CHAPTER XIX

PREVENTIVE MEDICINE IN THE WAR—(III) THE PREVENTION OF DISEASE[1]

The field for prevention

Of the total non-battle casualties admitted to *field ambulance* from the A.I.F. in France, 57·19 per cent. were for diseases caused immediately by parasitic infection or infestation (shown in *Chapter XVII* under Type III[2]). Of this total, five classes of aetiologically-related diseases contributed some 50 per cent., and formed the chief objective in the campaign for the "prevention of disease" in the field.

Of this last total, *gastro-intestinal (faecal) infections* were responsible for 0·74 per cent., and constituted the chief *raison d'être* for the measures comprised in "*field sanitation.*" Infection by mucus from the *respiratory tract or fauces* caused 19·49 per cent. Of these, specific air-borne respiratory infections, such as the exanthemata, were opposed chiefly by administrative measures, *notification and segregation*; the various non-specific infections, such as bronchitis, bacillary "influenza," coryza, tonsillitis, naso-pharyngeal catarrh, and laryngitis, were fought by measures calculated to prevent infection by promoting "easy resistance"—for example, by housing and ventilation, warmth and clothing, food and rest. *Contagious diseases of the skin, superficial coccal infections*, and *general diseases transmitted through a verminous host*[3] constituted approximately 17 per cent., and these three classes were mainly responsible for the vast army organisation built up to serve *"personal and social hygiene."* This leaves pyrexia of uncertain origin, "P U.O." (11·61 per cent.), which on the Western

[1] The reader is commended particularly to *relevant chapters and pp 413-15 of Vol I.*

[2] *See pp 501-3*

[3] Malaria, hydatid, and infective jaundice are excluded

Front comprised mainly undiagnosed trench fever and the sickness loosely classified at the time as "influenza."

The military scheme of preventive medicine in France and Belgium was closely modelled on the methods of civil life. It differed mainly in these two respects, that official control was extended to cover almost the whole gamut of social life in the "populations" concerned—the personnel comprising the military units—and that this military population was "regimented" to a degree impossible in democratic communities; the most significant result being that both the "rights" and also the responsibilities of the individual were far more restricted.

The social milieu

As in civil life, three distinct lines of action were exploited, and special personnel, procedure, and methods were developed to implement each of them. These lines of action were:

A triple campaign

(1) *Artificial immunisation*, the purpose of which was to increase individual resistance to certain specific infective agents.

(2) *Indirect* (*administrative*) *measures* to control the *human vectors* of infection. These measures comprised "notification" of cases of certain selected diseases, the immediate removal of such cases to field ambulance, and, if necessary after verification of the diagnosis by laboratory, their isolation in special medical units, and the segregation of contacts; also the search for "carriers." These measures were carried out through (*a*) international quarantine for troops moving by sea; (*b*) measures (of segregation and so forth) within the respective national armies.

(3) *Direct action*, attack or defence, was taken against the parasitic causes of disease, and this might be *immediate* (as by the destruction of the *acaris scabiei* in the skin) or *mediate*, through their vectors, whether these were animate (*e.g* lice or flies) or inanimate (food and water, blankets, clothing, dirt, air); as by "disinfection" or "spacing out."

Organised almost *de novo*, as was the machinery of health,[4] it worked at first stiffly even in the B.E.F., as is shown by the

[4] *See Vol. I, pp 10, 229.*

Australian records of early 1916. At that time it required frequent adjustments and close oversight. But by the end of 1917 habitude had for the most part made its procedures a familiar, almost automatic, element in the social life of attrition warfare. In the open warfare of 1918, however, it was to receive a disconcerting jolt.

1. Artificial Immunisation

In the present state of our knowledge, rational measures for the *prevention of disease* have much less concern with the processes of natural resistance—the *vis medicatrix naturae*—than have those which subserve treatment.[5] But in two diseases of first-rate military potentialities rational procedure to promote resistance obtained results of decisive significance. That the "Jennerian vaccination" against smallpox carried out in all the great national armies prevented outbreaks of this terrible disease and was thus a decisive factor in the health history of the war, is proved by the history of smallpox in the Australian force at Mena.[6] The results of Almroth Wright's "anti-typhoid inoculation" are of no less interest. The experience in Gallipoli has already been fully dealt with, but that in France must be shortly referred to.

Against the Enteric Group

The Enteric Group (officially typhoid, paratyphoid "A" and "B," and "enteric group"). The following facts are pertinent to any inquiry into the part played by inoculation in the remarkable freedom of the A.I.F. in France from the diseases caused by this group.

In principle every member of the A.I.F. was "compulsorily" inoculated with "T.A.B." in the prescribed form.[7] The extent

[5] We may recall in this connection that "natural" (*physiological*) resistance, individual and racial, to parasitic invasion is only developed by close contact with the several organisms concerned. Both the *instinctive* and *rational reactions* against infection, on the other hand, tend for the most part to avoid contact with it—an infected person or animal is shunned, even outlawed Thus—as has been stressed by Sir Almroth Wright—the creation of a national or racial resistance is delayed. Thence came the fact that in the French and the Australian armies *mumps*, in the British *roseola*, and in the American and Canadian *measles* in congested camps ran riot through the respective military communities. In the matter of cure, on the other hand, the line of demarcation between the *vis medicatrix naturae* on the one hand, and "instinctive" and "rational" lines of action on the other, is much less clearly defined

[6] *See Vol. I, Chapter v.*

[7] *See p. 478, and Vol I, p. 482*

to which re-inoculation was carried out cannot be determined with exactness but was certainly high. Advantage was, for example, taken of the long rest, June-August, 1917, to give effect to Army Council Instructions, issued on 5th July, 1916, and 31st March, 1917, which enjoined a more efficient inoculation and re-inoculation of all troops. The procedure laid down in these instructions was embodied in I Anzac Corps Routine Order No. 1415, dated 14th April, 1917, as follows:—

"All ranks who have not yet been satisfactorily inoculated or re-inoculated against Typhoid and Paratyphoid fever within a year are to be inoculated as soon as possible, the following instructions being observed:

(*a*) Men who have been inoculated with two doses of mixed vaccine within a year need not be re-inoculated.

(*b*) Men whose last inoculation was performed with mixed vaccine more than a year ago should be re-inoculated.

(*c*) Men whose last inoculation was performed with a single dose of mixed vaccine more than six months ago should be re-inoculated.

"Men who are being inoculated for the first time will receive an initial dose of ½ c.c. and after an interval of 8-10 days a second dose of 1 c.c. of the mixed Typhoid and Paratyphoid Vaccine. In cases of re-inoculation a single dose of 1 c.c. will be given.

"In addition to entry on page 17 of Pay Books, nominal rolls will be prepared and kept up to date by all Units, showing the date of inoculation and re-inoculation of all members of the Unit.

"Regimental Medical Officers will indent at once on nearest Field Ambulance for amount of vaccine required"

The policy was based on

"the assumption that one dose protected fully for six months and partially for twelve months, and that two doses protected fully for one year and partially for two years." (Sir William Leishman, Interallied Sanitary Conference, 1917.)

In the British Army, in which inoculation was voluntary, from 1915 the proportion of men inoculated against enterica "fluctuated between 90 and 98 per cent."[8] The proportion of the A.I.F. on the Western Front inoculated with T.A.B. was computed by the War Office at "98·4 per cent. for 1917, and 95 per cent. for 1918," but almost certainly was never below 99 per cent.[9]

[8] *Brit Off Med History, Pathology, p 249* Other references are taken from the Official History of the *Medical Department of the U S. Army in the World War, Vol. IX* and the *German Off Med History, Vol III*

[9] *See Vol I, p 40.*

In the French Army anti-typhoid inoculation was tackled seriously only from the end of 1915. At the outbreak of war—through "military exigency"—it was optional, was not pressed, and at first one dose only was given. Two types of vaccine were employed, given in two doses.

In the German Army anti-typhoid inoculation was completed by January, 1915 (3 injections)[10]—"T.A.B." was not generally used till 1918.

In the American Army inoculation was compulsory and from July, 1917, a triple T.A.B. vaccine was used, three injections being given.

Statistics of Enterica. The experiences of the Australian force in France and Belgium in relation to the enteric group of fevers is shown in the following table:—

Table showing incidence of the Enteric Group of Fevers in the Australian Imperial Force, Western Front, 1916-1918.[11]

Nature of case	1916	1917	1918	Total	Deaths
Typhoid (inoc.)	26	18	6	50	4
Typhoid (not inoc.)	–	–	2	2	–
Paratyph. A (inoc. T.A.B.)	25	17	2	44	–
Paratyph. A (not inoc. T.A.B.)	7	1	–	8	–
Paratyph. B (inoc. T.A.B.)	21	21	2	44	2
Paratyph. B (not inoc. T.A.B.)	5	2	1	8	1
Enteric group (inoc.)	25	25	3	53	–
Enteric group (not inoc.)	2	–	–	2	1
TOTAL	111	84	16	211	8

Year	Average daily strength	Incidence of Enterica (from notifications)	Rate per 1,000	Total deaths	Case mortality
1916	86,163	111	1·29	2	1·80 per cent.
1917	118,454	84	0·71	5	5·95 per cent.
1918	110,031	16	0·14	1	6·25 per cent.

Estimating the proportion of inoculated to uninoculated at 99 to 1 it is clear—for what it is worth in so small a group—that there is an advantage of nearly 10 to 1 in favour of the former.

The incidence of enterica in the British troops of the B.E.F.

[10] The period of protection was reckoned (after experiments) at about 6 months, and orders for re-inoculation were issued at the end of June, 1915—doses 0·5 and 1 c.c. The third and later inoculations were to be 1 c.c. (The number of organisms in each c.c. is not available.)

[11] The figures embodied in this table were most kindly made available to the Australian War Records Section in 1919 by the War Office. They were based on "notifications" by the D's M.S. of Armies etc. to the D.G.M.S. B.E.F. The 3rd Echelon (A.I.F.) figures show 6 deaths only. It is impossible to ascertain the degree of accuracy of these figures, but there is no reason to believe that they are inexact to any material extent.

is shown in the following table (per thousand of ration strength) :—

Year	Typhoid	"A"	"B."	"Enteric group"	Total death rate	Case mortality
1914 ..	—	—	—	—	—	12·1 per cent.
1915 ..	1·3	0·47	1·7	0·3	0·22	5·5 per cent.
1916 ..	0·57	0·45	0·7	0·27	0·02	1·12 per cent.
1917 ..	0·12	0·08	0·24	0·15	0·012	2·8 per cent.
1918 ..	0·03	0·015	0·06	0·015	0·007	5·9 per cent.

Total—20,149 cases with 1,191 deaths; all theatres; total case mortality 5·9 per cent.

In the French Army 45,200 cases occurred in 1914, 67,000 in 1915, 12,400 in 1916, 1,700 in 1917, 750 in 1918 (British Army *Manual of Hygiene and Sanitation, 1934*). The rate per 1,000 dropped from 39·37 in the first year to 7·18 in the second year and the case mortality from 12·08 to 2·5 per cent. (Interallied Sanitary Conference 1917.)

In the German Army 116,481 cases were treated in hospitals of whom 87·2 per cent. returned to duty, 10·1 per cent. died, 2 per cent. were discharged unfit. It would seem that paratyphoid was not included in the above. (*German Official History Vol. III, p. 99.* Figures are as given in the German text.)

The American Army (*Official History Vol. IX p. 17*) had a rate per 1,000 per annum of 0·37, with a case mortality of 14·85 per cent. This contrasted with—Civil War 29·86 per 1,000 and 36·92 per cent.: Spanish-American War 141·59 per 1,000 and 10·47 per cent.

Appreciation of Results There is no valid reason for doubting the correctness of the unanimous conclusion based on the war experience of the medical profession in the nations engaged, namely that the observed rise in the titre of blood antigen (agglutinin) brought about by the injection of heat-killed organisms of this group will very often tip the balance against clinical infection in men exposed to risk; and that in the war this played an important and even decisive part in the very greatly diminished incidence of the disease.[12]

It seems desirable however to emphasise the need for clinical and scientific balance by recalling (1) the well known fact that *infection* depends on a number of factors, which may act independently of each other in producing "disease"[13]—mass infection, virulence, depression of individual, or immunity-state; (2) the fact that on the Western Front dysentery was also greatly reduced through general sanitation, and (3) the further fact that in the civil communities Typhoid had greatly decreased.

Attitude of Australians to Compulsion. There was little opposition to the procedure on the part of the Australian troops, many of whom had personal experience of similar prophylactic procedures in animals—against pleuro, black-leg, and tick fever. Opposive propaganda in the civil community was most often due to the exploitation of half-baked

[12] The officer commanding No. 2 Australian Sanitary Section records that in his experience Typhoid was prevalent among the French civilian population both on the Somme and in Flanders, though it was often undiagnosed and the prevalence not officially recognised by the French authorities.

[13] As pointed out in this connection in *Vol I, p. 525* "No greater danger besets the medical profession than that of premature wresting of evidence to suit current theory"

theories by individuals who were themselves in the happy position of having no responsibility for the welfare of the force or the winning of the war. In others it was undoubtedly based on sincere conviction and actuated by strong desire to put right what was looked on as an error. Opponents of the latter kind would welcome without mortification the resolution of doubts happily afforded by the results obtained during the war.

Against pneumonia

Experiments were made in the French Army in the use of anti-pneumococcus vaccine in the "native" troops (African and Indo-Chinese), using a "mono-vaccine" (single type) prepared by the Pasteur Institute from a strain which agglutinated 93 per cent. of cases of pneumonia occurring in Paris. The morbidity among the inoculated troops was found to be "sensibly diminished." After a year in France the native troops acquired a partial immunity.[14]

Pneumonia and Measles. Vaccines were used in the terrible outbreaks of pneumonia which marked the epidemics of measles in the American camps of training—due to both pneumococcal and streptococcal invasion. A brief account of this and some allied matters—as influenza—will be given in *Volume III.*[15]

II. Indirect Action—The Human Vector

The history of mankind has been greatly influenced, and at times dominated, by some half-a-dozen of the uni-cellular organisms which have evolved a parasitic existence upon his social habits.[16] These were the subjects of a greater organisation even than Army Procedure—namely the system of international quarantine, an institution too fundamental to be shaken even by the Great War.

Quarantine

The most important are typhus, relapsing fever, cholera, smallpox, yellow fever, plague, and influenza. With typhoid, malaria, and dysentery these diseases have dominated warfare in the past and it was against these chiefly that the system of International Quaran-

[14] Report of the Interallied Sanitary Conference, 1918

[15] Inoculation against tetanus and gas gangrene is discussed as part of treatment of the wounded man *See pp. 308-10*

[16] The part played by epidemic diseases—in particular of the Rickettsia group—in wars of the past and in human history, and also the origin of disease in relation to parasitic life are discussed with great interest, if with some romantic licence, in Zinsser's *Rats, Lice and History*

tine operated. It was dove-tailed in the war into an inter-allied scheme of quarantine[17] functioning chiefly at the ports of Marseilles and Taranto in connection with native troops from Africa and Indo-China and with the movement of troops from endemic centres in the East along the Allied sea Lines of Communication.

The "sieve" at Marseilles

The negative history (as we may term it) of disease in the Great War is more significant than the positive, and the absence of certain diseases more impressive than the prevalence of others. It follows that the hitherto unrecorded medical events associated with a comparatively minor happening —the transfer of the A.I.F. at the beginning of 1916 from the Orient to the Occident—hold features of quite first-rate interest and significance. They do so on two counts: first, as an example in miniature of the vast problem of preventing epidemics of the major diseases of war on the Western Front which—as we have seen—has aroused the interest of military strategists; second and more particularly, as concerns Australian history, as in themselves of definite, possibly of great importance as an episode in the medical campaign—the holding of a breach against a potentially serious menace from exotic disease. This interpretation of the episode rests on the following considerations:—

1. During the course of the war great epidemics occurred in the military and civil populations where and whenever preventive measures were inadequate or conditions specially unfavourable: smallpox in Russia and Turkey, typhus in Serbia and Russia,[18] malaria in the Palestine campaign, dysentery and enteric at Gallipoli and in Mesopotamia, epidemic jaundice at the Dardanelles, measles, mumps and roseola in concentration camps, and wound infections universally.

2. Until the influenza pandemic of 1918-19, among some 15 million men who served on both sides on the Franco-Belgian front under conditions inviting outbreaks of the pestilences characteristic of warfare, only one outbreak achieved general epidemic proportions, namely trench fever—epidemiologically identical with typhus.

3. Cases of all these diseases were brought from the East with the

[17] *See Vol I p. 49* The International Headquarters of this organisation was in the Commission Sanitaire d'Hygiène Publique which served as the Headquarters of the "Interallied Sanitary Commission" and as the venue of the annual "Inter-allied Sanitary Conferences" in the deliberations of which the problems of quarantine entered largely. In this connection *see also Vol. III.*

[18] *See p. 545.*

Australian and British troops, but failed to gain a hold. The reason why they did not do so reflects the campaign against the major diseases in the war.

Events at Marseilles.[19] During the months of April, May and June, 1916 the greater part of the Australian troops were brought to France from Egypt, where most had lived for some months. Many had served on Gallipoli. They had been subject to risk of infection from various diseases not met with in Western Europe, or else occurring here in a modified form, and cases of the following diseases had actually occurred, some as epidemics—smallpox, typhus fever, relapsing fever, typhoid, trachoma and infective ophthalmia, ankylostoma, malaria, dysentery (Shiga, Flexner and amoebic), infective jaundice, Egyptian chancroid. To prevent the introduction of these into France the following steps were taken.

(1) In Egypt,[20] close sanitary supervision during a period of 3-4 months. (2) Before embarkation (*a*) a vigorous campaign (chiefly carried out with Colonel Hunter's railway van steam disinfester) to free the force from lice; (*b*) a complete medical inspection; (*c*) inoculation with T.A.B.; (*d*) re-vaccination against smallpox. (3) By order of the D.D.M.S. Marseilles on April 4th, on the arrival at Marseilles of the first Australian brigades from Egypt, No. 2 A.G.H. was established at Moussot and well equipped for the isolation of infectious disease. (4) Inspection of troops before disembarkation by the medical officer in charge of transports.

Report by Major H.O. Lethbridge, A.A.M.C. "I had charge of the Isolation compound in No. 2 A.G.H. at Moussot, Marseilles, when the Australian and many British troops were passing through from Egypt to Northern France. Almost every transport would send us its quota of infectious diseases so that the importance of this hospital as a filter was great. Where the gravity of the infection warranted, the whole unit or formation was segregated and held up till deemed safe for it to travel north. The fact that most transports took a week (between Egypt and Marseilles) meant that most infections brought from Egypt would have shown up. At one time we had as many as 13 different diseases in the compound, including smallpox, typhus, measles and roseola, mumps, diphtheria, relapsing fever, scarlet fever, scabies, pemphigus contagiosus, cerebro-spinal meningitis, dhobie itch, and chicken pox.

Typhus detected

"Three cases of typhus were detected," continues Major Lethbridge, "all in troops from Sollum. A case of smallpox, admitted on the first day of his illness, was diagnosed by a typical prodromal rash."

Quite dramatic interest surrounds the inner history of the detection

[19] Epitomised from a report by the Medical Officer (Lieut.-Col. A.G. Butler, A.A.M.C.) representing Australia at the "Interallied Sanitary Conference" in Paris, May, 1917.

[20] *See Vol. I. p 487.*

at No 2 A.G.H. of these cases of typhus fever, which were all in British troops. The staff of this hospital had some previous acquaintance with the disease, since at Mena Camp, in 1915, several cases of typhus were identified by the officer commanding No. 2 A.G.H. (Colonel T. M. Martin) and demonstrated to his officers. At Marseilles, in 1916, the first of the cases was sent to the hospital with a diagnosis of cerebro-spinal fever. There, however, it was identified with the cases that had been seen at Mena, and though "the differential diagnosis was a little difficult, the suspicion was strong enough in our opinion to justify our immediate report that the case was one of typhus." The fat was in the fire! The D.D.M.S. for Marseilles base disputed the diagnosis. The hospital refused to budge: its diagnosis was typhus. The movement of a whole Brigade of troops was involved. G.H.Q., B.E.F. was urgently informed: the Adviser in Pathology (Colonel Sir W. B. Leishman) came post haste. The experts upheld the hospital The Brigade from which they came was found very lousy, and two other cases occurred. The troops were segregated and deloused. "It is possible" (says Major Lethbridge) "that a grave epidemic of typhus was thus prevented." Whether this be so or not must remain conjecture. But it seems probable that against typhus fever the indirect line of defence is as important as the direct attack through "personal hygiene," which was to prove comparatively ineffective against the louse-borne disease "trench fever."

Comment. Why typhus did not become established among the troops in France has been the subject of much debate—*see e.g.* Zinsser, *Rats, Lice, and History*. Both lice and rats, the respective vectors in the human and murine strains of typhus, were plentiful enough to have supported an epidemic prevalence—as witness trench fever and the outbreaks of Weil's Disease. The following seems pertinent to the question "Can we say why epidemics appear and disappear? . . . It is of primary importance that this issue should be closely studied. If the decisive factor in an epidemic be the resistance of the population attacked, then measures must be devised to enhance that resistance. If, on the other hand, the inherent vigour of the virus be the only factor, then all agencies that affect the virus must be ascertained and enlisted for the campaign against the disease."[21]

It would seem that the answer is here to be found in the domain of mathematics rather than of biology. With a constant relative virulence in the infecting organism, until automatically checked by dilution of the population "exposed to risk" with "resistant" persons, the momentum of an epidemic augments in geometrical progression at a rate depending on the facilities for contagion.[22] The prime purpose in the mode of preventive medicine identified as "quarantine" is to achieve—so to speak—epidemic asepsis; to check the initial momentum of prospective outbreaks at their inception by reducing to zero the number of susceptable individuals exposed to risk by contact with an infective host. It would seem that the prompt and vigorous action taken here and

[21] Dr. J. H. L. Cumpston, now Commonwealth Director-General of Health, in his Presidential Address on "The new Preventive Medicine" to the Section of Public Health and State Medicine, Australasian Medical Congress 1920. *M.J.A. 4 Sept., 1920* The address admirably summed up the "lessons of the war" on "Public Health" methods.

[22] The fact that the rate of decline of an epidemic is also approximately in a geometrical progression, so that the curve is symmetrical, is due to causes of a "vital" nature. See Brownlee "Causes of epidemics and the laws which regulate their course"—*Proceedings of the International Congress of Medicine, London, 1913. Section XVIII, p. 153.*

elsewhere achieved this purpose. Typhus, the greatest epidemic disease known, lends itself more than any to methods of social control. Lice, highly organised multi-cellular creatures, are much less ubiquitous and pervading than the labile microbial or virus forms of life; and unlike the mosquito or the sandfly have but little mobility of their own. The experience of the Scottish Women's Hospital in Serbia in 1914-15 (*See Vol. I, p. 246*) proved that, now its life-history is known, even in war epidemic typhus is fairly readily checked if dealt with energetically by the methods of quarantine, and the disinfestation and "spacing out" of the louse-infected community.[23]

Only four cases in all are reported in the *British Official History* as having occurred in the B.E.F. in France The experience of the German Army on the Western Front was the same as the British, but on the Eastern Front, where typhus was endemic, the Germans had many cases.

It would be difficult to propose a matter more worthy the attention of students of social evolution than this one of typhus. Its place in the history of past wars has been referred to In the Great War and its aftermath the disease showed what it could do if social standards were relaxed. The epidemic in Serbia, 1914-15, was well up to reputation Starting in November 1914, in February and March 1915—we quote from Zinsser—"the epidemic flowed with a speed and violence never equalled in any typhus outbreak of which we have reliable record." Over 150,000 people are stated to have died from the disease, a mortality of from 20 to 60 per cent. In Russia 154,000 cases were recorded during 1916; after 1917 the toll was enormous. In his well known articles[24] Dr. W. Horsley Gantt of the Johns Hopkins University paints an astounding picture of the effects of war and of famine. Under their combined influence, between 1917-21 there occurred epidemics "of a magnitude unrivalled in modern history. . . . It is impossible (he continues) to keep accurate figures, but conservative estimates by Russians put the morbidity from typhus alone at 20-30 millions with a mortality of 3 millions (Professor L. A. Tarassewitch). About a third as many suffered from recurrent fever"—also louse-borne. The conditions in Serbia and in Russia (it may be conceded) were "exceptional." But it is not irrelevant even to an Australian history to note that so late as 1914 a severe outbreak of typhus fever occurred in Ireland.

Leakage of Cases Despite Quarantine. Leakage of cases through the quarantine sieve were few, at least in the experience of the A.I F. Two men who deserted from an Australian unit at Marseilles and pretended to be British were detected as Australians from Egypt two months later through the diagnosis of *relapsing fever* in a British General Hospital. Three other cases of relapsing fever occurred in the troops near Armentières. The battalions were deloused; no secondary cases were discovered. Two cases of mild *smallpox* in vaccinated Australian troops occurred after they had reached Second Army. The unit concerned was revaccinated; no secondary cases occurred. *Dysentery.* British and

[23] From a note by Dr. Elsie Dalyell, an Australian medical graduate who served with this unit and had experience also with the disease in Constantinople after the war.

[24] *British Medical Journal*, June 14, Aug 23, Sept. 20, 1924; Feb 5, Feb. 19, June 11, Oct 22, 1927, July 22, 1936 See also Dr. Haden Guest, *Lancet*, 21 Nov., 1931, and Zinsser, *loc. cit.*

French authorities at the Interallied Conferences were in agreement that "carriers" among the troops from the East and coolie workmen from Indo-China were responsible for the wide-spread infection of the troops on the Western Front with both bacillary and amoebic dysentery.[25]

Notification in the Control of Preventable Diseases. Notification followed by appropriate action was exploited even more extensively in the British Army than in civil life; the object was both to direct local action (as in mumps, scabies, C.S.F., or trench foot) and also to determine general policy (as in tetanus, typhoid, and dysentery). But save for a few special diseases a precise or standard line of procedure was not laid down for the whole of the B.E.F.; in each sphere of administration—of G.H.Q., Army, L. of C., and Base—local policy was in a large measure determined by the needs of the moment, and the purpose was achieved by improvised methods. The exploitation of the method was thus far from exact; but from the point of view of medical tactics the flexibility and initiative bestowed by devolution may well have been an important factor in the considerable measure of success ultimately achieved.

Procedure in British Army

This method of report or "notification" of disease was used for a variety of purposes and in several ways. It was employed

Four methods

(*i*) as in civil Public Health practice, to initiate prompt action for preventing the spread of certain highly infectious or especially dangerous transmissible diseases, in particular those of the respiratory class. Notification was made on *Army Form W. 3110.*

(*ii*) To furnish a statistical barometer of the *general health situation* in units and formations. For this purpose various regular returns were rendered, daily or weekly. The most important of these was *Army Form W. 3185,* a daily return of sick evacuated from field ambulances and C.C.S's. Field ambulances sent it to the A D's.M.S.; these officers condensed the field ambulance returns into a statement for "Corps"; and Corps similarly compiled the returns for "Army." Casualty clearing stations rendered the returns direct to the D.M S.

(*iii*) To ascertain the prevalence of particular diseases—such as trench foot, scabies, diarrhoea, C.S.F., V.D.—in order to direct administrative action, or to indicate the need for an extension of special accommodation; and also as a basis for disciplinary action.

(*iv*) Certain returns based on those rendered under (*i*) were sent

[25] A sharp outbreak of bacillary dysentery occurred in New Zealand troops soon after their arrival on the Armentières sector in May, 1916.

on by Army to G.H.Q. where they were used for purposes of policy and statistics.

The three last may be dismissed briefly.

As to (*ii*) : *A.F.W. 3185* showed by units—officers by name, others by numbers only—the sick and wounded admitted, evacuated, discharged, died, and remaining during the previous 24 hours. This return was the means whereby the *weekly sick rate* in all units was determined and published each week by Army Headquarters (D.M.S.). During the war the figure 0·3 per cent. per day—2·1 per cent. per week—was used empirically as a rough steel-yard for assessing the health and "sanitary discipline" of units and formations. Evacuations in excess of this figure were held to indicate an approach to the danger line, and to call for special enquiry.[26] The return was thus an important disciplinary implement and it was perhaps the most effective means for stimulating the sanitary conscience of units and formations.

As to (*iii*) : "Special" returns were required from time to time by D.M.S. of Armies of such conditions as scabies, trench foot, V.D., diarrhoea, mumps, C.S.F. *Army Form W. 3185* was often used as a means for obtaining this information.[27]

In the wider field of the general medical policy and health administration of the B.E.F., the Director-General at G.H.Q. kept himself informed—somewhat precariously it would seem—through his special technical officers, of the prevalence of the most important endemic or sporadic infections—such as tetanus, C.S.F, dysentery, enteric—by "consolidation" of army returns and notifications.[28] Here however the subject merges with that of the permanent records of the war, personal and statistical.

(*iv*) The enormous number of casualties in the B.E.F.—in the case of non-battle casualties some 3,500,000—made complete statistical analysis impossible; consequently these administrative records kept in the field achieved considerable importance for statistical purposes. Certain diseases —in particular enteric, tetanus, C.S.F., and the major quarantinable diseases—were recorded and, so far as the exigencies of warfare permitted, tabulated by the technical staff of the Director-General B.E.F.

It remains to examine in some detail the first of these procedures namely that of specific notification of "cases" of disease followed by segregation of presumed infective individuals.

The first of these four methods, immediate notification of

[26] *See Graph No 8 at p 493.* Before the war this figure was employed differently. *Field Service Regulations, 1914 (p 123)* laid down that "during periods of marching or halting without serious fighting, a steady inflow to the field ambulances of about 0·3 per cent. occurs daily, and . . . consequently a similar outflow from the field ambulances to the clearing hospitals, and thence to the stationary hospitals must be anticipated."

[27] Thus at the end of 1916 the D.M S. of Fourth Army required that this return should include a statement of the number of cases of scabies, venereal disease, and trench foot, and of "the three most prevalent diseases."

[28] For the first two years of the war the records of tetanus and of typhoid were confused by reason of lack of co-ordination between the B E F. and the army medical system in Britain. The importance of ensuring co-ordination between the Expeditionary Force and its base is illustrated almost as forcibly by the experience of the B.E F. as by that of the M.E.F.

specified diseases, was the only effective means available for checking the spread of those infectious diseases in which direct action against the agent was impossible. As such the procedure calls for particular note, and the more so because the methods adopted in the B E.F. are open to constructive criticism. In the Australian force it was the means for a most effective internal campaign against epidemic camp diseases, a campaign in which infections brought in the troop transports from Australia—in particular, *mumps* and *measles* —were eradicated from the training battalions in Britain and drafts for France. We shall examine the working and machinery of this very important branch of military preventive medicine, first as it developed in the B.E.F., and subsequently in its quite dramatically successful exploitation in the A.I.F reinforcement camps in England.

The notifiable diseases

Army Form W. 3110. "Notification of infectious diseases," corresponded to the form of notification in civil practice. It was

(1) the implement whereby the machinery for the control of infectious disease by administrative measures was set in motion. (2) The instrument through which the "higher" medical administration kept its finger on the pulse of fluctuations in the transmissible diseases that held a menace for the armies in the field. (3) The source of special returns, and (4) was also used to ascertain the prevalence or existence of new types of disease within the force.

Action Upon Notification In civil public health administration prevention of infectious disease by the indirect method of notification—followed by confirmatory diagnosis, the isolation of case and contacts, disinfection, and search for the previous case, carrier, or other source of disease—provides that the *practitioner* shall notify the occurrence in his practice of a case of such disease to the *health authority* by whom necessary action is initiated. Speaking broadly, in the army the procedure was reversed: specific notification, involving effective action, was made by the health authority (army or division headquarters) to the practitioner (R.M.O.) on information from the medical unit receiving the case. A positive diagnosis at the casualty clearing station, field ambulance, or by the mobile bacteriological laboratory was notified commonly through "Corps" to the A.D M.S. and through him to the regimental medical officer for appropriate action. By this line of procedure such action was liable to be much delayed. Thus during the battles of the Somme in 1916, notification was "often not received until after an interval of from 10 to 12 days when precautionary measures are of little use."[29]

[29] From the personal diary of the O C, No. 2 Sanitary Section, Major M. J. Holmes, dated 20 March, 1917.

By the end of 1916 the procedure was being speeded up by a short-circuit. A provisional notification of suspected cases by R.M.O. to A.D.M.S., was followed by direct action by the latter through his administrative sanitary officer, the Deputy Assistant-Director, to expedite diagnosis and if necessary to forestall it by segregation of contacts, search for carriers, and so forth. The effect of all this was, however, in a great measure offset by a peculiar hiatus in the chain of action which should follow notification. The defect lay in the fact that, apart from such steps as might be taken by the Deputy Assistant-Director to assist the regimental officer, an executive machinery was lacking for the difficult task of tracing the source of disease within or without the unit concerned, and of carrying through measures to prevent the further spread. This was brought about—as the A.I.F. in its experience under three armies discerned—by failure to exploit the possibilities of the *sanitary section*. Only, so far as can be ascertained, in Australian divisions was this public-health unit used for public-health purposes in the important field under consideration.

Experience in the A.I.F.

Shortly after the Australian divisions first entered the "nursery" front round Armentières, under Second Army, the staffs of I and II Anzac received the following order of D.M.S., Second Army, dated 14th June, 1916, which sufficiently indicates the regular practice in the B.E.F. In the matter of small-pox, typhus, relapsing fever, cholera and plague it necessarily followed the definite instructions of the D G.M.S. at G.H.Q.

"In order to regularise the Notification of Infectious Disease the following procedure will be adopted dating from midnight 1st July, 1916.

"(1) Telegraphic notification is only required in the case of the following diseases—Suspected cases of Dysentery, Typhoid Fever, Paratyphoid 'A' and 'B,' Enteric Group, Cholera, Scarlet Fever, Cerebro-spinal Meningitis, Diphtheria, Dysentery, Typhus Fever, Relapsing Fever, Smallpox, Jaundice It will be carried out as follows: Diagnosed cases of the above diseases will be notified by telegram to this office immediately a diagnosis has been arrived at. The notification will be sent by the Officer Commanding Casualty Clearing Station—or, in the event of a case being sent direct to No. 7 General Hospital, Malassise (for infectious cases), by the A.D.M.S. Division concerned—and will be in the form indicated *Suspected cases of Dysentery,* will also be notified.

"In addition to the notification mentioned above, on the diagnosis of a case of Diphtheria or Cerebro-spinal Meningitis, or on the admission of a case suspected to be suffering from one of these diseases, if the case has been diagnosed in the C.C.S., the O.C. of the C.C.S. will inform (by wire) the A.D.M.S. of the Division who will at once take steps in direct communication with the Officer-in-charge of the Mobile Laboratory concerned for the investigation of the carrier condition of the contacts in order that those found free from infection may be returned to duty without unnecessary delay and that the carrier contacts may be suitably dealt with.

"(2) A weekly nominal roll will be rendered direct to the D M.S.

2nd Army by A.D's.M.S. and Officers commanding C.C.S's. It will include all officers and men diagnosed during the past week to be suffering from any of the following infectious diseases:—Anthrax, Cerebro-spinal Meningitis, Cholera, Chicken pox, Diphtheria, Dysentery, Enteric Group, Erysipelas, Foot and mouth Disease, Glanders, Hydrophobia, Measles, Mumps, Plague, Paratyphoid fever (A & B), Pneumonia lobar, Relapsing Fever, Rose Measles (German M.), Scarlet fever, Smallpox, Tetanus, Typhoid fever, Typhus fever, Tuberculosis, Whooping cough.

"Should unusual evidence of any preventible disease manifest itself in any given formation, the matter will be the subject of a special report to this office by the D.D.M.S. of the Corps concerned, the fact of any unusual incidence of disease being reported by telegram."

In addition, a daily return of scabies was rendered to each Divisional A.D.M.S.[30]

The cases notified by army headquarters to I Anzac Corps during the period March, 1916, to February, 1917, are as follows:—[31]

Gastro-intestinal Infections	
Typhoid Group	
Typhoid	41
"Enteric Group"	5
Paratyphoid "A"	20
Paratyphoid "B"	12
Dysentery Group	
"Shiga"	26
"Flexner"	169
"Mixed"	18
Bacillary Unspecified	14
(Clinical) Unknown Origin	69
Protozoal Group	
Amoebic dysentery	16

Respiratory Infections	
Scarlet Fever	19
Diphtheria	71
Measles	211
Mumps	1,658
Cerebro-spinal Fever	51
Venereal Infections	1,194
Miscellaneous Diseases	
Acute Jaundice	18
Trachoma	17
Tetanus	6
Nephritis	50

Note.—During the period 3 cases of *smallpox*, 3 of *typhus fever*, 5 of *relapsing fever* were reported by Army or G.H.Q. as having been notified as occurring in Australian troops.[32]

As a means to early and exact diagnosis and disposal of

[30] Until 1918 no routine report of any kind was made by the regimental medical officers in France to the A.D.M.S. In the 1st Australian Division on Gallipoli a daily return was required by the A.D.M.S. (Colonel N. R. Howse), who was thus able to keep himself closely informed of the general health of battalions, and also of individual lapses from sanitary vigilance.

[31] The total evacuations from all diseases will be found in the statistical summary on *pp. 496-7*.

[32] The table was compiled by the D.A.D.M.S., I Anzac, from notifications *by Army to Corps*. It represents an approximation only, since such "notification" was not complete. The cases of typhus appear to have been credited to the A.I.F. in error. *See pp. 543-4*.

transmissible diseases an immense organisation was built up. Its scientific basis—research into the causes and pathology of "new" diseases, trench foot, trench fever, trench nephritis; into the conditions determining the spread of infective diseases, for example, the habits of the louse, the natural history of the house-fly, the existence or otherwise of the carrier state, the bacteriology of dysentery, the epidemiology of cerebro-spinal fever, and a host of other investigations; and the perfecting of technical measures such as disinfection and dis-infestation, sterilisation of water, treatment of carriers, and so forth—all this immense paraphernalia of research must for the purpose of this chapter be frankly postulated. It included the "mobile laboratories" at the front; those at the base in France, the latter for the most part departments of the general and stationary hospitals; the national research institutions, such as (to select among many) the laboratories of the Medical Research Committee in Great Britain, of the Institut Pasteur of France, and of the Academy Lucri of Rome; and the machinery of international co-operation—the permanent "Commission Sanitaire des Pays Alliées" and the annual deliberations of the "Interallied Sanitary Conferences."

The implements of indirect action

The Mobile (Bacteriological) Laboratories. These units, consisting of a senior and junior officer and one N.C.O. (laboratory attendant) together with a laboratory on a motor truck and a light car for the officers, were designed as strictly mobile units.[33] But during the years of static warfare they overflowed into huts or buildings and developed into a thoroughly organised rampart of diagnosis and of research along the whole front.[34] Australia supplied no such unit for her infantry in the *Western* theatre.[35] These mobile laboratories were "army" units, and, though allocated to serve the several corps, were administered directly by the D.M.S. of each army. Their work will be touched on in *Volume III*, but it may here be said that it made a lasting impression on the Medical Officers of the Australian Imperial Force. They were staffed for the most part by members from the teaching staffs of the medical schools. Combining routine work with "research" many of these men made important contributions not only to the medical

[33] The mobile hygienic laboratory had a precisely similar establishment.

[34] The place of the *pathological and bacteriological laboratory* in the prevention of disease in modern warfare has been sufficiently indicated by the study made in *Vol I* of the problems of wastage at Gallipoli and in Palestine On the Western Front also the history of the mobile laboratory is one of extraordinary interest, both military and professional.

[35] For the work of the Anzac Field Laboratory in Palestine see *Vol I*, *pp 603-4* In France a Canadian unit (No. 5 Mobile Laboratory) achieved a high reputation.

history of the war but to medical science in general. A second line of scientific defence and attack was created in laboratories at the bases in France which have already been described.

Isolation and Segregation This administrative procedure was carried out for the most part in "Stationary Hospitals"[36] or in casualty clearing stations set aside and specially staffed and organised for the purpose, and notified as such by "Army" to Corps and Divisions. Field ambulances were used as "scabies stations," and for the segregation of mumps—which disease provided at times a major problem in isolation.

Means of transport for infectious cases were arranged either by Division or—most commonly—by Corps, and were carried out by the horsed ambulance waggons of field ambulances or the motor ambulances of the motor ambulance convoy

Disinfection. Next to the chlorination of water, the operation of disinfection, or "disinfestation," was perhaps the most important mechanical procedure in the preventive medicine of the war. The matter relates more closely to the technique of "personal hygiene" than to the present subject; but it may be said that the routine and haphazard "disinfection" of the fomites of "infectious" cases or of premises, was recognised for what most often it is—an administrative gesture, not to say a fetish. By the end of the war to "disinfect" meant in the Army to kill by well-attested means some specific agent of disease, in particular the strepto- and staphylo-cocci, the sarcoptes scabiei (itch-mite), and the pediculus vestimenti or corporis (body louse).[37] The pragmatic outlook of medical science to-day reflects, and doubtless also in some degree derives from this line of development in war-medicine

The "carrier" problem

In 1914 the cult of "the previous case" as the prime factor in the epidemic spread of diseases, including that of wound infections, had reached the standard text-books of medicine and pathology; and so had the theory of the "carrier" as the most important instrument in maintaining the endemic forms of transmissible disease. Successive editions of these books, and not less clearly the actual records of the war itself, show that these views on the nature of the biological mechanism which maintains the continuity of the various "infectious" diseases received an immense impetus during, and in some part through, the war. *Pari passu* with increased mastery of the "sanitary" situation, this indirect line of approach to the problem of disease prevention was more systematically exploited. The idea of the "carrier" came indeed largely to dominate the outlook in many important diseases, in particular in dysentery—bacillary and amoebic—in enteric fever, cerebro-spinal fever, diphtheria, and (in France) in gonorrhoea. In

[36] These were properly Line of Communication units, but when employed as above might be administered by "Army."

[37] *See p 575*

the researches connected with this evolution the Australian Army Medical Service was well represented.

Results illustrated in R.T.I.

What (it may be asked) was the exact value of this particular line of "preventive" activity? Did the immense expenditure of effort and resources involved in its execution play a material part in preventing infectious disease—for example, in the notable success on the Western Front of the campaign against gastro-intestinal infections, or in bringing about the comparative immunity from the carrier spread (droplet) infections of low infective virulence—C.S.F., diphtheria, scarlet fever, and perhaps lobar pneumonia, or in reducing the potential incidence of the more highly infective virus infections, measles, mumps, roseola, and virus influenza? A categorical answer in general terms to these questions would be of less service than an examination of its influence in preventing the two forms of infection chiefly concerned—gastro-intestinal and respiratory tract. Its part in preventing the first is examined later in this chapter.[38] But the question is particularly germane to the group of diseases in which infection is spread through the respiratory tract and fauces, in which, indeed, except for inoculation, "spacing out," and promotion of general health, this *"indirect" method of attack was the only one available.*

In the Great War, the Achilles heel in the armour of preventive medicine was, as it is to-day, the respiratory tract. To micro-organisms seeking parasitic relations with man the most effective mode of entry in all highly civilised communities is transportation by droplets of mucus exhaled as in coughing or transmitted by manual or other mechanical mode of vection.[39] Against organisms adopting these tactics, failing artificial immunisation and granted a sufficient margin of virulence in the attacker, even the most scientifically organised community, civil or military, is little less vulnerable than the barbarian.[40]

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[38] *See pp 580-87*

[39] This last method of mucous interchange was recognised as being important in connection especially with diphtheria. Specific orders were issued in some armies for the disinfection of drinking cups in canteens

[40] At the present time in public health circles opinions differ greatly as to the value and scope of notification and isolation as a means for controlling epidemic diseases of or their spread through the medium of the respiratory tract For example in the various States of the Australian Commonwealth 37 distinct diseases are "notifiable"; but in the largest (New South Wales) only 13 of these are notifiable *See also p 490n.*

Incidence of R.T.I. in Army Life. The total deaths and disablings in the A.I F. from infectious disease transmitted by respiratory tract mucus or—as in diphtheria—*materies morbi* from the fauces was very great. No more than in civil life was the army system able to cope with this form of infection and in all great camps it took the place, held elsewhere by gastro-intestinal infections, as "Public Enemy No. 1."[41] Thus the experiences of camp life in the A.I.F. Depots in U.K. have a definite military significance as well as medical interest, and it is to these, with a brief prefatory note on the problem of respiratory infection at the front that we now turn.[42]

Considered aetiologically the diseases of this class present a wide variety of biological powers for achieving their parasitic continuity such as virulence, tenacity, resistance, saprophytic potentiality, adaptation to environment and so forth—and these determine the form of rational reaction against them. Though these various mechanisms overlap, for the practical purpose of prevention the experiences of the A.I.F. suggest that the several disease groups can be roughly grouped as follows.

Aetiological Varieties of Respiratory Infections. (a) "Respiratory" diseases (in the aetiological sense) in which the infective virulence of the *materies morbi* or the susceptibility of the host to invasion is such as readily to bring about epidemic spread through indirect—*i.e.* air borne—"contact." Of such were mumps, measles, rubella, virus influenza, varicella; with, perhaps, a captive giant—variola.[43]

It is perhaps not mere coincidence that the causative agent in each of these is a "virus." (*b*) Minor variants—the coryzas and "febricula," pharyngitis, "septic sore throat," laryngitis and "influenza." (*c*) As a strictly pathogenic division a small group, but one of great importance presents itself in the secondary infections super-imposed on virus infections or physical traumata.[44] (*d*) Microbic infections of short range and typically spread by "carriers" and contact; cerebro-spinal fever,

[41] Though diseases of dirt (next to be considered) had the advantage in numbers from the point of view of "Divisional" wastage in the field, the heavy incidence of that type of disease was largely confined to the zone of the field armies.

[42] The problem presented by the prevalence of diseases of this nature does not lend itself as a whole to the compiling of exact statistics; but figures showing the incidence of diseases of this type on the Western Front and some account of the several disease classes will be found in *Vol III.*

[43] Whether the disease is normally transmitted by air or by contact does not seem to be very clearly understood.

[44] For example, by the irritant and vesicant gases, or by measles, influenza, coryza. The most important of these complications (in general terms) were inflammations of the trachea, bronchi and lungs caused by streptococci, pneumococci, Pfeiffer's bacillus, and so forth, and infection of wounds by streptococcal "carriers" among surgeons or attendants.

diphtheria; rheumatic fever, "scarlet fever" and other haemolytic streptococcal infections (one of the great "discoveries" of the war), tonsillitis, occasionally lobar pneumonia; and we may include also Vincent's disease of the mouth and fauces. In these conditions direct "contagion" played a part possibly as important as infection through the air. (*e*) The morbid states comprised in the permanent pool of infection that has become notorious as chronic "upper respiratory tract infection" (U.R.T.I.), chronic tonsillar, nasal, and naso-pharyngeal infections, middle ear disease, sinus infections. With these we may place that strange pathogenic phenomenon, autogenous infection; wherein, under adverse physiological conditions, under infective pressure, or under impulse impressed by concurrent virus invasion, organisms of disease, tolerated as saprophytes, turn vicious and cause endemic infections such as "influenza," bronchitis, broncho-pneumonia, or lobar pneumonia. (*f*) Tuberculosis.

Each of these types was represented in the experience of the A.I.F. during and after the war as a source of specific problems. As a subject for study those included under (*e*) and (*f*) belong chiefly to the domain of clinical treatment and the prophylactic selection of recruits, and thus to the chapters of *Volume III.*

Experience of the A.I.F. in France

In the prophylaxis against this class of disease at the front, the most important question was whether it could be best fought by alleviating hardship or by combating infection. This question, together with the "carrier" problem will be examined in *Volume III,* where also figures are given showing the percentage of admissions of Australian troops to medical "units" for these diseases at the several levels of evacuation.

(*a*) *Mumps, Measles, Roseola, Virus Influenza* Until checked by action in the A I F. Depots in the United Kingdom, mumps was a serious cause of trouble in the Australian force[45] Isolation of cases and contacts did little to hinder its spread. The graph shows the inexorable course of such an epidemic through a susceptible military community, even in the field where contact was less close than in the camps or transports. The diffusion of mumps in the II Anzac Corps from the 3rd Australian to the New Zealand Division reflects, on a small scale, the spread of the influenza virus in 1918 throughout the civilised world The impact of this latter disease on the A I.F. troops in France has features of much interest, to which reference is made in later chapters The pandemic itself is dealt with in *Volume III*

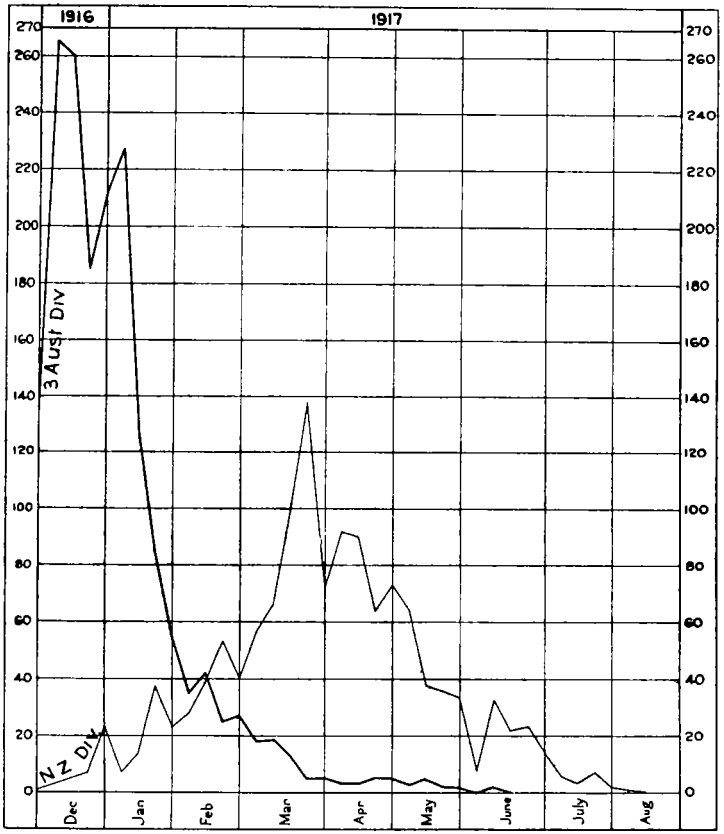
(*b*) *"Minor Variants."* These "diseases" were responsible for a

[45] Very extensive outbreaks of mumps occurred among recruits in the French Army.

large part of the sick parade of the R.M.O. and "light duty" list of battalions; and also of the drug bill of the War Office.

(*c*) *Secondary Infections.* Under the conditions of the front this group was largely unpreventable and it therefore calls for no particular reference here.

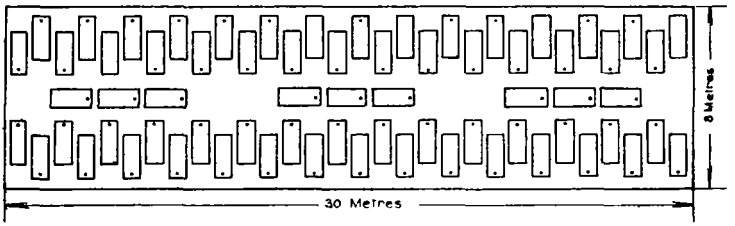
Graph No. 10—THE COURSE OF A MUMPS EPIDEMIC IN THE II ANZAC CORPS DECEMBER, 1916, TO AUGUST, 1917.



(*d*) *The "Carrier" Type.* Diphtheria, cerebro-spinal fever, scarlet fever, lobar pneumonia. Diseases of this type did not become unduly prevalent in the A.I.F. on the Western Front. In Circular Memorandum No 19 dated 1st April, 1917, the Director-General, B.E.F. laid down periods of isolation and prescribed "throat sprays."

But the Great War showed that in this type of infection the treat-

ment of contacts and search for carriers was of far less practical importance than the spacing out of potential cases, thus minimising the number of contacts made by each individual and also the "mass" of



Beds arranged in "Adrian" hut to accommodate 69 men "head to foot" to avoid mucous interchange.

infective matter inhaled. A wide spacing was inherent in the conditions of life at the front, except for brief periods spent in the staging camps the troops lived in the open trench, or in scattered billets To this fact may with confidence be attributed their comparative freedom from *cerebro-spinal fever, scarlet fever, lobar pneumonia,*[46] and perhaps *diphtheria.*

[46] In a discussion on respiratory diseases held in Paris in Sept, 1918, by the "Research Society of the American Red Cross Society in France," the A.D.M S Sanitation, B E F (Col W W. O Beveridge) emphasised this aspect of the problem and gave striking figures showing the result of tackling on these lines such diseases as diphtheria, C S F, and pneumonia. The American officers who spoke had not found it easy to apply this line of defence—by reason, probably, of the stupendous "mass production" of the A.E.F.

The following table shows "the incidence rate for pneumonia per 100,000 troops of the British Armies in France and that of the A E F" taken from a report by Major Haven Emerson M R S in *War Medicine, Vol II, No. 3, p. 312.* This volume contained reports of the "Research Society" and other matter and was published by the American Red Cross Society in France.

	1917		1918	
	A E F.	B E.F.	A.E F.	B.E.F.
Jan	—	8 67	392 3	17 16
Feb	—	25·27	155 3	5·65
Mar	—	14·58	163 9	10·11
Apr.	—	10 40	59·0	11 80
May	—	8·93	16·5	7 65
June	—	6 23	82 2	10·24
July	66 6	7·35	44 6	—
Aug	26 9	4·68	40·7	—
Sept.	20·4	3·49	—	—
Oct	70 21	5 68	—	—
Nov	66·0	6 65	—	—
Dec.	213·3	7 55	—	—

The report from which the figures are taken was published in October. Later figures do not seem to have been available at the time They include the experience of the A E F. in camps in U S.A., and on transports The following are given as "known" contributory causes:—Crowding in camps, trains, and ports in U.S A., crowding, inadequate ventilation, insufficient inspection on the transports; crowding in barracks in France, drilling beyond the point of reasonable fatigue, sleeping in wet clothes, insufficient blankets, cold food, practice of waiting complaint of sickness by men instead of searching for early symptoms of infection, neglect of ventilation, promiscuous spitting, coughing, and sneezing.

Relevant experiences in the A.I F. will be found in *Vol. III.*

(*c*) *Autogenous Infection.* We have here to do with diseases in which the specific means of "prevention" were much less significant than the *promotion of health.*

In (*a*), (*b*) and (*c*) as well as in (*e*) the most instructive experience of the A.I.F. abroad was in the A.I.F. Depots in U.K., and to this experience we may now turn.

The main exemplar—A.I.F. Depots in U.K.

"In peace and civilized conditions the spread of infection from man to man is restricted by the fact that the population is partitioned up into separate rooms and houses. . . . In war all this structural arrangement is swept away."[47]

During the winter of 1916-17, notorious in the AI.F. as "the Somme Winter," concurrently with the terrible experiences of the force in front of Flers, there occurred—in the curious medical parlance—"an outbreak of disease" in the A.I.F. Depots in U.K. such as brought these camps into disrepute which has persisted in spite of the fact that in the sequel they were the scene of one of the most ambitious and sustained and on the whole successful campaigns in preventive medicine in the A.I.F. The cause of the outbreak belongs to the general problems of military camps in war—one of the most important in military medicine.[48]

The Influence of Climate. That the various types of parasitic disease have seasonal predilections—*e.g.* the gastro-intestinal for summer and respiratory for winter—is a matter of common experience, and has, it would seem, some specific relation to the effect of temperature on the agents of disease (*e.g.* of warmth on the increase in water of B. Dysenteriae) or on the tissue of their host (*e.g.* of cold on the respiratory tract of man). Repeatedly during 1915-17[49] objections were raised to the wintering of Australian troops in Britain; and this in despite of the record of sickness at Mena camp in Egypt, and the fact that other troops—even Canadian—

[47] Sir Almroth Wright, in a special letter to *The Times*, 28 Sept., 1914. (*See Vol I, p. 74*)

[48] The experience of the Canadians in the camps of training in Britain in the winter of 1914-15 was a tragic one. And two years later, in 1917 and 1918, the experience of the American Expeditionary Force in the camps of training in U.S A. records a morbidity and mortality from disease which (though figures for exact comparison are not available) cannot have fallen short of one-half of the total casualties, battle and non-battle, sustained by America in the world war. Up to May of 1918—that is before the pandemic of virus influenza—"of the total loss of days due to hospitalisation from sickness" 42·61 per cent. were due to "respiratory infections"—namely, mumps, measles, scarlet fever, diphtheria, meningitis, acute bronchitis, influenza, lobar pneumonia, tonsillitis, broncho-pneumonia, and acute pharyngitis. ("Sinusitis, otitis, and secondary involvements commonly following upper respiratory tract infections" were not included.) From report by Major Haven Emerson, *loc. cit pp. 311, 313.*

[49] *See Vol. I, pp 429, 505.*

seem to have suffered in English camps as much sickness as the Australians.

But the experiences of the A.I.F. in the war proved that the prevalence or otherwise of infective diseases in a force will depend on the *intelligence, foresight, and energy applied to the particular problems of health far more than on the influence of temperature and climate per se*.[50] Of camp outbreaks of respiratory diseases it can be said that the history of the A.I.F. tends to show that they were rather attributable to neglect—sometimes no doubt unavoidable—of well recognised principles of medicine—and of common sense. The fact that climate was not the crucial factor is illustrated by a comparison of sickness and deaths in the A.I.F. Depots in England with those in the recruiting camps in Australia 1914-18, the training camps at Mena and Zeitoun 1914-15 and the reorganising camp at Tel-el-Kebir, 1915-16.[51]

The records of the depots disclose two clearly defined groups of problems in preventive medicine.

The problem defined

(*a*) From the pool of fit men—recruits or recovered—in the training battalions and Command Depots came (1) outbreaks of bronchitis, broncho-pneumonia, and lobar pneumonia, and, supporting these, a very large sub-stratum of minor diseases from infection—"influenza" and a horde of coryzas; from irritation—tracheitis, bronchial catarrh, and so forth; (2) a considerable incidence of cerebro-spinal fever and some diphtheria; (3) a very large one of venereal diseases; (4) epidemic virus diseases brought with troops from Australia—mumps, measles, roseola; (5) the epidemic of virus influenza in 1918.[52]

(*b*) From the other group of soldiers in the depots, men of B2b, C, and border line categories awaiting return to Australia for discharge, there derived, in addition to the diseases listed above, two important problems: (1) that of preventing[53]

[50] The absence of dysentery on transports in the tropics may be instanced. England, it may be recalled, was at one time grossly malarious, and, in parts, mosquitoes are hardly less prevalent than in Australia

[51] The medical history of these has been recorded in *Vol I, Part I, Chapters v, xxi. xxii, xxv.*

[52] In connection with the intestinal infections and the groups of disease whose prevention was mainly a matter of personal and social hygiene, it need only be said that the depots were "happy in having no history". At no time did trouble arise from gastro-intestinal infection. The camps had a reticulated water-supply and were served by the local civic sanitary services (pan). Heavy mineral oil was found very effective as a fly-deterrent. Scabies was prevalent in 1915 but, with the arrival of the main force from Egypt and of the A.I.F. Sanitary Section formed in Egypt under Lieut.-Col. J. S. Purdy—which became No 6 Australian Sanitary Section—fully satisfactory control was maintained.

[53] Officers engaged in depot work definitely recognised these as presenting problems in *preventive medicine.*

the development of permanent functional disability from the effects of wounding—in joints, nerves, tendons—or from those of gas, or from those of disease—D.A H., rheumatism, debility; and especially in preventing the neuroses; and (2) the problem, peculiar to Australia, of repatriating from the Western seat of war 60,000 invalids and some 150,000 troops, with a proportion of wives and families, 10,000 miles, through the tropics.

The problems under (*b*), and those of *venereal disease*, and of *virus influenza*, will be examined in *Volume III.* There remains to be dealt with here the general problem of respiratory disease as met with in the depots.

For three years these various problems extended to the utmost the abilities of as efficient a medical "team" as any that the war produced.

Machinery. The A.I.F. Depots were administered by the British D.D.M.S., Southern Command, but, in reality, full responsibility fell on the Australian "A.D.M.S., A.I.F. Depots" with the D.M.S., A.I.F. as the virtual director. The working of the depot scheme was indeed closely correlated with that of the boarding system and early treatment centres for V.D. at Horseferry-road Early in 1917 fears of a widespread epidemic in Britain of cerebro-spinal fever and the arrival of many cases of the disease in troops from Australia (among other matters) led to the recall from Egypt of the A.I.F. Adviser in Pathology, Lieut.-Colonel C. J. Martin.[54] Under his direction a "Central Pathological Laboratory, A.I.F." was formed, under Captain Eustace Ferguson, to deal with Australian carriers and cases. It was accommodated in the Lister Institute and for some time acted as the Central Laboratory for the "London Command." The "S.M O's" of the groups at Salisbury Plain, the Depot Medical Officers, and the R.M.O's, with their Sanitary personnel and Sanitary Squads completed the scheme which was built up during the last half of 1916 and first of 1917. To implement the campaigns against respiratory diseases in 1917, Australian "Group Clearing Hospitals" were formed clearing to the British hospital system of the Southern Command.

The diseases involved

Bronchitis and Pneumonia. The conditions during summer in the hutted camps on Salisbury Plain were admirably adapted to the requirements of the incoming Australian force. In spite of crudities inseparable from the conditions brought about by the wholly unforeseen demands created through the immense casu-

[54] The immediate reason for his recall was the accidental discovery of carriers in the staff at Horseferry-road Col Martin found that the incidence was the same in adjoining communities—as in the Army and Navy stores No outbreak occurred.

alties of the Somme—demands for drafts to replace wiped-out battalions and for expansion in the convalescent depots to accommodate the incoming wave of recovered casualties—for the first six months little serious disease occurred, and what there was of it derived from the troop transports. But autumn found the depots quite unprepared for a winter on the Plain. Some camps were ill-sited—exposed and bleak—in particular Larkhill, Rollestone, and Perham Downs. But, most important, there had not been time to build up a staff capable of rising to the occasion; living, messing, training, sick parades, were mechanical—there was *no* vision.[55]

During the first quarter of 1917, 123 deaths from pneumonia and broncho-pneumonia occurred in the depot camps, out of a total of 158 In the second week in January the depot staff was reorganised. On February 13th the Right Honourable Andrew Fisher, the High Commissioner for Australia, desired a report on the circumstances of the outbreak and on health at the depots in general. In his consequent report to the D.M.S., A.I.F., the A.D.M.S. Depots (Colonel McWhae) pointed out that although the daily sick parade averaged over 4 per cent. of the troops in camp and the evacuation to hospital almost 2 per cent. per week, about half of the total sickness was mumps and venereal. The average number in hospital at any time was 7·5 per cent. of the troops in camp, of which number venereal cases comprised 3·5. Of the total sick sent to hospital for three weeks, January 12th to February 1st, 57 only were for pneumonia, broncho-pneumonia, bronchitis, and cerebro-spinal fever, but these furnished the whole of the deaths that occurred in the period. In concluding his report the A.D.M S. gave his opinion that

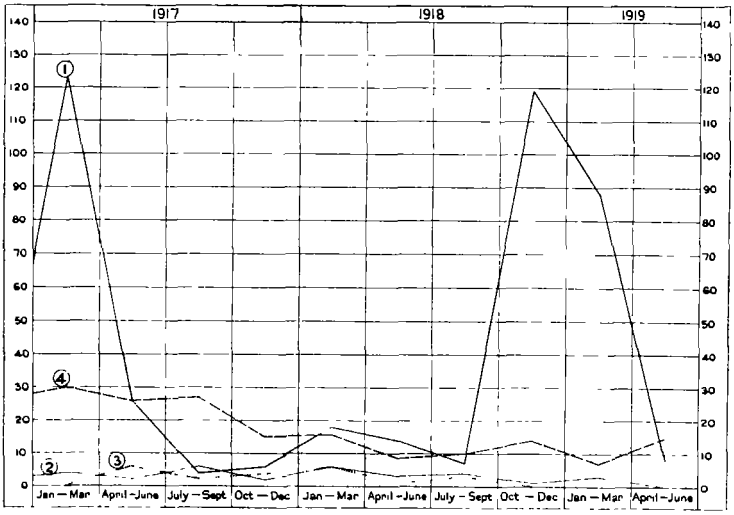
"in view of the prevalence of influenza (*sic*) and the severe winter and the presence of over 10,000 invalids in the command, the health of the troops is good and the mortality not greater than would be expected in ordinary civilian life"

The general records, however, make it clear that this mortality from pneumonia was the expression of a great mass of minor infection, Pfeiffer's influenza, coryza, bronchitis, a

[55] *See pp 446 et seq*

result of conditions in which infection, physical trauma (as from cold) "chill," and lowered resistance cannot be distinguished; and that this minor sickness was an important factor in precipitating the more serious forms of disease. That this fact was observed and understood is seen from the measures

Graph No. 11—MORTALITY AMONG TROOPS IN A.I.F. DEPOTS IN THE UNITED KINGDOM, JANUARY, 1917, TO JUNE, 1919, SHOWING THE INFLUENCE OF EPIDEMICS OF RESPIRATORY DISEASE.



Numbered lines indicate 1, Pneumonia and Broncho-Pneumonia; 2, Tuberculosis, 3, Cerebro-spinal Meningitis, 4, Other diseases

taken to meet the crisis. These were stated by the A.D.M.S. in his report as follows:—

1. Breakfast was not to take place before 8 a.m.
2. Sick parades were held at 8.45 a m. after breakfast.
3. No parade was allowed to be held before 9 a.m.
4. Special attention was paid to seeing that the men were provided with warm woollen underclothing and plenty of blankets, and a waterproof coat was issued to all.
5. Men were specially warned against standing or loitering about in the cold weather and parades in the open air were brisk.
6. All units received a light supper such as tea, soup, etc

7. All medical officers were instructed that cases with a temperature over 100 degrees for 12 hours must be sent to hospital, and that all soldiers marked exempt from duty at the morning sick parade were to be again examined by them in the afternoon.
8. New arrivals from Australia were specially warned of the precautions to be taken against catching cold in the severe winter climate.
9. At a general meeting of medical officers early in February these precautions were impressed upon all and special attention was drawn to the necessity of sending cases early to hospital.

Attention was given to ventilation of huts by an order that at least diagonally opposite windows were to be kept open.

It was to implement these orders that there were formed the Group Clearing Hospitals, in which men suffering from minor sickness might be held instead of being treated in the lines.

Cerebro-spinal Fever. The A.I.F. depots escaped lightly in the world-wide diffusion of this curious disease during the war years. Of the cases which occurred, there were 114 deaths; the great majority had been infected on the troopships. Colonel McWhae says:—[56]

"During the week ending 22.3.17 it seemed that an epidemic of cerebro-spinal meningitis might break out; 10 positive cases occurred and 6 doubtful cases during that week, and there were 3 deaths. Steps were immediately taken as follows:—Special attention was called to existing instructions re ventilation and over-crowding. All windows and both doors of huts were to be open between 8 a.m. and 4 p.m. All medical officers in charge of troops visited commanding officers and discussed matters in connection with cerebro-spinal meningitis. A circular re ventilation, in which the position was explained to men, was posted up in huts."

Cases and contacts were dealt with by isolation and by a search for carriers in accordance with a routine designed by the A.I.F. Adviser in Bacteriology, Lieut.-Colonel Martin.[57]

The Epidemic Virus Diseases. If the first duty of the A.D.M.S. was to protect his depots, a not less important one was to secure from infection the drafts for France. As in 1915 in Egypt, the origin of this problem lay in Australia.

[56] In this and subsequent extracts, Col. McWhae's report is abridged and sometimes paraphrased. The extracts, however, are, for convenience, enclosed in inverted commas

[57] The war-time studies of C S F., notably by Col M. H. Gordon, materially extended the knowledge of the carrier state as well as of this disease itself, some details of the experience of the A I.F are given in *Vol III.*

Each troopship brought its quota of contagion, and at first the conditions in the Command Depots made it impossible to urge an effective campaign in face of this constant reinfection from arriving reinforcements. "Mumps and measles were so widespread that it was impossible to exclude incubating cases from the drafts" [for France]. A solution to the problem was found in the creation of two "buffer zones": one of space and one of time. The spatial separation kept new arrivals away from the general depot system till they were clear of infection; the interval of time separated the medical inspection of the drafts from the date of their departure for the front. The latter process has already been described.[58] As to the former, to quote Colonel McWhae,

"The problems connected with infectious diseases did not arise from dangerous diseases such as cerebro-spinal meningitis but from 'ordinary diseases' such as mumps and measles. Except for a brief period practically all reinforcements from Australia were thoroughly infected with these diseases. Thus during January to March, 1917, 445 cases of mumps, 42 of measles, and 14 of C.S.F. arrived from the transports,[59] and cases in Command Hospitals increased from 300 on January 11th to 802 on March 5th. In this period the control of disease in the depots was in process of evolution. In the early winter months a great proportion of all men in camps were contacts. Effective isolation was impossible, the camps being crowded. . . ."

"By the end of March, 1917, the depots were reorganised. A thorough attempt was made to keep contacts from drafts. Contacts to the number of 8,600 were isolated, and in May it was possible to accommodate them in tented isolation camps in each training camp, which were placed out of bounds. Contacts of different dates were kept separate and did not mix with their units except in open air training. Nominal rolls showed the date of termination of isolation; cases among contacts were dealt with promptly and *their* contacts back-dated. The number in each tent was restricted and disinfection of blankets, etc. arranged."

The number of cases which occurred in the depots was greatly reduced; but the solution of the problem had to await "a yet more excellent way."

"Finally, (says the A.D.M.S.), to cut off at the fountain head the infection of troops in the depots, *all* drafts from Australia were isolated for 14 days in an isolation zone with their own training units instead of in separate camps, and thus could carry out their training. Cerebro-spinal fever and diphtheria from the transports were dealt with as in Command Depots, isolation depending on the Bacteriologist's report."

[58] *See pp 477-9*

[59] The incidence of respiratory infections on the outward voyage from Australia was enormous (*see Vol I, pp 35, 39*). The problem was never tackled systematically at the Australian end.

This determined action was attended by most satisfactory results.

"These diseases ceased to cause any further worry despite the continued arrival of large numbers of mumps- and measles-infected troops from Australia. The (average) number of mumps patients in hospital decreased from 800 to 200, (and for) the first half of 1918 to 62. The total number of contacts lessened from 8,500 to 2,500 and during the first half of 1918 the average number was 1,765. The effectiveness of the isolation is shown by the fact that almost all the cases of mumps and measles occurred among troops already isolated, and very few indeed outside the isolated areas. Thus during August to November, 1917, when large numbers of infected convoys were arriving in England, 92 per cent. of mumps cases occurred in the isolation area and only 8 per cent. outside. The effect of these various measures on the overseas drafts was remarkable. Instead of large numbers of soldiers being struck off drafts prior to embarkation it became exceedingly rare for infectious disease to occur in troops who had finished their training. The great success however is shown by the fact that from June, 1917, to December, 1918, not a single case of mumps and only 5 cases of measles got to France among nearly 100,000 reinforcements."

The experiences of 1917-1918

The remaining health history of the depots belongs to venereal disease and the influenza epidemic. In August, 1917, a suggestion was made by the D.D.M.S., Southern Command that "no drafts from Australia be landed in this country between 1st January and 1st March." The D.M.S., A.I.F., agreed that there were "good medical grounds for intermitting the landing of Australian reinforcements in England in the winter"—December, January and February—basing his opinion on the analysis of the deaths from pneumonia and broncho-pneumonia in the first quarter of 1917. Of the 162, practically all occurred among troops recently arrived, the great majority in December, among whom the death rate was 8·7 per thousand per month of the troops arriving. "Owing to shipping difficulties" the War Office found it impossible to arrange for the suggested change; but "in view of the representations made by Surgeon-General Sir Neville Howse" the Army Council co-operated in providing improved accommodation for the next winter.

For the twelve months from July, 1917, to end of June, 1918, deaths numbered 141—3 per thousand per annum—as compared with nearly 300 for the first half of 1917.

III. Direct Action—Hygiene and Sanitation

We come now to the third and last of the procedures that make up the preventive medicine of the war. Of those types of disease that are amenable to direct action by sanitation or personal hygiene, only a few, and these commonplace ones, were prominent on the Western Front; but, as they were elemental in their social involvements, and were kept in check only by the social structure that has developed with civilisation, when this structure was violently deranged by warfare they could be dealt with only by laboriously improvising, or else by attempting actually to reconstruct it in the field. In mobile warfare these social ramparts had, of course, to be improvised; the successful experiments made in this direction in the Sinai and Palestine campaigns are described in *Volume I.* At Gallipoli, broadly speaking, all efforts at hygiene were ineffective. On the Western Front the static warfare compelled the construction, in the rear belt (say, between 5 and 15 miles behind the primitive zone of the trench line), of a system of feeding, water-supply, transport, housing, sanitation, cleansing, recreation, education and policing only less complex than that which sustains the social life of vast cities. Two types of "disease" have been identified above as having produced the impetus for this reconstruction—the diseases of dirt and squalor (calling for Social Hygiene); and the gastro-intestinal infections (the prime objective in Field "Sanitation").

The curious overlapping of the physical and the infective elements in the "cause" of the most important respiratory diseases, and the dominant part in their prevention played by the promotion of the natural resistance of the body, have no parallel whatever in connection with the type of disease next to be examined—the diseases of squalor: in these the "cause" was practically synonymous with the "agent."

Social hygiene

Diseases of Dirt and Squalor. Colonel Soltau has written: "If some visionary could have foreseen the havoc the louse and the acarus would play, and had devised methods for their destruction, which could have been employed from the outset of war on an adequate scale, what a different story would have been unfolded in the medical history of the war."[60]

[60] "A note on Sick Wastage"—*Journal of the Royal Army Medical Corps, Aug 1920, p. 155.*

The most obvious social difference and not the least important between highly and less highly civilised peoples, as also between wealth and squalor, Dives and Lazarus, is to be found in their respective washing-bills. And until the middle of the Great War the same might almost be said of the contrast between the cleanliness of the average bourgeois life of the day and the squalor of that in the field armies on the Western Front. This state of squalor is reflected in the callousness to minor crudities of life such as verminous infestation[61] and social promiscuity, and to the associated minor physical discomforts and disabilities—itches, rashes, ulcers, boils, sores, and so forth; and these again are reflected in the evolution of those parasitic diseases in which verminous infestation plays an essential part as vector of the morbid agent. These social conditions have been the "cause," in the aetiological sense, of the most terrible of the epidemic diseases that have scourged mankind, diseases which have destroyed vast armies and great nations and have changed the fabric of civilisation: in particular the Rickettsia (typhus) group, bubonic plague, and relapsing ("famine") fever And on the Western Front in the Great War they were by far the most potent "cause" of temporary wastage—of a kind that did not, as a rule, take a man beyond the rest camp of his division. Their future is in the melting-pot with that of the human race; each will be determined by the triumph respectively of emotion and madness or of reason and sanity.

The Morbid Agents Concerned. The morbid states or "diseases" that compose this *group de convenance* are not difficult to identify though they come from various pathogenic groups. Most of the agents that have helped to create the universal instinct which manifests itself as "personal hygiene"—be this only a mud bath or a cat-lick—act on or through the *skin*. On the Western Front the most important of these diseases were scabies (caused by the acarus scabiei); inflammation of connective tissue, septic traumatic abrasion, and impetigo—the last often superimposed on scabies or on trench foot—and caused by strepto- and staphylo-cocci; sundry fungus (mycelial) diseases such as "dhobie itch," and "foot rot" (tinea albiginea). And in "trench fever" the Great War introduced a louse-borne disease quite new to medical science and, as a cause of temporary wastage, of first-rate military importance.

Incidence in the B.E.F. The most exact analysis of the cause of

[61] See *The Minor Horrors of War* by Prof A E Shipley, a publication which was much used on Gallipoli. *See also Vol. I, p 368.*

Army wastage made on a strictly pathogenic basis was that carried out during 12 months in a certain group of British casualty clearing stations which "tendered a monthly summary of diseases admitted." This summary was analysed by Colonel A. B. Soltau in "A note on Sick Wastage"[62] which sets forth more lucidly than any other writing known to the present author, the problem of preventive medicine in the Army zone in France. In relation to the immediate subject Colonel Soltau sums up thus:—

"[We arrive at] a total of 21,500 cases of trench fever. Adding to this total the 25,000 skin lesions originating in dirt, 'dirt disease' is seen to be the cause of 46,500 cases (out of 106,267 examined) or forty-four per cent. of the total incidence.[63] This mass of cases, so largely preventable, was a very serious factor in lessening the man-power of the Army. The methods of prevention were comparatively simple—careful inspection at frequent intervals, clean under-clothing, bathing facilities and disinfestation."

One further brief citation of Colonel Soltau's views will help to define an important type of disability which receives inadequate attention in military histories. Of the cases included in the group varicose veins, piles, hernia, appendix, eye, ear, and dental, Colonel Soltau remarks that "a very considerable number went to form the floating hospital population which was such a problem in the later years of the war. . . . Disabilities which in civil life do not prevent a man from being a wage earner, may on active service be a bar to fighting efficiency."

Re-grouped to permit some comparison with Australian figures Colonel Soltau's table is presented below.

DISEASE	Per-cent-age	DISEASE	Per-cent-age	DISEASE	Per-cent-age	DISEASE	Per-cent-age
						Varicose	
Measles	0·74	Trench Fever	4·93	Local injury	5·22	veins	0·09
Mumps	0·42	Scabies	10·10	Synovitis	0·43	Piles	1·27
Influenza	3·41	I C T	9·68	Trench foot	3·10	Hernia	1·23
Laryngitis	0·41	Boils	1·25	Myalgia	4·47	Appendix	0·66
Tonsillitis	1·34	Skin Diseases	4·27	Rheumatism	0·60	*Total*	*3·25*
Diphtheria	0·03	*Total*	*30·23*	Nephritis	1·53	Eye	1·01
Bronchitis	3·26	*V.D*	*6·34*	Debility	2·39	Ear	1·32
Pneumonia	0·71	Dysentery	1·71	*Total*	*17·74*	*Total*	*2·33*
Pleurisy	0·60	Gastro-		Neurasthenia	0·36	*Dental*	*2·45*
T.B.	0·24	enteritis	0·56	N.Y.D.N.	3·10	*Sundry*	*0·17*
Total	*11·16*	Diarrhoea	3·68	Cardiac	2·43	*Grand*	
P.U.O.	*14·48*	*Total*	*5·95*	*Total*	*5·89*	*Total*	*100·00*

The table shows percentage (for each class of disease) to the total admissions during twelve months to the C.C S.'s in question

[62] *Journal of the Royal Army Medical Corps, Aug 1920, pp 152-159* "A note on Sick Wastage" by Col A B. Soltau, Army Medical Service (T.F.). Col. Soltau was appointed Consulting Physician to First and Second Armies at the end of 1916, and was one of the clearest thinkers and most accurate observers on the consulting staff of the British Army (He received his early education at the old High School in Launceston, Tasmania)

[63] The comparable figure for the A I F. will be shown in the general statistical table in *Vol III* It should be noted that the tables given on *pp 496-7, 501-4* represent admissions to field ambulance

Personal hygiene

The system built up on the Western Front to promote escape from these scourges included organised provision for cleanliness of person and clothing together with prophylactic medical treatment. The first (and the most important) of these belongs properly to the history of the Quartermaster-General's Branch. Such a history is not known to the author.[64] Moreover, the relief of the medical service from this responsibility was a gradual and grudging concession by the military command to the facts, first, that a high standard of personal hygiene "paid" in terms of cannon fodder; and second, that military hygiene meant *organisation by the higher staff* at least as much as individual "discipline." From the "medical" standpoint, as distinct from the personal and aesthetic, "cleanliness" meant the destruction or removal of parasites as causes of specific diseases rather than as sources of discomfort and even of general ill-health. The medical service therefore remained deeply concerned in the technical adjuvants to baths and laundries—disinfection and delousing. But the comfort of cleanliness also had its medical involvements. The following account, therefore touches on A.I.F. experience in the general aspect of "cleanliness," as well as its more definitely "medical" side to wit, "disinfection" and "delousing" and the early detection and prophylactic treatment of scabies, pyodermia, I.C.T., trench fever, and so forth.

The war of 1914-18 did not differ from others less "great"

[64] Colonel Beadon's excellent work (*Vol II* of *The Royal Army Service Corps*—Cambridge University Press) is as its sub-title indicates, "a history of transport and supply" and not a technical study. The history of the Services of Maintenance in the British Army is a sordid and disillusioning one, that of the A.S.C. is seen by so great an authority as Sir John Fortescue (*The Royal Army Service Corps, Vol I, p. 265*) as "the long struggle of a great auxiliary service against the jealousy of Parliament and the prejudice of combatant officers." The most notable instance perhaps of this unfortunate British trait is the degradation of these services in the British Army after the Napoleonic wars. This is seen, *e.g.*, in the amazing contrast between the efficiency of the system of preventing wastage built up by Sir James McGrigor for Wellington in Spain, and the crudities of the Crimean War. Even to-day, with the "lessons" of the Great War still vivid, problems of maintenance are given little place in military training.

"Many historians would be hard put to it to give a clear account of the colossal work of 'Q' in the recent war . . . The late Sir John Cowans [Quartermaster-General] speaking at Carlisle, complained with reason that in the thanks given by Parliament to the Army, no mention had been made of the work done by the Administrative Services, although as a whole the war was one of administration rather than strategy or tactics." ("The Load carried by the soldier" by Major N. V. Lothian, *Journal of the R.A.M.C. Jan. 1922, p. 17.*)

in being a physical and moral degradation to the primitive, though its circumstances permitted a more or less effective camouflage of this fact. Crude and primitive individualism commingled with the most highly sophisticated scientific co-operation in a curious emulsion of life that was neither civilised nor yet wholly primitive but an ill-assorted admixture of each—the murky twilight of the old gods, but a false dawn of the new. An excellent illustration of this strange assortment is seen in the subject under consideration.

Disinfection in the field

Apart from its place in surgery "disinfection" in the Great War signified essentially an attack on three specific parasitic pests. These were—

The parasites

(*i*) The body louse, *pediculus humanus* var. *corporis* (*vestimentorum*).[65] This caused, directly, the morbid state known as "pediculosis"—with pyodermic complications; and, secondarily, certain major diseases—trench fever, typhus fever and relapsing fever.

(*ii*) The "itch mite" (*sarcoptes scabiei* var. *hominis*) causing "the itch," or scabies.

(*iii*) The pyogenic cocci (*strepto-* and *staphylo-cocci*), causing sores and suppurations—pyodermia—chiefly as impetigo, and I.C.T.

For the rest, it is, to say the least, doubtful whether the routine "terminal disinfection" of fomites (clothing and blankets) and premises after "infectious" diseases of the type of C S.F., diphtheria, measles, mumps, or even typhoid and dysentery, was of any real significance as a factor in the stay of outbreaks.[66]

So far as concerns the present issue, namely, the prevention of wastage due to diseases attributable to these three parasites, we are concerned with—(1) the bionomics of the agents in three morbid states, *pediculosis, scabies, pyodermia,* with various permutations and combinations—the latter more important than the "pure" diseases; (2) the implements and apparatus for opposing these by "direct" action—to wit, various methods of "dis-infection" and "dis-infestation"; and (3) the arrangements in the B.E.F. for making these preventive measures available to the troops. These measures came to centre round the system of "Baths

[65] See MacCormac in the *Brit. Off. Med. History, Diseases of the War, Vol II, p. 89n.*

[66] One of the strongest impressions that is gained as a result of study of "infectious disease" as a problem in the Great War, is the immense importance of direct contact with the "previous case"—whether as "case" or "carrier"—as a factor in contagion, that is to say, of personal contact between individuals, and the direct transfer of secretions containing so to speak "nascent" infection. Promiscuity, famine, and hygienic degradation, stand out pre-eminent as the major factors in epidemics of this type, in the Great War, on the Western Front, in the field armies, only the first of these factors, promiscuity, was effective. But the fate of Russia in and after the war suggests that in the next war it may be otherwise

and Laundries," and the divisional establishment of Thresh steam disinfectors mounted on Foden lorries.

For what it is worth to humanity the Great War brought about this beneficent result—that the bionomics of the body-louse and of the itch-mite were studied with an exactitude never previously approached in their history or man's, so that what we do not know of their intimate social and family life is scarcely worth knowing.[67] The consequent rise to fame of the streptococci does not require to be stressed.

The verminisation of a body of men thrust from civilised life into the promiscuity of mass warfare bears a close resemblance to the spread of "germs" in epidemic "disease,"[68] and this analogy carries through to the idea of "asepsis" and "antisepsis." The complete infestation of a battalion with lice or acari could be avoided only by the exclusion of "carriers"; a very few carriers—inevitable it would seem in our present social conditions—soon formed foci, and the general "rubbing of shoulders" and interchange of sleeping "pozzies," and other close contact involved in "active service" sufficed for the parasite, which spread by contagion with extraordinary rapidity in the population "exposed to risk."[69] The rate of their spread was influenced by various factors but chiefly by the population pressure, human and parasitic. The first Australian contingent was to some extent infested before it left camp, and at Mena much more widely so. Peacock found that, in 1916, 95 per cent. of British soldiers examined after six months' service at the front were lousy with an average of 20 lice per man; 5 per cent. were "dangerous carriers,

[67] Perhaps the most potent factor in the huge wastage caused by these parasites was failure to treat them seriously: the military command for long ignored them, the "scientific" medical profession disdained them. Though the rôle of the body-louse in the spread of typhus fever was discovered (by Nicolle) in 1909, comparatively little was known of the bionomics of this insect. Professor Shipley's *Minor Horrors of War*, published in 1915, and then looked on as a mildly improper *jeu d'esprit*, was precursor to a larger literature on the louse, reflecting studies such as those of Bacot at the Lister Institute and of Prof. G. H. Nuttall at Cambridge and of Capt. Peacock in the field—as exact and scientific as those which elucidated the life history of malaria or of bilharziasis. Of scabies Capt. J. W. Munro, R.A.M.C., in a report (*R.A.M.C. Journal July 1919*) of a research carried out by him on the initiative of the D.G., A.M.S. in 1918-19, states that "in the [pre-war] literature relating to scabies and to the itch-mite no two accounts of the life-history of the mite agree, and there is a similar difference of opinion regarding its mode of spread or disposal." Hardly less pronounced was the clinical ignorance concerning this disease and its complications as these occurred among the troops in the field. For a very complete presentation of the progress made in the war in the aetiology, prophylaxis, and treatment of these conditions, the reader may be referred to the *British Official History* (*Hygiene Vol. II*), where an adequate bibliography is given. Instructions and memoranda were issued during the war—on pediculosis in 1916 and 1918, and on scabies in 1918

[68] Compare also the extension of the plague of mice which in 1916-17 raged through the Australian wheat-stacks, and spread far and wide through the adjacent countryside.

[69] It was very widely held that some persons are repugnant to the louse and thus "immune" to pediculosis. There does not however seem to be any valid proof that such a condition exists as a physiological phenomenon, the freedom must be explained by extrinsic factors

each bearing between 100 to 300 lice."[70] The efficiency of the survival technique of *sarcoptes scabiei* is shown by the fact that, of admissions for disease to C.C.S. those due to lice, scabies, or pyogenic cocci might on occasion be as high as 90 per cent., and that of men evacuated to the base for skin trouble almost 50 per cent. had scabies. Pyodermia was present as a primary or secondary infection in nearly 60 per cent. of all admissions to the Dermatological General Hospital at the base.[71] The pyogenic complications of pediculosis—*per se*—and of scabies were by far the most important elements in these two diseases, while lesions created through the scratch reaction against the parasites gave the pyogenic cocci of the skin their best opening to the dermis.

(*i*) *The Body Louse.* This insect is one of the most highly specialised of external parasites; its every organ and member is adapted for this purpose. Its strong preference for clothing rather than for body hairs[72] indicates the degree to which it is specialised to man. Apart from man the insect is wholly lost and forlorn; the longest period during which lice could survive separation from the human body was found by Peacock to be about 9 days.

"The louse," he says, "is a parasite which is utterly dependent upon man's blood for sustenance and man's body and clothing for prolonged prosperous longevity and reproduction."

Dissemination. The louse is very expert at "digging in" among the seams of the clothing to which it strongly adheres by hooked claws. Favoured sites are the seams at the fork of breeches and creases at the back of the shirt. Its spread from man to man is by a process of contagion with a range measured, in terms of space, by a few feet and, in terms of time, by a few days. Its powers of rapid diffusion—and incidentally of promoting that of smaller parasites such as rickettsia—lie, not in its own feeble and faltering movements, guided it would seem solely by a sense of warmth, but in its prodigious ability to make the most of its opportunities when established. Dugouts, blankets, bedding, and so forth were found to harbour very few lice, but one or two per man would suffice; with 8 or 12 eggs per day, and a cycle from egg to egg of 16 days, infestation was soon enormous. The solution therefore of the louse problem lay, as gradually became evident, in keeping the louse population per man at a minimum; and its crux lay in the egg, which will hatch out within 3 days, or as late as 30 days or more.

Vulnerability. It requires some force to crack a louse, so that to kill the insect by this means he must be found and caught. Through the

[70] *The Louse Problem at the Western Front*, by Lance-Sergeant A D Peacock, R.A.M.C., *p 21.* Gross infestation reached as high as 1,300 to 10,000 counted lice as well as approximately 10,000 eggs on one shirt.

[71] No. 25 General at Hardelot. This hospital was in 1917-18 staffed by members of the A.A.N.S. These figures are from the *Brit. Off. Med. History, Diseases of the War, Vol II, p. 68* It should be said that the statistics of the Australian force do not reveal any incidence so high as this; *c f. p 496.*

[72] *Phthirus pubis* (crab louse) and *pediculus capitis* (head louse) were hardly more prevalent in the army than in civil life.

breathing pores (spiremata) it is vulnerable to oleagenous applications—exploited in the war in the form of vermijelli—and as with other insects naphtholene is highly toxic, and was used in "N.C.I." (naphtholene, creosote, iodoform) powder, or as a paste. It is killed by quite moderate heat, 55° C. dry heat in 5 minutes, 70° C. moist heat in 30 minutes. So far so good. But the catch in the louse problem lay first in the myriads of minute eggs; and, second, the fact that the rickettsia, if harboured in its excrement—their normal vehicle of contagion—were resistant to heat and antiseptics almost to the same extent as the pyogenic cocci.

Prophylaxis. The solution of the military problem of pediculosis was found to lie in the systematic mass disinfestation by the use of heat, as by ironing, hot air, or current steam. These amplified the individual efforts, which ascended through scratching, shaking, brushing, catching, applications, and scorching, to the home-made hot-air delouser (such as the "Russian Pit"), and so to the Foden lorry, steam hut, sulphur chamber, delousing train, and the system of "Baths and Laundries."

(ii) Scabies. The morbid condition known from time immemorial as the itch was found in the war to be a far more complex condition than had been supposed. The primary lesion —the "burrow" in the epidermis with underlying dermal reactive vesicle—is a minor and inconspicuous affair; the mischief came from infection of the scratch, and dermatitis from over-treatment. The crux of scabies as a medical problem lay in diagnosis by the R.M.O. and discrimination by the clinician; and in the education of these authorities. Few medical "lessons" of the war are more clear than this, that a practical knowledge of scabies in its every aspect is a matter of first-rate importance for every medical officer. This is far too large a matter to enter upon here but a few details as to the parasite are relevant.

Dissemination. Sarcoptes scabiei[73] lives in burrows in the human epidermis, but larvae, nymphs, and adult males wander when warm. As they are almost microscopic in size, transmission of the parasite is even more closely confined to contagion than in pediculosis. The vehicle most used by the itch-mite was the blanket, and next to this the underwear, both of which harboured the eggs as well as the acari, but direct personal contact was most important.[74] The life-cycle of the insect is 9 to 15 days —egg state 2½ to 3½, larval 1½ to 3, nymphal 1½ to 4, the adult female may live 4 to 5 weeks.

[73] All members of the sub-family sarcoptinae are parasitic in all stages, inhabiting the living tissues of their hosts They are somewhat closely discriminating, but readers of *Vol I* (*p 672n.*) will recall an outbreak of camel mange in the Light Horse in Palestine

[74] By no less an authority than Professor Darier (1917) the disease was classed, with *phthirus pubis* as "venereal." The data here given are taken chiefly from the article by Capt Munro It need hardly be recalled that there was an immense literature on scabies before the war.

Vulnerability. The clothing of persons suffering from scabies may remain infected for at least 11 days and blankets not less. "A fair amount of moisture is absolutely essential for the life of the mites and ova and this factor is as important as temperature." Acari, and in a less degree ova, are very susceptible to dry heat in the order of 50°-60° C. at 40 per cent. humidity. At 70 per cent. they are much more resistant. Of antiseptics, as is well known sulphur as ointment—1 in 15—was specific; but it was used with little discernment and too much stress on the sulphur.

Prophylaxis. Scabies alone of the three was attacked systematically by the indirect method of report and segregation, and this was implemented by regular scabies parades and scabies treatment stations—field ambulances or C.C.S's—as well as No 25 General at the base. This was indeed the prime factor in prevention, far more important than disinfection, but it was full of pitfalls, in particular in the criteria of cure.

(*iii*) *Pyodermia*—the "pyogenic" cocci. In official war writings we find the term "pyococci" used to include both groups—streptococci and staphylococci. Since the war the immense accession of interest in the parasites that still are loosely associated under this title, has carried the subject of their related "diseases" almost to a new plane of scientific analysis, on a par with that of the rickettsial diseases and the salmonella group. In the war the pathogenic differentiation of the various "strains" of streptococci had scarcely commenced, and the wide field of parasitic action allotted to these, and the full appreciation of the powers of the staphylococci for sustained and malignant parasitism, are both largely post-war developments.

In the pyodermias we find the prime objective in prophylaxis—one which in the other two was secondary—namely, the protection of the man against himself. The mobility of the organisms being *nil* their chance in life lay almost wholly in the exploitation of local opportunity. Their mode of dissemination from man to man was and is still largely a matter of informed conjecture. The factors in their viability need not be traversed The rôle of the two groups as a cause of septic skin lesions overlapped and from the point of view of prophylaxis by disinfection need not be discriminated. The most common skin disease at the front was impetigo which, MacCormac[75] states "as is well known . . . results from the streptococcal infection of the skin." "I.C.T." on the other hand was commonly staphylococcal. In both the prime factor in prevention was disinfection of the skin and of its immediate covering, the underwear, in other words baths and laundries

The apparatus of disinfection ranged from that improvised

[75] *Brit. Off Med History, Diseases, Vol II, p. 86*

Apparatus of disinfection

in the field units to the scientifically designed equipment of the Sanitary Sections and the highly organised mass-action of the baths and laundries. In both spheres, improvised and designed, an immense variety of apparatus was employed some of which has received notice in the earlier volume. A technical description is not called for. Besides, SO_2 which was found of service only at the Base, they exploited dry or moist heat.

Improvised Apparatus. The Serbian barrel was illustrated in *Volume I.* The "Russian Pit" hot air delouser reached the Western Front in 1918. Colonel Lelean's "boiler and sack" disinfector weighed only 50 lb., and worked on the principle of current steam passed through clothing by downward displacement in a collapsible water-proof sack in a hot-air chamber. (A diagram of the "Russian Pit" delouser is given at *p. 588.*)

Mass-action Apparatus. These may be classed as stationary and mobile. Of huts in which chiefly hot air was used various forms were designed, permanent or make-shift. The best known was that of Major Orr, C.A.M.C., which was heated by coke braziers placed in a central pit. Of mobile apparatus the Hunter railway van has already been illustrated at work in Palestine. For use on light railways at the front an admirable disinfesting truck was built at the I Anzac workshops under the direction of Captain C. D. Sheldon, R.E., for the A.Q.M G. Anzac Corps (Lieut.-Colonel M. G. Taylor) early in 1917.[76]

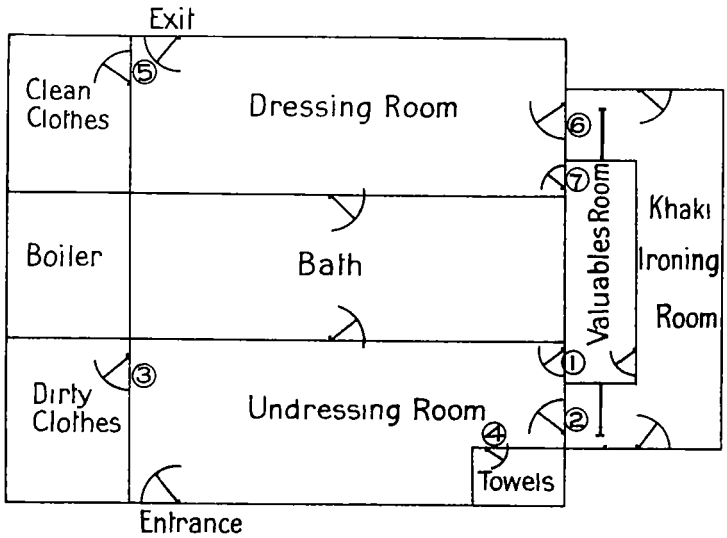
The *"Foden" Lorry Thresh Disinfector.* The standard apparatus for disinfection and disinfestation on the Western Front was the well-known Thresh apparatus mounted on a Foden steam lorry. This employed the steam from the engine; and a temperature of somewhat over 100° C. at steam pressure of 5 lb. could quickly be attained. Its capacity was 100 blankets or 50 kits of clothing; the time required for each operation was about an hour. In the later years of the war they were used in conjunction with the Divisional baths.

Baths and Laundries

Some five to fifteen miles behind the front, beyond the enemy's normal shelling, the social life of the military community merged more or less intimately—in billets, estaminets, markets, social services and so forth—with the normal communal existence of the civil population of Northern France. A national social symbiosis developed; and in this a great system of semi-military "baths and laundries" had replaced the British house wife's "washing day"—by means of it several million males

[76] The chamber was of 125 cubic feet, the temperature attained 210° F. at a few pounds pressure of steam Its capacity was 300 blankets in 2 hours Lice were killed in half an hour The blankets were dry on removal. A plan of this disinfector was shown at the Interallied Sanitary Conference in 1917, and was retained by the permanent Commission.

were kept reasonably clean and free from vermin. This had been, however, a very gradual development, and at the time with which we are dealing it had reached a very definite parting of ways.



PLAN OF AUSTRALIAN CORPS BATHS AT LINDENHOEK, MARCH, 1918.

At (1) the bather hands in his cap, boots, puttees, and valuables, and receives a numbered disc with a string for hanging round the neck, the number corresponding with that on a pigeon-hole into which his property is put. At (2) he hands in his coat and trousers, which are numbered in accordance with the disc he has received at (1). At (3) he hands in his underclothes and receives a second disc bearing a number to correspond with the number of garments he hands in. The bather is now naked and enters the bath, which consists of showers only Soap is provided in the bath and a disinfecting shower is used if necessary On completion of the bath, the bather receives a towel and proceeds to dressing-room. At (5) he receives the number of pieces of underclothing corresponding with the number shown on the second disc; at (6) his coat and trousers, which have been ironed and brushed, at (7) his cap, boots, puttees, and valuables.

In the first rush of 1914 (the *British Official Medical History* notes) men washed when and how they could. "Ground sheets were used for improvising baths, and some battalions even carried large tarpaulins for the purpose," but such efforts were found "quite inadequate to deal with the problem as a whole" By November, 1914, "Divisional" baths were being organised by individual initiative on the principle that bathing and the provision of clean underclothes and the de-lousing of outer clothes

should be combined in a single procedure. Such baths were established in all divisions of First and Second Armies in the winter of 1914-15. When the A.I.F. arrived in France in the spring of 1916, its medical service found itself responsible for the control of an extensive industrial organisation.

Of the arrangements with which the Australians first came in contact the D.A.D.M.S. I Anzac wrote:

Bathing arrangements Armentières Sector, May, 1916

"Each Division has Divisional baths (in a *blanchisserie* if possible)—*e.g.* 1st Division at Sailly Laundry; 2nd Division, Erquinghem Laundry. A Medical Officer from Field Ambulance is in charge. He makes contracts for employment of women for ironing and sewing. The personnel to run the Laundry and Baths is supplied by Field Ambulances; 50-80 men are thus employed. [Application was made to Corps that P.B. men should be used for this work, with a few A.M.C. men to superintend, but the proposal was turned down.] Men give up their dirty underclothes and are given a clean set; they have a hot bath; their tunic and breeches are brushed and ironed to kill the lice; the dirty underclothes are washed and mended. Half a pound of coal is deducted for the baths from the [daily] allowance per man in the Division."

DIVISIONAL BATH RETURN FOR ONE WEEK

UNITS.	No. Bathed	Garments washed	Mended.	Ironed and disinfected
1st Div.	7,150	35,034	4,995	5,391
2nd Div.	8,013	29,121	4,485	4,881

Australian Corps scheme of Baths

In this matter of bathing the B.E.F., "The Somme" created new conditions of life and a new outlook on its affairs. For the present reference these can be summed as follows:—

(*i*) The medical service was found too useful in other ways to be employed in running baths and laundries.

(*ii*) It was realised that the supply of clean clothes was an essential concomitant of bathing,[77] and that the job belonged properly to "Q" (Supply), not to the "A" Branch of the staff (personnel and discipline).

(*iii*) Proof that the louse was the vector of trench fever had called the attention of the General Staff.

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[77] Of this change a high Australian authority says: "Until August, 1916, no attempt seems to have been made to go in for Baths and Laundries on a large scale. From time to time divisions had baths at which men might get clean garments in exchange for dirty as long as the stock of clean lasted, but stocks (supplied as they were from small Divisional laundries) were so limited that the clean clothing was seldom sufficient to go round. In those days every man was supposed to carry a spare set of underclothing plus an extra pair of socks, making 3 pairs in all—one pair worn and 2 pairs carried. . . . A small reserve of underclothing was allowed the division [from Ordnance] which was wholly inadequate [but at first] the men were able to wash their own clothing." (From note in War Diary of Corps Baths and Laundries Officer by Lieut.-Col. G. C. Somerville, later A.Q.M.G. Australian Corps.)

(*iv*) The "Corps" replaced the "Division" as the executive unit for tactics and administration.[78]

In the I Anzac Corps the "Q" branch embarked on a scheme of "baths and laundries" which in the Somme Winter assumed enormous proportions.

A Corps baths officer was made responsible for the running (chiefly by P.B. men) of all baths except such as might be improvised by the Divisions in the forward area, and for the laundry work and disinfection for the whole Corps, and for implementing the scheme of exchange of underwear. Large baths were established at Cagny and Heilly, and smaller ones at Fricourt, Montauban, Naours, Flesselles, and Coisy. The following notes were supplied by the A.Q.M.G., I Anzac for the Inter-allied Sanitary Conference, 1917.

"The ideal of a bath and change of underwear for men every 10 days involved the establishment of 5 baths with a capacity of 160 [men] each per hour. Nissen huts were equipped for steam sterilising with a capacity —each hut with twelve working hours—for 8,000 men; *i.e.* 32,000 pieces of clothing, plus 5,000 towels. The total *laundry* capacity per week (at the baths and by contract) totalled 265,000 pieces, *i.e.* the washing for 7,440 men per day Contracts were let by weight or for pieces—the shirt, vest, drawers, socks and a towel were found to weigh—dirty 1·85 kilos, clean 1·70 kilos. Soap was not used. Washing was done with soda and ammonia. Women were employed for repairs."[79]

When the Corps went north its baths and laundries at Cagny were taken over by the Canadians, but they were resumed on its return south. Even while the front was fixed, the difficulties were stupendous; and with the rapid movement in "Alberich" the scheme was almost completely disorganised.[80] The Flanders offensive found the Corps again in control, but at the end of 1917 the Divisions resumed their normal executive autonomy, and the duty of establishing *baths* fell entirely on their respective D.A.Q.M.G's. The Corps however remained responsible for *laundry* work. The subsequent developments will be touched on in dealing with the open warfare of 1918.[81] Of the technical side of these enormous undertakings only a few facts can here be noted.

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[78] *See pp 66-69*

[79] The officers responsible for this fine scheme were Lieut.-Col. M. G Taylor, A.Q M G. and Lieut.-Col. S. G. Gibbs, D.A Q.M.G.—two officers attached to the Corps from British units The position of "Corps baths officer" created in August was filled by the appointment of Lieut. H H. R. Macknight who held the position till the end of the war

[80] *See p 140*

[81] *See p 712*

(*i*) *Bathing Routine.* The scheme was based on the principle that on entering the baths the soldier passed in his underclothes and uniform. The first were sterilised if possible and sent to laundry; the second was disinfested by ironing or steaming, while the soldier passed through the baths. A very exact method was required.

(*ii*) *The "Shower."*[82] The Australian soldier abroad found the apparatus of bathing different from those to which he had been accustomed. In Australia the "shower" is a normal installation in addition to a "plunge" bath, in Britain the usual provision was then a plunge bath or none. When the A.I.F. came to France the cult of the hot shower was in throes of evolution in the field, on the model—it would seem—of the mobile *bains douches* of the French Army.[83] By 1917 the hot shower had become general. It is not possible to enter upon a description of the various types of apparatus, stationary or mobile. The lesson of the warfare in France seems to be that improvisation and the exploitation of local resources can never be escaped, but standardised portable equipment for baths should be part of normal military impedimenta. The following note from the diary of the A.D.M.S., 4th Australian Division (Colonel Barber), sums up the situation at the end of attrition warfare:—

"Scabies is decreasing. This is apparently due to facilities for bathing. We have acquired four bathing sets. These weigh 7 cwt. and can be carried on one lorry with the Division. They can be erected in 24 hours and bathe about 60 men per hour. It is proposed to carry these sets with the Division, in which case there should be no more trouble on the bath question. Three rooms are necessary, one for bathing, one for undressing, and one for storing and serving out clean underclothes. If water [for bathing] is not available, as is the case with 12th Aust. Infantry Brigade at present, this is provided by water carts. It is hoped to provide an extra room for the ironing of the clothes."

The type disease of squalor in the war

The chief enemy against which all these medical defences were set up hardly appeared at all, or, if he did make his approach as in most of the great wars of history, he at least made no impression on the ramparts created by the medical service on the Western Front. Typhus was practically confined to the Eastern fronts.

Trench Fever. In his *Rats, Lice and History,* Hans Zinsser says. "Typhus had come to be the inevitable and expected companion of war and revolution; no encampment, no campaigning army, and no besieged city escaped it. It added to the terror of famines and floods; it stalked stealthily through the wretched quarters of the poor in cities and villages; it flourished in prisons and even went to sea in ships. And whenever circumstances were favourable it spread through countries and across national boundaries. As a matter of fact, until the last decade of the

[82] The provision for the very important matter of "*ablution*" (for example, of hands) was the responsibility of a man's unit, carried out in conjunction with the sanitary sections

[83] The programme of the Interallied Sanitary Conference in 1917 included a demonstration of French portable *bains douches* at work near the front

nineteenth century mankind changed very little as concerns those customs and personal habits which determine its relationship with typhus fever."[84]

In the Great War, the most bloody in human history, trench fever provides a burlesque anti-climax to the history of the exploits in destruction of one of the greatest among the "captains of the men of death" in the medical history of human wars. Typhus fever, chief actor in some of the greatest triumphs in the history of the parasitic exploitation of man by the underworld of life, was replaced epidemiologically, clinically, and aetiologically by trench fever, which, like typhus, was a "rickettsia" disease spread by lice. As a factor in the wastage of the Great War the story of trench fever is banal: though it incapacitated great numbers, it killed no one. In place of the terrific syndrome of typhus it presented, with vague pains and aches, an exasperating absence of objective evidence of "disease." But, as an episode in the age-long history of man's combat with his parasitic enemies, it stands out as the *raison d'être* and objective for one of the most clean-cut and successful campaigns in the history of rational scientific medicine.[85]

Trench fever may, indeed, well be termed the focal point of preventive medicine on the Western Front. It cannot be claimed that the A.I.F. had any special part in the researches that led up to this success. But the history of the campaign holds so important a "lesson" and is moreover so peculiarly fitted to impart a sense of life and purpose to the dry bones of the method and machinery which the Australians, like the rest of the B.E.F., employed, that a *résumé* of it will be given in a technical chapter in *Volume III.*

Field sanitation

The Gastro-intestinal Infections "In English there is a tendency to use the word 'sanitation' as if it were synonymous with scavenging, conservancy, and the removal of refuse and filth generally. . . . It is necessary to take a wider view of the subject."[86]

[84] Hans Zinsser, *Rats, Lice and History* (London: George Routledge and Sons Ltd., 1935), *p. 183*

[85] The researches that elucidated the life history of trench fever have a close analogue in, and had their scientific and professional inspiration from, those by which the pathology of yellow fever was worked out by self-inoculation by a team of scientific experimenters from the Rockefeller Institute.

[86] *Manual of Elementary Military Hygiene, 1912, p 1*

65. FODEN DISINFECTORS AT THE AUSTRALIAN CORPS CLOTHING EXCHANGE NEAR CORBIE

Aust War Memorial Official Photo No. I 3459
Taken on 10 September 1918

To face p. 580

66. Bath house of the 5th Australian Division at Daours, 21st May, 1918

Men of the 51st Battalion bathing

Aust War Memorial Official Photo No E2314

67. *Left* Fly-proof latrine seat made from a biscuit box
Right A standard ablution bench

These are photographs of models used in the Australian Corps School at Bailleul, February, 1918 (Now in the Australian War Memorial collection)

Aust War Memorial Official Photos Nos J0432 & J0431

To face p 581

The "sanitary" policy and methods of the British Army in 1914 were in great part the result of a mental complex created by the sinister spectre of typhoid and dysentery in the history of British arms, in particular of the British Army in India and in the South African War; the story of cholera added an incentive to pay a perhaps undue attention to water.[87] That in general this apprehension was justified is shown by events at Gallipoli. It may come as a surprise to Australian medical officers that, though by the end of 1915 fear of typhoid had been dispelled, dysentery remained throughout the war the *bête noire* of the sanitary staff of the B.E.F.[88] Happily, as the figures show, it remained a "nightmare." Data are lacking from Australian experience to discriminate between "sanitation" and "T.A.B." as the reason for the low incidence of typhoid, and, after 1915, of paratyphoid in France. In the absence of cholera we are left with "dysentery" and "diarrhoea"—intestinal flux—as the *raison d'être* for the vast structure of "field sanitation" in France.

Before we enter upon an account of Australian experience —so far as it went—in France in these matters it is desirable to take a general survey of the problem of dysentery in the B.E.F.

Comparison with Gallipoli

The extraordinary contrast between the nosological composition as well as the extent of the sick wastage in the Gallipoli forces and that in the B.E.F.[89] must be taken to reflect some profound difference of environment or in the sanitary methods employed. Some differences are obvious. But to which is to be attributed the fact that while at Gallipoli dysentery, "dysenteric diarrhoea," and entero-colitis formed 20·8 per cent. of the total sick wastage and 30·2 per cent. of that from transmissible diseases, on the Western Front the figures are only 0·68 and 1·18 respectively?[90] It is obviously a matter of great importance that the precise reasons for the difference should be determined, but the distinction is by no means easy. It is as difficult to assign to any specific factor, or even to several, the pandemic of dysentery in the M.E.F. as

[87] It would seem, from observations by Australian medical officers in the advances to the Hindenburg Line in 1917 and 1918, that the Germans were far less concerned about this matter than were the British

[88] This is clearly shown, for example, in the discussions of the Interallied Sanitary Conferences A serious outbreak was indeed thought not impossible in 1918

[89] *c f Chapter xxi of Vol I* and this and the previous two chapters of the present volume

[90] The percentages are based on figures given on *p 451 of Vol. I and pp 496, 501-4* of the present volume. If all cases diagnosed "diarrhoea" are included, the figures 0·68 and 1 18 will read 4·00 and 7 05 respectively See also *p 585n* this chapter

it is to account for the comparative freedom of the B.E.F.[91] In *Volume I* responsibility for the Gallipoli pandemic was laid chiefly on two factors. First, that the *early cases of dysentery* were *not recognised* as such but were attributed to "irritation" from "clay in the water"—or by the D.M.S., M.E.F., to "excessive sea-bathing." Second, that when the trouble was recognised as dysentery, it was impossible to remove the *sources of infection*—men could not be evacuated until too ill to fight. In this way the whole community became infected but without the benefit of an acquired immunity. By a deductive process of exclusion—on a somewhat vague basis of factual evidence—the house-fly was incriminated as vector of infection from the open latrines; direct contagion by "dirt"—from lack of soap and water—was an accessory factor. Vitamin deficiency was referred to as a possible negative factor, and intestinal irritation and poor food as a positive pre-disposing one. Drinking water was there exonerated. In the following table the two experiences are compared.[92]

PATHOGENY	GALLIPOLI	FRANCE
Evacuation of infective persons	Only if too sick to be of use.	Every case of suspected dysentery was investigated and, if positive, evacuated.
Carriers	Conditions put control out of question.	The "case carrier" was controlled: all "diarrhoea" cases were suspect.
"Diarrhoea"	M.E.F. *Standing Orders* that "all cases of diarrhoea are to go sick" were not made effective.	Scientific and clinical discrimination were attempted, probably with considerable success.
Faecal disposal	Fully exposed in open pit latrines.	The use of "fly proof" latrines was a matter of discipline, but in front lines covering was often impossible or the order ignored.

[91] It is doubtful, indeed, whether even to-day we are exactly informed on the relative importance of the several biological and mechanical factors in the epidemic diffusion of dysentery and typhoid and even of cholera through a community. There is much in the recorded experiences of the war (it is convenient here to impress) to suggest that the part played by personal—so to speak hand to mouth—contact in the dissemination of all types of contagious disease has been much under-estimated and that the rôle of the house-fly has possibly been over-stressed. Unit outbreaks of typhoid (German, *Typhus abdominalis*) recorded in German unit histories—*e.g.* in that of the 202nd R.I.R., *pp. 142-4* and the *German Official Medical History* seem to confirm more general impressions gained from Australian records that this mode of transfer may be dominant in quite extensive outbreaks of gastro-intestinal infection. In some forms of respiratory infection the rôle of the "spray" would seem over-stressed as against manual convection. We may instance diphtheria (*c.f.* Vincent's Angina), scarlet fever, tonsillitis, and other streptococcal infections of the naso-pharynx and respiratory tract.

[92] In the Gallipoli campaign the question of aetiology was burked by using the term "dysenteric diarrhoea." On Lemnos infection was as universal as on Gallipoli though, through circumstances, the disease was clinically somewhat less severe and was called "colitis."

PATHOGENY	GALLIPOLI	FRANCE
House-fly	Enormously prevalent.	Not considerable—kept in check by "sanitation."
Protection of of food	Practically non-existent.	A disciplinary matter, and reasonably effective.
Personal cleanliness (contagion)	"Soap and water" almost absent.	Except in the trenches facilities for cleanliness reasonably good.
Kitchens and messing	Cooks hopelessly handicapped.	For the most part clean, except in headquarters' messes.
Drinking water	Chiefly brought from overseas; presumed "safe"; not chlorinated.	Safety maintained by chlorination, with enormous effort, which, however, sometimes failed in the front line.
Food as a physical or physiological factor in the incidence of dysentery	Nominal ration identical with France, but as supplied was deficient in vitamins "B" and "C" and, as consumed, was "indigestible."	Greater variety; more fresh foods and much better cooking. A definite but certainly not a determining factor in the freedom from dysentery.
Promiscuity and crowding	Nothing approaching the crowding and promiscuity of Anzac was seen in France; but then Helles, Suvla, Lemnos, where these conditions were much less marked than at Anzac, were as badly infected.	
Climatic conditions	Summer continuously hot and dry.	Climate in summer moister and much more variable.
Seasonal incidence of fluxes	Practically confined to the summer months.	Seasonal incidence not so marked as at Gallipoli.
General factors	Continuous strain almost without any rest or relief.	Regular reliefs from the line to rest areas.

Prophylaxis of dysentery in B.E.F.

The initiation of prophylaxis and the research work in No. 3 A.G.H. on Lemnos have been described in *Volume I.* In France both lines of attack—on the human sources of infection, and on the morbific agents themselves—were vigorously pursued. It is at this point that, although it comes outside the category of direct action, some reference must be made,

as already foreshadowed in this chapter, to the method of *notification* as employed in the *prevention* of gastro-intestinal infections on the Western Front

In the B E.F. from the beginning of the war the policy was resolutely pursued of freeing the force from infection, and an elaborate organisation was built up to effect this. Cases of flux evacuated and found positive either to amoebic or bacillary dysenteric infections were not allowed to return to their units till after three consecutive negative findings. It must be said that in the experience of the medical service of the A.I.F., the policy was by no means easy to carry out. There were two reasons for this. First, the initial diagnosis as between diarrhoea and dysentery was often difficult or even impossible without exhaustive bacteriological investigation; and, second, it was not easy to ensure "disinfection" even if a man was clinically "cured."[93] In the first of these two reasons is bound up one of the major medical problems of warfare—which may indeed be identified as the type problem of military medicine.

"Diarrhoea" or "Dysentery"?

As far back as authentic history can take us in the matter, the question of "cause" as between infection and irritation, "dysentery" and "diarrhoea," has been one of the major problems of military medicine. From the beginning of the Great War until the end, in almost every theatre, this was a cause of much anxiety, of acute differences of opinion[94] and of intense research. Medical literature of the war is greatly occupied with the problem in its various bearings. In the first year or two of the war euphemisms such as "clinical dysentery," "infective diarrhoea," "gastro-enteritis," "colitis," "diarrhoea," provided pigeon-holes for diagnosis whose multiplicity had a single origin—ignorance—and whose vagueness

[93] Of such cases treated in No 3 A G H. at Brighton, in particular of the amoebic infection, Major Lawton notes "Many of the patients were there when we took over and remained when we left. Most of them had no symptoms except occasionally diarrhoea when having emetine bismuth iodide . . Practically, it might have been better to have let these men who had no symptoms join the other carriers in France, for there must have been any number of undetected carriers."

[94] The medical advisory committee of the M E F. held that much of the flux at Gallipoli was due to irritation—food *per se*—the same view was strongly pressed by the senior consultant physician of the A I.F., Lieut.-Col. J. W. Springthorpe The weight of evidence on the bacteriological side was strongly opposed to this In the Sinai Campaign the same question was raised, sand being incriminated. Here again laboratory investigation proved such an hypothesis, to say the least, risky

had one justification—military convenience. By the end of 1915 the situation had greatly changed as a result of the reaction against the terrible impact of intestinal disease in the Eastern theatres of war. Not only were facilities for the routine discrimination of the fluxes made available, but an immense body of new factual knowledge had been assembled and related. In these researches the Australian Medical Service was well represented. The clinical and bacteriological work at Lemnos, continued at Rouen by Lieut.-Colonel C. J. Martin, A.A.M.C., with Miss F. E. Williams, ranks among the most valuable contributions in the medical researches of the war[95] and is an important link in the chain which binds the discoveries of Flexner, Shiga, and their contemporaries to our present-day knowledge. Some account of these researches will be given in *Volume III.* For the present purpose it is only necessary to note that in this line of attack on the problem, procedure was greatly influenced by two discoveries; first that a negative result was often given in positive cases unless the stool was examined at once; second, that unless this was examined in an early stage of the disease it was often difficult, with the methods then in vogue, to identify the organism.[96] The tables given below and at *pages 501-4* and to be more fully set forth in *Volume III* analyse the records of intestinal fluxes in the A.I.F.

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[95] *See Vol. I, pp. 457 et seq., and Vol. III* (work of Martin and Williams).

[96] It will have been observed that the diagnostic entry "diarrhoea" has been allotted a different place in the aetiological analysis of the figures of the B.E.F. from that given to the same "disease" in the records of Gallipoli. This apparent anomaly requires explanation. The different allocations are based on the assumption (1) that the great majority of men cleared to medical units at Gallipoli and therein recorded as suffering from "diarrhoea" were in fact disabled through some form of intestinal infection, and (2) that in the great majority of the cases cleared to field ambulance in France for "diarrhoea" the element of infection was absent or unimportant.

The first of these assumptions is based (*a*) on the fact that at Anzac until the last few weeks of the campaign men were treated in the battalion lines until too ill to be of use in the trenches, (*b*) on the hypothesis—upheld against some weight of opinion—that apart from its deficiency in vitamins "B" and "C" the Gallipoli ration was not *in itself* such as would cause continued and progressive intestinal disorder of epidemic proportions. The second assumption is based (*a*) on the fact that in France all cases of flux were closely observed and their diagnosis controlled bacteriologically; and (*b*) on the clinical records of rest stations and R.M.O's.

However this may be, it can be affirmed categorically—as will have been obvious to readers of *Vol. I*—that the experience of the war of 1914-18 fully justified the vigilant attitude adopted in the British Army toward "diarrhoea." Even of B.E.F. experience, the consultant quoted above (Col. Soltau) wrote: "It is probable that many of the so-called diarrhoeas were in reality true dysenteric infections in mild form."

Relative percentages (of total admissions of Australian soldiers to medical units) due to intestinal flux.

	M.E.F.	WESTERN FRONT			
	Primary admissions to all medical units	F. Ambs Admissions	C C S Chiefly transfers	Exped. Base Transfers	Hospitals in U K. Transfers
Dysentery .	9·96	0·39	1·06	0·64	2·58
Entero-colitis ..	4·02	0·78	0·67	0·45	0·69
Diarrhoea .	6·52	2·90	2·17	0·97	0·63
Total evacuations for flux ..	20·50	4·07	3·90	2·06	4·10

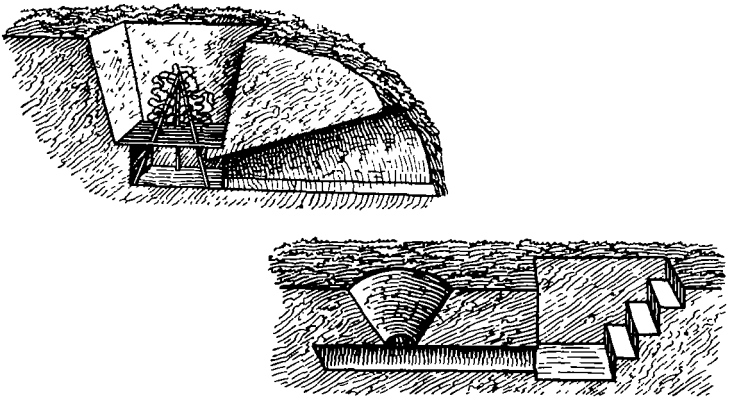
Primary admissions of Australians with intestinal flux to field ambulances on the Western Front and transfers thence to C.C.S., General Hospital, or to the U K.[97]

	F Amb.	C C S.	Exped Base	U.K.
Dysenteric Group				
April, 1916-1917	250	275	411	555
April, 1917-1918	107	67	139	299
April, 1918-1919	435	951	361	620
Total Admissions	792	1,293	911	1,474
Percentage of total sick ..	0·38	0·85	0·58	2·30
Colitis and Enteritis				
April, 1916-1917	606	394	274	105
April, 1917-1918	638	341	231	157
April, 1918-1919	327	233	193	135
Total Admissions	1,571	968	698	397
Percentage of total sick ..	0·75	0·63	0·44	0·62
Diarrhoea				
April, 1916-1917	2,101	750	365	68
April, 1917-1918	2,239	662	506	89
April, 1918-1919	1,667	1,695	585	221
Total Admissions	6,007	3,107	1,456	378
Percentage of total sick .	2·84	2·05	0·92	0·59
Grand Totals	8,370	5,368	3,065	2,249
Percentage of total sick ..	3·97	3·53	1·94	3·51

[97] These figures are based on a partial (over 33 1/3 per cent.) count of the Admission and Discharge books of medical units of the B.E.F.—Australian and British—dealing with Australian casualties. Fuller details will appear in *Vol III.*

Direct action against the fluxes

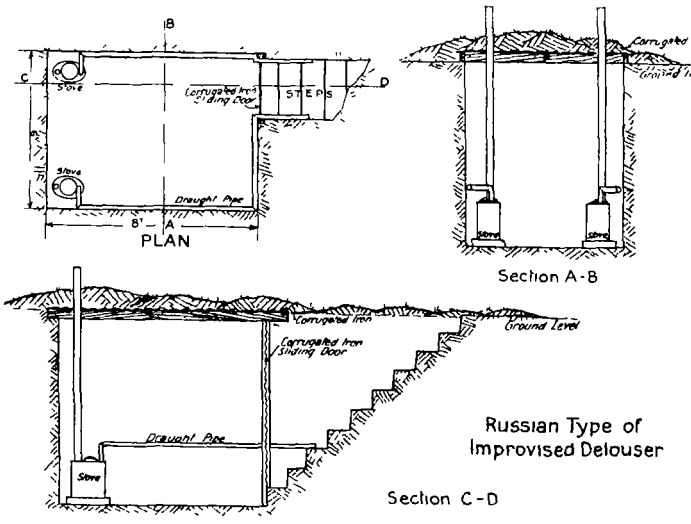
The prevention of the diseases of dirt by *social hygiene* involved, as we have seen, the stupendous task of keeping clean, in the unimaginable filth of attrition warfare, vast hordes of men closely concentrated along the entrenched lines. The problem of *field sanitation* in this form of warfare involved the reconstruction in some form of all the major conveniences of civilised urban existence. In terms of dysentery these may be defined as methods for preventing, directly or indirectly, the pathogenic organisms contained in faecal evacuations from being transferred from one soldier to another. Field sanitation centred on the following objectives. (*a*) The disposal of faeces. (*b*) Measures against the house-fly. (*c*) Providing for ablution. (*d*) Protection of food. (*e*) Protection and purification of drinking water. The immense labour involved in these tasks is reflected in the fact that a very great part of the medical records of the A.I.F. is concerned with their performance; and that in a great measure they monopolised the attention of the sanitary personnel.



The small pit incinerator. This consisted of a conical or sloping pit in the ground, 4 feet to 8 feet in diameter at the top and some 5 feet in depth. This led by a tunnel—commonly a couple of oil drums—either to the side of a bank (as in the upper diagram), or to a raking-out pit approached by steps (as in the lower one). Two or even four passages were sometimes used to catch any winds (The first diagram is taken from the war diary of No. 2 Sanitary Section; the second is drawn from a block model used in No. 4 Sanitary Section for instructional purposes. Each represents a mesial section)

It is, however, neither necessary nor possible to enter upon a detailed examination of the activities connected with each of these functions except to record the experience of the sanitary officers of the A.I.F. as to the technical procedures found most useful—the most suitable type of latrine and method of disposal of excreta in stationary and moving warfare; their conclusions as to the incineration of refuse and disposal of manure; or as to the facilities for ablution *en masse*, fly-proof safes, or kitchen standards and methods. These are dealt with in *Appendix No. 12*

The special interest of sanitation on the Western Front is however, contained in (*a*) the evolution of the method of direct chlorination for providing pure drinking water; and (*b*) the developments that took place in the machinery and methods for giving effect to the principles of field sanitation laid down for



the force. These two features call for more particular notice since in each the Australian force made original contributions to the problem. It is true that each is intimately related to the change in the situation and in the problems of sanitation brought about by the moving warfare of 1918, which is de-

scribed in later chapters. It will however be advantageous to include here the earlier aspects of each, together with certain other developments connected with the stationary warfare of 1916 and 1917.

The water problem on the Western Front

"Wholesome water in sufficient quantity was supplied under conditions often nothing short of appalling. There was no sewage so foul but what it was, when necessity arose, quickly converted into an important and safe drinking water supply in the face of unimaginable difficulty. . . . Let us think of huge armies of men and horses advancing through enemy territory with every source destroyed or fouled by the retreating enemy. A few hours without water and the advancing army would be brought to a standstill. Impure water would more slowly but just as surely stay its advance and lead to its impotence through disease."[98]

In the Army as in a civil community the problems of water supply are fundamental and can never be otherwise. Under favourable conditions the chief agents of gastro-intestinal diseases can live and within limits multiply[99] in this essential food-stuff; and in view of the facts that in warfare such contamination must be the rule, and that natural resistance is feeble, it is certain, notwithstanding any inferences that might be drawn from Gallipoli experience with water and inoculation, that measures to offset this factor in the environment must, as in the Great War, form the foundation-stone of the structure of field sanitation.

No writer could attempt to describe the work of the Services of Maintenance on the Western Front without a feeling of inadequacy; and this deepens when the subject is the steps taken to provide two million troops in the line with safe water —procured, stored, purified and distributed on the spot. No more can be done here than to identify those factors which

[98] From a lecture by Major M. J. Holmes, A.A.M.C., Officer Commanding No. 2 Sanitary Section, delivered to the Institute of Engineers (Canberra Division), Sept. 1932.

[99] Surprisingly little exact information is available regarding experimental investigation or epidemiological observation on this very important matter. The classical experiments of Dudgeon (quoted by Thresh, Beale and Suckling) in 1919 found Shiga bacilli able to survive in *sterile* water up to 3-4 weeks. Death (these writers state) would occur more speedily in "natural and impure water." H. W. Streeter (*Sewage Works Journal, 1930, Vol. II, p. 131*) discussing the natural purification of streams, notes an initial increase of bacterial density up to 10-15 hours, after which it decreased steadily, at least 8-10 days being required in the rivers studied for the bacterial content to become normal. Professor Harvey Sutton, to whom the author is indebted for the above, records an "epidemic of diarrhoea" in a unit of Light Horse in the Jordan Valley in 1916, which was proved to be due to infection of the water supply by a unit higher up the stream.

from the medical point of view most contributed to the astonishing success achieved.[100] If we accept the postulate that infected water is a major cause of gastro-intestinal disease,[101] then the part played by the medical service in this matter must take a high place as contributing to the successful prosecution of the war.

Factors in the Problem Responsibility. Division of labour is the foundation of social life, and a modern army is perhaps the most exactly organised form of communal living that man has evolved. This is not to say that it is the highest form of development in the art of living; but that it is the most complete and compelling form of social co-operation on a great scale directed to the fulfilment of a specific social object. Its activities are motivated by an intensity of purpose unapproached in the pursuits of peace. The history of water on the Western Front is that of progress in co-operation between the several services concerned—engineers (supply), "Q" (distribution), medical (purity), A.P.M. (order); and in the creation throughout the force of that mutual understanding of aims and methods which constitutes the only useful basis of "discipline." Of the four factors involved the medical service had all to do with purity, and much with the creating and maintaining of "water discipline" under the various conditions of fighting and season.

The Water Supply. Water in France was derived from extraordinarily diverse sources—from shell-holes, moats, shallow wells[102] and streams foul beyond conception—in ascending scale up to huge specially constructed reservoirs, and deep wells, the supply from which was reticulated to "water points" within a few miles of the front line.

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[100] A great part of *Vol I* of the two devoted to the hygiene of the war in the *British Official History* is occupied by an admirable account of the water supplies in different theatres of war

[101] The view held by Australian medical officers in France is indicated in the following extract from the lecture by Major M J. Holmes "In back areas, with troops in rest, there should be every chance of diarrhoea being eliminated, at least in the non-fly season, if water supplies are safe-guarded With the advent of the fly and dust season, of course, food probably plays a greater part than water in the spread of the disease"

The following is from the report to the Fourth Plenary Session of the Inter-allied Sanitary Conference in 1919 by the A.D.M S. Sanitary, B.E.F. (Col. Beveridge) whose opinion carried great weight —

"The period of greatest prevalence [in France] has been 10 to 12 weeks of July, August, September which coincides with the fly season, the hottest weather, and often the greatest military activity." The incidence rate in the B E F. for 1918 was 618·6 per 100,000 per annum (12,211 cases with 46 deaths, the majority the Flexner type) In 1916 the maximum incidence was 124 per 100,000 in September, in 1917 54·76 per 100,000 in August, in 1918 180 in August

The chief measures for control were stated to be "(1) attention to proper disposal of excreta so as to prevent the contamination of food and water, (11) removal and treatment of all cases of diarrhoea as they occur"

[102] It was a not infrequent complaint by the owner of houses in which troops were billeted that the water in the household well was made undrinkable by disinfectants put in their family cesspit

Purification. The Army scheme differs from that of civil life in that, however great the body of troops involved, the service is carried out, broadly speaking, on an individual basis,[103] the allowance for each man being rationed as strictly as his food.[104] The unit of demand in the infantry is the Battalion. At the outbreak of the war the unit of distribution and for purification was the 200-gallon water-cart fitted with clarifying and filtering apparatus (porcelain candles). The concentration of troops on the Western Front compelled new methods. A process of chlorination replaced the futile filter candles; the "step-by-step" battle made the two-gallon petrol tin the most important unit of distribution. The strategy of attrition required, since the matter bore on wastage, a new *standard of discipline* of which the Sanitary Section was the chief implement.

Of these elements in purification chlorination will be supplanted: the two-gallon petrol tin served a special purpose in the late war; but sanitary discipline was the answer to a human problem and will be required as long as armies. It was intimately bound up with the evolution of the Sanitary Sections, and will be examined in connection with the work of those units. The chlorination process and the two-gallon petrol tin call for a brief note.

Chlorination. Implemented as it was in the British Army by an admirable piece of military apparatus, the "Standard water sterilisation test case,"[105] the application of the chlorination process to the problem of water supply in the field must be held one of the great advances in military medicine and the agent in a new epoch of army sanitation. It replaced filtration through Berkfeld candles through which water was forced by hand pump—a rule almost invariably honoured in the breach, unless the candles were cracked! In the chlorination process water was sterilised by adding to the water-cart or other receptacle an amount of bleaching powder sufficient to combine with all the organic material contained—from 1 to 4 or 5 parts per million. The amount required was commonly determined by test on the spot after, if necessary, clarification from gross impurities by sedimentation—as with alum—and filtration through flannelette. Experimental work had been carried out before the war in the Royal Army Medical College and the amount of chlorine required in the form of bleaching powder had been roughly estimated.[106]

"Horrocks' test case."[107] This was based on the principles (1) that

[103] During the period of siege warfare in France some immense schemes of supply were created involving the construction of reservoirs, from which water was distributed under conditions which, in the "approach" areas, did not differ greatly from those of civil life Such conditions can, however, hardly be held normal for warfare in the field

[104] The official teaching in 1914 was that "each man would require daily"—in barracks, 20 gallons, in standing camps 3-5 gallons On active service a gallon per head was the estimated requirement, with a minimum of 3½ to 5 pints daily for drinking

[105] Commonly known as the "Horrocks' test case"—officially as "Case, water testing, sterilisation"

[106] Before the war the method of water purification by the use of chlorine had been chiefly exploited in America.

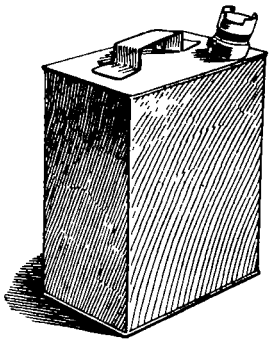
[107] This derived from suggestions made in 1914 by Professor G Sims Woodhead of Cambridge University. The outfit designed by him was, however, found too elaborate for field work. A simpler "test case," based on the 4 oz. tins of chloride of lime ("bleach") already supplied to the troops, was designed by Colonel Sir W H. Horrocks, Director of Hygiene at the War Office, and this became a general issue, for use both at home and in the field.

chlorine in water is "fixed" by organic material including bacteria which it kills, and (2) that with starch solution the presence of any free chlorine is shown by a blue colour. The purpose of the test was to determine the amount of bleaching powder required in any given sample of water. The apparatus could be used by "water duty" men or any intelligent soldier; but throughout the war its employment was almost wholly a responsibility of the Medical Service.[108] The chief reason was to ensure that it should be scrupulously done.

Distribution. Three distinct problems presented themselves in the reserve and approach areas and in the front line. The front line could be served only by hand-carry or pack animals drawing by water-cart or otherwise from the reticulation points, or other source, where (under the direction of "water point men") the units obtained and purified their supply.

Front Line Supply—the Petrol Tin. The Australian force arrived in France at the moment that the British High Command and every service of maintenance was preparing for the Somme. Early in April, 1916, the I Anzac Corps was asked to suggest, on the basis of Gallipoli experience, a method for supply to the front line.

"Some means of carrying water to the trenches by hand is required, and it is proposed to adopt some form of receptacle for this purpose and issue to a scale of so many per brigade or division in front line trenches. Before proceeding further in this matter I should be glad of your opinion on the following points: (1) What form of receptacle should be provided? (2) What amount of water should it hold? (3) How should it be carried? (4) On what scale should provision be made?"



Two-gallon petrol tin. The dimensions were: base 9½ in by 5¾ in., height 11¼ in.

The two-gallon petrol tin was recommended by the Australians "or tins of similar shape and somewhat larger size." The two-gallon tin was adopted, and in May an issue of 1,600 per division in the front line was approved by the Quartermaster-General B.E.F. (Lieut.-General Sir R. C. Maxwell) "for the purpose of carrying water to the trenches . . . these to be considered as trench stores and to be demanded from the Deputy-Director of Supply and transport." In July an Anzac Corps dump of these tins was formed in Albert, with a repair shop, and units drew at the rate of 3,500 tins per Division, to be returned when empty to the Corps dump. The scheme

[108] Under certain circumstances the test was carried out by the Engineers. Chlorination at the source was sometimes adopted, as in the supply to the Somme battlefield from the Ancre. Mobile hygienic laboratories carried out special tests and advised on the technical questions that arose in connection with the large supply systems. In the last year of the war highly elaborate mobile apparatus and a special army service were organised to meet the needs of rapid movement of troops. In the French Army *eau javelle* replaced "bleach."

was soon greatly extended, and experiments made in transport. A special framework was fitted to water-carts; and special vehicles were also used. On the medical side a procedure was worked out for chlorination direct in the petrol tins, using a standard solution of bleach.

In this manner was instituted the system of supply by petrol tin to the front lines which served the British force, winter and summer, through every vicissitude of trench warfare and the advance to victory. The 200-gallon water-cart, chlorinated direct, remained the unit of supply for battalions on the move or in rest.

Collective Supply—the Mobile Water Columns. The individual system of supply described above and elsewhere was in France as in other theatres supplemented, or even at times superseded, by "supplies" provided wholly by the engineers and distributed, somewhat like other rations, by A.S.C. "water companies." Only a bare statement is possible of these stupendous activities.

From early in 1915 experiments were undertaken into the possibility of making water an A.S.C. supply. The purpose was achieved by the provision of "sterilising" and "water tank" lorries, and barges. Soon afterwards Water Tank (M.T.) Companies A.S.C. were formed to operate them.[109] Sterilisation was by chlorine—in the form of bleaching powder or gas—and the plant consisted of (*a*) pumping unit, (*b*) filtering unit, (*c*) chlorinating unit and contact tank, (*d*) dechlorinating unit (by sodium bi-sulphate and ferrous sulphate, or SO_2). Transport was by 150- or 500-gallon tanks on 30-cwt or 3-ton lorries. An establishment for the Water Tank (M.T.) Companies A.S.C. was approved at the end of 1915.

The capacity of these Water Companies may be judged by the fact that by the time of the Armistice No. 1 Company had sterilised 5,500,000 gallons of water and carried 35,500,000 gallons. Their organisation and equipment made them highly mobile and adaptable.

The fact that the Australian Imperial Force was organised, trained, and used almost wholly in front line work was very exactly reflected in the reaction of its personnel to the varied conditions of their warfare; and its influence is strikingly evident in the history of the important medical units whose

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[109] In the companies first formed, complete arrangements were made for the detection and removal of arsenic and cyanides, copper and lead—from water "accidentally or purposely contaminated." The later formed companies were not so equipped.

The *British Official History* states that four Water Tank Companies were formed of which the first two and last two varied considerably in their capacity, equipment, methods and establishment. Nos. 1 and 2 consisted of 186 vehicles, of which 111 were lorries with 150-gallon water tanks, 19 3-ton lorries with clarifying and sterilising plant, 11 lorries with clarifying and anti-poison plant, and 20 3-ton lorries with 500-gallon tanks. The agent employed was "bleach." The staff consisted of Army Service Corps personnel, for carrying water, with R.A.M.C. attached who were responsible for the technical duties connected with sterilisation. Nos. 3 and 4 companies had 324 vehicles, and the personnel consisted of a headquarters, 6 sections A.S.C. "for carrying water," and 3 sections R.A.M.C. "for sterilising water." The agent employed was chloramine gas.

experiences on the Western Front we are now briefly to follow.

The Australian Sanitary Sections in France[110]

Their development, indeed, has a permanent place in the wider field of the general evolution of military medicine. It is not proposed to undertake a systematic account of the technique of sanitation in the field[111] as this developed in the A.I.F. in France at the hands of the Divisional Sanitary Sections and the sanitary personnel of field units, but rather to use their experience to indicate the trend of development of preventive medicine in war as this was visualised and explored in the Australian force.

The place of the Sanitary Section and the Regimental sanitary details in the organised scheme of "sanitation"[112] in the field army has already been indicated.[113] No special account

[110] *Manual of Elementary Military Hygiene, 1912* —"'Sanitation,' the synonym of hygiene, means health or health preservation, that is, the prevention of disease" In the *Army Manual of Hygiene and Sanitation, 1934*, "hygiene" is defined as "the science of the maintenance and promotion of health and the prevention of disease", and "sanitation" as "the practical application of the science of hygiene to the varied conditions of life"

[111] The experiences of the Great War have been translated into present military practice in the official *Army Manual of Hygiene and Sanitation* In this manual the methods and apparatus found most useful are described and figured To those who live in the Australian country parts, details of apparatus have particular interest, and it may be noted that a paper on the "Application to civil life of the lessons of military hygiene derived from the Great War" was read by Major M. J Holmes, sometime O C. No. 2 Australian Sanitary Section, before the Section of Naval and Military Medicine and Surgery in the 11th Session of the Australasian Medical Congress held in Brisbane in 1920, and appears *in extenso* in the Transactions printed and published for the Congress by the Queensland Government Printer. This admirable study advocated the application in civil life of three principles found valuable in Army sanitation. (*a*) Uniformity and simplicity of administration—clear definition of responsibility, (*b*) Research, (*c*) Education. It may be regretted that a wider publicity was not secured for this study, in particular to its relevance in the sanitary problems of "bush" townships These general principles had already been embodied by the Federal Director-General of Health (Dr. J. H L. Cumpston) in his national policy, and they are to be seen to-day inspiring the advances that have been made in the wide field of Federal co-operation in promoting the national health of the Australian people.

[112] Every military unit of any size either had special "sanitary" personnel, or was required, in military parlance, to "detail" some of its personnel for sanitary duties. This was the case with the Field Ambulances, C.C S's, and General Hospitals

The status of the Regimental "sanitary detachment" has been a matter of debate in the British Army from its genesis in Cromwell's "New Model" Army in 1645 Its inception seems to have been in this wise In the "Laws and ordinances of Warre" to govern the Parliamentary Army it was provided, as a punishment for "retreating before they come to handy-strokes" with the enemy, that if the fault lay with the officers "they shall be banished the Camp" for a period. If with the soldiers, "then every tenth man shall be punished at discretion, and the rest serve for Pioners (*sic*) and Scavengers till a worthy exploit take off the Blot." (Appendix to *Cromwell's Army* by C. H. Firth, *2nd Ed 1912*.)

It was laid down during the Great War (correspondence between Fifth Army and I Anzac Corps and 4th Australian Division, April, 1917) that "men belonging to Regimental Sanitary Squads should be trained [*i.e.* in Arms] as laid down in War Establishments, but it must be understood that their sanitary duties are to have preference"

[113] *See e.g. pp. 507-10 and relevant references in Vol I*

will be given of Regimental "sanitation," as carried out in France.[114]

The methods employed in the field units were those recommended by the Sanitary Sections, while *the development of an effective liaison* between the two is most conveniently followed as from the point of view of the Sections. It was, indeed, the major question in their evolution, far exceeding in its importance that of the methods and apparatus of field sanitation and only approached by their part in the problems of providing pure water for the troops in the field.

Beginnings. The Australian Sanitary Sections were created in 1915 as a new element in the medical system, not a part of the Divisional organisation. Their personnel belonged to the Medical Corps and were "non-combatants." They were raised on a basis of one per division, and were "attached" to divisions in much the same way as field ambulances to brigades. Though from the outset they were essentially "Divisional" troops, this "Divisional" association, which became so prominent a feature in their service, evolved rather as a functional urge than a structural heritage.

Allocation of Units. The early history of these units has in part been recorded. The 2nd Sanitary Section happened to be allotted to the 1st Division, and the 1st Section to the 2nd Division;[115] the others were

[114] Nevertheless, in sanitation as in all other matters, the battalions and other military units who carried out the real business of war were in a very high degree self-contained and responsible. Under each of the two theories regarding the place of the Sanitary Section in the preventive medicine of the front, it was accepted that, in the matter of conservancy, the duty of this new medical unit was to promote or to supplement, not to supplant, the internal "self-help" activities of the fighting units. This matter is dealt with in detail in *Vol. I.*

[115] *See p 29.* On 28 Jan, 1916 the following was issued by the G O C. Anzac Corps

"Approval is given for the inclusion of a Sanitary Section in each of the 1st and 2nd Australian Divisions . . The Sanitary Section, recently arrived from Australia, and now at Tel-el-Kebir, will be designated the 1st Australian Sanitary Section, and will constitute the Sanitary Section of the 2nd Australian Division The Sanitary Section of the 1st Australian Division will be designated the 2nd Australian Sanitary Section, and its formation will be carried out by the Divisional Commander in consultation with the D M S, A I.F., who will nominate a medical officer as O.C. Section. Any improvised Sanitary Sections previously authorised for these Divisions will cease to exist as such, and the personnel not absorbed in the Sections now authorised will be returned to the units from which they were drawn."

It may be recalled that on Gallipoli, in the absence of a specially enlisted Sanitary Section, a "sanitary" unit was improvised from Divisional personnel to fill a most pressing need. Stress is laid in *Vol. I (p 357)* on the results of the failure—due in great part to lack of a trained Sanitary Section—to educate the personnel of battalions in sanitary self-help such as the construction of "fly-proof" latrines from biscuit-boxes. *See Vol I, pp 28n, and 251.*

allotted to the division with the corresponding number, and this allotment was adhered to throughout their subsequent administrative vicissitudes as "Army" and "Corps" troops.

Establishment and Personnel The establishment of a Sanitary Section provided for 1 officer, 5 N.C.O's and 20 privates. On the Western Front throughout the war their command was given to legally qualified medical practitioners and the D.M.S., A.I.F would permit no deviation from this principle.[116] It may be said at once that with notably little exception the selection of their personnel ensured a very high standard of achievement; these units were commanded and served with conspicuous ability. The outlook and ideals of a public health service of preventive medicine was ensured by an initial leavening of the command with medical officers of health, and of the N.C.O's with public health inspectors. Practical efficiency was assured by the inclusion of officers and men who had "made good" in general medical work in the divisions, of tradesmen and artisans, carpenters, tinsmiths, plumbers, draughtsmen and so forth, among the rank and file.

Up to the time of their arrival in France the Sections were administered directly by the A.D's.M.S. and had acquired a very definitely Divisional outlook.

Control by Division ? Corps ? or Army ?

This was quickly modified. It will be recalled that when at the beginning of 1916 the A.I.F. arrived in France the Western Front had settled down deliberately to siege warfare and this was enormously accentuated by the Somme battles and in particular the "Somme Winter" (1916-17). The shallow and labile Divisional fronts congealed into deep and relatively immobile "Corps" areas, within almost wholly static "Armies"; the Divisions themselves, the fighting formations, moved for the most part within the restricted gambit of the front, relief and rest areas of their own Army Corps. The whole front (as we have seen) was organised as a 100-mile-long town of varying depth, with some two million inhabitants. The conditions of life and the problems of "sanitation" in the Army Corps and Army areas became almost as stable as in a civil community. The effect of this is to be seen in a similar congelation in the outlook on the problem of disease prevention on the part of the army authorities; in particular—in the British service though not as a whole in the Australian—it brought about that the function of the Sanitary Sections became envisaged in terms of *material*, rather than of *men*, of apparatus rather than education. The indubitable need for some more or less permanent sanitary *cadre* to assist the "Town Majors" in maintaining the structural

[116] In this the A I F diverged from British practice and—it must be added—principle See in this connection *Chapter* [illegible], and *Vol. I, pp. 609n and 629*

integrity of the permanent latrines, incinerators and grease-traps was *met, not* by the allocation of special personnel, but by immobilising the Sanitary Sections.

The consequent developments are noted here briefly; but the matter is considered to be of sufficient interest to justify inclusion of some relevant correspondence on the matter as an Appendix (*No. 12*).

(*a*) *1916: Corps Control.* The endeavour to exempt the sections from the rapid moves of the Divisions in and out of the line in the battles of August-September 1916 has been noted in *Chapter IV*; as three divisions only were concerned, and the Sections were allotted to areas controlled by the A.D.M.S. of the Division that happened to be passing through them,[117] the "personal touch" was not lost and the general control by the D.D.M.S. ensured continuity of policy. It was otherwise in Australian experience in the next development.

(*b*) *1917: Army Control.* As early as September, 1916, the authorities of Fourth and Fifth Armies had pressed for a revision of the order which (in 1915) made the Sanitary Sections Divisional units. In March, 1917, on the advice of the A.D.M.S. for Sanitation, instructions were issued by G.H.Q., B.E.F., as follows:—"In order to maintain continuity of sanitary work in Armies it has been decided to withdraw Divisional Sanitary Sections from their Divisions, and to constitute them as Army Troops Units. Instructions dealing with the employment of Sanitary Sections are issued herewith. Orders for the movement of these Sections between Armies will be issued by G.H.Q.; Orders for movements within Army areas being issued by Army Headquarters." The instructions implementing the order were put in force forthwith, and happened to coincide with the German retirement, "Alberich", within three weeks the A.D's.M.S. of the four Australian Divisions issued a combined protest to the Deputy-Director—the gist of their complaint being chiefly the loss of personal touch with their Sections. The real clash came when the Divisions moved north, since the policy conflicted with that of Dominion autonomy. The matter was passed by Haig to the War Office, with the result that instructions were issued whereby, when such action was possible without dislocating the army arrangements, the Australian units were exempted from strict compliance with the order. Control therefore reverted to Corps, which commonly delegated it to the Divisions. Subsequent developments will be described when we come to the final stage of the war.[118]

Results of Australian Policy. The "national" involvements of the policy fortified a technical and service objection which grew in strength as the staff of the Australian service observed the effect of the authorised policy on the British units. The crux of the matter was that while the Australian units carried out a policy of educating the combatant units in self-help, pioneers and others from the battalions being attached to the Sections for training in sanitary methods and in construction and especially in improvisation of appliances, the British units became for the most part executive, constructing, far in the rear, sanitary and other appliances for delivery ready-made to the battalions.

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[117] *See pp 69, 73*

[118] *See pp. 710-14.* New Zealand accepted the severance but made special Divisional arrangements. The Canadian Corps, like the Australian, secured the principle of "Corps" control of its Sections.

The nature of the duties of Sanitary Sections was clarified at the conference with the medical authorities of Second Army when I Anzac first reached France.[119] In the Australian service they gradually crystallised into three broad lines of action relating respectively to (*a*) co-operation in the indirect line of defence against infectious disease in general (by notification, and search for carriers or other sources of disease—in particular for sources in the civil environment and foci in the civil population), (*b*) disinfection and disinfestation, and (*c*) "direct" action against gastro-intestinal infections.

Functions of the Sanitary Sections

As to (*a*) Major M. J. Holmes says that, under the British system, as contrasted with that of the A.I.F.,

> "the Sanitary Section was outside the notification scheme—it was concerned with scavenging, water control and so forth. In the Australian force, in particular in the 1st Division, the unit had a definite place in the control of disease by public health methods, the duty of the O.C. Sanitary Section being to trace contacts and carriers, to carry out terminal disinfection, and to investigate the origin of the case (under orders from the A.D M.S. and in conjunction with the R.M.O.), especially in the civil population."

(*b*) Its duty of disinfection and disinfestation can also be dismissed briefly. In mobile warfare the "Foden lorry Thresh disinfector" was usually attached to the Section and moved with it, and Battalions had their blankets "disinfected" by individual arrangement; in static warfare the disinfector was generally attached to the Divisional baths, the Section usually allotting men to work it. The construction of improvised apparatus, such as the Russian Pit, was studied and taught to the battalions.

(*c*) The *raison d'être* of the Sanitary Section, however, was chiefly to promote "direct action" against gastro-intestinal infections. This has already been defined as the prevention of the contamination of food by flies or filth, and was ensured, in brief, by the disposal of excreta, prevention of fly-breeding, the protection of foodstuffs, the personal use of soap and water, and by achieving a safe water supply. The Sections developed a considerable degree of individuality in their methods of pursuing their purpose and in the relative prominence given to the

[119] *See pp 32-3.*

several features of their work, but in all these matters the duty of the Section was interpreted in the Australian Force as comprising *inspection* and *supervision, education, construction* and *research*, with the purpose of promoting a high standard of sanitary morale and technical efficiency in the combatant units. The Sections experimented, with varying ingenuity and initiative, with old and new methods for achieving the simple "sanitary" purposes noted above. Some illustration of apparatus favoured or developed in the Australian force will be found in this chapter,[120] and an outline of the sanitary technique on the Western Front in *Appendix No. 12*.

Divergent views on the Sanitary Section

It is only fair to record that some officers of the A.I.F. held views on the functions of a Sanitary Section which differed somewhat from that here presented. Thus the officer commanding No. 3 Sanitary Section[121] held that

"the only usefulness of sanitary sections for front line or support line is to make latrine boxes, and get them taken up at night. . . . The limit forward of usefulness is at about reserve Coy. cookhouses, where grease traps, latrines, F.P. food boxes and water supply can be gone into. The most useful work is in camps and villages where troops are camped or billetted in large numbers."

He proposed that—

"The time has come for a radical alteration in sanitary sections to be considered: (1) cease to have a medical officer as O.C ; (2) enlarge the size of the unit and make it a working unit with power to demand material and the duty of making *all* sanitary appliances; or (3) do away with the section as a unit and simply have 12 inspectors attached to the A.D.M.S. staff to inspect divisional units and work under the D.A.D M.S. of Division."

But on the other hand it is not less pertinent to quote the opinion of a British sanitary officer[122] who was closely associated with the Anzac Corps on Gallipoli:

"In trench warfare at any rate every division requires its Sanitary

[120] The hotly debated question of construction of apparatus for other units by the Sanitary Sections is touched on in *Chapter xii, p 654* and *Vol I*

[121] Major W. R. Kelly in a "Memorandum on Sanitation." The opinion of the D D.M.S , Desert Mounted Corps (Colonel R M. Downes, A.A.M.C) has been placed on record by him in *Vol I* of this work

[122] From a copy of a letter to Sir Alfred Keogh contained in Surgeon-General Howse's private papers. At this time the Sanitary Section was a line of communication unit

Section. . . . It must in future be an *integral part* of the divisional scheme, not to replace regimental sanitary duties and responsibilities but to give skilled assistance, to inspect, and to fill up gaps."

Even in France R.A.M.C. officers approved at times the Australian stand. Thus:—[123]

"15/7/18. This unit . . . is losing its special functions and is being forced into a constructional unit. . . . The latest XV Corps order provides that sanitary sections shall supply all sanitary appliances on demand by Area Commandants.[124]

"21/7/18. Had interview with D.D.M.S. re Corps order. . . . Pointed out that . . . the sanitary section is a medical unit primarily and not a branch of R.E. Put my views in writing for the D.D.M.S. who will bring the matter forward. 22/7/18. Again called to see D.D.M.S. at his request. This matter has been sent forward to the Corps for reconsideration. 29/7/18. Attended conference at XV Corps 'Q.' It was admitted by the Corps that sanitary sections should not be made to bear the responsibility of providing sanitary appliances on demand. . . . Corps order will be amended accordingly."

The Section's place in water control

In the very important matter of water control the Sanitary Sections were concerned chiefly with the problem of ensuring that the supply was made suitable for consumption and, in particular, that chlorination was carried out efficiently. The matter resolved itself into a problem of the organisation of supplies, and control of distribution—to ensure that the battalion water-cart and petrol tins were always treated, before consumption, with the amount of bleach found by the Horrocks' test to be required, and to minimise the use of untested and "illicit" supplies—as from shell-holes while in the front line. This last was partly solved by the two-gallon petrol tin. General organisation and control were effected in two ways:—

(1) There was established a system of *authorised water points* where representatives of four branches—Engineers, "Q," A.P.M., and Medical Service (Sanitary Sections)—co-operated to control and assist the distribution of the available supplies to the fighting units. There arose a question as to whether responsibility for chlorination rested with the regimental "water duty men" or the personnel of the Sanitary Section. It was found best to suit the rule to the circumstances, but with no weakening of regimental responsibility.[125]

(2) At the end of 1916 it was found necessary to test the efficiency of battalion chlorination by instituting a systematic campaign of in-

[123] From the personal diary of the O.C., No. 2 Aust. Sanitary Section (Major M. J. Holmes). His unit was attached to the British XV Corps, Second Army, July-Aug., 1918.

[124] These comprised ablution benches, latrines, urinals, incinerators, cook-houses, meat store-rooms, fly-proof meat safes, grease traps, cutting-up tables. They were required at times to make office furniture.

[125] British A.D's M.S. insisted strongly on complete regimental responsibility, Australia inclined to facilitate co-operation by the sections. The first was less efficient but also less influenced by circumstances and must inevitably remain the first, and perhaps the most important line of defence. The question whether test cases should be issued to Engineer companies came up in the open warfare later in the war.

spection of Battalion water-carts as they went up full to their units. The result was at first disconcerting; improper chlorination or none at all was the rule. But by admirably organised and sustained efforts and Divisional co-operation, by the beginning of 1917 an efficiency approaching 100 per cent. was achieved. This standard could not in all conditions be maintained. But it can be stated that in chlorination, controlled water-points, inspection, and the two-gallon petrol tin, reinforced by the mobile water column and hygienic laboratory, the army had a rampart of defence against water-borne infection invulnerable save to the extreme vicissitudes of trench warfare on the one hand and moving warfare on the other.

Preventive medicine—the significance of "P.U.O."

A feature that marks out the Great War, from the medical point of view, from all others, is the degree to which exact diagnosis and pathogenic discrimination influenced the routine not only of medical work but of military life In every campaign,[126] if with varying degrees of refinement, a soldier's sickness was diagnosed, and discriminated from that of his fellow "casualties." Each man and each "disease" received appropriate attention, whether of treatment or for prophylaxis. *Diagnosis and discrimination,* on the surgical side in treatment, on the medical in "prevention," give the keynote to the medicine of the war and its most profitable "lesson." But (it may be asked) what of "P.U.O."—of which "disease" admissions to Australian Field Ambulances in France totalled 24,593 cases, 11·6 per cent. of all evacuations for sickness? What of "N.Y.D" and "N.Y.D.N."? Do these not invalidate the thesis?

Consideration of the facts makes clear that the reverse is more true. "Shots" at diagnosis were taboo. In N.Y.D., the service frankly said, "We do not yet know." "P.U.O." was a tribute to "reality." In great measure it replaced the civilian practitioner's bluff of "influenza." The diagnoses "N.Y.D.N." and "N.Y.D. Gas" illustrate the practical military purpose secured by frank acknowledgment of ignorance, and a determination to achieve the nearest approach possible to the facts of pathogeny. Medical intervention (it was observed) is successful in proportion as aetiological factors are exactly recognised and taken into account, and deliberate research for such

[126] Provision for exact diagnosis was by far the most important feature of the medical reorganisation that followed the first "wave" of disease at Gallipoli *See c a. Vol I, p 247.*

eminently "worth while" even in the throes of a World War. Evolution along these lines was indeed characteristic of this war, and was probably its most important, perhaps its only positive contribution to the science and art of living. In this contribution the profession of medicine was able to further its own broad and humane purpose in the world, even while serving the inhuman purposes of war.