whether we have not ourselves been the unconscious agents of the spread of enteric by the use of the very measures designed to prevent it. Anyone who has watched the mode in which these measures are carried out cannot fail to be struck with the fact that it is a most dangerous proceeding. In collecting, boiling, cooling, transferring to and methods of storage, one can imagine numerous modes in which the organism of enteric may be introduced.'

This happened at **Lucknow** in 1897, causing an epidemic. The bacillus was found in drinking water supposed to have been boiled.

SOUTH AFRICA.

The incidence of enteric fever in the British army in South Africa in 1898 was 36·5 times that of the British army in the United Kingdom in the same year.

The 1898 Army Medical Report contains the report of Major R. J. S. Simpson, M.A., M.B., R.A.M.C., on the conditions under which enteric fever at **Pietermaritzburg** in Natal was causing more than half the enteric fever in the British army in South Africa between 1884-1896. This searching inquiry is one of the most complete and creditable studies that any officer in this corps has produced, and must be taken as a standard in South Africa generally. I shall therefore chiefly confine my remarks

on South Africa largely to this report, as the report states the sanitary condition of this town is not worse than that of most South African towns.

In 1897 the Principal Medical Officer for South Africa reports 115 of the total 160 South African cases of enteric fever occurred at Pietermaritzburg. The sanitary condition of the town was bad—no sewers, only surface drains. The sanitary contractor's men had been seen emptying pails in gardens of the town. With such arrangements and a large enteric epidemic in process in the garrison, in the civil population and amongst the natives, we have the ideal natural conditions for the experiment of the possible air-borne transmission of enteric fever.

In 1898 Major Simpson's special report confirmed the above. The following facts may be added from his complete account :

The mixed population is 24,595. The town is situated on the crest and side of a low ridge, sloping into a valley on either side, drained by a stream.

The rainfall is 45 inches.

General Sanitation.

The pail system used without earth ; the natives have no pails. The surface drainage for rain used also for excreta. The storm water from April to October flushes them. There are oxen and horses innumerable. Of the houses 19 per cent. have grave sanitary defects (official town report). General dirtiness prevails. After exhaustive details on almost every point, Major Simpson summarizes as follows :

(1) There is a connection between the early rains and the annual outbreak.

(2) The water-supply is subject to pollution in the collecting area, and till it enters the reservoirs, and till lately also in the distribution.

(3) It is endemic in Pietermaritzburg, and affects all classes and natives.

He continues :

'The cause is common to the city and the camp : the two common causes are water and dust. But if the dust were the chief means of propagation, one would expect the prevalence greatest during the dry weather, whereas enteric fever does not begin to prevail until after the onset of the rains, when dust is both less in quantity and frequency.'

'On the other hand,' he states, 'we have enteric fever occurring amongst the native population throughout the country. The first washings of the polluted surface pass into the water-supply, which is not efficiently filtered, and soon after the first onset of the rains we have enteric fever both in camp and city.'

Moreover, at the prison the boiling and storing of water are carefully attended to, and though exposed to the dust from the city where so much enteric was scattered about, yet 'not a single case occurred amongst 348 prisoners.'

These facts, with the almost impossibility of imagining the water, under the circumstances, free from the enteric bacillus, taken with the comparative immunity of women and children, who were largely protected by rules of barracks, which could not have protected them against dust-borne enteric, and the absence of enteric fever before the rains, makes the conclusion almost a certainty in favour of water-borne typhoid in this crucial test.

EGYPT.

The British army in Egypt and the Soudan has suffered severely from enteric fever, dysentery, and 'simple continued fever' from 1884 to the present time at every station that it has occupied. Intimate acquaintance with this country, especially Upper Egypt, during the past ten years, in civil practice, has afforded me considerable experience in the facts I shall here discuss.

In 1884 the Principal Medical Officer of the Frontier Field Force states: 'Enteric fever appears to be endemic along the whole Nile Valley.' This latter statement recurs repeatedly in other reports, but is not correct.

I propose to consider:

(1) The station of Assouan, situated at the first cataract; (2) civil experiences in Egypt, especially at Assouan.

Assouan.

This town of 15,000 natives is situated at the first cataract of the Nile, at the foot of the cataract on the right bank of the Nile. There is practically no cultivation on the banks of the cataract south of the town. There are three sites we must refer to:

1. 'North End,' on cultivated land north of the town.
2. 'Tagoog Heights,' situated immediately south of the town, on bare rocks 250 feet high. The new Cataract Hotel, built for 150 guests, on granite rocks, is at the foot.
3. 'Shellal,' three to four miles up the cataract on the same bank; this was a small native village under palms, and is now the site of the enormous barrage works of Sir John Aird and Co., and was the site of a British army camp in 1886.

These three sites have been occupied for several years by British troops.

In 1886 the Frontier Field Force strength was 3,503; admissions for enteric fever 467; 170 deaths. Of these Assouan had 276 cases and 97 deaths. The medical officer of Assouan Station Hospital reports:

'Its prevalence must, in my opinion, be chiefly owing to climatic causes, and not to the insanitary condition of the camps or water-supply, as at least on Tagoog Heights the sanitary arrangements are very fairly satisfactory, and the Nile water is better than any usually obtainable, and with the precaution of having the supply for drinking

purposes taken from the middle of the stream, boiled and filtered, it is most improbable that it should have been the cause of such an extensive outbreak.'

But the Principal Medical Officer of the Frontier Field Force reported of Assouan in the same year:

'The water-supply, too, was often taken for convenience from the river's bank, and the recommendations as to boiling and filtering were not effectually carried out; but on the whole I do not think that defects of drainage, latrines or water-supply were the most important factors in the spread of the disease.'

The principal comments I have here to make are:

The plan of selection and arrangement of the sites for camps was very bad.

In 1886 the sites 'North End,' 'Tagoog Heights,' with the subsidiary site 'under the palms,' and 'Shellal' were occupied simultaneously. In a distance of four miles on one bank there were three camps, all with enteric cases previous to removal to hospital, all containing 'simple continued fever' cases (of which 50 per cent. are probably enteric) before or after being in hospital. These men bathed in or washed in the river at each camp. By no possible means could the river and banks escape continuous enteric pollution, and as the

'water was often taken for convenience from the river's banks, and the recommendations as to boiling and filtering were not effectually carried out,'

by no possible means could the drinking-water be free from the enteric bacillus. Moreover, the Tagoog camp had the advantage of the Shellal bacilli as well as its own, and North End had those of both Shellal, Tagoog, the Bashi-Bazouks, and the town foreshore, and therefore rightly gained the reputation of being 'not nearly so healthy.'

The camp at North End has been occupied by British troops for years, and even in the last Soudan expedition

repeatedly. There is no excuse for such utter disregard of sanitation as to accept a site on a river immediately below a large town. Notwithstanding the above conditions of the water-supply, the medical opinions refer the epidemics to air and dust, and state that 'defects of drainage, latrines or water-supply were not the most important factors.' However, the price of these methods and opinions was paid.

We now pass to Assouan considered civilly in the past three or four years.

This same town and district has become a health resort for European visitors. Moreover, during the past three years 'Shellal' site has become the site of the great barrage works.

The Assouan Barrage Works.

These works and camps occupy the district called 'Shellal,' at the south end of the cataract, practically the camp site of British troops in 1886, and the scene of part of the great epidemic of that year. The works commenced in 1898 and are nearing completion. The site was practically a desert; it is now covered thickly with long rows of huts or barracks for workmen, blocks of houses for numerous young English engineers, hospital buildings, etc. The concentration of workmen in the bed of the river by day, and in the barracks and restaurants by night, is very great. They are exposed alike to river-water and the dust of a camping-ground that has been occupied for over three years.

The first report of the medical officer in charge covers nine months (October 1, 1898, to June 30, 1899.)

The average strength on the works was 704 Europeans (chiefly Italian, English and Greek) and 5,515 natives. There were 181 admissions to hospital, which included 53 accident and 33 sunstroke cases. Deaths: accidents

10; sunstroke 10; pneumonia 3; dysentery 2; heart disease 2; toxine 1. There was no enteric fever, and only 15 cases of dysentery.

The second report (July 1, 1899, to June 30, 1900) ·

Average strength—Europeans, 1,142; natives, 4,892. Total, 6,034. Enteric fever, Europeans 9; natives 1. No death from enteric.

Dr. White, medical officer to the barrage works, reports as regards the enteric cases: 'Typhoid all traced back to infection down country, except the native, which was not typical typhoid, and so far no Englishman has had true dysentery. This I take to be due to the care taken over the ice and water supply.'

Thus, during two years with a mean of 923 Europeans and 5,463 natives in one large camp on one site not a single case of enteric originated locally, although nine times was it brought by fresh arrivals from Alexandria to the camp. There was no death from enteric. At the starting of these works I was consulted by Sir John Aird, and asked to prepare a report on the sanitary arrangements, plans, site, etc., suitable for large camps of workmen in Egypt, and therein will be found recommendations, the carrying out of which has attained for these works perhaps the highest level ever reached sanitarily by a very large camp of workmen dependent on its directors for its sanitary arrangements.

Without going into details, I may here state that the diseases that report was planned chiefly to confront were enteric fever and dysentery, and the plans recommended were based upon the water-borne theory of these diseases only. The results speak for themselves. Encamped on the same spot twelve years previously, the army had 276 enteric amongst a force of Europeans only about twice as great, compared with no cases of local origin in the workmen's camp, although the latter was embarrassed by 5,463 natives always in the camp. The

1886 epidemic was attributed to air-borne infection 'and the local insanitary conditions inseparable from all camps,' and defects of drainage, latrines or water-supply were not 'the most important factors' in the spread of the disease. **The 1898-1900 total absence of enteric** is attributed to the scheme of protection being constructed on the water-borne theory.

Tourists in Egypt, 1900-1901.

There were 8,000 English and American visitors spending a great part of the winter in the Nile Valley, throughout which enteric fever is held by the Army Medical Department to be endemic. Even as late as 1898 Surgeon-General Taylor (medically in charge of the last Nile Expedition) has placed it on record that

> 'The specific germs are no doubt swarming in both earth and water. Considering the frequency of dust-storms, when it is impossible to avoid large quantities of soil, the prevalence of the disease is not surprising.'

Now, few soldiers swallow more of the soil and dust than these tourists, who are driven at a great pace on donkeys in large parties even of 50 to 100 people through every town, bazaar and temple in Egypt, yet most soldiers and armies would envy their health and spirits. In the whole of Egypt last winter (the time of the year in which enteric has been, and still is, rife in the British Army), out of those 8,000 visitors only 4 contracted enteric fever, and such results have happened in previous winters. There was not a single case either occurring at or developing in Assouan in an average of 300 visitors constantly at the three hotels during the winter, though two of the hotels are within a stone's-throw of the remaining two army camps (sites 1 and 2 previously mentioned).

It is extremely probable that the specific germs are neither in the soil, water nor dust of Egypt, except at a few points of special pollution and of rare occurrence.

The explanation of the different results obtained, and views thereon, is in the fact that wherever the British or other army has gone it has either taken enteric germs with it (with rare exceptions), or if it has not, it has managed to fix on some of the worst camp sites with no suitable protective methods. Should the disease have appeared, army methods have rarely been timely, adequate or comprehensive enough to command success.

I have selected only those natural experiments where the evidence in favour of air-borne typhoid seemed and was considered strongest, and I conclude :

1. **That the evidence of air-borne typhoid is not clearly established in recorded Indian military experience.**
2. **That in South Africa and Egypt the evidence is opposed to this theory.**
3. **That in India, South Africa and Egypt the immense weight of evidence and probability is in favour of a water-borne origin and spread.**
4. **That the evidence from Egypt proves that if the avenues to man by means of water be protected, all other avenues are powerless to originate and spread epidemics of typhoid in large bodies of men. There is strong evidence to suppose that the same methods would bring about like results in India, South Africa and other countries.**
5. **That the origin and spread of typhoid by means of flies and dust being theory only, can only be discussed as such in relation to certain laboratory experiments, and that in practice it is unjustifiable to hold this theory if it should deter, delay or hinder the adoption in armies of the most vigorous and comprehensive measures against water-borne typhoid.**

EXPERIENCES IN CIVIL LIFE.

Very briefly I must recall some of the facts established in civil life in England which have a bearing on the supposed spread of enteric in armies through the air.

Long before the typhoid bacillus was discovered, or prevention imaginable, Dr. Harley stated in 1865 : 'It is still held in London by those who have had most experience of enteric fever to be destitute altogether of contagious properties, or only possessing them in a very slight degree.'

After a searching criticism of the facts bearing upon Dr. Budd's argument that the poison was in the alvine discharges, Dr. Harley concluded : 'If so it is non-volatile.' And this opinion was supported by Murchison in the London Fever Hospital statistics for twenty-three years (1848-1870), where it is shown that 5,988 enteric cases were treated, and only seventeen residents contracted it, most of whom had no personal communication with this class of patients. Of the seventeen cases, twelve were after 1864, during repairs of drainage. Moreover, it has been repeatedly shown that persons employed on sewage farms do not suffer to any extent from typhoid. Dr. E. Hart, in his exhaustive inquiry into the causation of all the epidemics placed on public record in England from 1858 to 1893, refers to a water-borne origin in an 'extremely large percentage.' He only refers to two cases (Radford and Northallerton) in which the spread or keeping up of the disease 'may be thought of' by poisoning of the air. Further, all experiments in prevention based on this theory in Europe, and at least in Egypt, have proved effective.

LABORATORY WORK.

1. Soil.

Dr. Sidney Martin from 1896 to the present time has been engaged on a most important research, every experiment of which is extremely laborious. His work of 1896 on the growth of the bacillus in sterilized earths does not bear upon our subject.

The continuance of typhoid fever at Chichester, and the failure to trace the same to its usual channels, started the supposition that the bacillus might be continuously present in the soil of the 'fever areas.' Dr. Martin made a series of experiments during 1898-99 to find the bacillus in this soil. In no soil of the fever areas was any bacillus which gave all the culture characteristics, and responded to all the tests of *Bacillus coli communis* found, nor any bacillus like the typhoid bacillus. He also states : 'Attempts were made to recover the typhoid bacillus after it had been added to unsterilized soils. . . . In not a single instance was the typhoid bacillus regained.' The latter experiments were in a rather moist soil, at 37° C.

In 1899-1900 Dr. Martin summarizes his further work as follows :

1. When the typhoid bacillus is added to unsterilized soils, kept very moist and at a high temperature (about 19°-37° C.), it has not been possible to recover it from the soil, even after a short period (twenty-four hours). If, however, the soil be kept in a drier condition and at a low temperature (2°-12° C.), the bacillus can be regained after a certain interval, which in these experiments did not exceed twelve days. After this it appeared to die out.

2. The reason of the disappearance from the unsterilized soils appears to be the antagonism of some of the soil micro-organisms.

3. The typhoid bacillus, as far as is known, has no resting stage. It has no spores, so that if it once dies it cannot be expected to reappear.

Dr. Houston, 1899-1900, in his experiments on the soil of Chichester 'fever areas,' failed, as Dr. Sidney Martin had also done, to find either *Bacillus coli communis* or *Bacillus typhosus*. He states that '*Bacillus coli* is always associated with the typhoid bacillus, but the latter is less hardy, and as *Bacillus coli* is absent, this ought to be also.' Again, 'If the conditions were so unfavourable as to render all the soils in general unsuitable for the existence of *Bacillus coli*, it is unlikely that *Bacillus typhosus* could have maintained its vitality in any of them.' Again, he adds: 'In my judgment the reason why spores are present in such abundance in surface soil is because the conditions are frequently unfavourable, that only those bacteria which can form spores can maintain their existence for any length of time.'

2. Air.

Flügge and Fischer dried the bacillus in thin films, and recovered it after five to fifteen days.

The typhoid bacillus has not been recovered in transit through the air in dust, etc., although several observers have experimented specially on this point, the destructive effect of light and total drying being the probable cause of its absence. Dr. Brownlee, after experimenting in this manner and failing to recover the bacillus, concludes: 'The extent to which aerial infection takes place can only be decided by an appeal to natural processes, and not in the laboratory.'

Flies can transport the bacilli.

3. Water.

The difficulties in the search for the typhoid bacillus in water are very great.

Widal* has shown the causes of this difficulty. In the first series it still exists, but it is impossible to isolate it from the numbers of other germs with which it is struggling for existence.

In the second series the bacteriologist has arrived too late, the bacillus which was present at the beginning of the epidemic having disappeared for some weeks.

As regards the second series, Löffler was of opinion that the bacillus did not live more than fifteen days in natural water, and in a very pure water much less time. If the bacillus appeared for a long time it indicated continued pollution.

Thus all research goes to prove:

1. **That in soils in which it might be expected to be present it is never found;**
2. **That it is extremely difficult for the typhoid bacillus to live in soil, and that if much moisture exists, and a temperature above 66°, it will only live some hours;**

* At the Tenth International Congress of Hygiene.

3. **That the action of light and total drying on the superficial layers of infected dust are so specially deadly to the typhoid bacillus as to account for the fact that, though it may be partly dried in the laboratory, it has not been driven through the air and recovered;**
4. **That its recovery from water is difficult, and failure to recover it does not show either that it was not there at the time of examination, or at any time previous.**

It is interesting to find that the conclusions arrived at in the study of the natural experiments or epidemics coincides closely with the facts which laboratory research has established.

Whilst not taking any extreme view, we are justified in stating (1) **that air, by means of flies or dust, is an extremely weak medium of conveyance of enteric in armies, both on active service and at stations;** (2) **that if the army is free from enteric, it will in all probability remain so until it receives the bacillus by a water avenue;** (3) **that if enteric is prevalent, existing arrangements on service leave the water avenues infinitely more accessible to the bacillus than the extremely difficult air avenues;** (4) **that if enteric be allowed to become very prevalent, as at Bloemfontein, then it is still probable that the water avenues are the most important, though the air avenues increase in importance.**

This latter state of affairs is of no practical importance to the army sanitarian, because it is evident that such a condition can only arrive in an army unprepared to meet water-borne enteric, and with no proper sanitation, and in such an army the sanitarian can have no further influence.

Finally, **what is the bearing of these considerations on practical military hygiene?** Dr. Tooth at the Clinical Society came to the conclusion that in his opinion air

avenues were more important than water avenues in the present war, and that the conditions of life in an army on active service might well fill the soul of the sanitarian with despair. Taking an altogether different view of the facts, and seeing the practical application and results of this view in the modern non-military camps at Assouan, where once the despondency was deep enough, I am of opinion that the problem may be faced with certainty of success when the army, as a whole, shall consider it important.

Enteric will have to be met and overcome in no matter what part of the world—on the water-borne theory mainly, though every other avenue must also be guarded. As I have shown elsewhere, this will only be successfully done by means of a Royal Water Corps, this being a special section of the Royal Army Medical Corps, but linked to each regiment, and receiving the loyal support of the whole army. This corps would have practically independent transport in war. The functions of this corps would be to prevent enteric fever, dysentery, cholera, and diarrhœa by whatever means may be best suited to the time. The responsibility for the occurrence of these diseases would rest with this corps. This corps would have to provide boiled or approved water on all active service, field service, route marches, and manœuvres in both the army and volunteer forces, and at all foreign stations in peace, and no other water must be allowed. Its other duties I have detailed elsewhere. On every occasion when their recommendations were not carried out a public record would be kept of the same, with the General's reasons for not doing so. At the present time there is a process of decentralization going on, a process of subdivision of responsibility and power of initiative. One of the first cases in which this is necessary is in the Royal Army Medical Corps, and especially in a Royal Water Corps. All officers must be examined in military hygiene, espe-

cially as regards the power, origin, and spread of these four water-borne diseases, and be responsible for the ordinary sanitation of their own regiments, subject to repeated and critical inspection by the Royal Water Corps.

The sites for camps must be decided in consultation with the Principal Medical Officer of the Royal Army Medical Corps and Royal Water Corps. It is almost criminal the way in which the choice of camps hitherto has been left to officers quite ignorant of the dangers they are placing their men in. I will only refer to a single instance—that of Assouan in five different years.

Sanitation must mobilize first in war, field service, route marches, or arrival at stations.

The men must be taught the awful destruction that has happened from the *laissez boire* theory, and that in drinking only approved water they are not only avoiding disease themselves, but chiefly they are saving their comrades from destruction. It must be regarded as a crime to drink unapproved water, and cowardly to get enteric or other water-borne disease. If an officer boils every drop of water he takes (and hundreds have done so of late), why should we deny this right to the men in the ranks?

Pure water—the one important thing in war—is practically no man's business in the army; water polluted with enteric, dysentery, and diarrhœa organisms is still drunk every day in South Africa. A Royal Water Corps would make it impossible to find the bacillus in the regular drinking water or soda-water, as it would mean disgrace to the corps. Now the bacillus is found in the milk, in the drinking water, in the aerated water, in the butter, in the salads, etc., at stations in India, South Africa, and elsewhere, but no one is blamed, because no one is responsible. If a Royal Water Corps existed, is it likely that the bazaars, so far as they represent drinking

places, would continue to pour these four diseases into our men at foreign stations in the Empire? Would a Royal Water Corps allow men with diarrhœa from any cause, or with a temperature from no assigned cause, either on active service or at stations, to remain a moment marching and mixing with the healthy men? If there was a Royal Water Corps, would several months pass in an epidemic at stations abroad before the bacteriological examination of the water-supplies or inquiry into the causes of the epidemic took place? I am not attributing blame in any way to the Royal Army Medical Corps, for the best of them have too often found themselves hampered by a thousand foolish restrictions, limited to recommending reforms, and with no power to carry these out on the spot. Nevertheless, out of this chaos of persistent bacilli and reckless men the light will finally dawn, and the line be fixed by the men against their true enemies in war.

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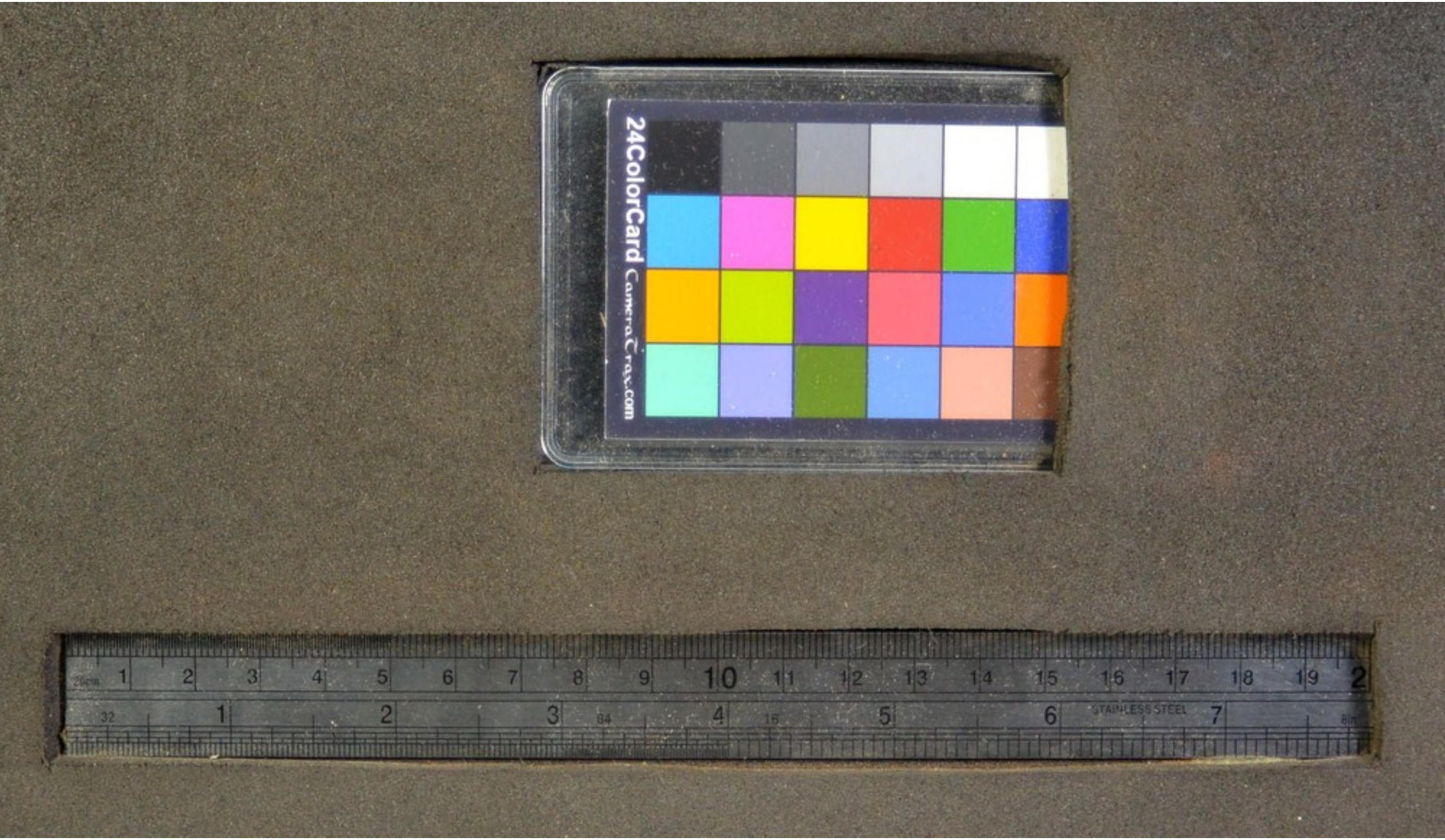
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