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Two Hundred Years of British Army Casualties and Statistics

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ABSTRACT
This paper covers the evolution of medical statistics on the Army from the early nineteenth Century to the present day. Although several policies during this period described the importance of medical statistics for the planning and management of military health services, there have been problems with collecting and analysing medical data at the beginning of the First World War, the Second World War, and the campaigns in Iraq and Afghanistan. The paper considers the key features and analytical reports that have been shown necessary to report on the health of the Army and activities of the medical services in peace and war.

Introduction

The Russian surgeon Nikolay Pirogov described war as an epidemic of injuries[1]. As with epidemics of disease, military medical statistics and epidemiology can be used to understand the characteristics of wars on human beings and to measure their impact over time. The armed forces, as an instrument of the state, bear the brunt of the consequences of war, although of course the civilian population may also be seriously impacted by conflict. Governments may be expected to report the number of deaths and injuries within their armed forces during war and may suffer political consequences if the public perceive this cost to be too high. The leadership of the armed forces also needs their personnel to be fit to fight which places a requirement on the medical services to report statistics on the medical fitness of the armed forces and the effectiveness of the military medical system in returning the sick and injured to duty. This paper will examine the history of casualty statistics within the British Army and

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[1]Inge F Hendriks, James G Bovill, Peter A van Luijt, and Pancras CW Hogendoorn, 'Nikolay Ivanovich Pirogov (1810–1881): A pioneering Russian surgeon and medical scientist', *Journal of Medical Biography*, 26,1 (2016), pp. 10-22.

the wider UK armed forces in peace and war and discuss how the sources of data and analysis have evolved. Whilst primarily based on 'official statistics' published by the Government, it will also consider the importance of statistics published in medical journals and military publications. In closing, the paper will make recommendations for the medical statistics that should be collated on the armed forces in peace and war and how these might be used to inform personnel and medical policy in the future. The analysis particularly highlights the importance of Royal Commissions and other external inquiries in directing the Government to capture data to describe the impact of war on armed forces personnel and to explain how military casualties and Veterans are provided healthcare.

Medical statistics of the armed forces are compiled from periodic 'reports and returns' that are initiated by medical units and passed to a central office. At the most basic level, these comprise events such as deaths, admissions to hospital, and discharge from the armed forces on medical grounds – medical discharge or invaliding. These events may be classified by broad cause, such as battle injury, infectious disease, chronic disease etc., or may be clinically coded using agreed definitions such as the International Classification of Diseases (ICD). Each record may also be associated with demographic data such as age, rank, gender, military unit, treating medical unit, and location. When aggregated, these records can provide numbers over time and location, and rates when linked to the total military population at risk. This is the core "person, place, time" of descriptive epidemiology[2]. Collated data can be analysed and compared to examine issues such as demand, causation, outcome, and trends. Such analysis is useful for a retrospective analysis of 'what happened' but, more importantly, it can help to develop strategies for preventing ill-health and contributes to predicting demand or casualty rates in order to inform planning of health services. This is the essence of the role of the military doctor in advising the chain of command in the protection of health, the prevention of disease, and the allocation of resources to the medical services. The relationship between the medical services and the executive in their respective interest in the well-being and fitness of the armed forces is an interesting example of military 'sociology'.[3]

The word 'statistics' had first entered the lexicon in 1749 when it was used by Gottfried Achenwall in Germany as 'Statistik' to describe the political, economic and social status of a country.[4] Initially in narrative form, it quickly evolved to include

[2]Lewis H Kuller, 'Epidemiology: then and now', *American Journal of Epidemiology*, 183, 5 (2016), pp. 372-380.
[3]Martin Bricknell, and David Ross, 'Fit to Fight – from military hygiene to wellbeing in the British Army', *Military Medical Research*, 7, 1 (2020), pp. 1-7
[4]George Rosen, *A History of Public Health*. (Baltimore: Johns Hopkins University Press, 2015).

numerical data, described as 'political arithmetic'. In 1786, the Scotsman Sir John Sinclair of Ulbster (1754-1835) encountered the concept whilst on a tour of northern Europe and adapted it to a more general description of the 'state of the country', including the 'quantum of happiness' of its people i.e. their wellbeing, and leading to the publication starting in 1791 of his groundbreaking 21-volume *Statistical Account of Scotland*, based on data provided to him by parish Ministers.[5] This was the beginning of a growing interest in collecting and publishing data, including on the incidence of diseases and mortality, which in due course was to have a profound influence on medical planning in the armed forces.

The British government has a long history of publishing medical statistics on the health of the armed forces. Although statistics had been collected during the Peninsular War (1807-1814), these were not published. The first published statistics appeared in 1835 in Colburn's United Services Magazine, following a careful analysis of sickness and mortality rates by Sir Alexander Tulloch (1803-1864), an infantry officer. Tulloch's work came to the attention of the Secretary of State for War, Lord Grey, who commissioned him to prepare further analyses for Parliament, in collaboration with Thomas Graham Balfour (1813-1891).[6] These were published as a series of 'Blue Books' between 1838 and 1841. As will be described later, routine publication of military medical statistics began in 1861. These formed the evidence base for a profound change in the level to which the military leadership would be held accountable for the health of their personnel. In the twentieth century, specific volumes on casualties and medical statistics were published as part of the official histories of the First World War and the Second World War.[7] However, these were not published until as late as 1931 and 1972 respectively and so were of no value in the immediate postwar periods. The Ministry of Defence published a series of comparable datasets from the campaigns in Iraq and Afghanistan during the first two decades of the twenty-first century but it took some time before the suite of information represented a full picture. Part of this delay in compiling medical statistics during wartime can be accounted for by the sheer volume of material and the limited staff available to conduct the analysis of the wartime medical records. It might also be partly explained by the political sensitivity of such information entering the public

[5]John Sinclair, *The Statistical Account of Scotland. Drawn up from the communications of the ministers of the different parishes* (Edinburgh: William Creech, 1791).
[6]Richard Froggatt, 'Sir Alexander Tulloch (1803-1864): Soldier; army reformer'. *Dictionary of Ulster Biography,* http://www.newulsterbiography.co.uk/index.php/home/viewPerson/1994. Accessed 24 Dec 23)
[7]Thomas John Mitchell, and Miss GM Smith, *Medical services: casualties and medical statistics of the Great War,* (London: HMSO, 1931); Franklin W. Mellor (ed.), *Casualties and medical statistics*. Vol. 6, (London: HMSO, 1972).

domain. Medical statistics during war are likely to have a high level of security classification in order to prevent the enemy interpreting them as a measure of military success or political vulnerability. This fact has been demonstrated by the lack of authoritative information on the casualty figures for either side in the current Russian/Ukrainian war. Thus, whilst official government publications may be the only source of reliable information on casualties and medical statistics in the armed forces, their production may be delayed, and any statistics promulgated during the conflict may be of questionable provenance and accuracy. It may take external inquiries or public pressure to oblige governments to place this information into the public domain.

The Birth of Official Military Medical Statistics in the Nineteenth Century

The nineteenth century saw important advances in the collection and publication of statistics on the health of armed forces. The first Statistical Report on the Health of the Royal Navy was published in 1840 covering the years 1830-1836, and set in place a legacy for the Royal Navy Medical Services.[8] Dr James McGrigor (1771-1858), as the Director General Army Medical Services (1815-1851), established the first formal series of returns on the health of British Army in the mid-1800s, having proven the value of statistical returns during his service in the Peninsular War. These reports were prepared by Tulloch and Balfour, continuing their earlier work, but as Balfour recounts, 'The outbreak of the Crimean War [1853-1856] put an end to our labours in this direction'.[9] Undoubtedly a contributory factor was McGrigor's retirement three years earlier, at the age of 74 years.[10] Soon after the Crimean War a Royal Commission was established to review the medical arrangements for the British Army as a result of multiple failures including a huge death toll from potentially preventable diseases.[11] The Commission's report marked the start of a half century of sanitary reform and reorganisation of the medical services of the British Army. It included a recommendation to compile and publish medical statistics on the British Army. An

[8]F. P. Ellis, 'The health of the Navy: the changing pattern', *Occupational and Environmental Medicine* 26, 3 (1969), pp. 190-201. http://dx.doi.org/10.1136/oem.26.3.190

[9]Graham T Balfour, 'The Opening Address of Dr. T. Graham Balfour, FRS, &c, Honorary Physician to Her Majesty the Queen, President of the Royal Statistical Society. Session 1889-90. Delivered 19th November, 1889', *Journal of the Royal Statistical Society*, 52, 4 (1889) pp. 517-534. https://doi.org/10.2307/2979100

[10]M. W Russell, 'Sir James McGrigor', *Journal of the Royal Army Medical Corps*, 13,2 (1909), pp. 117-148.

[11]*Report of the Commissioners Appointed to Inquire into the Regulations Affecting the Sanitary Condition of the Army, the Organization of Military Hospitals, and the Treatment of the Sick and Wounded: With Evidence and Appendix. Presented to Both Houses of Parliament by Command of Her Majesty*. (London: George Edward Eyre and William Spottiswoode, 1858).

innovative feature of these newly-reported statistics was the ability to make a comparison of mortality between personnel in the Army stationed in the United Kingdom and civilians. The report presented carefully curated data which showed that the soldiers on home service had nearly double the rate of mortality compared to an age-matched civilian population, and substantially greater mortality than broadly equivalent occupations such as agricultural labourers, outdoor trades in cities, and miners. Many of the statistical analyses presented in the report have been attributed to Florence Nightingale and her innovative approach to the presentation of data.[12] As a result of the report the Secretary-at-War set up a committee to define statistical policy for the Army.[13] The first Report of the Army Medical Department was published in 1861, covering the year 1859[14]. Instructions for the completion of statistical returns for these reports were contained in various editions of the regulations for the Army Medical Department.[15] The annual reports on the health of the army (published under a range of titles over the years) provide a rich source of comparative data of hospital admissions and mortality between military commands within the United Kingdom and overseas commands.[16] They also provide data on the medical examination of recruits and the numbers and causes of medical invaliding – discharge from army service for health reasons.[17] The Royal Commission also augmented the role of the Army Medical Officer with additional direction, beyond care of the sick, to 'advise commanding officers in all matters affecting the health of troops, whether as regards garrisons, stations, camps, and barracks, or diet, clothing, drill, duties or exercises'. In 1864, Edmund Parkes (1819-1876), as the first Professor of Military Hygiene at the Army Medical School, published 'A Manual of Practical Hygiene for use by the medical service of the Army' which made extensive use of health statistics to illustrate the importance

[12]S Rosenbaum, 'Report of the Royal Sanitary Commission (1858)', *Journal of the Royal Army Med Corps*, 106, 1 (1960), pp. 1-11.

[13]Committee on the Preparation of Army Medical Statistics, and on the Duties to be Performed by the Statistical Branch of the Army Medical Department (London: House of Commons, Parliamentary Papers, 21 June 1861)

[14]Army Medical Department. Statistical, Sanitary and Medical Reports for the year 1859. (London: HMSO, 1861) https://books.google.com.au/books?id=ESBcAAAAQAAJ&pg=PP11#v=onepage&q&f=false. Accessed 14 October 2024.

[15]An example is Part 6 Statistical Regulations of Regulations for the Medical Department of Her Majesty's Army. (London: HMSO 1878) https://wellcomecollection.org/works/r7v35w22. Accessed 14 October 2024.

[16]By military district in England, Scotland, Wales and Ireland; By overseas command, Mediterranean, Canada, West Indies, Africa, Ceylon, China, Japan, and India.

[17]A list of online copies of Army Medical Department Reports 1959-1906 compiled by Dr Beverly Bergman is available at: https://www.friendsofmillbank.org/fightdisease/. Accessed 14 October 2024.

of preventive medicine in advising the chain of command on standards for water supply, rations and accommodation to keep the army healthy.[18] The regular publication of official statistics on the health of the Army and Navy provided the evidence to show how the improvements in military accommodation and sanitation led to a reduction in sickness and death in both services.[19] As described later, these core data sets continue to form the basis of contemporary military medical statistics produced by the health section of the Defence Statistics branch of the UK Ministry of Defence. The relative risk of death from military service compared to civilians continued to be a topic for statisticians. One early paper on this topic published in the Journal of the Institute of Actuaries in 1898 showed that the 'average extra rates of mortality which may for life insurance purposes be considered as incident to service in the British Navy and Army, is, that these may be fairly taken at 6 per 1,000 for the Navy, and 10 per 1,000 for the Army'.[20] Later in this paper we will consider how the health impact of military service compared to the referent age/gender matched civilian population continues to be a contemporary political topic, especially in relation to mental health, suicide and exposure to military hazards such as radiation from past atomic bomb experiments.

The Royal Army Medical Corps came into being in 1898 and had not had time to reorganise its services by the start of the South African War. The subsequent Royal Commission inquiry found many deficiencies in the organisation of the Army Medical Services during the South African War (1899-1902) as a result of being 'overworked, undermanned, and under-orderlied' and especially challenged by outbreaks of typhoid fever.[21] Notably Sir Almroth Wright's typhoid vaccine had started to be used but the constraints of war and Wright's aversion to statistics prevented the collection of data on its efficacy.[22]The primary data for casualties and medical statistics were published

[18]Edmund Parkes, 'Manual of Practical Hygiene. Prepared especially for use in the medical service of the Army'. (London: Churchill & Sons, 1864) https://wellcomecollection.org/works/jwgpcjyz/items?canvas=5. Accessed 14 October 2024.

[19]Thomas Graham Balfour, 'Comparative health of seamen and soldiers, as shown by the naval and military statistical reports', *Journal of the Statistical Society of London*, 35, 1(1872), pp. 1-24.

[20]James J McLauchlan, 'On the Mortality of the British Navy and Army, as shown by the Official Reports', *Journal of the Institute of Actuaries*, 34, 3 (1898) pp. 251-281.

[21]'Report of the Royal Commission on the South African War', *The British Medical Journal*, 2, 2226 (1903), pp. 484–487.

[22]Henderson J. The Plato of Praed Street: the Life and Times of Almroth Wright. J R Soc Med. 94(7) (2001), pp.364–365; William Leishman, 'Anti-typhoid inoculation', *Glasgow Medical Journal*, 77,6, (1912), pp. 401-410.

in the report of the Royal Commission on the South African War.[23] Unfortunately the staff employed to collate medical statistics from the South African War were disbanded before an official report was published, though the data were eventually added to the volume on casualties and medical statistics in the medical services series of the Official History of the Great War.[24] These data, plus an analysis of the War Office death registration system, were used to plot the mortality rate against each month in the campaign, with the primary purpose of calculating the annual premium required to provide £100 of life assurance by type of service – officers, NCOs and soldiers, based on the estimation of the value of a soldier's life at £100 by Dr Burke, late Inspector-General of Hospitals in Bengal.[25]A further analysis of these medical statistics was published in the Journal of the Royal Army Medical Corps.[26] This important and well-researched paper starts with a discussion on estimating the number of troops at risk based on the records of soldiers who disembarked ships on arrival in South Africa. The paper shows how 'wastage rates per thousand' as a combination of deaths and invaliding home varied according to the phases of the war. The paper then examines admissions and deaths from fevers, dysentery, other diseases and hostile action and compares these rates with other military campaigns in Africa from the late 1800s. It challenged the previous criticisms of the Army Medical Services by showing that the case-fatality rates for fevers was much lower in this war than other shorter wars from the same period. The data analysis published by the Royal Commission also had an additional outcome; beyond the medical statistics from the actual war, the data from official recruiting and military medical statistics on the medical examination of entrants to the Army focussed attention on the parlous state of the general health of the British male working-age population. This resulted in a formal Parliamentary inquiry into the physical condition of the working classes and a range of measures to improve general civilian public health, chiefly in order that there would sufficient fit men of working age to be recruited into the Army at a time of national crisis.[27]

[23]Royal Commission on the South African War. (London: HMSO, 1903)
[24]Casualties and Medical Statistics of the Great War. Ref 7.
[25]Frederick Schooling and Edward A. Rusher, 'The Mortality Experiences of the Imperial Forces during the War in South Africa, 11 October 1899 to 31 May 1902', *Journal of the Institute of Actuaries*, 37,6 (1903), pp. 545-627; J. R. Martin, 'The Health and Efficiency Of The British Troops In India', *The British Medical Journal*, 90, 2 (1858), pp. 798-799.
[26]John Ritchie Simpson, 'Medical History of the South African War'. *Journal of the Royal Army Medical Corps*, 14, 3 (1910), pp. 23-38.
[27]Report of the Inter-Departmental Committee on Physical Deterioration (London: HMSO, 1905)

The impact of formal reporting and analysis of statistics on the health of the Army can be observed in the content of military medical training publications used in the instruction of members of the Royal Army Medical Corps for their role during this period. The 1911 edition of Royal Army Medical Corps Training has a whole section devoted to sanitation or the prevention of disease. This includes a table of statistics extracted from the annual reports on the health of the army showing the reduction in admissions and deaths in different overseas commands between 1860 and 1909.[28] The 1912 Edition of the Manual of Elementary Military Hygiene (the successor to Parkes' Manual of Practical Hygiene) contains a table showing admissions and deaths for British troops in war, categorised by disease and action, for all wars from the Crimean War to the South African War.[29] Thus, at the start of the twentieth century, it was being taught that disease rather than battle injury was the biggest cause of hospital admission and death during war, and that public health measures were the most important medical intervention that would keep the Army healthy. Whilst data from the Boer War could have also been used to inform the 'casualty estimate' function within medical planning, at the start of the First World War the British Army was still using the formula created by the Austrian General Cron, based on historical data on casualties from European wars. He assumed that in a battle, only 3/5 of the force would be at risk and that 15% would become casualties, namely 10% of the whole force.[30] Whilst moderately accurate for the Crimean War, this was to prove hopelessly low in respect of the major battles of the First World War, when casualties were incurred on a scale never previously seen. However, by the Second World War, this formula was again able to provide a reasonable estimate.[31] Thus, by the beginning of the First World War, the British Army was publishing reliable data on the peacetime workload of the Army Medical Services but there was no viable plan for the analysis of war casualties and medical statistics which could reliably inform medical planning.

The First World War: 1914-1918

Preparations for writing a medical history of the war were established soon after the outbreak of hostilities in 1914. The Director General Army Medical Services (DGAMS) Lt Gen Sir Alfred Keogh (1857-1936) issued instructions for the formal collection and archiving of war diaries and other sources centrally. In addition, the national Medical Research Committee, later to become the Medical Research Council, established a statistical department to support the Army Medical Services for analysis of medical statistics and the scientific investigation of war injuries and disease. The

[28]Royal Army Medical Corps Training. (London: HMSO, War Office, 1911), pp.14-15.
[29]Manual of Elementary Military Hygiene. (London: HMSO, War Office 1912), p. 78.
[30]T. B. Nichols. *Organisation, Strategy and Tactics of the Army Medical Services in War*. (London: Balliere, Tindall and Cox, 1937), pp. 46-56.
[31]A. J. Shaw, 'Medical planning factors', *Journal of the Royal Army Med Corps*, 122, 4 (1976), pp. 208-214.

process involved reviewing over 38,000 war diaries and other documents.[32] Each of the volumes of the Medical History of the War contains basic numbers of killed, wounded, missing in action, and died of wounds for each campaign and phase of the war across the principal geographic areas of operations alongside the organisation and capacity of the medical services. [33] The First World War saw the introduction of chemical warfare, a novel cause of war casualties and a new challenge for the medical services. The volumes also record the leading diagnostic categories for the sick and wounded. The epidemiological features of individual conditions are covered by the volumes on clinical services – pathology, disease, hygiene, and surgery. These volumes contain insights into the scale of wounded and sick, and their treatment by the Army Medical Services. However, they do not provide a comparison of the activities and performance of the medical system in historical context nor any data on the whole medical system at a strategic level including the long-term impact of the cost of the war injured on the Ministry of Pensions. Unfortunately, the volume on Casualties and Medical Statistics could not be completed within the time allocated to the other volumes and did not appear until much later.

Notwithstanding the delay, it was considered that the First World War statistical information would still be of use for (a) military purposes in future wars; (b) medical purposes for the Army Medical Services; (c) medical purposes for the medical history of the war; and (d) general medical scientific purposes. This would be based on the data contained on individual medical record cards that had been transcribed from admission and discharge books sent by each medical unit to the War Office (prior to 1916), or from cards that were initiated by medical units (after 1916). These cards recorded a single episode of care for a single person and were collated by the Ministry of Pensions in order to corroborate claims for disability pensions. This information was then coded onto a 'Hollerith Card'[34] that could be read by a 'tabulator' which used an electric counter to count each dimension in a selected group of cards.[35] This process was further refined in September 1921 and initially formed the basis for the data for subsequent editions of the Annual Report on the Health of the Army.[36] Regulations for the Medical Services of the Army contained the detailed instructions

[32]'The Official Medical History of the War', *Journal of the Royal Army Med Corps*, 43,3 (1924), pp. 213-219.
[33]The last of the eleven volumes of the original series was published in 1924.
[34]An early type of punched card
[35]Director of Statistics. 'Medical (War) Records', *Journal of the Royal Army Med Corps*, 41,2 (1923), pp. 131-136.
[36]A. M. D. 2. 'Medical Statistics', *Journal of the Royal Army Med Corps*, 44, 6 (1925), pp. 411-419.

for the provision of statistical returns and the Hospital Case Card (AF 11220) to the War Office.[37]

After much effort, including adjustments to the scope and number of personnel assigned to the analysis to cope with the quantity of data, the volume on Casualties and Medical Statistics of the medical history of the Great War was eventually published in 1931.[38] This concentrated on providing data and analysis of casualties, manpower, and wastage to inform military officers, administrative staff and medical officers in the estimation of the demand on the medical services for future wars.[39] The introduction to this volume provides a full description of the challenges in collating around 30 million individual index cards on every admission and discharge from medical units during the war. The first chapter describes the manpower data on the size of the British Army and the allocation of troops to campaigns and battles that provide the denominator for all calculations of rates. The second two chapters cover high level data on battle casualties and non-battle casualties respectively. There were 11,096,338 British and Dominion casualties of whom 91.54% were treated by the medical services; the remainder were either killed or became prisoners of war. Of the sick or wounded admitted to medical units, 3.04% died, 58.1% were returned to duty within that theatre of war, and 37.4% were evacuated home. Subsequent chapters followed a standard framework covering the strength of the force, classification of casualties, admissions to hospital, hospital accommodation in the lines of communication, and principle causes of non-battle casualties.[40] The book also presented the data from the Boer War in the same structure. The volume of index cards for the period 1916-1920 was so great that a sample of 1.04 million cards was analysed to provide reference percentages as a proportion of the total for topics such as cause of wounds such as weapon, accident, self-inflicted, old injury, type of wound such as flesh wound, major fracture, minor fracture, dislocation, anatomical location of wound, period in hospital, and disease diagnosis. The final chapter summarises the numbers of personnel awarded compensation by the Ministry of Pensions for physical or mental disablement arising from a wound, injury, or disease caused by war service. From 1919-1929, a total of 4,878,285 medical assessments had been undertaken and 27.7 percent of those who had served were in receipt of a war disablement pension. As observed after the Boer War, there was also a crisis of recruiting for the armed forces in the later years of the First World War. Whilst primarily an issue for the Adjutant General, the system of

[37]Regulations for the Medical Services of the Army (London: HMSO, 1923), pp. 50-55.
[38]Casualties and Medical Statistics of the Great War. Ref 6.
[39]The term "manpower" reflects its contemporaneous military usage as a measure of available personnel, and has no implications as to gender, with casualties being a loss of effective manpower.
[40]By rank (officer or other rank), nationality (British or Dominion).

medical examination of entrants was also revised.[41] After many false starts, a Ministry for National Service was created and the task of classifying recruits into categories of fitness was subordinated to civilian local government.[42] Similar to the conclusions after the Boer War, this whole process reignited awareness of the importance of the health of the working age population as a strategic economic and military asset.[43]

The data on medical activities and invaliding contained in the volumes of the 'Medical History of the Great War' represent a formalisation of the data included in the Royal Commission investigations that occurred previously after the Crimean War and the South African War. Indeed, the preface to Volume I laments the pre-war situation that

> the facts and lessons taught by war have to be searched for in reports of Royal Commissions and of parliamentary, interdepartmental, and War Office committees ; in the appendices to the annual reports of the Army Medical Department ; in general publications and articles in journals ; in Continental literature ; as well as amongst other documents, many of which are untabulated and their existence not generally known.[44]

Chapter II of the Medical History of the Great War is quoted in the 1935 edition of Royal Army Medical Corps Training as the source of data to estimate casualties from future conflicts.[45] The chapter on 'calculation of casualties' in Nicholls' book on the organisation, strategy and tactics of the Army Medical Services in war analyses this data in much greater depth and provides a fuller description of the calculation of a casualty estimate for a campaign.[46] Both Royal Army Medical Corps Training 1935 and the 1938 edition of Regulations for the Medical Services of the Army contained

[41]The Adjutant General performs the function of the Director of Human Resources in the Army.

[42]Sir W.G. Macpherson. Chapter V11 The Medical Examination of Recruits, in *History of the Great War based on official documents by direction of the Historical Section of the Committee of Imperial Defence. Medical Services: General History Vol. 1,* (London: Macmillan, 1921), pp. 118-137.

[43]Jay Murray Winter, 'Military fitness and civilian health in Britain during the First World War', *Journal of Contemporary History*, 5, 2 (1980), pp. 211-244.

[44]Sir W.G. Macpherson. Preface, in *History of the Great War based on official documents by direction of the Historical Section of the Committee of Imperial Defence. Medical Services: General History Vol. 1,* (London: Macmillan, 1921), p. vii.

[45]Royal Army Medical Corps Training WO 26/2883. (London: HMSO, 1935), pp. 107-111.

[46]T.B. Nichols. *Organisation, Strategy and Tactics of the Army Medical Services in War*. Ref 31.

detailed instructions for the completion of reports and returns during war and peace in order to provide the data for the compilation of medical statistics by Army Medical Directorate 2 (AMD 2) in the War Office.[47]

The Second World War: 1939-1945

As with the First World War, the compilation of statistics and the publication of the routine annual report on the health of the army was suspended at the start of the Second World War. Surprisingly, there was no plan for the collection and compilation of medical statistics in this conflict, which was further compounded by the absence of data on the many military casualties treated in the UK by the civilian emergency medical services. However, by 1941, an editorial board had been established to direct the work to collect and review material ready for the production of an official history of the medical services from this war. The scope was expanded to cover the Royal Navy, the Royal Air Force, the civilian medical services, and the medical services of the Commonwealth forces. It was intended to include statistics within the text of individual volumes and to publish a special volume on the topic.[48]

As with the analysis of medical data from the First World War, the first challenge was to collect the reports and returns from the individual operational theatres, based on two sources: personal medical documents and consolidated medical returns. The primary personal medical documents were the field medical card Army Form (AF) W3118 and the hospital record AF 11220. All AF 11220 forms were coded using punched cards and this provided the data for collating disease statistics. These coded medical returns were consolidated into a single report, AF W3180, by districts and commands with information from medical units, military hospitals, civilian hospitals, convalescent depots, and other sources. Inevitably, many records were lost in-transit due to enemy action. Beyond this there were issues with compliance with War Office instructions and oversight of the quality of data before it arrived at the War Office. Thus, there were several reviews and revisions to the procedures during the war.[49] The changes resulted in the formation of an Army Medical Statistics Branch that had three functions: current administration in the form of hospital admission information

[47]Regulations for the Medical Services of the Army. (London: HMSO, 1938), pp. 146-159.

[48]A. S. MacNalty. 'The Official Medical History of the War', *Journal of the Royal Army Med Corps*, 81,2 (1943), pp. 51-60.

[49]AE Crew, (ed.) Chapter 12 Hospitals, Convalescent Depots; Medical Embarkation and Distribution, Medical Documentation; Rehabilitation, Invaliding, in *Volume 1. Administration. The Army Medical Services. History of the Second World War. United Kingdom Medical Series,* (London: HMSO, 1953), pp. 428-433.

and the health of Army personnel; long-term planning utilising comparisons between population groups (location, employment, ethnicity etc); and medical research.[50]

The denominators for all medical statistics were derived from the government paper on the 'Strength and Casualties of the Armed Forces and Auxiliary Services of the United Kingdom 1939-1945' published in June 1946.[51] The first analysis was the Statistical Report on the Health of the Army 1943-45 published in 1948.[52] This only covered the last three years of the war and did not contain rates per thousand, only comparative (relative) rates between commands. The report covered several topics: medical wastage rates based on evacuations from operational theatres and invaliding from the Army; medical categorisation and anthropometric measurements of recruits; medical (including nurses and dentists) manpower relative to the Army populations at risk; surgical casualties during the battle for Normandy in 1944; psychiatric morbidity; and some clinical trials data on the efficacy of penicillin in treating war wounds and venereal disease. Much of the tabulated data was visualised using graphics and charts. One important chart, reproduced as Figure 1, showed the proportionate disposal of patients admitted to medical units in Normandy broken down between injured, sick and psychiatric patients and their disposal between returning to unit (RTU), evacuation to UK, medical reclassification, and medical invaliding. The structure and format of this chart became a common visualisation for casualty estimation in training manuals for medical planning.[53]

Each of the Campaigns volumes of the medical series of the Official History of the Second World War contains health data for individual campaigns and geographical commands. The volume on the campaign in North-West Europe contains a specific chapter on the health of the troops of 21st Army Group and compares this data with the experience from the First Word War.[54] This showed a reduction in admissions from enemy action to hospital per week per 1000 strength from 7 during 1914-18 to 2.4 for October to December 1944 and a reduction for sick and non-enemy injury from 12.3 to 5.5. The chapter also reproduced the analyses of casualty data from field

[50]HG Mayne. Army Medical Services, in Mellor WF (ed.), *Casualties and Medical Statistics. History of the Second World War. United Kingdom Medical Series*, (London: HMSO, 1972), p. 99.
[51]Strength and Casualties of the Armed Forces and Auxiliary Services of the United Kingdom 1939-1945. Cmd 6832. (London: HMSO, 1946).
[52]Statistical Report on the Health of the Army 1943-45. (London: HMSO, 1948).
[53]An example is Serial 41 Personnel Casualty Estimate Chp 3 – Sect 41 – Page 1 of the Staff Officer's Handbook. Army Code Number 71038. D/DGD&D/18/35/54. Jul 1999.
[54]Chapter 10 Health of the Troops, in FAE Crew (ed.), *Volume IV North-West Europe. The Army Medical Services. History of the Second World War. United Kingdom Medical Series*. (London: HM Stationary Office, 1962), pp. 560-636.

medical cards for casualties wounded in the period of the assault on Normandy immediately following the D Day landings, June 6 to July 31 1944, and their long-term outcome, which had been previously published in the earlier Statistical Report.

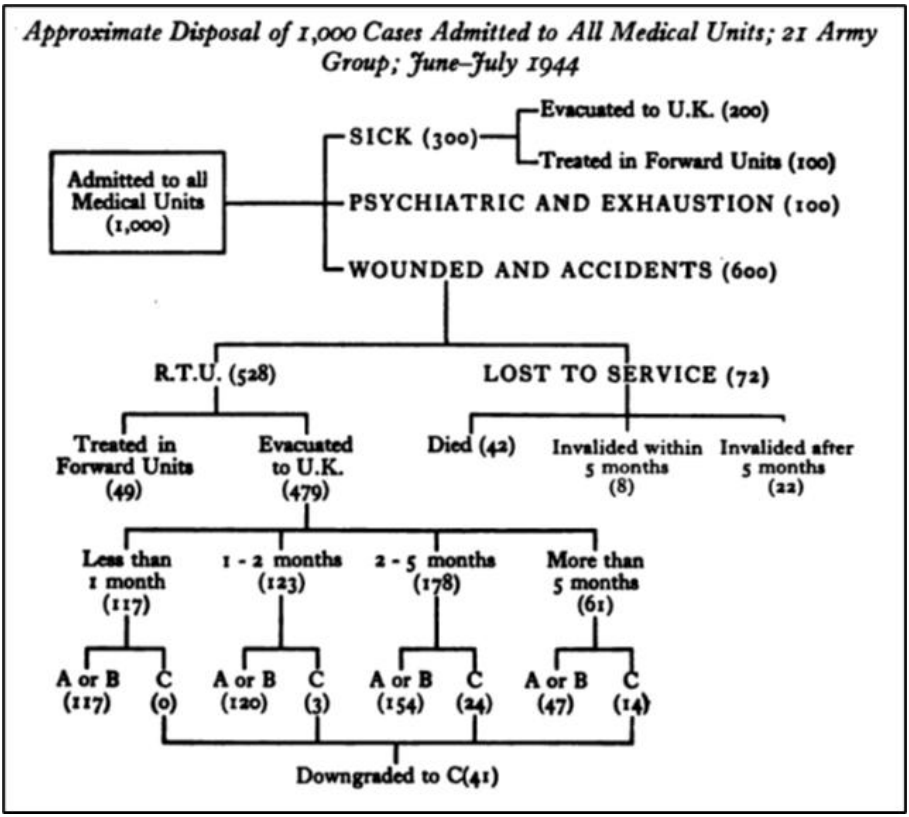

Figure 1: Disposal of Cases – June to July 1944.[55]

The volume on Casualties and Medical Statistics for the three military Services, Army, Royal Navy and Royal Air Force, and the civilian emergency medical services was finally published in 1972.[56] It is a very comprehensive historical record covering deaths and hospital admissions in the main theatres of war, and the causes of medical discharge, invaliding, for the period 1943-1945. This volume also provides a record of the

[55]Chapter 10 Health of the Troops, in FAE Crew (ed.), *Volume IV North-West Europe. The Army Medical Services. History of the Second World War. United Kingdom Medical Series*. (London: HM Stationary Office, 1962), p. 619.
[56]Franklin W. Mellor (ed.), *Casualties and medical statistics* Ref 7.

challenges faced by each of the medical statistics branches of the Royal Navy, Army, and Royal Air Force during the war and the reasons for incompleteness of the datasets. However, this volume lacks the interpretive analysis that was contained in the equivalent volume from the First World War. Fortunately, the final volume in the medical history series – Principal Medical Lessons of the Second World War – contains a comparison of the calculations of casualty rates referring to 'Cron, the Great War Casualties and Medical Statistics' volume, Nicholls, and data later published in the Second World War Casualties and Medical Statistics volume.[57] This analysis had already been incorporated into the medical planning guidance within the RAMC Training Pamphlet on Army Medical Services in the Field in 1950.[58] Medical planning calculations were contained in subsequent training publications such as 'Medical Support in the Field', published as an internal pamphlet in 1981, and editions of the Staff Officers' Handbook.[59]

Towards the Twenty-First Century

Although the volumes of the Official Histories provide a useful summary of the evolution of casualty statistics during the Second World War, the delay between the end of the war and their publication means that they do not entirely reflect the implementation of learning in respect of measuring the health of the army and casualty estimation since 1945. A review by Rosenbaum, from the Statistics Branch of the Army Medical Directorate (AMD), published in 1958 summarised some of the post-war changes. After the dissolution of the statistics branch of the Directorate of Medical Research, the function was absorbed into the Directorate of Army Health in 1947. It then regained its independence as AMD Statistics (AMD Stats) in 1951.[60] The 1950 edition of the Handbook of Army Health contained statistics on the causes of manpower wastage from the Army during World War 2 including admission data from the campaigns in North Africa and the Central Mediterranean. This showed that hospital admissions for sickness were much greater than battle injuries and accidents. It also included data from South-East Asia Command to emphasise the importance of leadership in the reduction of malaria cases.[61] Rosenbaum personally published papers

[57]Arthur Salusbury MacNalty and W. Franklin Mellor. *Principal Medical Lessons of the Second World War*. History of the Second World War. United Kingdom Medical Series. (London: HMSO, 1968), pp. 135-142.

[58]Army Medical Services in the Field. RAMC Training Pamphlet No2. WO Code 5672. (London: War Office. 28 July 1950), pp. 16-22.

[59]See reference 64.

[60]Simon Rosenbaum, 'Army Medical Department Statistics', *Journal of the Royal Army Med Corps*, 104, 3 (1958), pp. 164-165.

[61]Handbook of Army Health. WO Code 5691. (London: War Office, 1950), pp. 1-3.

on the anthropometric data of recruits and the medical fitness of recruits.[62] The function of AMD Stats as contained in the 1965 Manual of Army Health was primarily to analyse, comment and advise on medical statistics for the Army based on the FMed (forms, medical) system that replaced the previous AF series documents.[63] This detail had been dropped by the 1976 edition of the Handbook of Army Health.[64] The procedure for managing FMeds and the despatch of relevant documents to the AMD Stats continued to be described in the Manual for Medical Assistants[65] and Regulations for the Army Medical Services.[66]

There were no official publications that contained data on the casualties and medical statistics from the military campaigns of the second half of the twentieth century. However, there are multiple papers in the academic medical literature that provide snapshots of the clinical experience of the Army Medical Services from the Northern Ireland Troubles, the Falklands War, and the Gulf War of 1990.[67] Official health statistics from military operations from this period are dominated by the studies into the unofficially-named 'Gulf War syndrome' as a cause of ill-health amongst veterans who served in the Middle East.[68] It should be noted that these statistical studies mirror previous concerns about the long-term impacts of exposure to health threats whilst

[62]Simon Rosenbaum, 'Heights and weights of the army intake, 1951', *Journal of the Royal Statistical Society. Series A (General)*,117,3 (1954) pp. 331-347; Simon Rosenbaum, 'Cross-sectional review of morbidity among young soldiers', *British Journal of Preventive & Social Medicine*,13, 3 (1959) p. 103; Simon Rosenbaum, 'Experience of PULHEEMS in the 1952 Army intake', *British Journal of Industrial Medicine,* 14, 4 (1957), pp. 281-286; Simon Rosenbaum, 'The Association of Medical Discharges from the Army with Initial Grading', *Journal of the Royal Army Medical Corps*, 10,6 (1960), pp. 111-118.

[63]Manual of Army Health. War Office ACN 10157. (London: HMSO, 1965), pp. 404-405.

[64]Handbook of Army Health. Army Code 61257 (London: Ministry of Defence, 1976).

[65]Manual For Medical Assistants. Army Code 61535 (London: Ministry of Defence, 1987) p. 25-3-16.

[66]Regulations for the Army Medical Services continued to be published as updated editions until 1984. It was previously known as Regulations for the Medical Services of the Army.

[67]Examples of such papers are: Cameron Moffat, 'British Forces Casualties Northern Ireland', *J Royal Army Med Corps*, 122, (1976), pp. 3-8; A. R. Marsh, 'A short but distant war-the Falklands campaign', *Journal of the Royal Society of Medicine*, 76, 11 (1983), pp. 972-982; T. J. W Spalding, M. P. M. Stewart, D. N. Tulloch, and K. M. Stephens, 'Penetrating missile injuries in the Gulf war 1991', *British Journal of Surgery*, 78, 9 (1991), pp. 1102-1104.

[68]Simon Wessely, 'Ten years on: what do we know about the Gulf War syndrome? King's College Gulf War Research Unit', *Clin Med (Lond)*, 1,1 (2001), pp. 28-37..

on military service. In 1983 the Ministry of Defence commissioned the Nuclear Weapons Test Participants Study (NWTPS) as a long-term epidemiological study of the health of UK personnel who were present at UK atomic bomb atmospheric tests conducted between 1952 and 1967.[69] A later example is the 2003 Porton Down Veterans Cohort Study to investigate the long-term health effects of exposure to chemical weapons during research at the Porton Down government research establishment.[70] Meanwhile, military medical planning was still primarily concerned with the threat of war in Central Europe and the potential for the employment of nuclear and chemical weapons. The specific detail of the casualty estimates from this period remain classified, though some insights can be found from a paper on medical planning factors published in 1976.[71] This paper cites much of the previous work already described and emphasises the collaboration between countries of the NATO alliance in the historical analysis and forecast for casualty rates. The British Army Staff Officers Handbook of 1999 provided a flow chart to estimate the number and types of casualties from military operations against the Warsaw Pact forces.[72]

The statistics branches of the three Services (including the health statistics branches) and other parts of the Ministry of Defence were merged into the Defence Analytical Services Agency (DASA) in 1992. In 2008 this was changed to Defence Analytical Services and Advice following changes to the nomenclature of the Defence agencies. This then split in 2013 to form Defence Economics and Defence Statistics, with Defence Statistics (Health) as a specific branch of the latter dedicated to the collation of data and the production of official statistics on the health of the armed forces and veterans, the data now complying with the National Statistics standard. The Army Medical Services adopted electronic health records during the late 1990s, and these were eventually integrated into a single system for the Defence Medical Services (DMS) as the Defence Medical Information Capability Programme (DMICP). This led to the replacement of paper versions of FMeds with electronic versions as the routine source of data for collation and analysis.

[69]Nuclear Weapons Test Participants Study (NWTPS): Information Sheet. London: UK Health Security Agency, https://www.gov.uk/government/publications/nuclear-weapons-test-participants-study/nuclear-weapons-test-participants-study-information-sheet. Accessed 20 Aug 2024.
[70]The Porton Down Veterans Cohort Study. https://www.kcl.ac.uk/research/portondownstudy. Accessed 20 Aug 24.
[71]A.J. Shaw. Medical planning factors. *Journal of the Royal Army Med Corps*, 122, 4 (1976), pp. 208-214.
[72]Personnel Casualty Estimate. *Staff Officers Handbook*. Army Code Number 71038. (London: Ministry of Defence, 1999).

Whilst AMD continued to produce annual reports on the health of the army, over time these ceased to be official publications and were published as Annual Army Health Tables for internal use within the Ministry of Defence.[73] The reports were rejuvenated as DGAMS Annual Reports on the Health of the Army with the formation of the Army Health Unit in 1996.[74] The UK military hospitals were closed during the 1990s, with secondary care being transferred to the National Health Service (NHS), and so the source of data on soldiers in hospital ceased. The arrangements for collecting primary care sickness data were changed in 1995 with the introduction of the J95 (later J97) health surveillance system.[75] This was also introduced for military training and operations, and allowed the development of a predictive model for primary care activity for military operations.[76] By the time of publication of the sixth edition of the new DGAMS Annual Report in 2000, a common format had been established that combined data from DASA, the J97 data, dental health data, communicable disease data, and medicolegal data into a holistic report aligned to a health improvement plan for the Army.[77] As expected for a predominantly young male workforce, the principal health issues for the Army as causes of working days lost were consistently reported as being musculoskeletal disorders and injuries, mental health, respiratory disorders, including smoking-related disease, and sexual health, the first of which accounted for two-thirds of medical discharges from service.

Statistics & Legacy of Afghanistan & Iraq

Recent military medical statistics have been dominated by the experience of military operations in Iraq and Afghanistan during the first and second decades of the twenty-first century. In common with the commentaries in the official histories of the Army Medical Services in the First and Second World Wars, the procedures for collecting health-related information from military operations had waned by the start of these campaigns. As a policy decision, a split was made between the production of official statistics extracted from specific electronic health records within DMICP by DASA e.g. results from Medical Boards using FMed 1 and FMed 23 health records, the

[73]Beverly Bergman and Simon Miller, 'Unfit for further service: trends in medical discharge from the British Army 1861-1998', *Journal of the Royal Army Med Corps,* 146,3 (2000), pp. 204-211.

[74]Alastair Macmillan, 'Armed forces public health: is it hitting the target?' *Health and Hygiene*, 21, 1 (2000), p. 16.

[75]Jeremy Tuck and Martin Bricknell, 'A review of 10 years of systematic health surveillance in the Army', *Journal of the Royal Army Med Corps,* 151, 3 (2005), pp. 163-170.

[76]Tom Jefferson and Vittorio Demicheli, 'J95-EPINATO based planning parameters for medical support to operations other than war (OOTW)', *J Royal Army Med Corps,* 144, 2 (1998), pp. 72-78.

[77]Personal Communication. Dr B Bergman. DGAMS Annual Report 2000.

archiving function for medical records, which became the responsibility of the Ministry of Defence's Central Health Records Library, and clinical epidemiology using bespoke samples of patient populations by individual clinicians under the authority of the 'Defence Medical Director' within the Headquarters of the Defence Medical Services. DMCIP provided data from the garrison health system, but there was no universal system for the collation of health records from operations akin to the arrangements that emerged during First and Second World Wars based on collation of data from field medical records and the admission/discharge books from medical units.

Initial reporting of medical statistics was based on case series from individual field hospitals deployed at the start of Operation TELIC (Op TELIC) in Iraq in 2003.[78] It was clear that the interpretation of military epidemiology from war casualties would benefit from a standardised approach to data collection which would endure beyond the tours of individual clinicians.[79] By 2006, the handwritten Operational Emergency Department Register (OpEDAR), that was the modern equivalent of the hospital admissions book, had been replaced by an electronic version managed by DASA.[80] Alongside this, a Joint Theatre Trauma Registry (JTTR) was established to collect detailed clinical information on the most serious military trauma patients.[81] This was originally based in the Royal Centre for Defence Medicine, but then transferred to DASA when it became an 'official' statistic.

The care of military casualties from the wars in Iraq and Afghanistan attracted increasing political interest during 2006-7 with particular attention being focussed on their treatment within the UK by the UK NHS and subsequent rehabilitation by the

[78]David A. Rew, Jon Clasper, and Gregor Kerr, 'Surgical workload from an integrated UK field hospital during the 2003 Gulf conflict', *J Royal Army Med Corps*, 150, 2 (2004), pp. 99-106; C. Grainge and M. Heber, 'The role of the physician in modern military operations: 12 months experience in Southern Iraq', *Journal of the Royal Army Med Corps*, 151, 2 (2005), pp. 101-104; Paul Reavley and J. Black, 'Attendances at a Field Hospital emergency department during operations in Iraq November 2003 to March 2004 (Operation Telic III)', *Journal of the Royal Army Med Corps,* 152, 4 (2006), pp. 231-234.

[79]Martin Bricknell, 'Reporting clinical activity on military operations–time for some standardisation', *J Royal Army Med Corps*, 151, 3 (2005), pp. 142-144.

[80]Robert Russell, Timothy Hodgetts, Jo Ollerton et al, 'The operational emergency department attendance register (OPEDAR): a new epidemiological tool', *Journal of the Royal Army Med Corps,* 153,4 (2007), pp. 244-250.

[81]Jason Smith, Timothy Hodgetts, Peter Mahoney et al, 'Trauma governance in the UK defence medical services', *J Royal Army Med Corps*, 153, 4 (2007), pp. 239–242.

Defence Medical Rehabilitation Centre (DMRC).[82] This attention placed even greater emphasis on the collection and analysis of data concerning the care of military casualties. This data provided the evidence for the Healthcare Commission report into the Defence Medical Services which considered the arrangements for the care of operational casualties to be exemplary in regard to trauma care and rehabilitation, based on the evidence from the JTTR and comparisons with civilian trauma care.[83]

DASA first released publicly available annual summary statistics of cause of deaths for Armed Forces personnel based on casualty notification signals and other sources in 2001.[84] The 2003 edition, published in 2004, provided the first citation of 'Killed in Action' as a cause of death. 'Killed in Action' became the principal driver of the overall military mortality rate by 2006. The first of a series of Afghanistan casualty and fatality tables covering 7 October 2001 to 15 November 2009 was published on 15 November 2009. These tables combined data from the casualty notification system (NOTICAS[85]) with the OpEDAR and aeromedical evacuation records.[86] Mirroring the interest in casualty outcomes, the first summary of medical discharges from the Armed Forces was published in 2011.[87] These documents hark back to the authoritative

[82]Medical care for the Armed Forces. Defence Committee Seventh Report Session HC 327 (London: The Stationary Office, 18 Feb 2008), https://publications.parliament.uk/pa/cm200708/cmselect/cmdfence/327/327.pdf. Accessed 30 Aug 2023

[83]Timothy Hodgetts, Simon Davies, Robert Russell, and Jo McLeod, 'Benchmarking the UK military deployed trauma system', *J Royal Army Med Corps,* 153, 4 (2007), pp. 237-238.

[84]Deaths in the Armed Forces 2001. Statistical Notice. (Bath: DASA, 27 Mar 2002), Archived versions from 2001 to 2012 are available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20140116145122/http://www.dasa.mod.uk/index.php/publications/health/deaths/deaths-in-service. Accessed 30 Aug 2023

[85]NOTICAS is also the system which triggers notification to the next of kin of serious casualties.

[86]Afghanistan casualty and fatality tables. (Bath: DASA, 15 Nov 2009), https://webarchive.nationalarchives.gov.uk/ukgwa/20140116143519mp_/http://www.dasa.mod.uk/publications/health/operational-casualties/fatality-and-casualty/2009-11-15/15-november-2009.pdf. Accessed 30 Aug 2023

[87]Medical Discharges in the UK Regular Armed Forces. 2005/06 – 2009/10. (Bath: DASA, 11 Aug 2011), https://webarchive.nationalarchives.gov.uk/ukgwa/20140116143451mp_/http://www.dasa.mod.uk/publications/health/medical/medical-discharges/2009-10-financial-year/2009-10-revised.pdf. Accessed 30 Aug 2023

publications on casualty statistics published by the War Office after the First and Second World Wars though the number of casualties is much lower.[88]

In addition to publishing data on deaths, DASA started a new series of publications on very seriously ill/injured (VSI) and seriously ill/injured (SI) casualties in 2010.[89] The sample was created from the NOTICAS system. The clinical outcomes for the sample were determined from the OpEDAR, the JTTR, DASA's Medical Discharge Database, Compensation and Pension System (CAPS), DMICP and other new datasets such as the Defence Patient Tracking System (DPTS, initiated 8 Oct 2007) and DASA's Mental Health Returns Database. These data systems were initiated some time after the start of the campaigns in Afghanistan (2001) and Iraq (2003) and reflect the demand for data in response to public concern and parliamentary inquiries on the care for battle casualties and the mental health consequences of the wars. The complete series of reports provides a similar depth of overview to that relating to medical evacuation, treatment, and long-term outcomes of British Army casualties from June-July 1944 described in the North-West Europe volume of the Official History of the Second World War.[90] A separate summary of the DPTS data was published in 2012 that complied the monthly internal data into an annual report.[91] A similar summary for amputation data was also published in 2012.[92]

[88]Strength and Casualties of the Armed Forces and Auxiliary Services of the United Kingdom 1939-1945. Reference 42.

[89]Tracking Op HERRICK (Afghanistan) VSI/SI Operational Casualties: 2008 and 2009. (Bath: DASA, 13 Oct 2010), https://webarchive.nationalarchives.gov.uk/ukgwa/20140116143552mp_/http://www.dasa.mod.uk/publications/health/operational-casualties/VSI-and-SI-tracking/2010-01-01/1_january_2010.pdf. Accessed 30 Aug 2023.

[90]See Chapter 1 Strengths of the British Expeditionary Forces from a Medical Administrative Standpoint, Reference 2 and Chapter 10 Health of the Troops, Reference 45.

[91]Monthly Op TELIC and Op HERRICK UK Patient Treatment Statistics: RCDM and DMRC Headley Court 8 October 2007 – 31 July 2012. (Bath: DASA, 4 Sep 2012), https://webarchive.nationalarchives.gov.uk/ukgwa/20140116143539mp_/http://www.dasa.mod.uk/publications/health/operational-casualties/patient-treatments-RCDM-and-DMRC-headley-court/2012-07-31/31-july-2012.pdf. Accessed 30 Aug 2023.

[92]Quarterly Afghanistan and Iraq Amputation Statistics. 7 October 2001 – 31 December 2011. (Bath: DASA, 31 Jan 2012), https://webarchive.nationalarchives.gov.uk/ukgwa/20140116143515mp_/http://www.dasa.mod.uk/publications/health/operational-casualties/amputations/2011-12-31/31_december_2011.pdf. Accessed 30 Aug 2023.

The public concern regarding the health outcomes from the Gulf War of 1991 continued into the twenty-first century. Official statistics were published from 2004 on the cause of death in a cohort of veterans from this war compared to a group of service personnel who did not deploy.[93] Whilst no significant difference in overall mortality was demonstrated, concerns over suicide and other mental health conditions in this group rolled across into similar concerns regarding service in Iraq and Afghanistan. Multiple academic research programmes were initiated to explore the epidemiology of mental ill-health in the armed forces during the 2000s. DASA produced the first of a long series of analyses of patients with mental health conditions at the military Department of Community Mental Health centres in 2007 based on a new Mental Health Returns Database.[94]

The experience of the first decade of this century demonstrated the continuing requirement for medical statistics on military casualties from operations, alongside routine reporting of the health of, and utilisation of health services by, members of the armed forces. It also reflected an increasing public demand for transparency and visibility of data. The current list of routine publications of official medical statistics of the Ministry of Defence covers death in service (with subsidiary reports covering operational deaths, training and exercise deaths, and suicide), operational casualties (including amputations), health and safety statistics, morbidity statistics (covering medical discharges, mental health, and NHS commissioning statistics), and Veterans statistics.[95] This is a substantial list, though it could be argued that the coverage of these statistics is similar to those from the previous century and that the evolution of the system in the twenty-first century represents a restoration of previously decayed institutional knowledge rather than new learning, augmented by the greater ease of accessing information which has been brought about by the information technology

[93]1990/1991 Gulf conflict – UK gulf veterans mortality data. 2003-2012. (Bath: DASA), Available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20140116145214/http://www.dasa.mod.uk/index.php/publications/health/veterans/gulf-1-deaths. Accessed 30 Aug 2023.

[94]Corbet C and Nick Blatchley. UK Armed Forces psychiatric morbidity: Assessment of presenting complaints at MOD DCMHs and association with deployment on recent operations in the Iraq/Afghanistan theatres of operation January – March 2007. (Bath: DASA, March 2007), https://webarchive.nationalarchives.gov.uk/ukgwa/20140116142555/http://www.dasa.mod.uk/index.php/publications/health/medical/mental-health-quarterly/2007-03-31/. Accessed 30 Aug 2023.

[95]MOD National and Official Statistics by topic. Ministry of Defence. https://www.gov.uk/government/statistics/mod-national-and-official-statistics-by-topic/mod-national-and-official-statistics-by-topic#health-statistics. Accessed 30 Aug 2023.

revolution. Clearly though, the current volume of data is substantially smaller than the past due to the reduction in the size of the armed forces and the lower intensities of wars since 1945 compared to the First and Second World Wars. In response to the COVID-19 pandemic, a new periodic statistic on coronavirus testing and cases in Defence personnel was published between 30 July 2020 and 20 September 2022.[96] In contrast to the Official History Series, there has not been a consolidated review of medical statistical data from the most recent wars, nor is there a publicly accessible document that shows the application of this retrospective data into predictive calculations of the casualty estimate for future conflicts.

The Future for Military Medical Statistics

As evidenced by the many references cited in this paper, the Armed Forces represent a unique population for the collection and analysis of medical statistics. They are employed and receive healthcare through services commissioned by the state, but the activities which they undertake may involve unavoidable risks to health over and above those faced by the wider civilian population. Their health is assessed on joining, periodically during service, and on leaving the service. Their episodes of healthcare are recorded, and their clinical outcomes can be measured over time. Adverse outcomes of military service can be measured by the rate and cause of medical discharge, claimants of a military disability pension or compensation, and deaths in service. This data can be collected, collated, and analysed to provide information on the overall health of the military population, to determine the causation of medical attrition, and to forecast a future demand for in-service healthcare both in peace and war. The value of such a medical statistics system was demonstrated during the nineteenth century through observing the effect of improvements in hygiene and sanitation in reducing the mortality of the British Army at home and overseas. Medical statistics underpinned the medical research efforts during the First and Second World Wars by both improving measures to protect the health of the armed forces and improving treatments for those who needed medical care. The open publication of medical statistics also demonstrates the transparency of the state in husbanding the people who serve the nation in the armed forces. Thus, the three functions of a military medical statistics branch described in the volume of the Official History of the Second World War on Casualties and Medical Statistics remain unchanged, namely: current administration of the health services; long-term planning to reduce medical wastage by understanding causation of ill-health; and targeted research on causation, attribution and treatment of medical conditions affecting the armed forces.[97] The military medical statistics system generates enduring datasets that should be routinely

[96]Coronavirus in Defence. Ministry of Defence. https://www.gov.uk/government/collections/coronavirus-in-defence. Accessed 31 Aug 2023

[97]Mayne HG. *Army Medical Services*. Ref 51.

analysed in peace, and additional datasets which should be analysed during war. The medical statistics system should be integrated into the clinical records system so as to minimise transcription of clinical data into parallel administrative databases, with due regard for privacy, data protection, and other legal, ethical, security, and personal perspectives. The medical statistics function should also link to the personnel statistics function so as to define populations at risk to determine the denominators for calculations of rates and risk.[98] It is a welcome development that the Defence People Health and Wellbeing Strategy of 2022 formally acknowledges the importance of evidence to address potential issues affecting the health and well-being of personnel in the UK armed forces.[99]

Based upon the historical experience of medical statistics, it would seem that there are four key events that generate data: the recruit medical examination; medical activities; medical discharges; and the award of a military ill-health pension or compensation. These are shown in Figure 2. The first is a measure of the health of the working age population, the prevalence of disease, and the threshold of medical fitness suitable for military service. As frequently shown in history, this is a measure of the 'public's health' and has significant implications for the 'medical quality' of the population for the defence of the nation. Unfortunately, due to recent contracting-out of the recruit medical examination process, data from this source is no longer routinely published. The second is a measure of the demand for in-service health services, covering physical health, mental health, and dental health. Appropriate coding will provide insights into diagnosis, causation, severity, and duration of medical conditions. This information allows commanders to balance risk to health with realism of military training, and the medical services to plan and monitor the performance of health services supporting the armed forces. It should be the primary source of evidence to inform Defence health and well-being policies. Those personnel not medically suitable for continued military service are medically discharged. Information on manpower 'wastage' by diagnosis, causation and severity can also inform prevention and treatment. Finally, the financial cost of medical discharge is measured by the value and duration of War Pensions and the post-April 2005 Armed Forces Compensation Scheme. The seminal volume on casualties and medical statistics from the Great War stands as an indicator of such a holistic approach to the military information set.

[98]Martin Bricknell, 'Options for future military health surveillance systems', *Journal of the Royal Army Med Corps,* 145, 2, (1999), pp. 80-83.

[99]Defence People Health and Wellbeing Strategy 2022-2027. (London: Ministry of Defence, 22 June 2022) https://www.gov.uk/government/publications/defence-people-health-and-wellbeing-strategy-2022-to-2027. Accessed 24 Aug 2024.

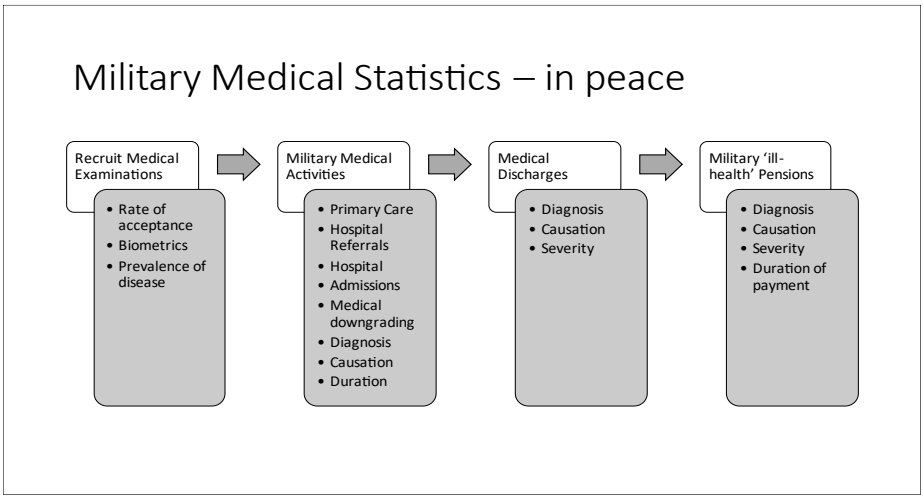

Figure 2: Military Medical Statistics – in peace.

This review has shown however that the peacetime system for collecting data and reporting medical activity has not been suitable for the exigencies of war. The volume of casualties far exceeded that of peacetime, pressure on resources prevented the expansion of capacity in the medical statistics system, many records were lost due to enemy action, and lack of compliance with procedures. However, it is precisely because of the challenges of war that information on medical statistics is valuable, both to manage the medical services in war and also to learn lessons for future wars. The basic features required of the medical statistics system in peace are the same as during war. In every war over this period, the medical assessment system of recruits required to be modified due to the shortage of personnel in the armed forces. It is clear that the demand for accurate information about the recruit medical assessment system will also increase during war.

As stated at the beginning of this paper, 'war is an epidemic of injuries', although disease also plays a part, and so effective and efficient planning and operation of the medical system will be highly dependent on management information about clinical activity. The essential datasets for monitoring and planning medical activity will be similar to those needed in peace, but the policy and procedures to manage the information will need to be adaptable to the realities of field medical services, and to reach into the NHS care system. This should cover all causes of ill-health due to war. It is noticeable that Defence Statistics developed the Defence Patient Tracking System (DPTS, initiated 8 Oct 2007) and the Mental Health Returns Database during the Afghanistan campaign. The understanding of the epidemiology of war has advanced with the formalisation of common datasets through the creation of registries such as

the Joint Theatre Trauma Registry. It is important for the system to be planned and resourced in peace in order to avoid the loss of data and knowledge that has been shown to occur at the beginning of every war described in this paper. Figure 3 shows some additional components of a military medical statistics information system for war.

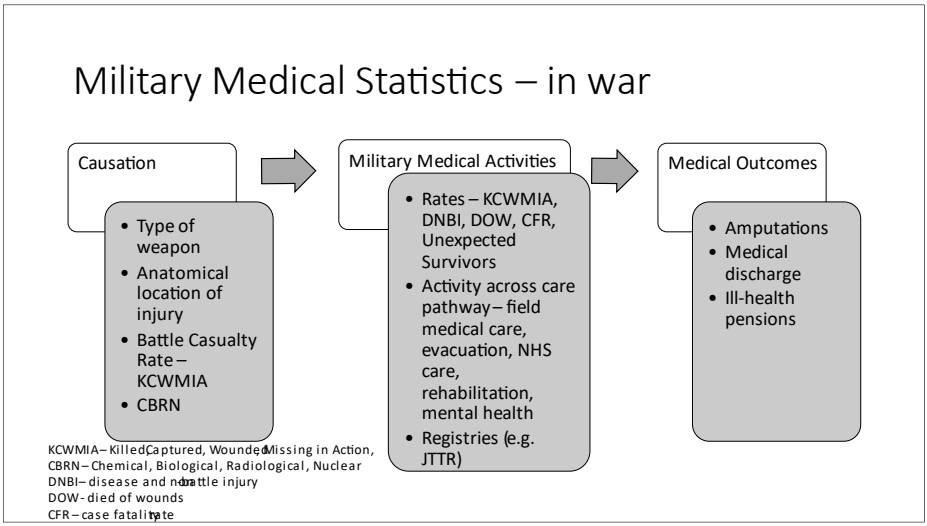

Figure 3: Military Medical Statistics – in war

Medical planning is derived from the 'casualty estimate', which endeavours to predict not only the medical resources which will be required but also the likely attrition in effective manpower. The medical statistics system must reliably record the four categories which feed into the casualty estimate in war: killed; captured; wounded; and missing in action (KCWMIA).[100] The medical services are concerned with the number of wounded from battle, and the demand from disease and non-battle injury (DNBI) patients. A range of statistical measures of the performance of the whole medical system has been developed, including: distribution of cause of injury; distribution of injury by anatomical location; died of wounds; overall mortality rate; case-fatality rate.[101] These can be compared between wars and civilian trauma systems to see

[100]Allied Joint Medical Planning Docrine. AJMedP-1. (Brussels: North Atlantic Treaty Organisation, September 2018) pp. 3-21-5 Available at: https://www.coemed.org/files/stanags/02_AJMEDP/AJMedP-1_EDA_V1_E_2542.pdf. Accessed 30 Aug 2023.

[101]Jeffrey T. Howard, Russ S. Kotwal, Caryn A. Stern, Jud C. Janak, Edward L. Mazuchowski, Frank K. Butler, Zsolt T. Stockinger, Barbara R. Holcomb, Raquel C.

whether the observed figures differ from the statistically expected figures. This has been considered to have provided the most accurate measure of improved performance of the whole military medical system during the war in Afghanistan. [102]

This type of analysis can be further refined by matching cases for severity using standardised clinical severity scores applied to the data on patients recorded with the patient registries. A paper that applied this approach to UK casualties from Afghanistan showed a year-on-year improvement in survival rates for the most severely injured.[103] It is also necessary to link medical records with personnel records to ensure accurate denominators for the exposed population at risk; with modern IT systems and smaller numbers of personnel in service, this should not present an insurmountable challenge. History has shown that military personnel may present with unexplained medical symptoms with possible associations with exposure to environmental hazards or toxins for example the unofficially-named Gulf War Syndrome of the 1991 Gulf War and the more recent 'burn pit' syndrome ascribed by US Veterans to exposure to toxins from open burning of rubbish on military bases.[104] It is important to establish the necessary longitudinal cohort studies during and after military campaigns to be

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Bono, and David J. Smith, 'Use of combat casualty care data to assess the US military trauma system during the Afghanistan and Iraq conflicts, 2001-2017', *JAMA Surgery*, 154, 7 (2019) pp. 600-608.

[102]Cannon, Jeremy W, Holena, Daniel N, Geng, Zhi, Stewart, Ian J, Huang, Yanlan, Yang, Wei, Mayhew, Emily R, Nessen, Shawn C, Gross, Kirby R and Schwab, C William, 'Comprehensive analysis of combat casualty outcomes in US service members from the beginning of World War II to the end of Operation Enduring Freedom', *Journal of Trauma and Acute Care Surgery*, 89, (2020), pp. S8-S15; Adam Stannard, Nigel Tai, Doug Bowley, Mark Midwinter, and Timothy Hodgetts, 'Key Performance Indicators in British Military Trauma', *World Journal of Surgery* 32, (2008), pp. 1870–1873.

[103]Jowan Penn-Barwell, Stuart Roberts, Mark Midwinter, and Jon Bishop, 'Improved survival in UK combat casualties from Iraq and Afghanistan: 2003–2012', *Journal of Trauma and Acute Care Surgery*, 78, 5 (2015), pp. 1014-1020.

[104]Edgar Jones, Robert Hodgins-Vermaas, Helen McCartney, Brian Everitt, Charlotte Beech, Denise Poynter, Ian Palmer, Kenneth Hyams, and Simon Wessely, 'Post-combat syndromes from the Boer war to the Gulf war: a cluster analysis of their nature and attribution', *British Medical Journal*, 324, 7333 (2002), pp. 321-324; Timothy M. Mallon, Patricia Rohrbeck, Kevin M. Haines, Dean P. Jones, Mark Utell, Philip K. Hopke, Richard P. Phipps et al, 'Introduction to Department of Defense research on burn pits, biomarkers, and health outcomes related to deployment in Iraq and Afghanistan', *Journal of Occupational and Environmental Medicine*, 58, 8 (2016), pp. S3-S11.

able to follow up such concerns with valid epidemiological investigations.[105] This should be an increasingly practical proposition as military health and personnel records are digital and share common identifiers (such as National Insurance number and NHS number) with other government databases.[106] Alongside returns of the more immediate deaths and seriously injured, the true human costs of war on members of the armed forces will be measurable through long-term outcome measures such as medical invaliding, medical pensions and compensation schemes as shown throughout the twentieth and early twenty-first centuries. Studies also need to extend into the veteran years in order to capture the long-term consequences of military service. One such example is the Armed Services Trauma Rehabilitation Outcome Study (ADVANCE) that is long-term outcome study following a cohort of UK male military service personnel who were injured during the conflict in Afghanistan and periodically conducting a comprehensive suite of physical and mental health assessments to measure any changes.[107]

Conclusions

This paper has provided an overview of the analysis of casualties and medical statistics over the past 200 years for the British Army, and more recently, the UK armed forces overall. It has shown how the emergence of a formal requirement to publish health data on the British Army led to improvements in the hygiene and preventive medicine functions in the Army Medical Services, and hence to an overall improvement in the health of the Army. However, the medical statistics function in peace has not been adequate to meet the requirements for providing accurate management data in the

[105]Martin Bricknell, 'Options for future military health surveillance systems', *Journal of the Royal Army Medical Corps*, 145, 2 (1999), pp. 80-83; Amy Hall, Trish Batchelor, Laura Bogaert, Robert Buckland, Ali B. Cowieson, Michael Drew, Kate Harrison, David I. McBride, Aaron Schneiderman, and Kathryn Taylor, 'International perspective on military exposure data sources, applications, and opportunities for collaboration', *Frontiers in Public Health*, 11 (2023) p. 1154595.

[106]Examples are: Dierdre MacManus, Kimberlie Dean, Margaret Jones, Roberto Rona, Neil Greenberg et al, 'Violent offending by UK military personnel deployed to Iraq and Afghanistan: a data linkage cohort study', *The Lancet*, 381, 9870 (2013), pp. 907-917, Beverly Bergman, Daniel Mackay, Daniel Smith, Jill Pell, 'Suicide in Scottish military veterans: a 30-year retrospective cohort study', *Occupational Medicine*, 67, 5, (2017) pp. 350–355 and Beverly Bergman, Daniel Mackay, Jill Pell, Acute Myocardial Infarction in Scottish Military Veterans: A Retrospective Cohort Study of 57,000 Veterans and 173,000 Matched Nonveterans, *American Journal of Epidemiology*, 179, 12 (2014), pp. 1434–1444.

[107]Armed Services Trauma Rehabilitation Outcome Study. Defence Medical Rehabilitation Centre. https://www.advancestudydmrc.org.uk/. Accessed 24 Aug 2024.

major wars in South Africa (1899-1902), the First World War, the Second World War or indeed in the recent military campaigns in Iraq and Afghanistan. Not only has the system, including new data collection methods, had to evolve, but the volume of returns and the lack of resources (personnel and space) resulted in the publication of the analyses many years after the experience of war. This reduced the overall results of the statistical analysis of human cost of war to historical value, with limited contemporary impact. It could be argued that most of the recent developments in data collection and analysis on military health statistics have been driven by public opinion pressuring politicians and the Ministry of Defence for evidence of the quality of healthcare being provided to armed forces personnel and veterans rather than internal efforts to improve the management of the health system. However, this criticism needs to be balanced against the large volume of academic papers published during and after the major wars on clinical developments in the care of military casualties, and the improvements in major trauma care in the wider community which have resulted from scientific analysis of medical care during war. The role of military medical statistical information to inform the management of three domains for a military health system remain unchanged: the current administration of the health services; the long-term planning to reduce medical wastage by understanding causation of ill-health; and targeted research on causation, attribution and treatment of medical conditions affecting the armed forces.