Medical advances consequent to the Great War 1914–1918

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The First World War caused upheavals in many spheres of life, but especially in medicine, where it acted as a giant field trial. A new feature amongst the many problems caused by so great and widespread a conflict was the medical administration and sanitation of vast armies. This prompted Garrison in his study of the History of Medicine[1] to state that: 'Viewed after the lapse of a decade, the medical innovations and inventions of the war period seem clever, respectable, but not particularly brilliant. The administrative achievement was, however, truly remarkable'. There was a general lack of preparedness (except Germany) for war and following the outbreak of hostilities the medical services of the Allied nations were expanded on an unprecedented scale. The United Kingdom drew 11 000 civilian practitioners, France mobilized the whole of the medical profession and the United States expanded the medical services 20-fold, enrolling 29 602 doctors as reserve officers. Napoleon is quoted as saying[2]: 'Three fourths of mankind never do the necessary thing until occasion arises, and then it is just too late'. Fortunately it was not too late and the medical services responded well, and learnt many lessons. Merrite W Ireland, Surgeon General United States Army, held that[3]: 'Left to themselves our children would scarcely acquire any education worth considering - we owe that to the schoolteacher. And so it is with nations, once defined as "great simple minded children". For the medical profession at least, war has been a very efficient schoolmaster'.

Statistics

Lt General Sir John Goodwin, Director General of Army Medical Services from June 1918 until 1923, when speaking at a meeting of the War Section, Royal Society of Medicine in December 1919[4] drew attention to the fact that he would not be making reference to the ratio between deaths from disease and those from wounds. It was well known that in previous campaigns the deaths from diseases predominated, but he considered that although the death rate from illness was acceptable, the enormous influence exerted by the increased destructive powers of modern weaponry - which would raise the ratio of death from wounds, must be borne in mind.

Major General Sir William Macpherson reported 15% of armed strength killed, as compared to 10% in the Russo-Japanese, 6.7% in the Russo-Turkish and 3.6% in the Franco-German wars. This correlates well with figures given for specific groups - 15.2% of all army officers dying, 12.8% other ranks. However some categories were much higher, eg Oxford students matriculating in 1913 suffered a casualty rate of 31% killed[5]. The point we need to realize is that the mortality amongst the wounded of 10% was very low as compared with previous wars, ie 39% in the Crimean, 32% in the Russo-Turkish, and 25% in the Franco-German wars[4]. German losses for the World War were 1 531 048 killed, 4 211 569 wounded and 155 013 died from disease. In this war we can add a new figure: the Germans estimated that there were 762 796 deaths among their civilian population from food shortages.

Treatment of wounds

Sepsis almost inevitably followed wounding on the battlefront. Aseptic routines were impossible and it was a foregone conclusion that surgeons would revert to the doctrine established by Lister of the use of antiseptics. The initial development was done by Wright, who is chiefly remembered for his bandage siphon system[6]. In fact he was concerned with the whole picture of wound infection which he regarded as so important that he considered the Army Medical Services to be divided into three parts. These were a service for administration, one for sanitation and a third for the treatment of the sick and wounded. Prior to the outbreak of war the management of wound infection had been a relatively simple matter performed, as he says, by anyone on the medical register. It comprised drainage at the most dependent point, washing out with antiseptics, and application of dressings. As this system had completely broken down he planned for civilian specialists to be sent out to the Front as integral elements of the Medical Services. They were appointed as 'physicians in charge of wounds', with the necessary knowledge of 'the substitution of hypertonic salt solutions for antiseptic, autoinoculations, vaccines etc'[6]. His system of siphons and wicks allowed the application of antiseptic to all internal and external surfaces of the wound, coupled with drainage.

However for the severely contaminated wounds involving gross tissue destruction found at the Front these methods were inadequate, a fact known to Lister[7]. The Surgeon General of the US Army considered that one of the greatest surgical discoveries of the War which came from the mass of chemical agents, moist versus dry, sunlight versus electric light versus occlusion treatments etc, was the principle of disinfection by the release of a gas from a liquid solution[3]. Keen went so far as to say[8]: 'Lister taught us, above all, how to prevent infection; Dakin and Carrel, following Lister's principles, have taught us how to conquer even rampant infection'. Alexis Carrel and Henry Dakin published their work in 1915[9]. Dakin himself was a research chemist. The principle of antiseptics is that bacteria are killed by a chemical reaction with their proteins and other cell constituents. The reaction is hindered by contamination with the proteins in blood, pus etc. Increased strength of antiseptics is associated with irritation and damage

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to the tissues. Ridding them of this effect compromised their bactericidal activity - hence the importance of Dakin's preparation of sodium hypochlorite solution. Part of Carrel's treatment was the mechanical cleansing and removal of debris and loose devitalised tissues from the wound. Ireland considered that: 'From there it was but a step to debridement, or complete excision of the devitalised tissues by the knife - a kind of mechanical sepsis'[10].

The history of the third part in this progress of wound management in the Great War is much older however, and fully supports the aphorism: 'The lesson of history is that the lessons of history are never learnt'. The first evidence of debridement being used as a considered clinical procedure was by Le Dran in 1737[11] and it was extensively applied by Desault, Larrey, Perca, Dupuytren and Baudens. However Billroth in 1859 in his historical study of the treatment of gunshot wounds (GSW) was sceptical and in 1877 Esmarch in his handbook on military surgical techniques did not discuss it - neither did Krueger, SS Standartenfuehrer in his *Amtliches Unterrichtsbuch über Erste Hilfe*[12], probably because in essence it is a direct copy of Esmarch's work. At the German surgeon's conference of 1892 Thiersch stated: 'I think we shall do best if we go on doing what we have done up to now - leave the gun wounds open'[11]. However in 1909 General Vollbrecht reaffirmed von Bergmann's statement of 1877 (he had derived his experience from the Russo-Turkish War of 1877) that the projectiles were sterile and GSW were not primarily infected. Friedrich's treatise of 1898 on debridement, although published, remained generally unknown. He excised the wound and then closed it primarily and this method was continued by Gray[13] so as to avoid the disadvantages of the painful and long lasting postoperative treatment involved in the care of an open wound. This put the treatment of war wounds on a definite footing - there was full agreement about the need for complete excision of dead, badly damaged or grossly infected tissue. The timing was, however, less certain, Gray preferring vigorous 'salting' - hypertonic treatment to render the wound suitable for excision. Bowlby in his summary of the practice[14] considered that the wound may be sutured at once or left up to 4 days with identical results. He added the qualification that if the wound edges were indurated or inflamed the wound must never be closed. He used a varnish and gauze dressing - to give wide support and relieve tension.

Sanitation

Sanitation was an area in which the Director General Army Medical Services could not be accused of falling prey to Napoleon's dictum - in 1904 he read a paper at the Royal United Services Institute[15] and stated: 'The future success of an army in the field must, and will, to an enormous extent, depend on the efficiency with which measures for the prevention of disease can be carried out'. Goodwin ascribed the vast improvements in rates of disease to the advances made regarding water purification, disposal of waste and field sanitation generally and to the improved education in hygiene of the Army as a whole, and last but not least to the increase in preventive inoculation[4]. The vaccine department of the Royal Army Medical College made and issued during the war years over 23 million millilitres of typhoid and paratyphoid vaccine. Tetanus was prevented by prophylactic injections so successfully that its incidence immediately fell 90%[7]. An even more successful reduction was achieved with typhoid. As late as the last decade of the 19th century this disease was still causing 5000 deaths annually, and in the Crimean War it had caused greater mortality than the war itself. Colonel Sir Almroth Wright began trials using vaccines made from killed typhoid bacilli on himself and the military surgeons at the Royal Victoria Hospital at Netley - which subsequently became a psychiatric centre (no connection). The current thinking, developed by Pasteur, was that immunity could be acquired only by infection with

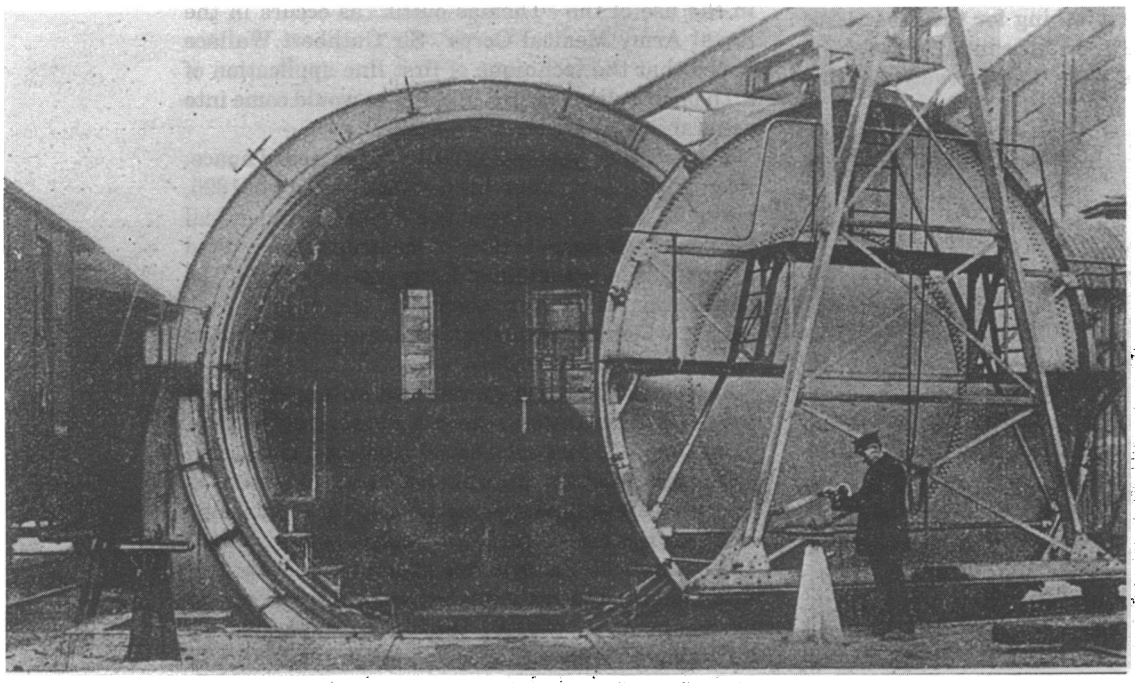

Figure 1. 'The remarkable apparatus installed at Potsdam, in which an entire railway coach can be thoroughly disinfected. The coach inside has been used to carry infectious "cases" from the Front, and is about to be disinfected before being put into commission again, in order to safeguard against infection among the troops'.

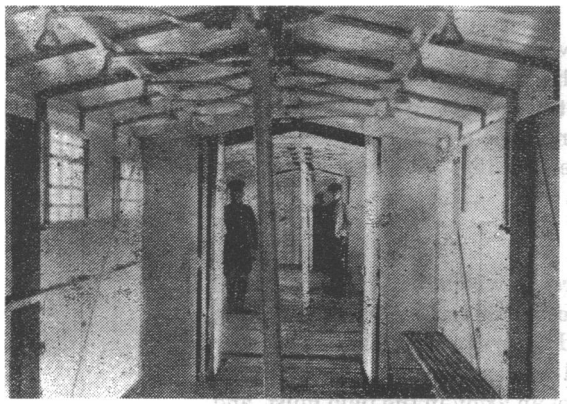

Figure 2. 'Interior of one of the bathing compartments of one of Germany's special bathing trains that travel behind the firing lines and provide bathing accommodation for the soldiers'

living pathogens. Wholesale inoculation of British troops was attempted in the South African War but due to bitter opposition from influential persons less than 4% of the soldiers received the vaccine. As a result of this blunder the Army had some 58 000 cases of typhoid and about 9000 deaths[16]. During the whole of the Great War there were 7423 British cases, with 266 deaths, in an average strength of 1 200 000. The French figures decreased dramatically with the introduction in their army of compulsory inoculation[4]. In January 1916 records showed a British death rate from typhoid 31 times higher among the unprotected. In June 1916 the ratio had increased to 50 to one, a fact brought home to the public by a popular medical journalist of the time[17]. Goodwin made the point in 1919 that inoculation was still voluntary in the British Army and that in 1914 the efforts made to persuade the men to have it were met by 'the production of the page of a certain daily journal which strongly advised against inoculation'. He goes on to state: 'I think it says something for the persuasive powers of our eloquence and for the intelligence of the British soldier that we were able to overcome this

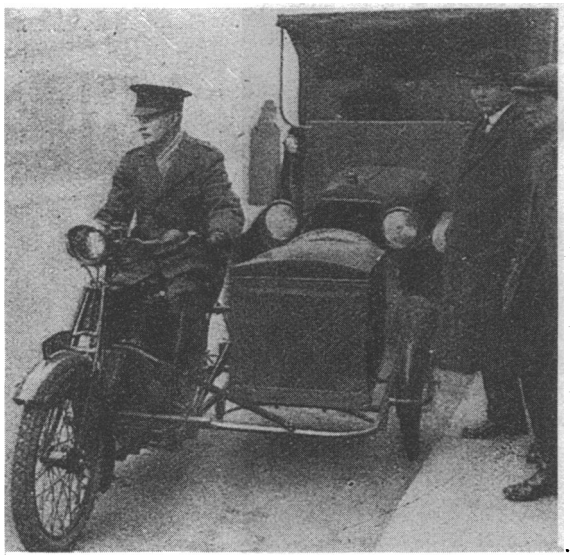

Figure 3. 'Bacteriological motor laboratory going to the battlefields in quest of deadly bacteria for medical examination'

most pernicious advice, and that 98% of our Army were inoculated against the disease'[4]. Armies were not slow to adapt current technology and modes of transport for the massive sanitation problems found. The following illustrations are taken from articles which appeared in *The War Illustrated* 12 June 1915 (Figures 1 and 2) and 13 August 1915 (Figure 3).

Surgical advances

Orthopaedic innovation consequent to war was not new. Plaster of Paris bandages were the invention of a Dutch Army medical officer, A Mathijssen in 1852[18]. At the outbreak of war Robert Jones was 57 and had gained an international reputation[19]. He joined the Royal Army Medical Corps and was asked to make a tour of inspection of military hospitals. A major problem was that of early discharge without proper rehabilitation. He tackled this by opening in 1915 a hospital of 250 beds for this purpose at Alder Hey, near Liverpool. This experiment was followed by others. In the early months of the War compound fracture of the femur had a mortality rate of 80% - mostly from sepsis. Jones' chief concern was the usage of splintage, employing the Thomas (his uncle) splint. In 1917 a contingent of 20 carefully selected American orthopaedic surgeons came to Liverpool to help him. It became clear that special clinics were needed to carry out reconstructive surgery of bones and joints. Fracture clinics were set up in general hospitals where orthopaedic specialists could control the whole course of the patient's treatment and convalescence. The first of such fracture services were started at Ancoats Hospital in Manchester in 1914. It was suggested that fracture cases in general hospitals should be collected in special fracture wards equipped with the necessary apparatus for extension and also supplied with a mobile X-ray unit[7]. So dramatic were the improvements made during the War that the President of the Royal Society of Medicine could state in his Presidential Address 9 January 1920 that: 'Arrangements are being made so that ambulance drivers and orderlies are trained in the use of the "Thomas outfit" as occurs in the Royal Army Medical Corps'. Sir Cuthbert Wallace hoped that the technique of first line application of a Thomas' splint learned in the War would come into general use as a first aid measure[7].

The use and experience of X-rays proceeded apace. Roentgen had only made his famous discovery in 1895, yet in 1915 at a meeting of the Electrotherapeutical Section of the Royal Society of Medicine it was stated in a paper on yet another X-ray detector that: 'The localisation of foreign bodies in the tissues is a subject which has been discussed recently almost ad nauseam'[20].

Reconstructive surgery received an impetus with the dramatic increase in cases. A Royal Army Medical Corps major presented over 20 cases at a discussion on injuries affecting the orbit and accessory sinuses at a combined meeting of the sections of Ophthalmology and Laryngology of the Royal Society of Medicine in 1918. Case 17 (to pick an example) consisted of 'Rhinoplasty and reconstruction of the left lower lid by means of a reversed pedicle forehead flap. In reversing the pedicle a few hairs from the right eyebrow were included so as to make the eyelashes for the lower lid'[21].

Blood transfusion was tentatively used at the First Battle of Cambrai in 1917[22]. Prepared citrated blood

was sent up to the Field Ambulances prior to battle during the Allied advance in 1918 as it could be safely kept for 12-18 hours. The suggestion was made that sterilized gum solution should be kept ready for use by civil hospitals and also that test sera for donors of blood should be regularly stocked[7].

Other diseases

Trench fever was said to have appeared for the first time during the 1914-18 war and to have disappeared, never to return, soon after the Armistice[23]. There is good reason to believe that it had been endemic in parts of Poland and persisted there, although regarded as a form of malaria or influenza. The first German reference was made by His in February 1916[23]. He described it as 'Febris Wolhynica', having observed it among German soldiers in the Wolhynia province of Poland. Trench fever was probably conveyed early in 1915 by lice-infected German soldiers from the Eastern to the Western Front. It first appeared in the British Army in France in the early summer of 1915 and was at first only observed amongst those living near the trenches. Subsequently cases occurred further from the Front. The name 'trench fever' was not officially sanctioned until 1917 by which time its specific nature had been recognized by Graham[24]. McNee and Renshaw found that it could be transmitted to healthy soldiers by intramuscular and intravenous injection of the blood of men suffering from the disease[25]. It was suspected that lice were the vector as all sufferers admitted to being infested and the incidence of the disease closely paralleled the degree of cleanliness of the units involved. Lt General Sir David Bruce proved it to be louse borne and the campaign against lice in the Salonica army in 1916 was followed by the almost complete disappearance of trench fever.

Trenchfoot was a newly coined disease for a condition which had been seen before. This manifests as pain with a cold swollen red foot which may be numb and blistered. It was found to be caused by prolonged standing in cold water or wet mud, or by the continued wearing of wet socks and boots, and hence was preventable[26]. By good preventive medicine the incidence among British troops fell from 38.45 per 1000 in 1915 to 11.34 in 1917 and finally 3.82 in 1918[27]. An adequate supply of thick woollen socks and means for drying boots were provided. An anti-frostbite grease (whale oil, tallow, and boric acid) was developed but was later replaced by foot powder[28].

The study of the whole of respiratory physiology was given a tremendous stimulus by the effects of gassing. Efficient stimulators were in use by 1916 and their use almost abolished the danger of drift gas. Before this about 5% of those who reached the clearing stations died within 48 h[29]. Of those who reached the base hospitals, between 1% and 2% died in the second or third week from bronchopneumonia or other pulmonary complications[30].

The mental tests of Binet and others were introduced into the American recruiting system for the first time in 1917 by RM Yerkes, and 'revealed the large percentage of 12 year old minds in our recent population'. In addition it was reported that 'psychology did much for weeding out mental defectives, always bad risks for armies'[31].

Rehabilitation was seen in a new light. In 1915 a Government actuary estimated that 12% of the soldiers at the Front would be permanently disabled - this would mean 240 000 wholly or partially maimed[32]. Exact figures are difficult to find - especially when one questions what constitutes disablement. The important outcome was that in the second year of the War the problem was realized and measures taken. The position was exemplified by a newspaper headline: 'We must take as much trouble to find a man a job when his regiment throws him up as we did to find him a regiment when he threw up his job'. This was utilized especially in the Royal Army Medical Corps. The Almeric Paget Massage Corps supplied trained masseuses and it was reported in 1915 that the Corps had been strengthened by the first graduates from St Dunstan's - four men blinded in action and taught their profession since the beginning of the War[33].

Social advances

As a result of infant welfare activities in the very midst of war infant mortality in 1916 dropped to 91 per 1000 in England, the lowest on record. In Germany gout disappeared entirely with the deficiency of meat but a reduction in diet to 950-1100 kcals (officially 1350) produced hunger oedema and the incidence of infantile rickets increased eightfold. A new term was coined, 'Kriegsneugeborene' - underdeveloped at birth and characteristically having symptoms of persistent restlessness with automatic grasping movements. In aid of the starving infants of Vienna, von Pirquet in 1917 introduced feeding by 'nems' (the energy in 1 ml milk), based upon height : weight ratio[34].

Pavloff recorded that obesity, alcoholism, gout, gastritis, appendicitis, biliary disorders and constipation all but disappeared in post Revolution Russia but there was a marked increase in enteritis, peptic ulcer, noma, pyorrhoea and, interestingly enough, arteriosclerosis[35].

Profound changes in the pattern of disease, new diseases and injuries on a vast scale together with the social upheaval of the Great War acted as a catalyst for changes in medical administration. In 1917 David Lloyd George, by then Prime Minister, set up committees to decide how the future health services would be run - in particular the need to bring preventive and curative medicine together. Major Bernard Dawson, later Lord Dawson of Penn proposed an idea, subsequently adopted by the Labour Party, for the introduction of Health Centres[36]. In this he incorporated an element of Royal Army Medical Corps wartime organization. The War had accustomed all classes to the concept of hospital treatment for serious injury and down-the-line evacuation was a principle which could be applied to civil practice. Dawson's idea was to have a primary health care centre staffed by general practitioners with a limited number of beds and laboratory facilities - in many ways it would resemble a casualty clearing station. Consultant advice would be available but the main working area of specialists would be in a secondary health centre located in a hospital. This scheme would have integrated general practitioners with consultants, and preventive practice with curative, but it was subsequently thrown out.

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