The Medical Response to the Trench Diseases in World War One

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By

Dr Robert L. Atenstaedt
MA MPhil (Cantab) MBBS (Lond) MSc DPhil (Oxon) MPH (Liv) MFPH

(Holder of the Robert Skerne 1661 Scholarship from St Catharine's College, Cambridge University, the Norah Schuster Prize in History of Medicine and the Young Epidemiologist Prize from the Royal Society of Medicine, and the St. Bartholomew's Medical College Medical History Prize)

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This book is dedicated to all the doctors who lost their lives in the First World War, and especially the approximately 1,000 medics of the Royal Army Medical Corps.

I would like to make a supplementary dedication to my great-grandfather, Lieutenant John Hutt MBE (*milit.*) R.N.V.R., who served with distinction in World War I; also to my grandfather, Group Captain Leslie Bonnet MA LLB (cantab) of Criccieth, Gwynedd - writer, duck-breeder and originator of the Welsh Harlequin Duck; serving with distinction in the RAF in World War II, he received the Order of the Cloud & Banner with Special Rosette from the Chinese Nationalist Government for services to China.

Cyfaill blaidd, bugail diog

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LIST OF ABBREVIATIONS

(A)	Officer from another allied army	***JCH***	*Journal of Contemporary History*
ADDMS	Assistant Deputy Director Medical Services	***JH***	*Journal of Hygiene*
ADGMS	Assistant Director-General Medical Services	***JHM***	*Journal of History of Medicine*
ADMC	Assistant Director of Medical Corps	***JPB***	*Journal of Pathology & Bacteriology*
AMS	Army Medical Service	***JRAMC***	*Journal of the Royal Army Medical Corps*
AG	Adjutant-General	***JRSM***	*Journal of the Royal Society of Medicine*
ARC	American Red Cross	***Lancet***	*The Lancet*
BEF	British Expeditionary Force	**L of C**	Lines of Communication
BJHS	*British Journal of History of Science*	**LGB**	Local Government Board
BHM	*Bulletin of History of Medicine*	***MH***	*Medical History*
BKW	*Berlin Klinische Wochen*	**MO**	Medical Officer
BMJ	*British Medical Journal*	**MOH**	Medical Officer of Health
BJS	*British Journal of Surgery*	***MPC***	*Medical Press & Circular*
(C)	Civilian	**MRC**	Medical Research Committee
CBHM	*Canadian Bulletin for the History of Medicine*	***NEJM***	*New England Journal of Medicine*
CCS	Casualty Clearing Station	***NYMJ***	*New York Medical Journal*
CME	Commission on Medical Establishments	***Practitioner***	*The Practitioner*
CO	Commanding Officer	***PRSM***	*Proceedings of the Royal Society of Medicine*
CRSAS	*Comptes rendus de l'Académie des sciences*	**PUO**	Pyrexia of Unknown Origin
DADMS	Deputy Assistant Director of Medical Services	***QJM***	*Quarterly Journal of Medicine*
DAH	Disordered Action of the Heart	**QMG**	Quarter Master General

DDGMS	Deputy Director-General Medical Services	**(R)**	Regular Officer
DDMS	Deputy Director of Medical Services	**RAMC**	Royal Army Medical Corps
DGAMS	Director-General of the Army Medical Services	**RMO**	Regimental Medical Officer
DMS	Director of Medical Services	***SHM***	*Social History of Medicine*
FA	Field Ambulance	**(T)**	Temporary Officer
GHQ	General Headquarters	***TMO***	*The Medical Officer*
GHR	*Guy's Hospital Reporter*	**TNA**	The National Archive
HWJ	*History Workshop Journal*	***WJM***	*Western Journal of Medicine*
IMS	Indian Medical Service	**WL**	Wellcome Library
IWM	Imperial War Museum	**WO**	War Office

CHAPTER ONE

KEY CONCEPTS AND QUESTIONS

> The medical officers on the western front found themselves confronted …with the problems of trench warfare and the diseases consequent upon prolonged exposure to cold, dampness, contaminated soil, filth, lack of bathing facilities and the ever present possibility of vermin infestation (Garrison 1970, 203).

The combat dangers encountered by the soldier during the Great War were numerous, including barbed wire, shelling, grenades, machine-guns and poison gas. Sitting in his trench, he also faced assaults from the diseases that prospered in this environment. Historians have paid attention to certain conditions such as "soldier's heart" that afflicted troops serving in the western sphere of operations (Howell 1985, 34-52). However, a neglected area of research is the group of diseases that bear the name of the trenches, namely trench fever, trench nephritis and trench foot.

The War was fought between the major world powers. In this study, discussion will be concerned with the Western Front, where the Germans faced the French and the British (and later the Americans). When the front stabilised in November 1914 (Woodward 1967, 38), there were four million men living in 4,000 miles of excavated earthworks, stretching from the North Sea to the Swiss border. These trenches were "well-dug entrenchments, protected by barbed wire, occupied by full complements of infantrymen, and disposing of ample quantities of machine-guns, mortars, shrapnel and high-explosive shells" (Prior and Wilson 2004). Although, they "proved able to hold at bay even well-mounted attacks" (Prior and Wilson 2004), trenches were not comfortable places to inhabit. One occupant complained: "nowhere to sit but on a wet muddy ledge; no shelter of any kind against the weather except the clothes you are wearing; no exercises you can take to warm yourself" (Lloyd 1976, 31). They could also be extremely dangerous; for example, Captain J. Hare wrote in his diary: "Had near squeak today - a bullet literally passed through my hair" (RAMC/1327, 13). Another medical officer (MO), Captain M. Lecky, was

not so fortunate; shot though the neck, he had to be left, mortally wounded, during a flight from the Germans (79/17/1T, 24 Aug. 1914).

The trench diseases were selected as a topic of study for four main reasons. Firstly, they are interesting conditions because they stretched the limits of contemporary medical knowledge. Secondly, as seen in World War II, the Falklands and the Gulf War, trench warfare is still relevant today. Thirdly, trench fever has recently been found in populations of homeless alcoholics and HIV sufferers and so the research has a topicality (Relman 1995). Lastly, both Roger Cooter and Mark Harrison have argued that military medicine is an area that has been poorly served by historical scholarship (Cooter 1993a; Harrison 2004a). This analysis seeks to redress this imbalance. By concentrating on the military-medical response to a group of diseases that dominated trench warfare, and thus the medicine of the War, it is anticipated that a clearer understanding of the conflict can be obtained.

This study concerns the orthodox medical profession. This includes clinicians serving on regular (R), special reserve (SR) and temporary (T) commissions in the Royal Army Medical Corps (RAMC) or other allied armies (A), and those on the home front in civilian practice (C).[1] Research concentrates on doctors because they were the personnel most closely involved in tackling these diseases. The work is gendered, with reference to male MOs, since the nursing perspective has already been much investigated (Summers 1988), and will concentrate on the Western Front, as this was the primary location where men were affected.[2] The British reaction will remain the principal focus. However, some reference will be made to that of other combatant nations such as the U.S.A., Australia, France and Germany. Military medicine was an international affair and the British army scrutinised the performance of other countries.

The book assumes a chronological and narrative framework and seeks to provide an in-depth analysis of medical practice and the context within which it existed, exploring the medical discourse concerning the trench diseases as it developed. Through examining disease entities which are different to those in the modern world and placing them in the context of military-medical practice as it existed at the time, the aim is to present a historicized work.

The study seeks to analyse the various and changing views regarding the origin, spread and control of the trench conditions, with reference to the scientific, medical and military-medical context of the period. In

[1] The position of a doctor has been indicated once per sub-chapter. Uncertainties in designation have been resolved using by using Drew (1968).
[2] Trench fever also occurred in Salonica on the Eastern Front.

particular, it examines the contemporary understanding of disease aetiology and investigates the conditions prevailing during the War years, with specific reference to the trenches. The research also highlights the personal and professional interests of medical personnel, both military and civilian, and relates the progress of their response to a range of political, social and economic factors.

It is imperative in any social history that the voice of the individual is preserved. MOs created an abundant record of their experiences during and after the War. They wrote a substantial number of editorials and scientific articles for professional journals, which show an ongoing medical debate and reveal a multiplicity of perspectives. MOs, and others, also left behind a number of memoirs, diaries, personal papers and correspondence, which provide more personal glimpses of their experiences of war and military medicine. Documents (such as General Orders, instruction manuals, special and annual reports) produced by the War Department and its agencies provide the official and most public record of RAMC activities.

In terms of secondary sources, there is far less material available. Early twentieth-century studies in medical history were, in the main, written by doctors and concentrated on medicine's classical origins. These works were dominated by the biographies of great medical men, whose role in warfare was merely one aspect of their lives, for example Garrison's *An Introduction to the History of Medicine* (Garrison 1929). The next generation of medical historians, for example, George Rosen, worked within the "socialisation of medicine" and regarded war as: "By virtue of its episodic nature, the least suitable historical means for illustrating the integral nature of medicine to politics, economics and culture" (Cooter 1993a, 1538). Similarly, military historians rarely pursued medical history, preferring the lives of generals to that of MOs. More recent histories of sickness have moved from the analysis of biological events and their repercussions to the broader social construction of disease (Brieger 1993, 30). Since the opening of official government files in the 1960s and 1970s, a number of specialist studies on medicine in the War have been written. For example, Joel Howell examined the way that heart disease was redefined during the conflict (Howell 1985) while Ted Bogacz's study on "shell-shock" linked theoretical and practical developments in psychiatry to changes in society, economy and culture (Bogacz 1989). Steve Sturdy described an important aspect of the medical response to gaseous warfare (Sturdy 1992), Joanna Bourke scrutinised social attitudes towards military disablement as part of a study on the male body (Bourke 1996), and Mark Harrison focused on the management of venereal disease in France and

Egypt (Harrison 1995). Lastly, Cooter has utilised a study of orthopaedics to explore the social and health conditions of men in the War (Cooter, 1993b). However, medical historians have neglected the trench diseases, perhaps because the epidemics coincided so completely with the conflict and because military medicine often falls outside their scholarly interest. There is a short section on trench fever in the *Cambridge World History of Human Disease* (Harden 1993) and a short article in the *Western Journal of Medicine* describing the military reaction to trench foot (Haller 1990). Therefore, no authoritative history of the trench diseases existed prior to this work, which has generated a series of papers on this topic and the military-medical service (Atenstaedt 2006a, 2006b, 2006c, 2006d, 2007, 2010). In order to deal with the subject and its context, it is necessary to examine the general history of military medicine from the Crimean War to 1914 and the socio-economic atmosphere in Britain in the early years of the twentieth century. It also seems appropriate to consult some general histories of the War to provide a context for the response.

The book comprises five chapters, the first of which provides an introduction to the study; the second chapter sketches the socio-economic and scientific context within which the response was mounted. The development of bacteriology, sanitation and medical research in the British army is examined, as are the structure and role of the wartime RAMC, the main body involved in the response to the trench diseases. Divisions between medical practitioners concerning the aetiology of epidemic diseases are also described. The third chapter presents a detailed inquiry into how the diseases were defined and named, while the fourth explains how that definition was used in developing an approach to treatment and prevention. Finally, the effectiveness of the medical response to the trench diseases is evaluated in the conclusion, which also examines the impact of the response on military-medical progress and medical specialisation.

CHAPTER TWO

SETTING THE SCENE

1. Introduction

Medicine is a product of the society in which it is practised. War is a peculiar state, but cannot be treated as separate from society. Tim Travers argues that military history is not a separate entity but that warfare, and ideas about warfare, are socially produced and vary with the evolution of society (Travers 2003, xxii). Cooter agrees that war and medicine should be studied as "part and parcel" of the societies and cultures in which they are set (Cooter 1990, 147). In the sixty years preceding the Great War, European and American scientific and technological advances set the stage for a quantitative change in military medicine. For the first time, it was possible to get wounded soldiers to aid stations and hospitals and to furnish treatment that would actually affect survival and quality of life. To fully understand how this was achieved, it is necessary to examine the scientific and societal contexts that existed in Edwardian Britain prior to and during the War.

2. Sanitation, Bacteriology and Medical Research in the British Army

The period 1880-1920 saw people in Britain reap the benefits of improved public sanitation and the new science of bacteriology (Byerley 2001, 33). Society profited from scientific and technological developments that helped to reduce infant mortality and deaths from a number of infectious diseases, as well as increasing life expectancy. Deaths from tuberculosis, for example, fell from 3.8 per 1000 in 1838 to 1.8 in 1894 (Frazer 1950, 273). Mortality from typhoid and typhus averaged 1.24 per 1000 in 1847-50 but only 0.07 by 1906-10. In the 1850s, the crude annual mortality for England and Wales was 22.7 deaths per 1000. By 1900, this had fallen to 17.7 per 1000.

Historians debate the degree to which these advances were due to improved nutrition and living standards versus medical interventions.

Thomas McKeown states that nutritional improvements were the prime cause of the Victorian mortality decline (McKeown, 1976). By contrast, in a revisionist paper published in 1988, Simon Szreter argues that human agency, in the form of an expansion in public health measures, rather than the "invisible hand" of rising living standards, was central (Szreter 1988). In 1885, Britain's public health services had been rudimentary - largely confined to environmental sanitation but, by 1914, almost the entire population had access to a wide range of sanitary services operated by local authorities ("Some Key Events in the History of Public Health in Britain in the 19th Century," 2005). Facilities such as municipal sewer systems and sand filtration of water drove cholera, dysentery and typhoid from the cities, and milk pasteurisation reduced infant mortality and tuberculosis rates (Byerly 2001, 34). In addition, "germ theory", defined in 1881 in a medical lexicon as "the idea that the origin of many diseases lay in the pathogenic action of certain micro-organisms when introduced into the body" (Power and Sedgwick, 1881), promised new medical technologies that would increase the physician's ability to combat disease, and accordingly boosted confidence in the profession. Although he admits that contemporaries usually wrote of a single theory, Michael Worboys argues that rather than there being a single, all-encompassing theory, there was a range of "germ theories" of disease in Britain (Worboys 2000, 2-3). He gives the example of John Drysdale, who identified at least ten types of germs in 1878 (Drysdale 1878). Germ theories had gained favour in the 1880s, based on the work of scientists such as Louis Pasteur and Robert Koch, who identified the anthrax and tuberculosis bacilli. Koch also developed postulates to regulate and standardise laboratory procedures by which scientists could reach consensus on the causative organism of bacterial diseases. Most of the new diseases discovered during the late nineteenth century were of bacterial origin, so that a bacteriological laboratory was regarded primarily as a place of research, and the bacteriologist as a researcher. Above all, laboratories had become "obligatory passage points" for researchers wishing to be credited with medical discoveries, as well as indispensable for authentication of a wide range of diagnoses and prognoses (Jardine 1992, 304). Historians have claimed that germ theories played a central role in the scientific revolution in medicine of the last quarter of the nineteenth century, which was forged around the growing role and authority of the laboratory in medical investigation and practices (Youngsen 1979; Pickstone 1993). However, Andrew Cunningham and Perry Williams hold that the laboratory revolution was not a natural development but the outcome of a concerted struggle, resulting in victory of the laboratory advocates (Cunningham and

Williams 1992). As scientists identified one pathogen after another, a battery of new technologies was developed to identify and control disease, such as laboratory analysis of water and vaccination.

In Britain, like other advanced industrial nations, the public and private sector were beginning to use medical science in order to improve their efficiency, with medicine being increasingly seen to fulfil a vital function in the organisation, mobilisation and management of society:

> The reduction of disease and the promotion of health were elements of a modernizing ideology shared by all industrialized countries…All recognised that medicine and public health had a vital role to play in the rational management of the state's human resources…all countries began to take a more active interest in preserving the health of their populations (Harrison 2004b, 146).

"Scientific management", a theory developed at the end of the nineteenth century by Frederick Taylor, espoused the economic virtues of standardisation, systemisation and specialisation (Krose 1998). Taylor discussed what he termed the struggles for control of production between management and labour in his 1911 book, *The Principles of Scientific Management* (Taylor 1911). His goal was to design a production system that would integrate men and machines and work efficiently (Hughes 1989). Although originally coined in industry, scientific management was increasingly applied to both military and civilian domains:

> …the differences between civil and military spheres were becoming increasingly blurred, both in practice and ideology. Like the late Victorian city with its expanding system of integrated public utilities, the field of battle was now networked by railways, telegraphic lines of communication and specialised and co-ordinated emergency services. The same kinds of rationalisation deemed necessary for the conduct of large-scale business, philanthropy and industry were seen to be essential for the efficient operation of mass armies. Both the military and civilian spheres were reorganised and disciplined in accordance with the same notions of socio-economic efficiency (Cooter 1998, 3).

Followers of the theory encouraged both physical and mental health in the name of efficiency (Harrison 2004b, 146), leading to the provision of state healthcare. Insurance schemes were started with state aid, to ensure that at least some workers had access to basic health care. In Britain, a Liberal government under Lloyd George established a national insurance scheme in 1911, which provided treatment by a doctor drawn from a panel (Grigg 1978, 350). This instituted comprehensive health insurance for the

workingman (Porter 1999, 144). Another reason for the rapid expansion in state aid was the threat of war (Harrison 2004b, 146). Both Ann Summers and Harrison have linked increased state control of working conditions, sanitary arrangements and water supplies to the diffusion of militaristic ideas among the populace, a development linked with imperial expansion and the forging of national identities (Summers 1976; Harrison 1996a).

Armies, which had long suffered from a variety of fevers, for example, typhoid, began to benefit from the new knowledge and technologies (Byerly 2001, 35). The identification of specific pathogens allowed army MOs to differentiate fever outbreaks and their causes, and thereby put into operation preventive sanitation measures to protect the well from the sick. For example, the discovery of the typhoid bacillus allowed MOs to distinguish typhoid from other fevers and to detect the bacteria in water and food supplies; it also enabled them to develop a typhoid vaccine. Therefore, the new laboratory techniques and vaccines, emerging from germ theories, provided the military-medical authorities with tangible new powers (Byerly 2001, 35), albeit the process took a long time, improvements only really starting after the Crimean War.

The military-medical historian Fielding Garrison stated: "Of all recorded wars the Crimean has perhaps the greatest teaching value for military medicine" (Garrison 1922, 171). When Britain went to war with Russia, it was woefully unprepared to support its troops most basic needs (McCallum 2001, 14). Historians acknowledge that the British campaign was pursued with inadequate medical provision; for example, the Army sailed with virtually no medical supplies (Rice 1989, 148; Shepherd 1991, 113-119; Cunningham 1993, 230-232) . Six months after war was declared in March 1854, it was reported that less than half the British forces were fit for service. Even before the war began, over 1,000 soldiers had been admitted to hospital with cholera, with a mortality approaching 64%. News was, for the first time in military history, instantaneously cabled home to the public, alerting them to the pressing need for improved medical care (Cunningham 1993, 229-230). In April 1855, the War Secretary sent a medical investigation committee to the Crimea, with instructions to prepare a report "as it may be the means of elucidating the nature of the diseases" suffered by British soldiers during the conflict ("One Hundred Years of Army Pathology" 1955, 272). This document, submitted to parliament in 1857, contained detailed descriptions of these illnesses, signalling the birth of army pathology.

The period following the Crimean War has been identified as a time of military-medical reform, though limited in its scope (Rice 1989, 148). The government appointed a series of royal commissions with a remit to

reorganise army medical services. A warrant granted in 1858 improved the pay of army MOs and gave them equality of rank with other officers. One of the other recommendations was the formation of an army medical school.

In October 1860, the Army Medical School was established at Fort Pitt in Chatham, moving to Netley in 1863 (Dunnill 2000, 24). The School initially ran a four-month course for MOs selected by examination. This was routinely followed by a further two months training in field ambulance work at Aldershot (RAMC 1091/2/8). The first group comprised 29 officers from the British army and 14 from the Indian Medical Service. It is significant that, in addition to professors of surgery and military medicine, professors of pathology and hygiene were appointed to instruct these students. The first professor of hygiene at Netley was Edmund Parkes, a clinician who had been superintendent of the Renkoi Civil hospital in the Crimea and Professor of Clinical Medicine at University College London prior to this (*Concise Dictionary of National Biography* 1992, 3: 2301). Parkes taught for over 30 years, and it has been recognised that his department was of the highest quality (Blair 1998, 95). The first professor of pathology was a civilian practitioner called William Aitken, who had done important work in the Crimea. At this time, Britain possessed only a few professors in this discipline (Dible 1957, 3). In his historical review of army pathology, Major-General A. Sachs writes that Aitken's professorial tenure from 1860-92 can be considered as the first stage in the growth of the army pathology service (Sachs 1955, 100-121). In contrast, Dunnill notes that Aitken was a man of "limited vision" who did not include bacteriology in the curriculum (Dunnill 2000, 29). The scheme of instruction at the Army Medical School incorporated bacteriology and germ theories and contained laboratory work in hygiene, pathology and microscopy only from the 1890s. However, the absence of laboratory work at Netley before the 1890s was typical of English medical schools (Worboys 1999, 80). The Medical Act of 1858 had formally unified the medical profession in the UK and trainee doctors were increasingly instructed in medicine, surgery and midwifery in medical schools or hospitals linked to universities. Bacteriology classes were started in a small number of centres in the mid to late 1880s, run mainly by surgeons or pathologists (Worboys 2000, 232). Initially only research methods were taught, as clinical pathology had not yet evolved and routine laboratory testing had still to be developed. By the end of the 1890s, bacteriology was taught in most medical schools, but only in extramural classes and postgraduate qualifications (Worboys 2000, 264). However, there was no requirement for practical training in bacteriology in basic medical

education, so the level of instruction received depended on where students trained and the specialisms of teaching staff. At St Bartholomew's Hospital, London, a short course in bacteriology was taught from 1889 In 1894, there were bacteriological laboratories at Guy's, University College, King's College and St Bartholomew's, and the subject was taught at Oxford, Cambridge, Manchester, Durham, Edinburgh, Aberdeen and Glasgow. A course in microscopic pathology, including both bacteriology and morbid histology, became compulsory for all students in 1896 at Guy's Hospital. In the same year, Sheridan Delépine raised the topic of making bacteriology a compulsory subject in initial medical qualifications at the BMA conference ("Pathology and Bacteriology: Wednesday, July 29th: Address by the President of the Section" 1896) and the matter was brought before the Royal College of Physicians in October 1896. It was decided that its inclusion would overload the curriculum. Bacteriologists were, therefore, left to make slow inroads in a number of areas, but especially in pathology practicals (Worboys 2000, 264).

Major A. Rundle writes that the introduction of bacteriology teaching at Netley was due to the influence of David Bruce, who became Aitken's assistant in 1889 (RAMC/1091/1, 7) Bruce had graduated in medicine in Edinburgh in 1881 (*Concise Dictionary of National Biography* 1992, 1:369) and had been commissioned in the AMS two years later (RAMC/950, 2). His first overseas posting was to Malta, where he discovered a new organism and proved it the cause of Malta fever, a disease that for many years had been a major cause of disability in the British forces (RAMC/950, 2). He next spent a year at Koch's laboratory in Berlin, a "mecca for budding bacteriologists, and here he picked up a mass of scientific information and laboratory technology" (RAMC/950, 4). Colonel E.E. Vella notes that the course he introduced in bacteriology at Netley was the very first in any medical school in England (RAMC/950, 4). Therefore, tuition in this subject at the Army Medical School at least mirrored, if not surpassed, that in the civilian sphere.

When Aitken died in 1892, Bruce lost the professorship to a civilian, Almroth Wright, a new type of experimental pathologist, who placed great emphasis on laboratory methods and the acquisition of new techniques (Dunnill 2000, 34). As professor from 1892-1900, he established an influential research centre at Netley, pioneering field trials, and developing a strong research orientation in the department (Worboys 2000, 269). He also invented the typhoid vaccine (Chen 1992, 248) and turned out "a cadre of new recruits...who were well versed in, if not full converts to and missionaries for, the latest bacteriological knowledge and techniques" (Worboys 2000, 253). During his professorship, there were a number of

important discoveries by military pathologists, the majority being seconded to work on diseases in the colonies:

> It would indeed be difficult to over-estimate the influence of the Army Medical School on the course of tropical pathology and medicine in the world at large through the work of Army pathologists like Bruce, Ross, Leishman, Semple, Cummins, Lewis, Boyd, and many others (Sachs 1955, 103-104).

For example, Bruce went to Zululand in 1894 and established *Trypanasoma brucei* as the cause of tsetse-fly disease and nangana, and supervised investigation of sleeping sickness, proving it to be trypanosome disease caused by tsetse. The AMS was therefore at the forefront of medical discovery at this time.

During the period 1880–1914, international army authorities increasingly came to appreciate the relevance of bacteriology and sanitation to the waging of war. Advances in military bacteriology and sanitation meant for the first time that microbes were responsible for fewer casualties than those caused by hostile action (Cooter 1993a, 1542-1543). Before this, disease carried off an average of seventeen soldiers for each one injured in battle (War Office 1912, 3). Michael Osborne has shown that the development of bacteriology in the French military was closely associated with the history of the Chair of Illnesses and Epidemics at the French military-medical academy (Osborne 1992). Léon Collin, who took up the post in 1867, was an early convert to Pasteur's doctrines. Louis-Felix-Achille Kelsch, who held the post from 1882-1892, lectured to his students on contagion and germ theories. In Germany, bacteriology and its application to war advanced even more rapidly. The Franco-Prussian War of 1870-71 saw important developments in military medicine, with the general impression that the German Medical Corps had performed so well that it became a model for how an effective unit should operate. Historians have recognised its superiority over the French in this conflict (Cunningham 1993, 283).

In spite of Netley's excellence in sanitation and bacteriology, the British army, however, seems to have made slower progress in applying new scientific knowledge to military practice. The British seemed to have learned little from their Crimean experiences and when war broke out in South Africa in 1899, the authorities were totally unprepared. The military-medical establishment was isolated from the civilian profession and its physicians tended to be poorly trained (McCallum 2001, 27). There were only two military hospitals in England, Netley for army and Haslar for naval personnel. Since there was no provision for treatment of other

than active-duty military staff in those hospitals, caseloads were not sufficient to keep the medical services fully occupied. Moreover, there was no provision for continuing education or up-to-date texts and journals (Ogston 1919, 43-44). In addition, the RAMC found itself acutely short of personnel, with only 800 regular MOs available (Rice 1989, 149). John Blair notes that the establishment of the AMS had been greatly reduced in the 1880s after the Egyptian War (Blair 1998, 4). The military was therefore forced to recruit 700 civilian practitioners to make up the shortfall. More importantly, MOs were not held in high esteem and their advice generally went unheeded (Harrison 2004a, 9). In fact, Harrison notes that the centralised style of command in campaigns such as these kept MOs at "arms length" and ensured that matters of sanitation and hygiene were treated with indifference or contempt (Harrison 2004a, 111). He cites *The Soldier's Pocket Book* (Wolseley 1886, 109), written by the Adjutant-General (AG) (later Commander-in-Chief), Sir Garnet Wolseley, which notoriously stated that the most useless officer in the Army was the Sanitation Officer (Harrison 2004a, 109). Consequently, field hygiene largely came under the direct control of the commander and regulations were often ignored. Few facilities for purifying water were made available and men filled their water bottles from muddy pools and streams, ensuring that many thousands suffered from bowel disease. In an address to the Army in 1914, Sir William Osler, Regius professor of medicine at Oxford, stated that there were 57,684 cases of typhoid fever during the South African war, of which 19,454 were invalided and 8,022 perished (Osler 1914, 570). He added: "Of the 22,000 lives lost in the last war - can you believe it? - the bullets accounted for only 8,000, the bacilli for 14,000!" (Osler 1914, 569). A typhoid vaccine had been developed by Wright at the Army Medical College but less than four percent of soldiers had been inoculated, as the Army was unwilling to make it compulsory (Dunnill 2000, 56). In her study of the medical response to an outbreak of bubonic plague that also occurred during the Boer War, Molly Sutphen argues that the British army failed to embrace the "talisman of modernity: bacteriology" (Sutphen 1998, 58). Although the military authorities supported laboratory medicine, they were unwilling to authorise mass inoculation, advocated by civilian practitioners. Both these examples imply that bacteriological and sanitary expertise at Netley was not being implemented the field of battle.

The shortcomings of the AMS in the Boer war spurred improvements in the British military establishment, and between 1902 and 1914, the medical service was reorganised under Sir Alfred Keogh (*Concise Dictionary of National Biography* 1992, 2:1658). He joined the AMS in

1880 as a surgeon and was posted to Bermuda, where he first encountered tropical diseases (RAMC/1799, 58). He was next sent to India and served there for 10 years. In 1899, at the outbreak of the South African War, he was put in charge of No. 3 General Hospital near Cape Town. Harrison notes: "He was...more diligent than most in the maintenance of hygiene and sanitation, ensuring that his hospital was relatively free from the epidemic diseases which claimed the lives of thousands of British soldiers" (Harrison 2004c). Unfortunately, Keogh caught Enteric fever and was sent home in 1901 (RAMC/1799, 58). However, his exalted reputation (Harrison 2004c) ensured that he was included on the consultative committee on the medical services, set up in 1901 by the Secretary of State for War. This committee proposed a complete overhaul of training for MOs and increased recruitment of better-qualified practitioners (*Report of the Committee Appointed by the Secretary of State to Consider the Reorganisation of the Army Medical Service* 1902, 10). The importance of recruiting sanitary officers was also emphasised. Furthermore, the construction of a new army medical college in London was recommended, together with the formation of a permanent advisory board on medical matters (Harrison 2004c). Keogh was promoted in 1902 to Deputy Director-General of the AMS and in December 1904 to Director-General (RAMC/1799, 58). According to Colonel Ralph May**,** Keogh's main interest was in sanitation and hygiene (RAMC/1799, 58). In September 1902, courses for MOs in these subjects were initiated in the examination halls of the English conjoint board on the Victoria Embankment (Cunningham 1993, 234). The laboratories of the Royal Medical Colleges were made available for training in military hygiene and pathology. The Army Medical College was transferred to Millbank, London, in 1903, and incorporated a School of Pathology and Hygiene, equipped with "excellent laboratories and lecture-rooms" (Herringham 1919, 48). In 1905, The *Journal of the Royal Army Medical Corps (JRAMC)* was started and the Queen Alexandra Hospital was built in the same year (McCallum 2001, 32). In a major status change for military medicine, this hospital treated civilians as well as military personnel, and included prominent civilian physicians among its consulting staff (Lovegrove 1951, 30). Laboratories appeared for the first time in British military hospitals (Blair 1998, 89).

Also occurring during this era was the outbreak of the Russo-Japanese War (1904). The AMS studied the medical arrangements of the Japanese Army in this conflict closely, sending observers for this purpose (MacPherson 1906; War Office 1908). The main lesson for medical science was that disease prevention through sanitation was preferable to cure. Indeed, it has been written that "the Japanese opened the eyes of the

world to what [could] be achieved by scientific care and thoroughness" (*The Times* 21 Sept. 1914, 6). This provided another powerful force for medical reform, and led to improved training in sanitation for MOs, as well as initiatives to increase awareness of hygiene of combatants (Harrison 2004a, 9). Keogh made the regiment's health the CO's responsibility, with advice from the MO. Army regulations were promulgated, stipulating that all regular troops receive instruction in field sanitation and hygiene, with study compulsory for all officers before promotion (Rice 1989, 149). This does not seem to have been resisted, as Colonel Sir W.P. Herringham commented: "the combatant officers took to the instruction with readiness" (Herringham 1919, 49). In 1906, Keogh founded a School of Sanitation at Aldershot to educate officers and non-commissioned officers for service in sanitary sections (Lovegrove 1951, 31). Courses in sanitation were added at the Staff College of the Royal Army Medical College in Sandhurst and the Royal Military Academy at Woolwich. The Army Medical College was recognised as a medical school of the University of London in 1908. In the same year, a WO committee was appointed to develop a scheme of instruction to be presented through lectures at this institution. As well as their undergraduate training, RAMC officers had to undergo five months instruction at the College, known in the ranks as the "junior" course. An important element of this was the teaching of bacteriology, especially aspects relevant to a military situation. This typically covered subjects such as microscopy and culture of the causative organisms of many conditions, including syphilis, plague and dysentery (RAMC 595, 1-2). In addition, before an officer could attain the rank of major, a further "senior" course of study was necessary with the option of specialising in bacteriology. Aiding training was the provision of a range of medical handbooks, compiled by the Medical Section of the Directorate of Military Operations. Thus, when war was declared, there was a standardised system of training for the regular RAMC, Special Reserve and the Officer Training Corps. These changes in the medical sphere were part-and-parcel of changes in the British army at large, which underwent a transition during the period 1900-14, developing from a small volunteer force to a large professional army (Travers 1992, 4-5). Travers adds that this was in line with the "efficiency" movement of the period.

As a result of all these developments, the RAMC was much better prepared for the war in France than it would otherwise have been. By the beginning of the conflict, military planners understood that it was vital to send soldiers from the base depots to the front line free of disease. The Army Sanitary Committee was reconstituted in November 1914 to advise

on all matters connected with the health of the Army and consisted of members from the Local Government Board (LGB), India Office, and the civil and military sanitary experts of the Army Advisory Board (Beveridge 1924, 7). Placed in charge of sanitation on the Western Front were MOs, well schooled in practical field sanitation at centres of instruction, established by the Director of Medical Services (DMS) in Military Hygiene, Lieutenant-Colonel W.W.O. Beveridge (MacPherson 1921-23a, 1:3). Beveridge had co-written the manual on practical hygiene for sanitary officers; the 1912 edition included sections on water, sewage, ventilation, analysis of foods and beverages, calculation of diets and bacteriology and chemical disinfectants (Beveridge and Wanhill, 1912). Each military unit had personnel for sanitary duties consisting of one MO and between two and eight men. Every base had use of a sanitary unit consisting of one officer, two sergeants and 23 men. In November 1914, with the beginning of trench warfare, every division was given a sanitary section. In March 1916, they were posted to a particular locality, rather than moving with their division, so that they could gain an intimate knowledge of their area. The Sanitary Service mushroomed during the course of the conflict: by the end of 1917, personnel in France numbered 25,000 officers and men (Blair 1998, 226). They performed routine duties in the field and aided the Regimental Medical Officers (RMOs) with their work. They also had a number of other functions. These included supervising the removal and destruction of excreta and refuse, construction of latrines, disinfection of billets and clothing, supervision of bathing and disinfestation stations and purification and protection of water supplies (War Office 1917a). Their main role, however, was in trench hygiene. As one sanitarian related:

> In the early days we were engaged on what was certainly a missionary enterprise, preaching a gospel in which cleanliness of all kinds was the central article of our faith (Foster 1924, 68).

These units performed additional work in connection with other branches of AMS, cooperating with consultants and pathologists in diagnosing and combating infectious disease.

Early in the conflict, the need for hygiene laboratories was recognised. In October 1914, the Commander-in-Chief of the British Expeditionary Force (BEF), Sir Douglas Haig, asked the WO to send out mobile hygiene laboratories. The first arrived in France in November 1914; there were later eight of these on the Western Front, staffed by a MO and a laboratory attendant. Their work involved the analysis of water supplies and other tasks in connection with general hygiene (MacPherson 1921-3a, 1:13).

Early in 1915, a fully equipped chemical and hygiene laboratory was established at Boulogne under the direction of Major Wolff (R) (MacPherson 1921-3a, 1:14). It carried out routine examinations of water, food, disinfectants, and effluents, as well as toxicological examination of human organs.

The beginning of the War saw the Army with a severe shortage of bacteriologists. Between 1903 and 1914, only 59 officers had been trained in this specialism and there were only 11 appointments within the AMS (Herrick 1996, 182). By 1914, the majority of these men had reached seniority and were entitled to be engaged in administrative, rather than laboratory work. In fact, the *Official History of the War - Medical Services* admitted that only four remained actively engaged in clinical bacteriology in 1914 (MacPherson 1921-3b, 6). Captain J.H. Dible (T) commented on this problem in his diary: "each of my two [bacteriologist] friends who are so employed tells me that there is a great dearth of men with the requisite qualifications for this work" (Captain J.H. Dible, 101). To explain their scarcity in the Regular Army in 1914, Claire Herrick has argued that bacteriology within the military was generally of low status, synonymous with routine testing of the water supply, examination of blood and preventative inoculations (Herrick 1996, 189-190). According to Cay-Rudiger Prüll, at the outbreak of the War, the authorities did not consider employing pathologists as a primary goal, but the high occurrence of tetanus and gas gangrene changed the situation (Prüll 1999, 136). Writing in an official history of the Australian military-medical services, Major S.F. McDonald noted that, with the advent of war, there was a shortage of RMOs and junior regular officers were allocated to these positions, in spite of some of them having specialist bacteriological qualifications (McDonald 1940, 231). All these factors go some way to explaining the rarity of these specialists in the RAMC.

In August 1914, a new post was created, Adviser in Pathology to the Director-General of Medical Services (DGMS), British Forces in France. This was held by Colonel Sir William Leishman (R), until he was replaced by Colonel S.L. Cummins (R), professor of pathology at the Army Medical College, in April 1918 (WO 95/3983, 10 Apr. 1918). Educated in Glasgow and entering the AMS in 1887, after three years home service, Leishman was posted to India, where he spent the next seven years (Rolleston 2004). Returning to the UK in 1899, he was placed in charge of the medical wards at Netley and also appointed Assistant Professor of Pathology at the Army Medical College, helping Wright in his laboratory. In the next three years, Leishman enjoyed three major achievements in the field of bacteriology. In 1900, he identified the causative agent of dumdum