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The Evolution of Military Surgery during the French Wars, 1793-1815

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Abstract

The long period of the wars against Republican then Napoleonic France (1793-1815) was prosecuted in a wide variety of environments and climates, which incurred much disease and loss of life in the British Armed Services. This was particularly the case in the early years of the wars. Long sea journeys, lack of land transport and gruelling physical challenges were imposed on soldiers, sailors and marines. Surgeons in the Army Medical Department were poorly trained and ill-prepared to manage their patients within the contemporary military setting. Bearing a lowly status compared to their few physician colleagues, the regimental and hospital surgeons had to manage most medical problems as well as dealing with the wounded. Combat injuries were diverse and, without knowledge of bacteriology, anaesthesia, good hygiene and sanitation or the physiology of trauma and with limited nursing support, surgical outcomes initially left much to be desired.

There was a gradual improvement in the perception and performance of surgeons to understand the needs of sick and wounded soldiers and the types of diseases and wounds predominant on campaign. Also importantly, there evolved a closer co-operation of the military surgeon with his field commanders at all levels, which might be described as the 'militarisation' of surgeons. During the Iberian campaigns, with increasing experience and the strong support and efficient administration of Inspector General Sir James McGrigor (1771-1858), most of the improvements in surgical practice evolved from 1812. These innovations and developments led in 1814 to the apogee of the Army Medical Department's performance. This was enhanced by the teaching and examples of some burgeoning British military surgical giants.

Keywords

Military surgery, Wounds, Napoleonic War, Sir James McGrigor, George Guthrie

Introduction

Occasional enlightened texts relating to military surgery and medicine had arisen over the centuries, notable examples being those of Thomas Morstede (c1411-50), Richard Wiseman (1622-76) and John Woodall (1570-1643), concerning naval surgery.[1] [2] [3] During the mid-eighteenth century Sir John Pringle (1707-82) published seminal advice for the care and protection of sick soldiers after the War of the Austrian Succession and the second Jacobite Rising (1740-48).[4] John Hunter (1728-93), while serving as a staff surgeon during the Seven Years' War (1756-63), wrote of his experiences and contributed much to challenge contemporary field practice.[5] However, despite the French Wars (1793-1815) lasting through the latter stages of the Ages of Enlightenment in England and Scotland, both publications and early experiences in the French Revolutionary and Imperial Wars reflected continued underdevelopment in the health and surgical management of the British soldier. Doubtless, the provision of sound hygiene, sanitation, appropriate diet and clothing would save far more lives than the surgeon's blade.

This article will focus on improvements in the practice and organisation of British and some aspects of French military surgery during the wars of 1793 to 1815, with occasional comments on naval practice. The advancement in surgery was seriously hampered by the lack of anaesthesia and infection control, limited understanding of the pathophysiology of trauma and inadequate pain relief for casualties. The wars were prosecuted in many parts of the globe, from the West Indies to India and Moscow to Africa, thus exposing service personnel to a large variety of climates, diseases and maritime disasters. Early in the wars, Britain suffered large losses from campaigns in The West Indies and the Low Countries, principally from disease and ill-informed medical management, the latter due to ignorance of the nosology, pathogenesis and mode of transmission of fevers and sepsis and also lack of appropriate transport and hospital siting for the sick and injured. During the later Peninsular Campaigns (1812-1814), only one in five deaths was from combat injury.[6]

The surgeons and their patients

What then of the patients during these wars? From 1805, many soldiers volunteered and many were recruited from the militia, yet others entered the service as an escape from

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[1] Morstede T. [attributed]. *A Fair book of Surgery*. London, 1446. British Library. Harley MS 1736.

[2] Wiseman R. *Several Chirurgical Treatises*, Second Edition. London: R Norton and J Macock for R Royston and B Took; 1686. Books V, VI and VII.

[3] Woodall J. *The Surgion's Mate*. London: E Griffin for L Lisle; 1617.

[4] Pringle J. *Observations on the Diseases of the Army*, First American Edition. Philadelphia: Edward Earle; 1810.

[5] Hunter J. *A Treatise on the Blood, Inflammation and Gun-shot Wounds*. London: John Richardson for George Nicol; 1794.

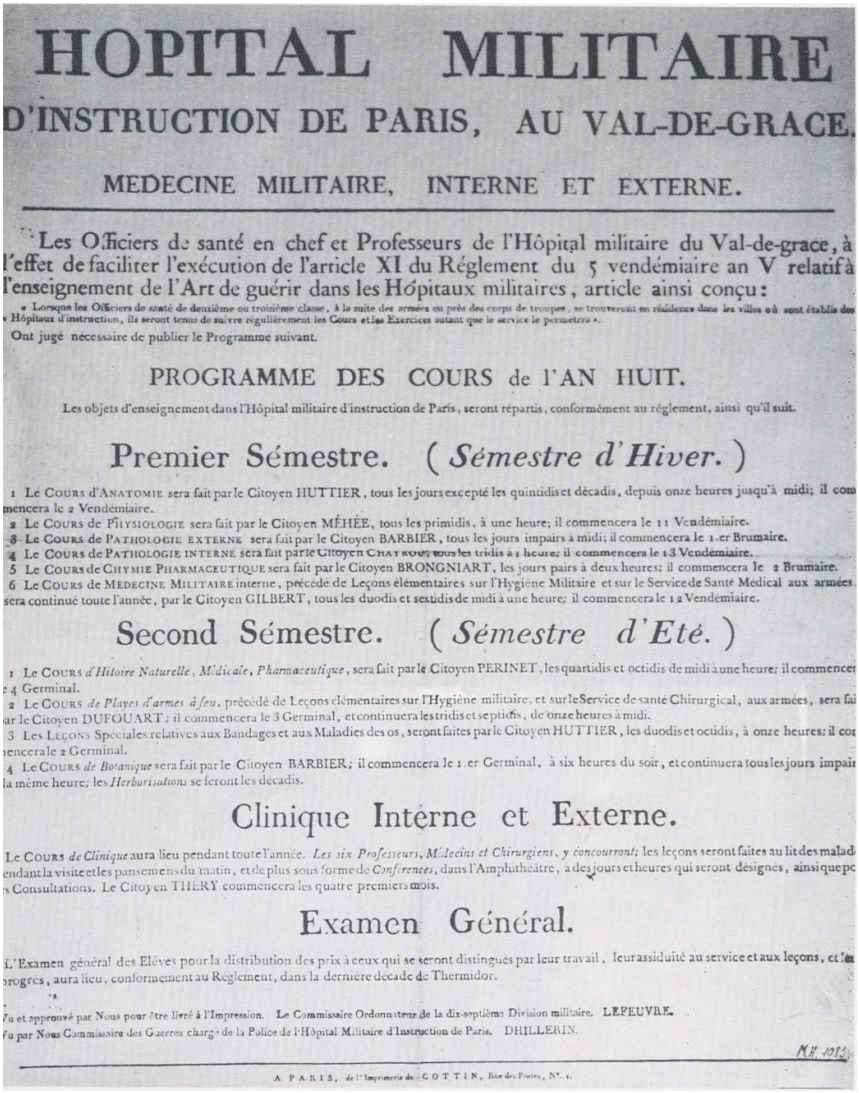
[6] Cantlie N. *A History of the Army Medical Department*, *Vol. 1*. Edinburgh & London: Churchill Livingstone; 1974. p.509.

boredom, harsh and tedious physical labour, financial difficulties or prosecution (Figure 1). Many recruits were thus inured to arduous physical work, low wages and early death of family members. While extremes of fatigue and hunger would diminish immunity, most men were adjusted to the multitude of risks and hardships offered by service life and were aware of what little comfort was available following injury. Albeit a rather crude selection process, the overall rejection rate of recruits for the Army was around 30 per cent, with damaged limbs, rheumatic disorders and ruptures being common reasons for failure.[7]

Figure 1. Recruiting party for the 33rd Regiment outside a Yorkshire tavern. Coloured aquatint by R and D Havell, 1814; from the series *Costumes of Yorkshire*. Photograph of an original engraving by the author.

Republican France lost many educational institutions established under the *ancien regime.* Fourteen medical schools and all but eight military and naval hospitals had been closed.[8] However, the evolving new regime established new military teaching hospitals and fresh curricula for aspiring surgeons (Figure 2). As the wars progressed several reputable military advances took place in the *Service de Santé* (Military Health Service), such as the *Ambulances Volantes* (Flying Ambulances) and a cadre of dedicated stretcher bearers. These innovations speeded up casualty evacuation and provided surgical aid at the frontline. With territorial gains and treaties, students from most parts of the French Empire could train as military surgeons in the French system.

[7] Crumplin M. *Men of Steel: Surgery in the Napoleonic Wars*. Shrewsbury: Quiller Press; 2007. p.26.
[8] Howard MR. *Napoleon's Doctors: The Medical Services of the Grande Armée.* Stroud: Spellmount; 2006. p.3.



HOPITAL MILITAIRE
D'INSTRUCTION DE PARIS, AU VAL-DE-GRACE.

MEDECINE MILITAIRE, INTERNE ET EXTERNE.

Les Officiers de santé en chef et Professeurs de l'Hôpital militaire du Val-de-grace, à l'effet de faciliter l'exécution de l'article XI du Réglement du 5 vendémiaire an V relatif à l'enseignement de l'Art de guérir dans les Hôpitaux militaires, article ainsi conçu :

« Lorsque les Officiers de santé de deuxième ou troisième classe, à la suite des armées ou près des corps de troupes, se trouveront en résidence dans les villes où sont établis des Hôpitaux d'instruction, ils seront tenus de suivre régulièrement les Cours et les Exercices autant que le service le permettra ».

Ont jugé nécessaire de publier le Programme suivant.

PROGRAMME DES COURS de l'AN HUIT.

Les objets d'enseignement dans l'Hôpital militaire d'instruction de Paris, seront répartis, conformément au réglement, ainsi qu'il suit.

Premier Sémestre. (*Sémestre d'Hiver.*)

1 Le Cours d'Anatomie sera fait par le Citoyen HUTTIER, tous les jours excepté les quintidis et décadis, depuis onze heures jusqu'à midi; il commencera le 2 Vendémiaire.
2 Le Cours de Physiologie sera fait par le Citoyen MÉHÉE, tous les primidis, à une heure; il commencera le 11 Vendémiaire.
3 Le Cours de Pathologie externe sera fait par le Citoyen BARBIER, tous les jours impairs à midi; il commencera le 1.er Brumaire.
4 Le Cours de Pathologie interne sera fait par le Citoyen Chaussier, tous les tridis à 1 heure; il commencera le 13 Vendémiaire.
5 Le Cours de Chymie Pharmaceutique sera fait par le Citoyen BRONGNIART, les jours pairs à deux heures; il commencera le 2 Brumaire.
6 Le Cours de Médecine Militaire interne, précédé de Leçons élémentaires sur l'Hygiène Militaire et sur le Service de Santé Medical aux armées, sera continué toute l'année, par le Citoyen GILBERT, tous les duodis et sextidis de midi à une heure; il commencera le 12 Vendémiaire.

Second Sémestre. (*Sémestre d'Eté.*)

1 Le Cours *d'Hiloire Naturelle, Médicale, Pharmaceutique*, sera fait par le Citoyen PERINET, les quartidis et octidis de midi à une heure; il commencera le 4 Germinal.
2 Le Cours *de Playes d'armes à feu*, précédé de Leçons élémentaires sur l'Hygiène militaire, et sur le Service de santé Chirurgical, aux armées, sera fait par le Citoyen DUFOUART; il commencera le 3 Germinal, et continuera les tridis et septidis, de onze heures à midi.
3 Les Leçons Spéciales relatives aux Bandages et aux Maladies des os, seront faites par le Citoyen HUTTIER, les duodis et octidis, à onze heures; il continuera le 2 Germinal.
4 Le Cours *de Botanique* sera fait par le Citoyen BARBIER; il commencera le 1.er Germinal, à six heures du soir, et continuera tous les jours impairs à la même heure; les *Herborisations* se feront les décadis.

Clinique Interne et Externe.

Le Cours *de Clinique* aura lieu pendant toute l'année. *Les six Professeurs, Médecins et Chirurgiens, y concourront;* les leçons seront faites au lit des malades pendant la visite et les pansemens du matin, et de plus sous forme de *Conférences*, dans l'Amphithéâtre, à des jours et heures qui seront désignés, ainsi que pour les Consultations. Le Citoyen THIERY commencera les quatre premiers mois.

Examen Général.

L'Examen général des Elèves pour la distribution des prix à ceux qui se seront distingués par leur travail, leur assiduité au service et aux leçons, et leurs progrès, aura lieu, conformément au Réglement, dans la dernière decade de Thermidor.

Vu et approuvé par Nous pour être livré à l'Impression. Le Commissaire Ordonnateur de la dix-septième Division militaire. LEFEUVRE.
Vu par Nous Commissaire des Guerres chargé de la Police de l'Hôpital Militaire d'Instruction de Paris. DHILLERIN.

M.H. 1015

A PARIS, de l'Imprimerie de COTTIN, Rue des Postes, N°. 1.

Figure 2. A French military medical training programme for 1799. Author's photograph of original document held at the Val de Grâce Hospital Museum in Paris.

By contrast, as the wars rolled out, Britain failed to initiate apposite training schedules for aspiring army doctors. This reflects the lack of a national revolution and revival in Britain as had taken place in France, where the revolution had wiped out the ancient regime of military medicine. In Britain there had been no reformation of the Army Medical Department (AMD) before or during the earliest part of these wars. After a Commission of Military Inquiry's Fifth Report on the AMD published in 1808 and the disaster of the Walcheren Campaign (1809), the Department was investigated and reconstructed. This resulted in the appointment of three senior experienced governing surgeons, all of whom were Scots. The report condemned wastage, inefficiencies and irregularities in promotion. The fact remains that France could train, educate and organise its new revolutionary army with zeal *de novo*. Britain did not have this impetus.

For a man aspiring to enter the AMD as a surgeon, there was little in the way of targeted teaching for the management of diseases or wounds suffered on campaign.

There was no military medical school, nor a chair in military medicine in Britain until 1806 when a Regius Chair of Military Surgery was established in Edinburgh. So how were men trained in surgery? Their education usually consisted of an indentured apprenticeship of two to five years, commencing around the age of fifteen. The apprentices' masters were physicians, surgeons or apothecaries, so the master's practice would clearly influence knowledge and skills gleaned by the apprentice. Walking the wards of a civilian hospital as a 'plaister man', house pupil or surgeon was followed by attendance at anatomical dissections and lectures in surgery, anatomy, medicine, midwifery and *materia medica*.

To serve as an army doctor entailed passing an examination to gain either a military diploma or sometimes a full college membership (MRCS). In England, at the Company (after 1800, the College) of Surgeons in London, ten members of the Court of Examiners, having ascertained the adequacy of the candidate's training, then proceeded with purely a *viva voce* (Figure 3). One examiner with military experience would ask questions relevant to field practice. To take a few examples from the only contemporary crib-book published: in the matter of the Practice of Physic, 'What are the symptoms of enteritis?'; in the subject of Surgery, 'What method is to be taken after a cannon ball has torn off a limb?' and in the subject of Anatomy, 'What is there peculiar to the second vertebra?'. Other topics included Physiology, Chemistry, *Materia Medica* and Midwifery.[9] Having satisfied the examiners, a diploma or membership in surgery was awarded.

Figure 3. A nervous candidate (left) being examined at the College of Surgeons in London. Engraving by G Cruickshank, c1811. Author's collection.

During the wars, there was an escalating demand for medical staff for the army. In London, for example, around 500 exams were taken in 1810, 130 more than in 1790.[10]

[9] Hooper R. *Examinations in Anatomy, Physiology and Pharmacy*, Third Edition. London: Longman, Hurst, Rees, Orme and Brown; 1814.
[10] Crumplin. *Men of Steel*, 2007 (Note 7). p.164.

In general, twice the number of candidates opted for the military diploma rather than taking the full membership examination, which suggests that there was a lower standard expected with the diploma. There is no evidence to prove this since the exams were oral, there was no strict written syllabus and the only crib-book published does not differentiate between the two types of examination; we may only surmise on this issue.

From the outset of the wars the low status, poor pay and risks inherent on campaign did little to boost recruitment of surgeons. However, some reforms made in 1796 eased the problem and improved recruitment. On 30 November 1796, a Royal Warrant increased pay for regimental surgeons and mates, the former unchanged for 150 years. Regimental surgeons were given the rank of captain, while mates, now re-designated and commissioned as assistant surgeons, were ranked lieutenant.[11]

North of the border, Scotland proved a cheaper and better opportunity for learning prior to service life. A significant and disproportionally high number of army surgeons were Scots or received a Scottish medical education. During the Waterloo Campaign, 40 per cent fulfilled these criteria.[12] A separate cohort of 454 army surgeons studied in depth by an Oxford group of historians showed that 29, 31 and 30 per cent had English, Irish and Scottish origins, respectively.[13] Degrees could be obtained in Edinburgh, Glasgow and Aberdeen.[14] The first holder of the Regius Chair of Military Surgery in Edinburgh (from 1806-22) was Professor John Thomson (1765-1846) who gave us some insight into surgical care in general hospitals after the Battle of Waterloo.[15]

Such training and examinations were inadequate to prepare British doctors for combat surgery and life in the army. This could only be learned on campaign and on the battlefield. In both the French and British Armies, if the junior surgeon had aptitude and a robust nature, he could learn much from his seniors, for there was a great deal of material to work on. In combat, certainly after 1803 when there were two assistant regimental surgeons allocated to each battalion, the senior of the two was usually sent to the front line, while the regimental surgeon would be assisted by the junior one at a regimental aid post or a field hospital to the rear. In field and general hospital settings, the assistant surgeon was often supervised by a staff surgeon.[16] Inspector General James McGrigor (1771-1858) also supervised the standards of practice of junior staff during the Peninsular Campaigns.[17] Perhaps it goes without saying that the junior surgeon would require a robust nature. He would soon have to learn about military life and discipline, the rigours of campaigning, and operating on casualties without anaesthesia.

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[11] Cantlie. *A History of the Army Medical Department*, 1974 (Note 6). p.198-199.
[12] Crumplin M, unpublished data.
[13] Ackroyd M, Brockliss L, Moss M, Retford K, Stevenson J. *Advancing with the Army: Medicine, the Professions and Social Mobility in the British Isles, 1790-1850*. Oxford: Oxford University Press; 2006. p.60-61.
[14] Kaufman M. *The Regius Chair of Military Surgery in the University of Edinburgh, 1806-55.* Amsterdam: Editions Rodopi BV; 2003. p.3.
[15] Crumplin M, Glover G. *Waterloo After the Glory: Hospital Sketches and Reports on the Wounded after the Battle*. Warwick: Helion & Company; 2019.
[16] Grattan W. *Adventures with the Connaught Rangers, 1809-1814*. London: Greenhill Books; 1989. p.77.
[17] Scotland T. *Sir James McGrigor: The Adventurous Life of Wellington's Chief Medical Officer*. Warwick: Helion & Company; 2021. p.119.

Once the successful candidate was seen at Berkeley Street, the headquarters of the AMD, having presented his college certificate to serve as an army surgeon, he would be appointed as a hospital mate (by warrant or commission) or be commissioned as an assistant surgeon (formerly mate) to a regiment. Hospital experience exposed a junior surgeon to more serious diseases, wounds and operations. In the battalion, assistants or full surgeons acted as general physicians and surgeons to their unit, but the surgery they performed was often limited to providing first aid measures such as splinting, bandaging, wound exploration**,** suturing, venesection and minor procedures such as amputations of digits. The regimental surgeon, however, by virtue of his experience, the serious nature of an injury or his isolation in combat would not infrequently undertake more complex operations in the field. Such occurrences were eased by regimental staff working together at a designated field hospital, sometimes supported by more senior staff surgeons. Figure 4 shows the appearance of medical officers in uniform.

Figure 4. Left. A Deputy Inspector of Hospitals, 1805. Original print by CCP Lawson. Author's photograph. Right. Assistant Surgeon, 33rd Regiment: a re-enactor, photograph taken in 2015 courtesy of photographer Paul Cooper. Author's collection.

British military surgeons stood in relatively poor standing when compared with regular army officers. Medical staff were often better educated but had fewer privileges than their combat colleagues. These issues could lead to personal discord in a battalion but the results were beneficial when there was sound co-operation between the commanding officer and his surgeon. The most senior surgeon in the AMD before 1810 was the Surgeon General. Thereafter, there was a Director General and two Principal Inspectors governing the Department. Other senior staff consisted of a few senior well-

paid Physicians, senior Inspectors and Deputy Inspectors of Hospitals, and Garrison and Recruiting Surgeons.[18]

The notable John Hunter rightly holds the sobriquet of 'the Father of Scientific Surgery'. He excelled in anatomical knowledge and encouraged experimentation and scientific reasoning. He held the post of Surgeon General for three years, dying at the outset of the war against Republican France. This surgical giant influenced the AMD, not least by introducing directions for the selection, appointment and training of military surgeons. He stipulated that surgeons should be selected and appointed to units solely by the AMD, not by military patronage, that regimental surgeons should have had experience as hospital mates, that the most talented operators should be assigned to hospital service and that no army physician should be appointed without experience as staff or battalion surgeon or as an apothecary.[19]

Surgical staffing in the British Army consisted of regimental staff for the infantry (there were some more senior surgeons for the larger Foot Guard regiments) and cavalry. As noted after 1803, two assistant surgeons were assigned to support each battalion's regimental surgeon. On campaign, regimental surgeons were frequently fewer than needed, through poor recruitment or illness. Wellington protested at the lack of junior surgeons in the aftermath of the Talavera Campaign of 1809.[20] Until 1853, there was a separate Ordnance Medical Department, which maintained a good reputation.

Other medical staff consisted of staff surgeons (also known as surgeons to the forces), assistant staff surgeons (previously mates), physicians, apothecaries and purveyors. At home and sometimes abroad there were paid hospital ward masters, orderlies and nurses. The latter were less well educated, trained or skilled than modern nursing staff. They would help with ward chores, feeding, cleaning and so on. On campaign, local women and soldiers' widows often acted as nurses and assisted with hospital work.

As the wars dragged on the AMD learned from its experience and its reputation improved. A good deal of this improvement was due to the indefatigable labours of the very able and experienced reformer, Inspector James McGrigor. Higher standards and care in British medical and surgical military practice occurred principally during the later Peninsular Campaigns, with the arrival of McGrigor as Wellington's Inspector General in January 1812. McGrigor soon gained Wellington's confidence with his industry, efficiency, organisation and commitment. He proved unrivalled as an innovative first-rate military doctor. He encouraged discipline, training and apposite promotions, and raised morale and support for surgeons, all key factors in the care of sick and wounded soldiers. Improvements were also due to relatively low attrition rates amongst medical staff, increasing aptitude, the emergence of better therapeutic and management protocols, and some exemplary surgical staff, including George Guthrie (1785-1856) (Figure 5), John Hennen (1779-1828) and Samuel Cooper (1780-1848).[21]

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[18] Johnston W. *Roll of Commissioned Officers in the Medical Service of the British Army, 20 June 1727 to 23 June 1898.* Aberdeen: The University Press; 1917. xxv-lii.
[19] Cantlie. *A History of the Army Medical Department*, 1974 (Note 6). p.171.
[20] Gurwood J. *The Dispatches of Field Marshal the Duke of Wellington, During his Various Campaigns, Vol. 3*. London: John Murray; 1852. p.611.
[21] Scotland. *Sir James McGrigor.* 2021 (Note 17). p.111-137.

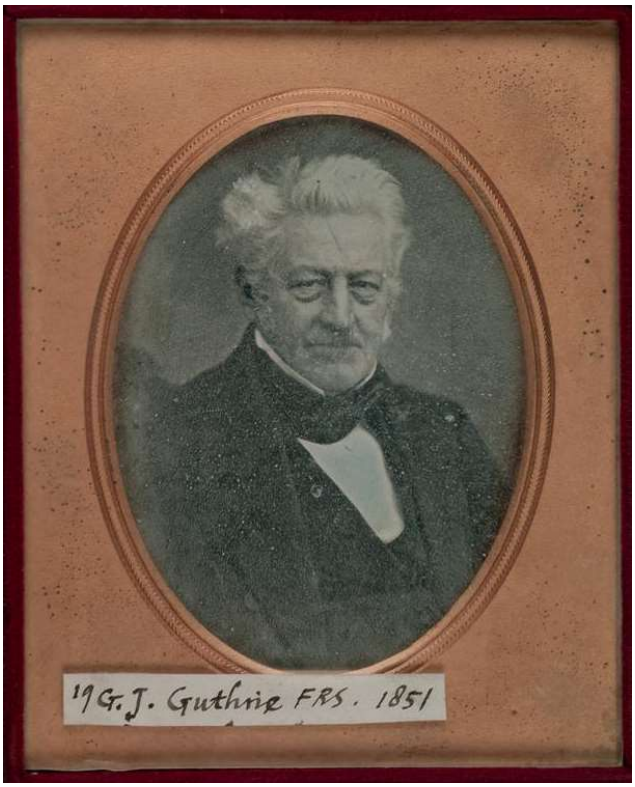


Figure 5. George James Guthrie, nicknamed the 'English Larrey'. Daguerreotype. Courtesy of Royal College of Surgeons of England.

Management of the injured

In addition to facing a steep learning curve on campaign, the British and Allied surgeons lacked some of the aforementioned French innovations, notably dedicated stretcher bearers and mobile field hospitals or 'ambulances' (Figure 6). Another bugbear was the constant lack of wheeled transport for the sick and wounded. This was a key requirement to maintain the fighting force by keeping less severe casualties and ill soldiers close to their units. Even after these wars, Britain refrained from copying the excellent concepts of flying ambulances and Baron François Percy's (1754-1825) limited provision of trained companies of *brancardiers* or *despotats* (stretcher-bearers).[22] In 1819, John Gideon van Millingen (1782-1862), the son of a Dutch merchant, who had studied medicine in France during the revolution and was eventually promoted as a British staff surgeon, tried in vain to introduce to the AMD some of the principles of frontline care that had been in use by the *Service de Santé*. In the austerity of victorious post-war Britain, his efforts were ignored.[23] The AMD continued to rely purely on regimental musicians and twelve heavy stretchers supplied to each battalion.

[22] Howard. *Napoleon's Doctors,* 2006 (Note 8). p.125.
[23] Crumplin MKH. *The Bloody Fields of Waterloo: Medical Support at Wellington's Greatest Battle*. Huntingdon: Ken Trotman Publishing, 2013. p.163-164.

The French *Service de Santé* suffered appalling losses in Europe, Iberia and especially in Russia. As the wars dragged on the service was dogged by large swathes of sickness, declining recruitment, administrative failures and lack of support.[24]

Figure 6. A French ambulance at work in the field. Image by V Huen (1874-1939). Courtesy of the French magazine, *Tradition.*

In the early part of the war (1793-99), campaigns in the West Indies and the Low Countries took a massive toll on the lives of British servicemen. Yellow Fever, dysentery, malaria, typhoid, typhus, viral and bacterial chest infections, and climatic extremes caused the greatest proportion of deaths. With a paucity of physicians, it fell to the lot of line and staff surgeons to assist with the management of all these diseases. Limited nosology, and lack of understanding of the bacterial and parasitic origins and the transmission of disease by vectors, meant that therapies were often inappropriate. Venesection, dousing with cold water, and administration of cathartics and emetics did little if anything to help the hapless febrile patient.[25] Leg ulcers caused by infected insect bites or ill-fitting gaiters posed additional challenges.

Table 1 illustrates the causes of mortality in the British Army serving in the Peninsular War from 1812 to 1814. The figures indicate the high incidence of bowel infections and fevers and the lesser number of deaths from combat. While around one in five soldiers died on the battlefield, only around 6,000 of the 103,000 sailors and marines who perished died in combat. Most deaths at sea were caused by drowning, accidents, shipwreck, explosion and disease.

[24] Howard. *Napoleon's Doctors*, 2006 (Note 8). p.17.
[25] Howard M. *Wellington's Doctors: The British Army Medical Services in the Napoleonic Wars*. Staplehurst: Spellmount; 2002. p.155-193.

	1812	**1813**	**1814**
Dysentery	2,340	1,629	748
Cont/rem fever (various)	2,087	1,663	403
Typhus	999	971	307
Intermittent fever (malaria)	148	139	4
Diarrhoea	79	106	34
Chest infection	107	291	168
Sundry illnesses	199	129	50
Wounds	**905**	**1,095**	**699**
Hospital gangrene	**35**	**446**	**122**
Tetanus	**4**	**23**	**24**

Table 1. Causes of mortality in the British Army serving in the Peninsular War, 1812-1814. The table shows the incidence of mortality from disease and battle trauma (bold type) in regimental and general hospitals; deaths from combat trauma: 3,353 of 16,968 (20 per cent). From: Cantlie. *A History of the Army Medical Department,* 1974 (Note 6). p.509.

Samuel Cooper (1781-1848) categorised the types of contemporary wounds as: the 'incised, punctured, contused, lacerated, poisoned' and those caused by gunshot.[26] This classification does not specifically define the more serious problem of limb avulsion. Visible, often dense masses of infantry and cavalry made for high attrition rates when exposed to explosion, canister or round shot. In contrast to the high proportion of deaths from explosive devices (60 to 70 per cent) on the Western Front 100 years later, most combat deaths during this period resulted from various types of missile strike. Energy transfer from small arms 200 years ago was considerably less than from modern weaponry and was soon dissipated, as shown in Figure 7. This implies that unless men were shot at close range, many were hurt by 'spent' rounds. Lord Nelson's fatal wound was fired at around 21 metres, which would have imparted about 200 Joules of energy, sufficient to shatter an adult femur. The most effective way of destroying advancing infantry and cavalry was to deliver unit volley and random fire at close range. Wounds thus incurred by blunt shot were often severe and resulted in macerated tissues and shattered bone.

Ordnance delivered relatively low velocity, high kinetic energy transfer damage, with the varying weights of solid round shot avulsing limbs, decapitating or destroying the torso. Occasionally, multiple files of men were taken out by direct or ricocheting strikes. The only way a soldier could survive such trauma was to have a limb avulsed or receive a tangential hit, some of which could leave relatively little surface evidence of the serious internal bruising and tissue destruction inflicted. One feature of avulsion injuries was that bleeding from arteries torn apart soon ceased as a result of stripping and vasoconstriction induced by the release of local constrictor agents. By contrast, vessels cleanly cut through continued to bleed.

[26] Cooper S. *A Dictionary of Practical Surgery*. Fourth Edition. London: Longman, Hurst, Rees, Orme and Brown; 1822. p.1179.

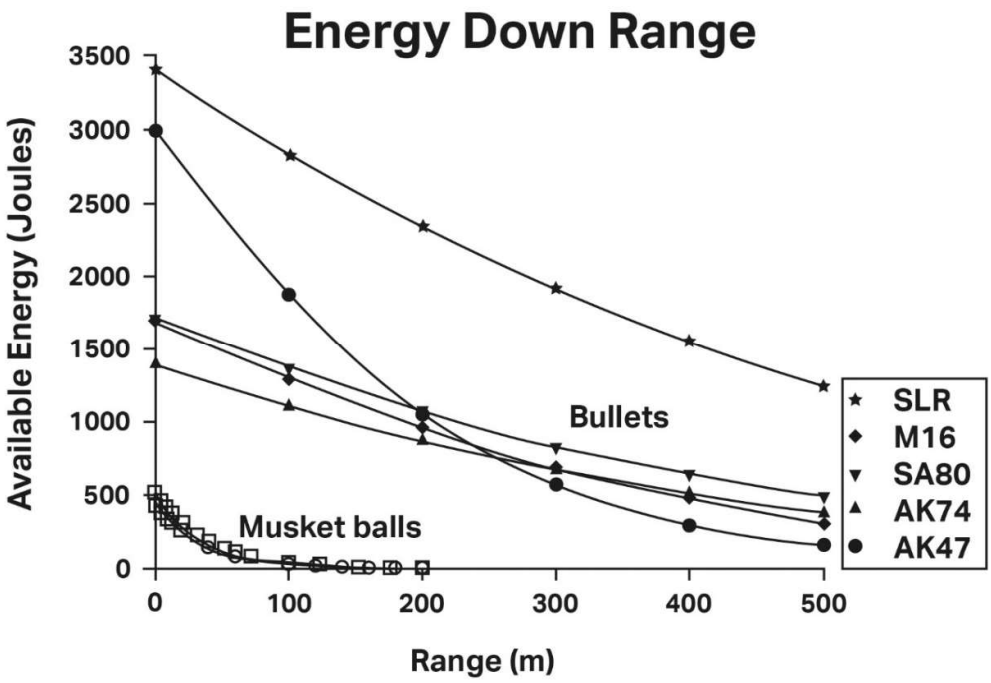


Figure 7. Energy dispersal of Georgian firearm missiles compared with modern weaponry (SLR is a modern self-loading rifle; M16 refers to a 5.56 mm US rifle; SA80 is a standard British assault rifle and AK47 and AK74 represent variants of Russian automatic assault rifles). Courtesy of the late Major General Peter Craig.

Types of injury varied between naval and military service; Table 2 shows two small series of casualties (including some early mortalities) presenting to surgeons.

French & British Army	French Navy
Musket/pistol – 449 (62) Sword/sabre – 98 (13) Round shot – 60 (8)* Canister – 34 (5)* Case/shell – 32 (4)* Lance/spontoon – 28 (3) Bayonet – 9 (1) Other – 18 (4) TOTAL – 728	(*L'Algéciras/L'Argonaute* – 74 guns) Splinters – 35 (34)** Round shot – 25 (24)** Grapeshot – 9+ (9)** Musket – 14 (13) Bayonet – 12 (12) Burns – 9+ (9) TOTAL – 104+

Table 2. Causes of early nineteenth-century naval and military battle injuries (percentages in parentheses). It is noteworthy that, while 17 per cent of injuries were due to cannon shot in the Army (*), in the French naval data that figure was greater than 65 per cent (**). Author's data taken from sundry British Army sources and data from two French naval vessels serving at Trafalgar.

Almost two-thirds of army casualties were inflicted by small arms and almost the same proportion of wounds were caused at sea by naval ordnance. Many wounds were inflicted on soldiers by edged weapons, spontoons (weapons with a long wooden shaft and steel spear point) and lances, the latter a weapon not yet in use by the British Army. Bayonet wounds were infrequent.

There was more delay in army casualties presenting to the surgeon than those in the navy where, in the limited space of the ship, wounded men soon reached the orlop deck. The British Army designated musicians (more likely the band, rather than the drummers and fifers) to act as the only cadre of men permitted to stretcher out the wounded. (Figure 8). Soldiers were often forbidden to retire with any casualty (excluding officers!). The mobile casualty had to make his own way to a field hospital or was assisted by bandsmen or lightly wounded comrades. A significant proportion of casualties suffered continued pain, received little assistance and bled out on the field, many perishing before reaching surgical aid.

Figure 8. Bandsmen acting as stretcher bearers at Talavera, 1809. Painting by Elizabeth Thompson, later Lady Butler. Photograph of print in the author's collection.

In the frontline the casualty was assessed by the regimental staff, usually the assistant surgeon, at a known location. Minor wounds were trimmed, sutured or dressed, superficial foreign material removed, limbs splinted, and haemorrhage from a limb controlled with a field tourniquet.

Figure 9. The British 1st Corps Field Hospital at Mont St Jean, Waterloo, 18 June 1815. Original oil painting, created for the author by artist Beth Hough. Author's collection.

At the field hospital (Figure 9), regimental surgeons would manage casualties, sometimes assisted by divisional staff surgeons. Men requiring major surgery might be operated on there or at a general hospital to the rear. Sprung or unsprung carts were used to carry the wounded to a general hospital, where most of the sickest and more severely injured were collected (Figure 10). With the inevitable delay in casualty evacuation, reaching a field or general hospital was a survival indicator. Particular problems were associated with retrieving cavalry wounded who were often widely dispersed.

The practice of triage as we know it today, that is to say in practical terms, sorting wounded men into four categories – those who require immediate care to preserve life, those with less urgent wounds, the 'walking wounded', and those with little or no hope of survival – was not carried out routinely in these wars. The intention of surgeons to prioritise the most dangerously wounded was recommended and probably occasionally practised by Jean Dominique Larrey (1766-1842). This was attributed to him after the Russian Campaign of 1812, but it was rarely feasible in the frenetic times of combat. Nationality and status of casualties frequently influenced prioritisation of treatment.[27]

[27] Howard MR. *Napoleon's Doctors*, 2006 (Note 8). p.103.

In British military history a form of triage was first described by the naval surgeon James Yonge (1647-1721) in the mid-seventeenth century.[28]

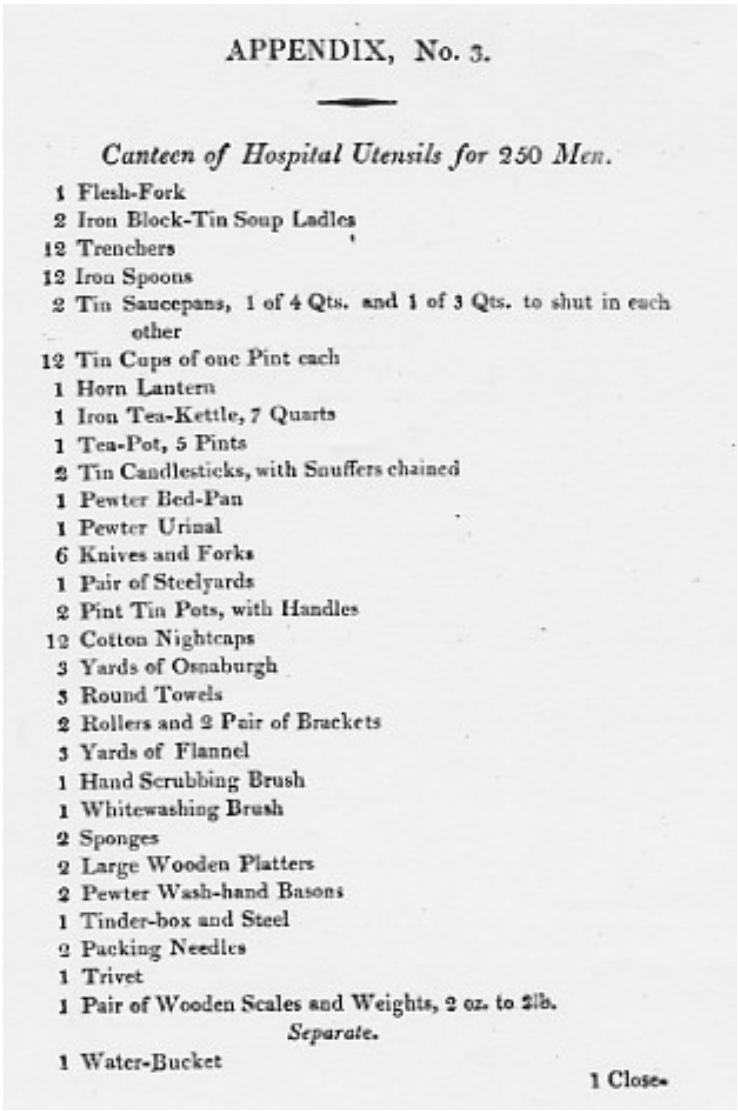
Figure 10. Casualty evacuation by tumbril after Waterloo. Print of an engraving by M Dubourg, 1819. Author's collection.

During his service as a staff surgeon on the Island of Belle Île, John Hunter had observed that fevers and wound sepsis were to claim many victims. He endeavoured to distance himself from what was commonly taught, which brought some scorn from his colleagues.[29] Observing poor outcomes from wound dilatation and rough surgical exploratory or ablative techniques, he assumed that conservatism was the way forward.[30] Hunter had also noted that five badly wounded Frenchmen who had hidden to avoid capture, and some other casualties, had survived without surgical intervention.[31] This added fuel to Hunter's conservative attitude. He advised that amputations should be delayed until the inflammatory process was past. He considered that suppuration was to be avoided, conflicting with the contemporary term 'laudable' pus, which merely revealed the patient's survival to that point! His service in Portugal after Belle Île in

[28] Crumplin M. Surgery in the Royal Navy during the Republican and Napoleonic Wars (1793-1815). In: Haycock DB, Archer S (eds). *Health and Medicine at Sea, 1700-1900*. Woodbridge: The Boydell Press; 2009. p.79.
[29] Moore W. *The Knife Man*. London: Bantam Press; 2005. p.131-132.
[30] Hunter J. *A Treatise on the Blood, Inflammation and Gun-shot Wounds by the Late John Hunter.* London: Printed for Sherwood, Gilbert and Piper; 1828. p.659-672.
[31] Hunter J. *The Case Books of John Hunter FRS.* Allen E, Turk JL, Murley R (eds). London: Royal Society of Medicine Services Limited; 1993. p.274-275.

1762, plunged him into hectic administrative work with little chance to develop his surgical skills further.

As the successive French wars progressed, Hunter's understandably conservative surgical practice became less appropriate. As surgeons gained experience, they understood better the indications and optimal timings for different surgical procedures, introducing a degree of flexibility in the management of individual casualties, often with improved outcomes.[32] [33] It became clear that early surgical intervention could be life-saving.



APPENDIX, No. 3.

Canteen of Hospital Utensils for 250 Men.

1 Flesh-Fork
2 Iron Block-Tin Soup Ladles
12 Trenchers
12 Iron Spoons
2 Tin Saucepans, 1 of 4 Qts. and 1 of 3 Qts. to shut in each other
12 Tin Cups of one Pint each
1 Horn Lantern
1 Iron Tea-Kettle, 7 Quarts
1 Tea-Pot, 5 Pints
2 Tin Candlesticks, with Snuffers chained
1 Pewter Bed-Pan
1 Pewter Urinal
6 Knives and Forks
1 Pair of Steelyards
2 Pint Tin Pots, with Handles
12 Cotton Nightcaps
3 Yards of Osnaburgh
3 Round Towels
2 Rollers and 2 Pair of Brackets
3 Yards of Flannel
1 Hand Scrubbing Brush
1 Whitewashing Brush
2 Sponges
2 Large Wooden Platters
2 Pewter Wash-hand Basons
1 Tinder-box and Steel
2 Packing Needles
1 Trivet
1 Pair of Wooden Scales and Weights, 2 oz. to 2lb.

Separate.

1 Water-Bucket

1 Close-

Figure 11. Equipment required for a regimental surgeon. From *Instructions for the Regulation of Regimental Hospitals*, London: Horse Guards; 1812. Appendix 3.

[32] Guthrie GJ. *Commentaries on the Surgery of the War, in Portugal, Spain, France and the Netherlands*, Sixth Edition. London: Henry Renshaw; 1855. p.41-42.
[33] Guthrie GJ. *On Gunshot Wounds of the Extremities*. London: Printed for Longman, Hurst, Rees, Orme and Brown; 1815. p.24.

A battalion surgeon was provided with a cart and horses or mules, which could carry around 200 lbs in weight. The necessary regimental medical kit included canteens, mugs, blankets, bed posts with canvas supports, candles, dressings, such as lint and linen bandages, urinals and so on. These items normally allowed for the treatment of around 200 sick or wounded. Tents were provided in 1812-13 (Figure 11).

Figure 12. A capital surgical instrument set, c1820. Author's collection.

Surgical instruments, aside from pocket instruments to be carried on the field, consisted of capital sets, which the surgeon provided for himself. These were stored in a reinforced felt-lined wooden box with spaces for particular instruments. Figure 12 shows a typical capital set and the instruments approved for surgeons by the Royal College of Surgeons of London in 1813. The chest contains ebony-handled carbon steel knives and saws for amputation, a tenaculum, Assalini artery forceps, two Petit screw tourniquets, instruments for trepanning, trocars and cannulas, and sundry items for minor surgical operations.

Surgical practice

Soft tissue wounds were examined and then repaired with or without a search for embedded missiles or foreign material. It was important to remove most primary or secondary missiles (the latter consisting of human or other foreign material introduced by the initial missile strike) and especially porous substances such as fragments of clothing (Figure 13), as it became clear that sepsis was more likely should these be retained. Lead balls could be left *in situ* if inaccessible.[34] Occasionally differentiating between a metal missile and bone was difficult. Simple incised wounds were sewn up with silk or linen sutures or, if swelling prevented this, just treated with lint dressings and linen bandages. Contusions were managed with cloth or vegetable poultices.

Figure 13. Elbow amputation specimen showing a portion of soldier's red jacket driven in by a musket ball. Courtesy of the Royal College of Surgeons of Edinburgh.

Conflicts are often described as 'Wars of Orthopaedics' since, at these times, most surviving casualties suffered limb injuries. The usual ratio of leg to arm injuries was 2:1, the lower limbs presenting a large surface area to metal missiles assuming a 'dropping' shot. Splints made of wood, tin or whalebone were too short to prevent subsequent deformity. In 1813, Surgeon Guthrie had some success using long limb splints for thigh and leg fractures. Nearly all fractures and dislocations were compound injuries, with

[34] Scotland T, Heys S. *Wars, Pestilence & the Surgeon's Blade*: *The Evolution of British Military Medicine and Surgery during the Nineteenth Century.* Solihull: Helion & Company Ltd; 2013. p.98-110.

exposed bone in contaminated wounds. With severe tissue maceration and retained foreign bodies, chronic bony sepsis with frequent 'flare-ups' was all too frequent. Gas gangrene, tetanus and necrotising fasciitis (a severe infection, destroying connective tissues and muscle, caused by a mixture of bacteria, usually incorporating streptococcus group A) often fatally complicated wounding and surgery. Missiles embedded in bone could be removed using the circular crown trephine saw.

Wounds caused by small arms (muskets, carbines or pistols) present a complex problem of detection in the absence of modern diagnostic aids. Spent rounds could track along tissue planes or be deflected and deformed by clothing, buttons and bones, frequently taking the course of least resistance (Figure 14).

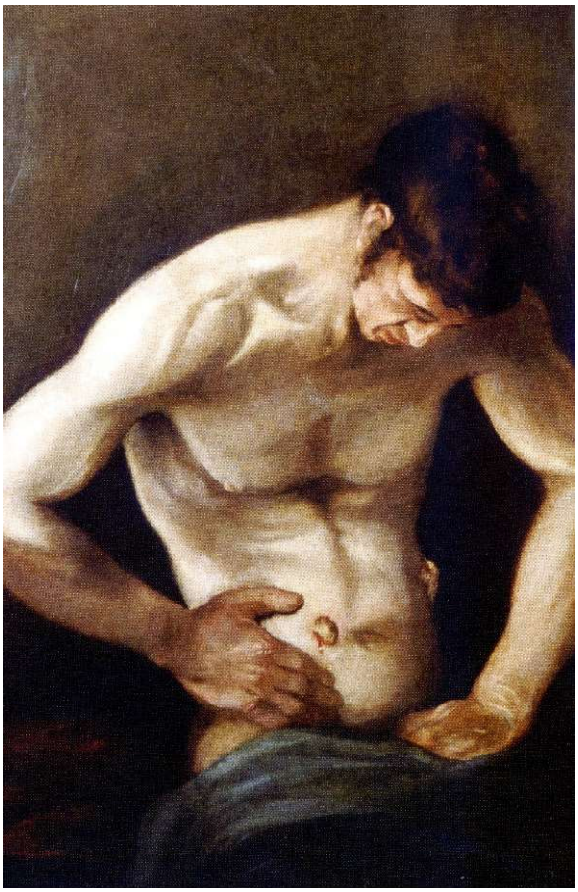


Figure 14. An injury caused by a spent ball tracking around the abdominal wall. Painting by Sir Charles Bell (1774-1842). Courtesy of the Royal College of Surgeons of Edinburgh.

In an attempt to localise retained bullets, surgeons often placed the soldier in the position he was in when wounded. Having located the missile using digital exploration or a probe, a bullet extractor was slid down beside the probing finger and the missile retrieved. A bullet forceps would often be carried by a line infantry surgeon along with his pocket set. See Figure 15.

Figure 15. Left. A naval pocket instrument set, c1808. Courtesy of the Royal College of Surgeons of England. Right. A Coxeter bullet extractor, c1800. Courtesy of the Wellcome Collection.

One occasional septic complication was erysipelas, which could cause such soft tissue swelling as to threaten the blood supply of the limb. In 1812, Surgeon Guthrie treated a soldier with this infection and incised a sheath of fascia enveloping swollen infected muscles, so relieving the pressure on the leg's blood supply and thus preserving the limb. This was possibly the first recorded case of a fasciotomy.[35] Formal primary wound excision (wide exposure of a wound and removal of all dead and dying soft tissues and bony fragments) was not practised at these times and would not develop for another hundred years or so.

Close-range musket rounds, canister shot, round shot and shards of metal from exploding shells frequently caused serious tissue damage necessitating more radical surgery. In extreme circumstances, amputation, trepanning or some limited interventional procedures around the torso were performed. Without adequate analgesia and general anaesthesia, the pain during surgical procedures could be unimaginable. Pain tolerance varied considerably between patients. Providing the patient was fit enough, surgery undertaken soon after injury was often endured better than when there was delay or inflammation and sepsis had set in. Syncope (fainting) provided frequent relief for both surgeon and casualty. Post operative analgesia was usually limited to a few doses of opiates and a cordial.

At this time before invasive cranial and body cavity surgery was available, timely limb ablation proved the greatest surgical challenge. Converting a badly mangled wound of an arm or leg into a clean surgical stump was often a patient's best chance of survival. As the wars progressed several authors clearly defined the indications for surgery. These were extensive tissue damage, especially involving large joints, nerves and blood

[35] Crumplin M. *Guthrie's War: A Surgeon of the Peninsula & Waterloo.* Barnsley: Pen & Sword; 2010. p.100.

vessels, acute or chronic sepsis and later, pain or deformity.[36] Table 3 compares mortality results in 1813 with a smaller series in 1815.

	1813 – Vittoria, Nive & Nivelle		1815 – Waterloo	
Amputation	Number	Mortality (%)	Number	Mortality (%)
Shoulder/arm	318	131 (41)	129	30 (23)
Hip/thigh/leg	258	149 (58)	242	85 (35)
TOTAL	576	280 (49)	371	115 (31)

Table 3. Comparative mortality rates for amputations, 1813 and 1815. Data taken from Guthrie, *Commentaries on the Surgery of the War*, 1855 (Note 32), p.155 and sundry data from Crumplin, Glover, *Waterloo After the Glory*, 2019 (Note 15).

The mortality rates are not particularly encouraging but reflect results of both primary (early) and secondary (delayed) operations. Despite the relative lack of Peninsular-experienced surgeons at Waterloo the improved survival is evident. In patients requiring amputation there is much evidence to say that, given adequate surgical skills, the sooner the limb was removed (a primary amputation) the better the outcome. Delay courted increased pain, sepsis and poor healing. Table 4 demonstrates the improved survival rates with primary surgery.

Operation	Primary	Deaths (%)	Secondary	Deaths (%)
Shoulder	6	1 (17)	12	6 (50)
Hip	0	0	1	0
Thigh	54	19 (35)	94	43 (46)
Leg	43	7	50	16
Arm	21	4 (19)	51	13 (25)
Forearm	22	1	17	5
Carotid artery tied	0	0	1	0
Trephine	0	0	2	1
TOTAL	146	32 (22)	228	84 (37)

Table 4. Improved survival with primary (early) surgery at Waterloo. Figures in brackets show mortality as percentages for shoulder, thigh and arm (and their total) to emphasise differences in death rates. Data compiled from: Thomson J, Somerville E. Collection of Sketches and Reports of Wounded at the Battle of Waterloo. Centre for Research Collections, University of Edinburgh Library. Coll-535, 594D and 595D.

[36] Cooper. *A Dictionary of Practical Surgery,* 1822 (Note 26). p.51-56.

With severe limb injuries there always remained the question of whether to retain the damaged limb or remove it. Deputy Inspector Guthrie addressed this issue by comparing the results of late amputation *versus* retention of the damaged limb. He studied 43 soldiers with compound fractures of the femur, thirteen of whom died at an early stage. Of the 30 remaining patients, twelve underwent late amputation with five deaths (one or two might have lived with primary surgery). Eighteen patients were managed without surgery. Eleven wished they had their limb removed and seven had moderately serviceable (two) or useful (five) retained legs. It would seem that early surgery was a reasonable option for most cases, with only seven of eighteen cases happy with the conserved limb. This small study underpins the contribution of thoughtful surgeons like Guthrie who kept detailed records later in the Napoleonic War and carefully considered treatment options.[37] Impressively, the mortality rate for all amputees at the Battle of Toulouse was 21 per cent, a result that reflects the best outcome for those times.[38] Figure 16 shows the appearance of a gunshot wound of the thigh.

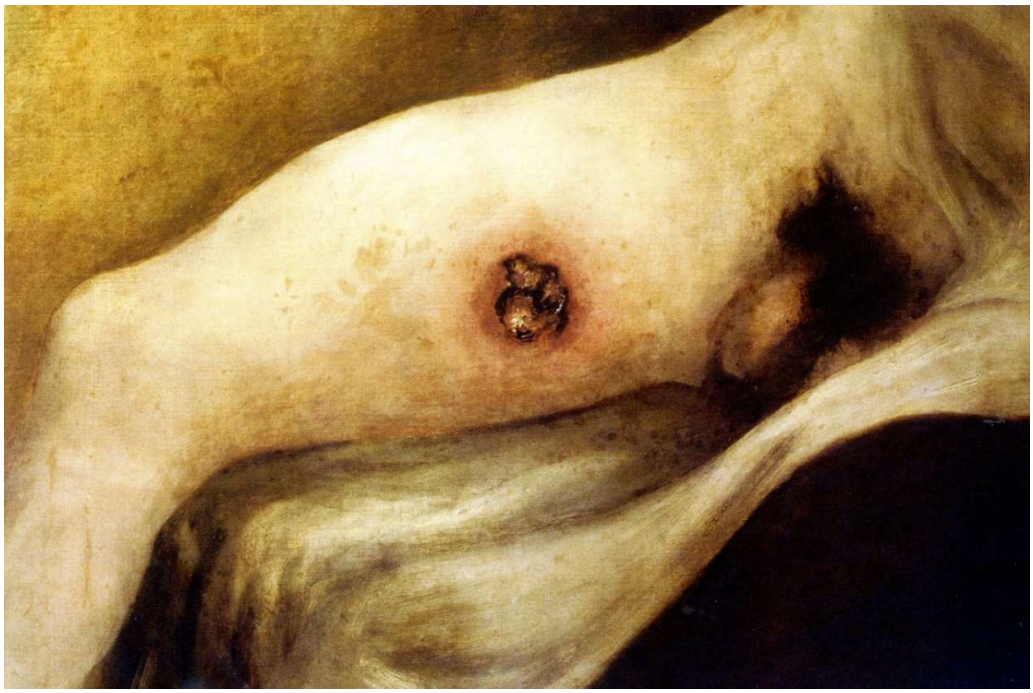


Figure 16. Gunshot wound of the thigh with no bony injury. Painting by Sir Charles Bell. Courtesy of the Royal College of Surgeons of Edinburgh.

As to the practicalities of limb ablation, the patient was normally sat upright. This gave ease of access for the surgeon and the restraining assistants to move around the patient (Figure 17).

[37] Guthrie. *On Gunshot Wounds of the Extremities*, 1815 (Note 33), p.192-195.
[38] Guthrie. *Commentaries on the Surgery of the War*, 1855 (Note 32). p.154.

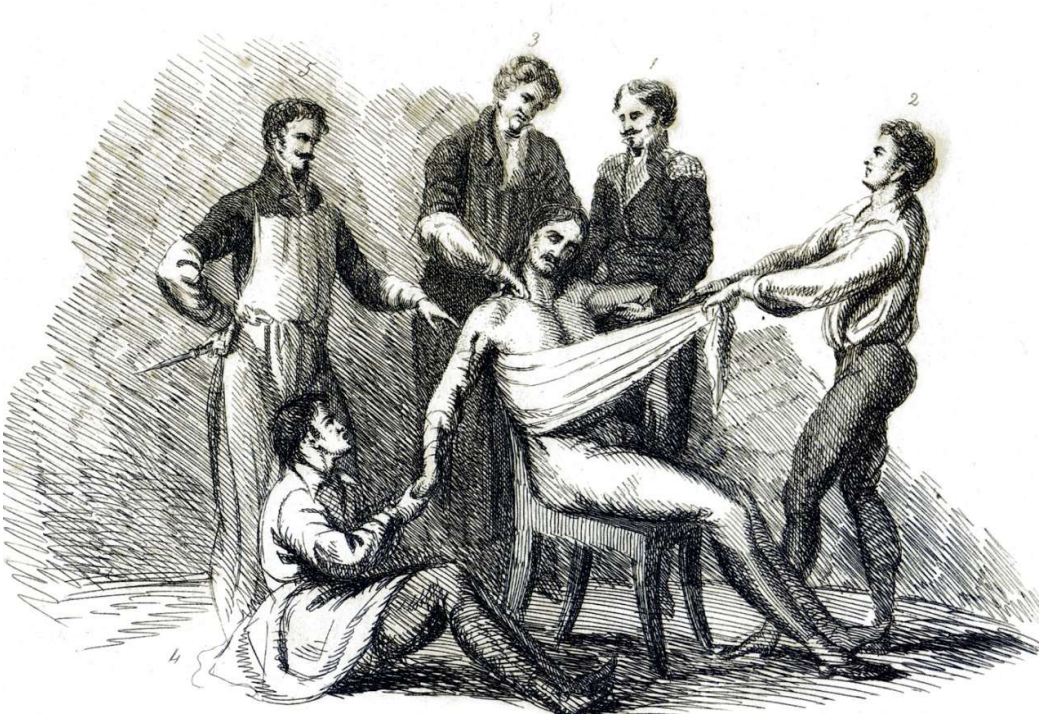


Figure 17. A patient awaiting a disarticulation at the right shoulder joint. Note the anticipated syncope, the patient's sitting position and the assistant's supraclavicular arterial control. Painting by Sir Charles Bell from his book *Illustrations of the Great Operations of Surgery,* Longman, Hurst, Rees, Orme and Brown, London, 1821, plate 11. Author's collection.

Direct pressure was applied to a major artery using an assistant's fingers, a cork pad or a Petit screw tourniquet. The latter was applied after upward skin traction (to allow maximum skin coverage of the stump), the skin and fat were cut using a curved knife in a circular manner and the muscles divided higher up (Figure 18). The soft tissues were retracted to prevent snagging as the surgeon used a tenon saw to cut swiftly through the bone. The arteries (rarely the veins) were teased out with a handled sharp hook (a tenaculum) or pinched out with a sliding catch forceps and then ligated with silk or linen ties. These were left long and pulled off on about the tenth day. After transient release of the tourniquet to check for haemostasis, the remaining soft tissues were pulled over the bone and closed with a few sutures or adhesive tapes. This procedure took around fifteen to twenty minutes.

Improvements in performing amputations consisted of two innovations in particular. The first was the use of a straight amputation knife to form flaps. The blade was thrust straight through the skin and muscle of the limb, each side of the bone. By cutting obliquely outwards, two soft tissue flaps were formed. This procedure was reputably less painful and gave considerably better soft tissue cover for the stump (Figure 19).

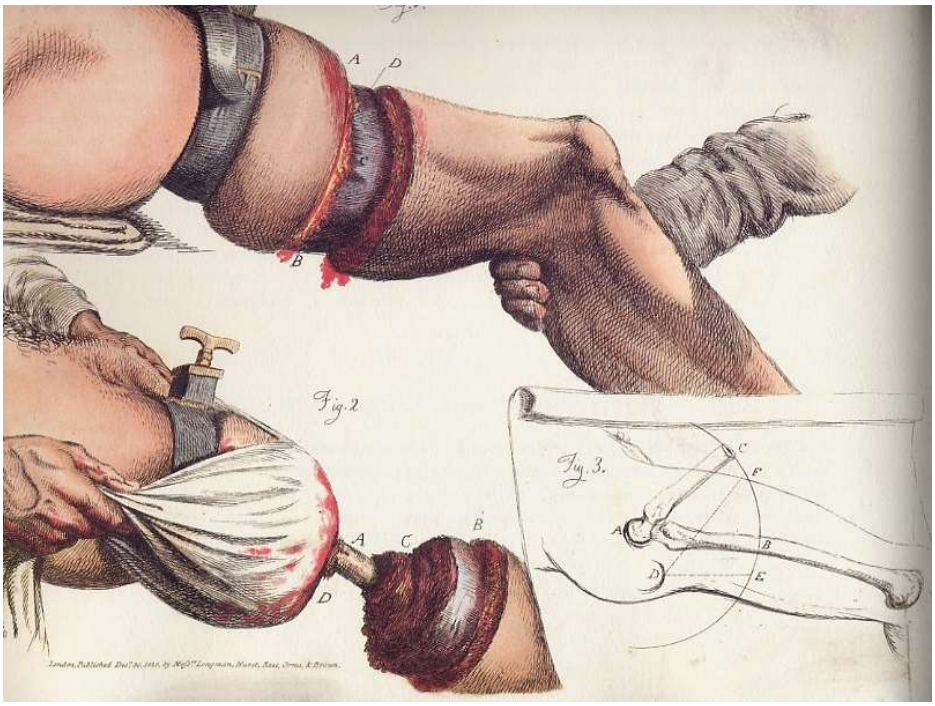


Figure 18. An above knee amputation. Painting by Sir Charles Bell from his book, *Illustrations of the Great Operations of Surgery,* Longman, Hurst, Rees, Orme and Brown, London, 1821, plate 9. Author's collection.

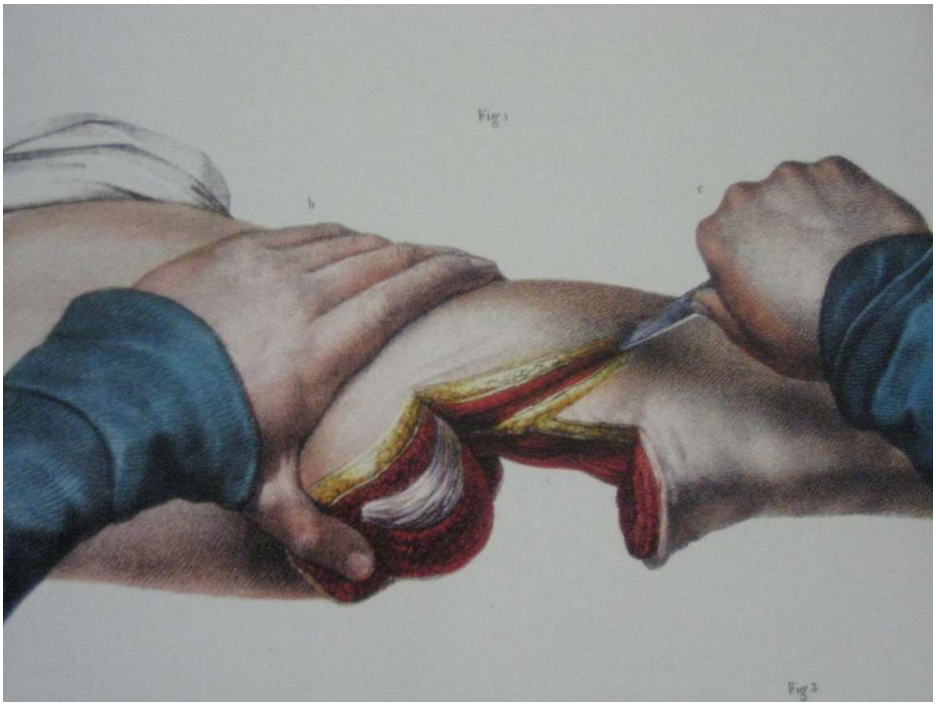


Figure 19. An above knee amputation employing the formation of flaps. Image from original copy of Bourgery JM, Jacob NH. *Atlas of Human Anatomy and Surgery*, Paris; 1831-54. Courtesy of John Kirkup. Author's collection.

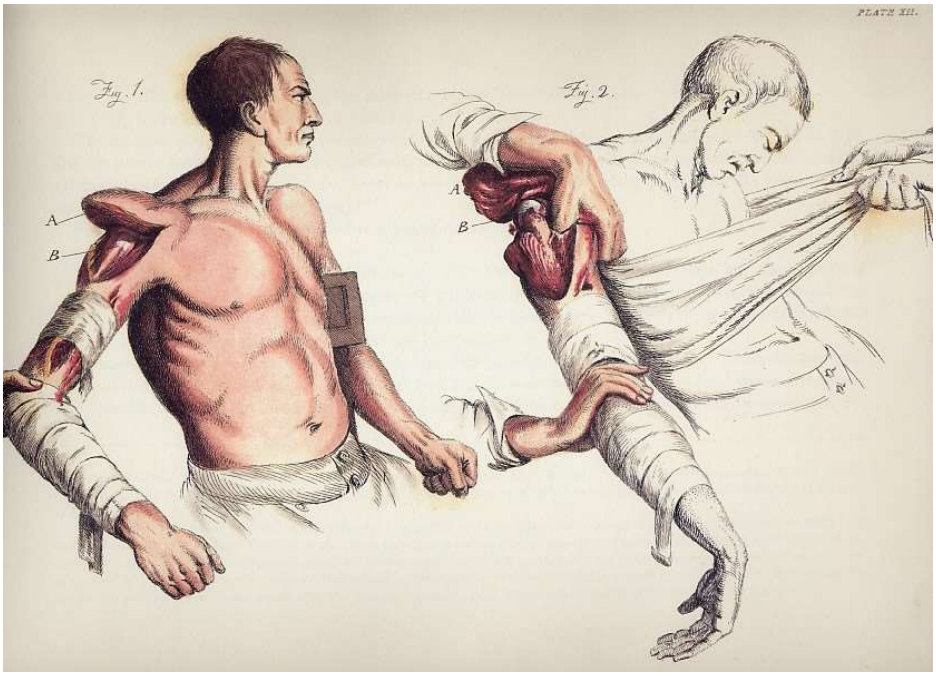


Figure 20. Disarticulation at the shoulder joint. Painting by Sir Charles Bell from his book, *Illustrations of the Great Operations of Surgery,* Longman, Hurst, Rees, Orme and Brown, London, 1821, plate 12. Author's collection.

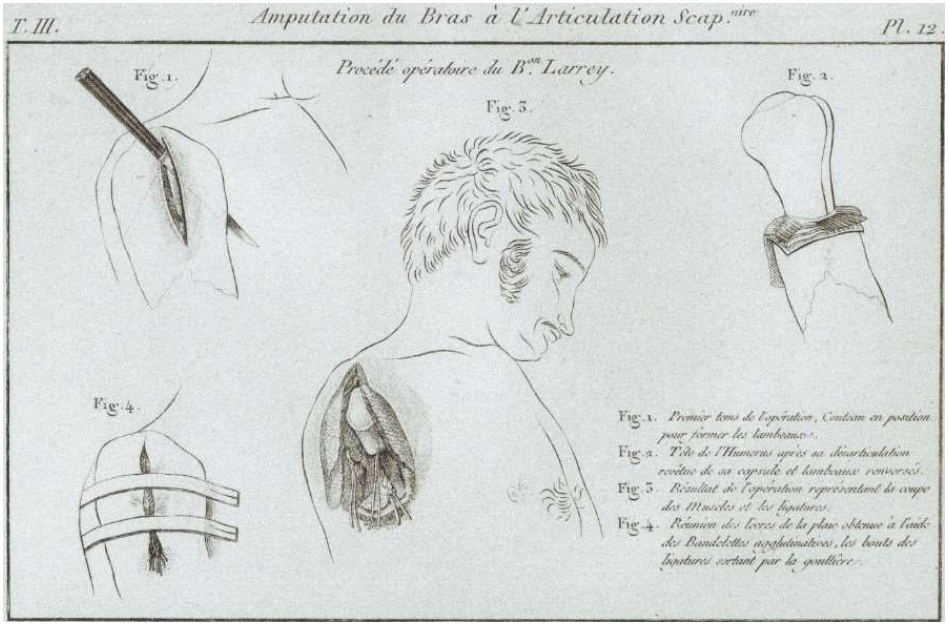


Figure 21. Dominique Larrey's technique for disarticulation at the shoulder joint. Evrard E, Mathieu J, Francois RJ, Moorthamers R. *Esculape aux Armées: 500 Ans de Médicine Militaire en Belgique.* Bruxelles: Société Scientifique du Service Médical Militaire; 1997. p.92. Courtesy of the authors.

The other concept was an increasing practice of removing only part of a damaged limb, so preserving some limb function and cosmesis. Removal of an elbow joint or just the head of the humerus, after the bones were irretrievably shattered, avoided a limb disarticulation (removal of a limb through a joint). Developed by several leading surgeons, these conservative surgical manoeuvres came to the fore, albeit they often left a relatively useless limb in place. Well described in contemporary literature after the wars, such conservative techniques became routine.[39] Disarticulation, as illustrated in Figure 20, mirrored the severity of an amputation. Larrey often preferred disarticulation as there was less cut muscle and no bone incision compared with amputation. The most frequent disarticulation of a larger joint was of the shoulder. Larrey specialised in this procedure, employing vertical flaps, which generally healed well (Figure 21).

During a six-month period in 1813, British surgeons at smaller field hospitals carried out nineteen major shoulder operations with only one death, while in those sent to general hospitals, fifteen of nineteen died.[40] The first disarticulation at the shoulder joint, also removing the scapula, was performed by a naval surgeon in Antigua in 1806.[41] Disarticulation at the hip joint was the most formidable contemporary procedure. French surgeons had performed the operation earlier in the eighteenth century and Larrey carried it out on seven occasions, but the outcomes of these cases are uncertain. Surgeon Brownrigg succeeded in the operation at Merida in 1812, while George Guthrie produced a well recorded success on a French prisoner of war after Waterloo.

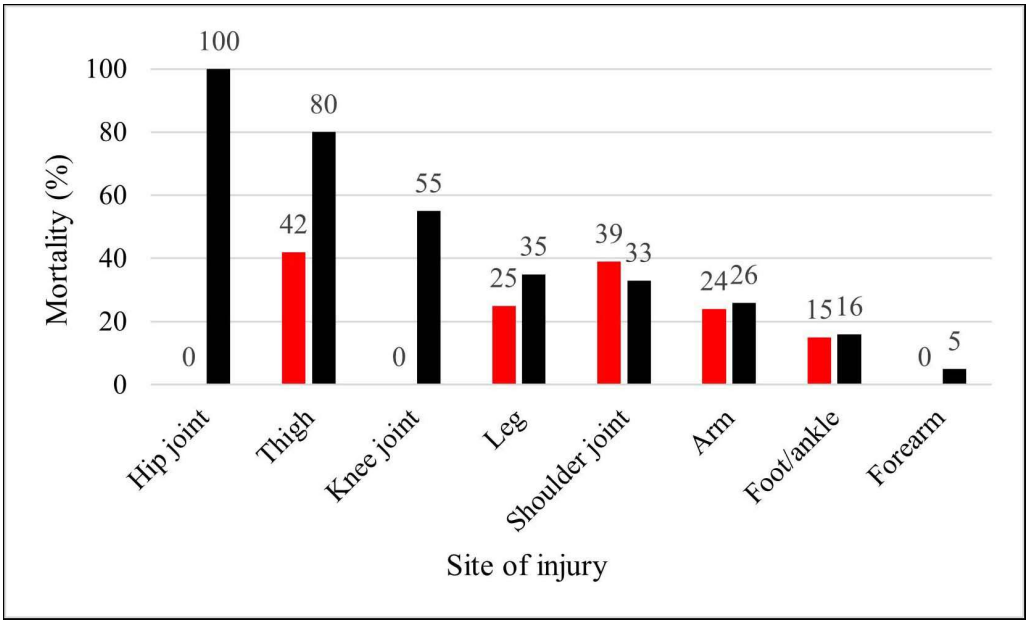


Figure 22. Mortality of capital operations by limb site. Red: Battle of Waterloo (1815). Black: Crimean campaign (1854-55). Selected data from: Thomson J, Somerville E. (see legend to Table 4) and Cantlie N. *A History of the Army Medical Department, Vol. 2*. Edinburgh & London: Churchill Livingstone; 1974. p.193.

[39] Guthrie. *Commentaries on the Surgery of the War*, 1855 (Note 32). p.118-127 & 128-129.
[40] Crumplin. *Men of Steel*, 2007 (Note 7). p.294-295.
[41] Lloyd CL, Coulter JLS. *Medicine and the Navy, Vol. III, 1714-1815*. Edinburgh & London: E & S Livingstone; 1961. p.366.

Figure 22 compares mortalities of larger (capital) and lesser surgical procedures carried out on soldiers' limbs at and after Waterloo and during the Crimean campaigns. It is tempting to speculate that British surgical results at the end of the Napoleonic era were at least as good or even better than in a war fought 40 years later.

Frequently, primary stump healing did not occur and post-surgical complications were all too common. Post-operative haemorrhage due to inadequate or slipped ligature of arteries, venous bleeding, wound sepsis or failed blood clotting with generalised sepsis could be alarming. Poor stump healing with bone end protrusion, with or without chronic osteomyelitis, often complicated the guillotine method of amputation. Painful post-operative muscle spasms in the stump were often troublesome, as were neurological complications including stump neuromas, chronic limb pain and the 'phantom limb' phenomenon.

Some, but by no means all amputees obtained limb prostheses. These were supplied (often after considerable delay) from the Royal Hospital at Chelsea or from Kilmainham in Dublin, but as often as not, regimental or village carpenters would be the supplier. For ideal comfort after an above-knee amputation, the surgeon would aim to shape a well-healed conical and pain-free stump that could be fitted into a padded bucket prosthesis. However, this was frequently not the case and further surgical intervention and delay would occur. Below-knee operations were not so often a problem since the amputee could kneel on a padded lower limb prosthesis. For the more fortunate and wealthier patients, there was a greater range of articulated upper and lower limb prosthetics.

Other surgical procedures included trepanation (Figure 23), superficial management of penetrating wounds of the abdomen and chest, control of bleeding arteries following trauma and drainage of septic sites.

Head wounds in survivors were complicated by bleeding into the skull, sepsis, epilepsy and sensory or motor defects. In former times, cranial trepanning was performed too liberally and for spurious reasons. As the wars drew on, guiding principles for assessment of head injuries were drawn up by several military surgeons and surgery evolved.[42] [43] It was recognised that indriven fragments of cranial bone that pressed on or damaged the dura or brain needed to be elevated to relieve temporary neurological defect, prevent sepsis, bleeding and, later, epilepsy. There were many examples of success recorded for this procedure. The crown saw of the trephine was placed over stable bone near the fracture site and a circular disc of bone removed. This gave access for the elevator to lift the depressed fracture segment. Occasionally, and inadvertently, a collection of blood or pus was also released. Sometimes, multiple trepanations were needed to get access, remove missiles or 'tidy up' the wound.

As surgeons' experience with head injuries increased, some enlightened clinicians, although ignorant of the neurological cross-representation of the cerebral hemispheres, recognised the signs of increasing cerebral compression despite them being masked by alcohol intoxication.[44] The dura mater is the toughest of three membranes covering the

[42] Hennen J. *Principles of Military Surgery.* Philadelphia: Carey & Lea; 1830. p.228-229, 232-233, 264-265 & 271-273.
[43] Bell C. *Illustrations of the great operations of surgery, trepan, hernia, amputation, aneurism, and lithotomy*. London: Printed for Longman, Hurst, Rees, Orme and Brown; 1821. p.5-22.
[44] Crumplin. *Men of Steel*, 2007 (Note 7). p.253.

brain, and the importance of dural integrity to prevent intracerebral sepsis was not then appreciated.

Figure 23. Cranial trepanation, showing the stable site for placement of the crown trepan. Painting by Sir Charles Bell from his book, *Illustrations of the Great Operations of Surgery,* Longman, Hurst, Rees, Orme and Brown, London, 1821, plate 2. Author's collection.

Major interventional surgery for penetrating injuries of the torso was precluded by lack of anaesthesia, sufficient pathophysiological knowledge and adequate supportive therapies. Although initiated in the early twentieth century, it would not be until World War One that significant progress would be made in the management of these injuries.

Surgeon Guthrie, caring for patients with penetrating chest wounds in the Peninsular War, advised that all open chest wounds should be closed as soon as feasible. Indriven portions of broken ribs, clothing and missiles should be sought for by opening the wound, and occasionally Guthrie advised lavage. He would incise into the chest cavity if blood, fluid or air were dangerously oppressive.[45] He recommended that all patients with penetrating chest wounds should be nursed on the side of the injury to ease breathing and encourage drainage and adherence of the lung to the chest wound.[46] With uncontrolled haemorrhage from the intercostal vessels, Guthrie and some continental surgeons recommended direct isolation and ligature of the vessel or passing a curved needle around a rib to compress the neurovascular pedicle below it.[47] Sepsis was a

[45] Guthrie. *Commentaries on the Surgery of the War*, 1855 (Note 32). p.435.
[46] Guthrie. *Commentaries on the Surgery of the War*, 1855 (Note 32). p.449-450.
[47] Cooper. *A Dictionary of Practical Surgery*, 1822 (Note 26). p.1197.

common cause of death, following formation of chronic empyema (collection of pus in the chest cavity) and broncho-pleural fistula (a communicating track between a bronchial tube and the chest cavity). Many patients survived bullet wounds that had passed right through the chest, despite the escape of air or blood into the chest. During these wars, several prominent figures suffered penetrating chest injuries, including Admiral Lord Nelson, Major General Robert Craufurd, Sir Lowry Cole and the Earl of March.

Likewise little surgery was feasible for penetrating abdominal and pelvic wounds. Superficial tracking wounds by spent balls around the chest and abdomen were easy enough to manage with local incision, sutures and poultices. Traumatic hernias were controlled with bandaging and the only surgical intervention for hernia which developed while on military service was for irreducibility and bowel strangulation. After an incision over the hernia, a blunt-ended bistoury (a scalpel with a long curved or straight blade) or scalpel was slid along a grooved director into the inguinal constricting ring, which was divided to release the trapped bowel segment (Figure 24). The hernia was then controlled by a truss. Admiral Lord Nelson suffered a traumatic hernia of his lower abdominal wall during the Battle of Cape St Vincent in 1797.

Figure 24. Early nineteenth-century wax model showing the incision and wound closure performed for the reduction of an irreducible groin hernia. Photograph taken by author around 45 years ago from wax model at University College Hospital, possibly created by Sir Charles Bell.

Most patients with deeply penetrating abdominal wounds died from catastrophic haemorrhage or peritonitis. Around five to ten per cent of cases either had no internal organ damaged or had minimal bleeding and sepsis and would survive without surgical

intervention. In those few survivors, the swollen and everted mucosa (the internal lining of the gut) following bowel penetration by a sword, lance or musket ball could limit escape of bowel contents into the peritoneal cavity and, with the natural adherence of the greater omentum (the fatty apron lying over the bowels) sealing off septic sites in the peritoneal cavity and adjacent organs, patients might survive any ensuing paralytic ileus (paralysis of gut movements after injury or sepsis) and focal peritonitis. Occasionally an intra-abdominal abscess might rupture externally or internally or be drained surgically. After such events, gut or urinary fistulae sometimes resulted and usually resolved if there was otherwise bowel continuity. There were a few examples of bullets or fragments of clothing being passed per anum after the injury to the gut had been sealed and sepsis localised.

If the gut was traumatically exteriorised (Figure 25), it was inspected and if intact replaced, often with difficulty, into the peritoneal cavity. The patient was sat up and the surgeon enlarged the external wound as necessary. This was assisted by lubrication of the surgeon's hands and milking any flatus into the abdomen.

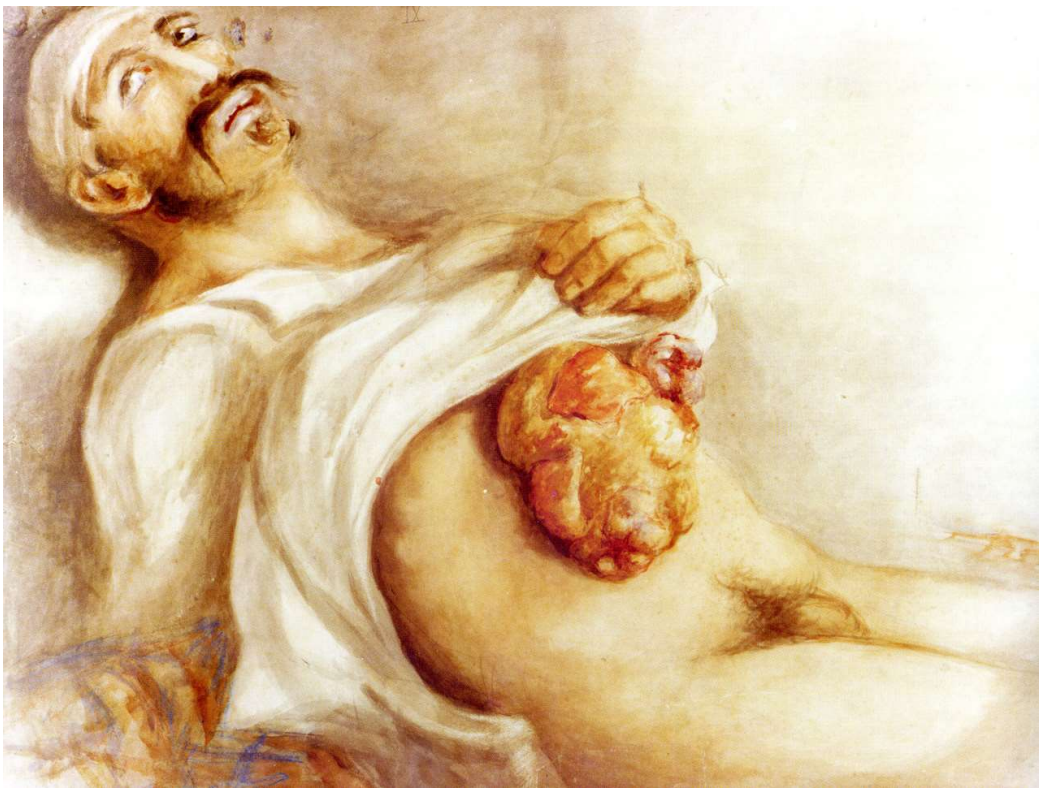


Figure 25. Waterloo French casualty with extruded colon following a sabre injury. Painting by Sir Charles Bell. Courtesy of the Trustees of the Museum of Military Medicine.

If contents were leaking from protruding bowel, the holes in the bowel wall would simply be sutured and the repaired bowel replaced in the abdomen. Despite experimentally successful bowel resection and anastomoses (suturing divided bowel

ends together to restore continuity) in the seventeenth century, this was not performed during these wars and did not become routine practice until 100 years later.[48] [49] Occasionally more seriously damaged gut could be trimmed and sutured to the abdominal wall, creating an ileostomy or colostomy. The resulting stomata proved very difficult to dress and threatened life with fluid and electrolyte loss and nutritional deprivation. Bleeding and leakage of bile, pancreatic secretions and urine often complicated penetrating injuries of the solid abdominal organs. Such was the case with Lieutenant George Simmonds (1785-1858) who received near-fatal injuries to his chest and liver, and deputy Quartermaster General Sir William De Lancey (1778-1815) who died from retroperitoneal bleeding (bleeding into the tissues at the back of the abdominal cavity) after Waterloo. Most men with abdominal wounds who survived death on the field would perish with peritonitis, paralytic ileus or continued bleeding.

Patients presenting with buttock or groin wounds frequently had bladder or rectal injuries. Subsequent pelvic sepsis was sometimes successfully managed by incision and drainage, with or without a catheter inserted per urethram or suprapubically. After Waterloo, at the Yorke Hospital in Chelsea, Guthrie, after splinting the urethra with a sound (a metal probe with a curved end), removed a bullet from the bladder via a perineal incision using a pair of forceps inserted into the bladder, a similar procedure to a perineal lithotomy. Genital wounds and pelvic injuries were frequently complicated by necrotising fasciitis.

Supportive therapy

The surgeon's responsibilities included applying contemporary therapies to aid recovery after injury, surgery and during recuperation. Bed rest was encouraged, with a low diet in the early stages, consisting of bland items such as sweetened milk, panada (a soup made of bread pulp), tea, rice and barley gruel. Wine, red meat and vegetables were added later. To counter sepsis, an 'antiphlogistic' regimen was employed, consisting of venesection, emesis, catharsis and a low diet. The logic of bleeding a wounded soldier, already suffering from previous or continued blood loss, would escape the modern clinician. The humoral theory of medicine still permeated medical practice. To contemporary doctors, a septic or wounded soldier was anxious, in pain and, if febrile, had a bounding tachycardia, sweating and rigors. The logic of bleeding a patient (by venesection, Figure 26) and also inducing vomiting (using ipecacuanha and antimony tartrate) or diarrhoea (with jalap, aloes or rhubarb) was to reduce these hectic symptoms and irritability and 'divert' noxious poisons away from the patient. Diaphoretics (medications to promote sweating) such as opiates, mercury compounds or some essential oils were also prescribed. Sedatives and stimulants also came into the therapeutic armamentarium.

[48] Cooper. *A Dictionary of Practical Surgery*, 1822 (Note 26). p.1219-1222.
[49] Crumplin. *Men of Steel*, 2007 (Note 7). p.279-281.

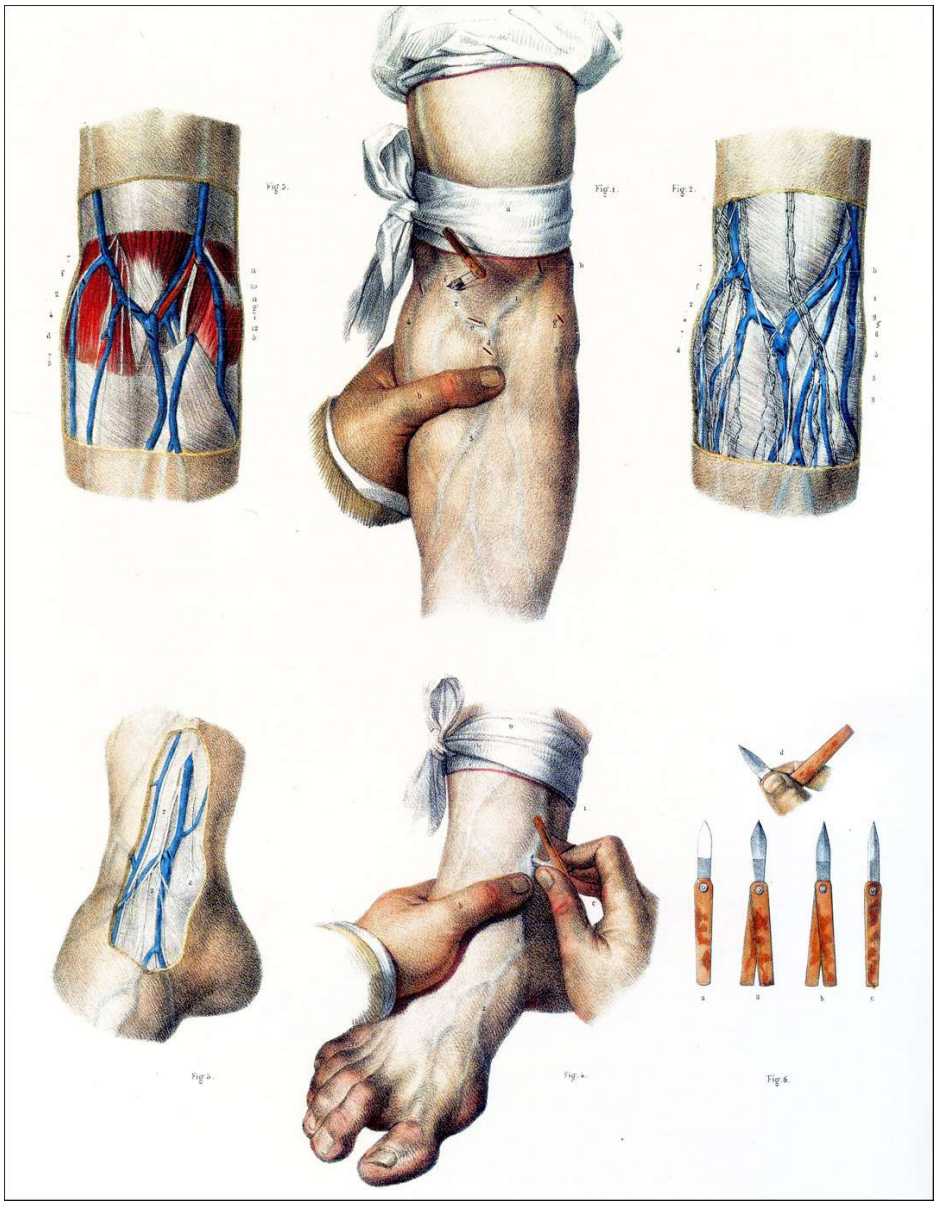


Figure 26. The technique of venesection. Original engraving from Bourgery JM, Jacob NH, *Atlas of Human Anatomy and Surgery,* Paris; 1831-54. Courtesy of John Kirkup.

Counter irritation was likewise used to provide an 'exit' for symptoms or disease from various body parts with an intention to heal using local irritation and thus 'extraction.' Unremitting acute or chronic pain was countered by providing heat near the affected area, produced by moxibustion (the application of smouldering portions of leaves or moxa wood near the diseased part) or use of the 'actual' cautery (topical application of hot cautery irons). Other forms of local irritation were scarification, dry cupping (as opposed to wet cupping, a form of venesection) and vesication, with the local use of irritant chemicals or crushed and powdered dry remains of the *cantharides* fly. These two latter procedures were named the 'potential' cautery. Another method of diverting the disease was by inducing local sepsis near the part to be treated by the

superficial implantation of small pieces of foreign material named 'issues' (also called *fontanels*), such as peas or small metallic objects under the skin. Figure 27 shows an alternative method of induced surgical sepsis. This consisted of the puncture of the skin and superficial tissues with a large flat seton needle, threaded with a skein of cloth fibres, passed through the wound.[50]

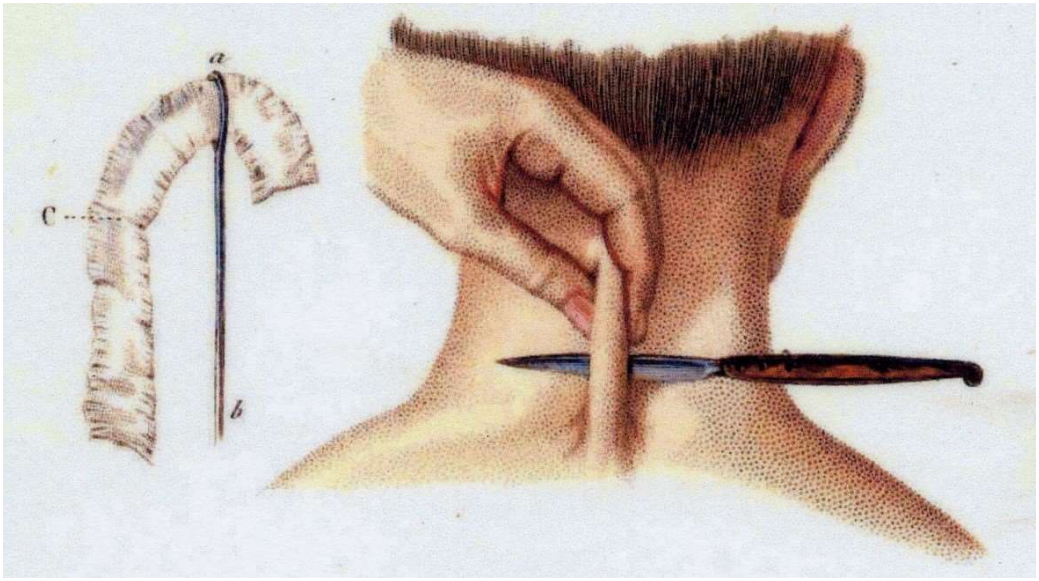


Figure 27. The insertion of a seton blade and skein of threads. Original engraving from Bourgery JM, Jacob NH, *Atlas of Human Anatomy and Surgery,* Paris; 1831-54. Courtesy of John Kirkup.

The survivors of severe sickness, wounding and major or complicated surgery required hospitalisation. Aside from larger general hospitals abroad, as at Coimbra or Elvas in Iberia, Jamaica and Barbados in the West Indies and later, in Brussels and Antwerp in Europe, there were important base hospitals in Britain. Military hospitals existed at Portsmouth, Chatham, Deal, Plymouth, Chelsea, Colchester, a depot hospital on the Isle of Wight, and interestingly, a unit at Bognor Regis specialising in diseases of the eye, after the continued problems associated with *ophthalmia*, following the Egyptian campaigns.[51] The historiography of these wars constantly emphasises the higher mortality rates in larger hospitals compared with regimental or smaller temporary hospitals. Unsurprisingly, since severely ill patients were treated in crowded conditions, they were at considerable risk from poor hygiene, lack of ventilation and cross-infection. This was despite the tightening of regulations for all military hospitals in 1812-13 by Sir

[50] Kirkup J. *The Evolution of Surgical Instruments: An Illustrated History from Ancient Times to the Twentieth Century.* Novato CA: Historyofscience.com; 2006. p.403-404.
[51] Cantlie. *A History of the Army Medical Department*, 1974 (Note 6). p.275.

James McGrigor,[52] [53]. Among other issues, McGrigor's revised Instructions laid down details of care, cleanliness, sick returns and duties of the various staff and the various other responsibilities of medical staff, apothecaries, nurses and purveyors. Weekly, monthly and quarterly hospital returns ensured continued statistical data on the current sick and wounded and their movements, essential information for assessing the fighting strength of the army in the field.

Surgical outcomes

Table 5 shows some treatment outcomes in both regimental and larger general hospitals, collated towards the end of the Peninsular War. These data reflect a diminution of treatment episodes, reduced admissions to smaller and larger hospitals and lower mortality rates in those units. While probably demonstrating improved results, it is clear that despite the issue that the fittest men had survived, the Army and its AMD were likely at the pinnacle of their performance.[54]

Year	Treatments (GH + RH)	Admissions (GH)	Mortality (GH + RH)
1812	176,180	95,075	7,193
1813	123,019	46,715	6,866
1814 (x2)	53,073 (x2 = 106,146)	22,013 (x2 = 44,026)	2,909 (x2 = 5,818)

Table 5. Number of hospital treatments, admissions and mortality from 1812 to 1814. GH – General Hospitals; RH – Regimental Hospitals. Total hospital deaths: 16,968. The data for 1814 cover a six-month period and are also shown doubled for ease of comparison with earlier full-year data. Data from: Cantlie. *A History of the Army Medical Department,* 1974 (Note 6). p.507-509.

As to surgical performance in general hospitals, it is informative to study the results of surgical management in the larger hospitals in Brussels following the Battle of Waterloo in June 1815. Each of the five principal Allied hospitals in the city had a senior member of the medical staff supervising, either a staff surgeon or a physician to the forces. Casualty mortality rates in one hospital, collated for the various anatomical parts injured amongst a cluster of 322 soldiers, revealed: head and neck 15%; thorax 24%;

[52] Army. *Instructions for the Regulation of Regimental Hospitals and the Concerns of the Sick. Horse Guards, 24th September, 1812.* London: Printed by W Clowes and Co; 1812.
[53] Army. *Instructions for the Regulation of Military Hospitals and the Sick with Divisions of the Army in the Peninsula.* Lisbon: Printed by Antonio Rodrigues Galhardo; 1813.
[54] Crumplin. *Guthrie's War*, 2010 (Note 35). p.138.

abdomen 9%; upper limb 3%; lower limb 9%. These data refer to patients who may or may not have undergone surgery.[55]

The operative mortality rates (in parentheses) showed variation between the five hospitals: 134 patients (28%); 103 patients (28%); 51 patients (37%); 25 patients (56%); 35 (40%). Interestingly, those hospitals with larger operative case-loads had more survivors. What remains conjectural is whether this was due to better surgeons or therapy at larger units, or due to patients admitted later in a more serious condition being managed at smaller hospitals. In all 6,636 patients treated the mortality rate was 11%.[56] Predictably, those undergoing surgery had less favourable outcomes; in the 508 patients operated upon, the mortality was 42%. The total hospital mortality rate of 11% is commensurate with figures cited by WB Hodge for soldiers dying of their wounds during the Peninsular War: 8% for officers and 12% for NCOs, rank and file.[57]

Those casualties fortunate enough to survive serious wounds with or without surgery, returned to an increasingly industrialised homeland and many were left destitute after the wars. Forced into penury, many servicemen, often limbless, blind, crippled or simply worn out, could no longer continue arduous labour or their skilled crafts. Both surgeons and their charges eventually received appropriate medals and a pension if seriously hurt. There was a considerable difference in the award of disability pensions between officers, NCOs and privates. Awards for officers were broadly categorised by the equivalent of the loss of a limb or eye and varied between £50 and £450 (£3,400 to £30,600 today).[58] The Court of Examiners of the Royal College of Surgeons of London examined injured and sick officers. Injured men of all ranks and the widows of soldiers killed in action were considered for relief. Some more fortunate victims were admitted as in or outpatients at The Royal Hospital Chelsea or Kilmainham.

It is difficult to have a complete picture of the sickness rate and mortality amongst medical staff over these long wars. We read of James McGrigor's and George Guthrie's illnesses, but there clearly were other deaths from illnesses in the Caribbean, Low Countries and in the Peninsula campaigns.[59] [60] Sickness took a greater toll of Army medical staff than battle injury. Following the retreat from Burgos in late 1812, the AMD lost 11 medical officers from typhus.[61]

As to the post-war careers of the medical staff and any benefits to the civilian population, around two-thirds of medical men in the army were discharged on half pay. Only the more senior doctors would find this sufficient for comfortable living. Many returned to their nation of origin while others found work in Europe or further afield.[62]

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[55] Crumplin, Glover. *Waterloo After the Glory*, 2019 (Note 15). p.108-122.
[56] Crumplin, Glover. *Waterloo After the Glory*, 2019 (Note 15). p.124.
[57] Hodge WB. On the Mortality Arising from Military Operations. *Journal of the Statistical Society of London*. 1856; 19: 219-271.
[58] War Office. *Return of the Names of the Officers in the Army who receive Pensions.* London: House of Commons; 1818.
[59] Scotland. *Sir James McGrigor*, 2021 (Note 17). p.31-32.
[60] Crumplin. *Guthrie's War*, 2010 (Note 35). p.48-49.
[61] Cantlie. *A History of the Army Medical Department*, 1974 (Note 6). p.353.
[62] Ackroyd, Brockliss, Moss, Retford, Stevenson. *Advancing with the Army*, 2006 (Note 13). p.217-254.

It remains well-nigh impossible to assess what influence the principles of military best practice had on civilian surgical practice following the wars. Many publications, orations and lectures based on the war's experiences would influence aspiring army surgeons for a time, but lessons would be forgotten and, significantly, military education would take time to get properly established in England. Dispersal of valuable experience would prove patchy and several hard-learned lessons gleaned over these wars would be forgotten in the next tough challenge for the British Army, the campaigns in the Crimea in the war against Russia (1853-56).

Surgical advances

Finally, it remains pertinent to summarise the advances in surgical practice over this long period of conflict, particularly in the latter four years. In the first instance, surgeons who formed the majority of the medical staff learned to serve as military doctors despite receiving little appropriate training before they joined the AMD. They worked under military discipline, accrued experience and knowledge from more experienced colleagues and gained a better understanding of crucial issues. They learned when an operation was indicated, when the soldier was fit for a wound exploration, amputation or trepanning and, importantly, that delay could pose major risks.

Senior army commanders and medical officers alike took care later in the wars to select the most appropriately experienced surgeon for a particular posting. Surgeons began to comply better with improved hospital regulations and their duties as laid down by the Inspector General, later Director General of the AMD, Sir James McGrigor.[63] There were opportunities to learn from post mortem examinations, and glean operative skills from surgeons including John Hennen, Samuel Cooper and George Guthrie. One drawback to any study on surgical abilities is the poor understanding we have of the skills of the 'average' regimental, staff or naval surgeon. Most of the information on surgical performance was recorded by men who had clearly excelled in their profession. Some survival rates were remarkable when one realises that operations were carried out without the knowledge and facilities we possess today. The results reflect that what to do and when to do it became second nature to most experienced surgeons.

Specific advances in surgical skills would not have been learned immediately by all surgeons since there were limited ways of dispersing knowledge. Firstly, in regard to damaged limbs, there was a trend towards using the flap method of amputation rather than the guillotine technique. In managing upper limb injuries, some surgeons were preserving limbs and merely removing damaged bone or joints. What was abundantly clear was that when an amputation was required, the earlier it was performed**,** given a short period of psychological and physical adjustment, the better. Guthrie had shown in a small uncontrolled series that compound femoral fractures were best managed by early amputation. In addition, a naval surgeon reputedly had some success with cutting arterial ligatures short before closing the amputation wound.[64] Experience had shown that simple fractures of the femur and leg were better managed by using long splints.

[63] Army. *Instructions for the Regulations of Military Hospitals and the Sick*, 1812 (Note 52).
[64] Lloyd, Coulter. *Medicine and the Navy*, 1961 (Note 41). p.365.

Surgeon Guthrie had made the very basic observation that wounded arteries needed to be tied off above and below the site of injury in the vessel. Also, he had relieved incipient pressure-induced ischaemia and prevented gangrene by performing a modified fasciotomy for severe swelling caused by sepsis in a soldier's leg.

Case reports show that, despite limited success, there were improved criteria for trepanning the skull and a clearer understanding of when to operate on compound cranial injuries. Depressed fractures, drainage of intracranial haematomas and even excision of infected cerebral hernias were often attended by reasonable recovery.

As these wars drew on, doubts were voiced occasionally concerning the role of venesection in the management of febrile soldiers who had already bled profusely on the battlefield.[65] [66]

Crucial to our understanding of surgical performance was the successful collection of data on the types of wounds, operations and surgical results. It would be another hundred years before military surgical therapies, reforms, innovations and critical support services could significantly impact better surgical outcomes in a devastating industrial war.

[65] Bell C. *A System of Operative Surgery Founded on the Basis of Anatomy, Vol. II*. London: Longman, Hurst, Rees, Orme and Brown; 1814. p.463.
[66] Hennen. *Principles of Military Surgery*, 1830 (Note 42). p.67.

Biographical details

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For over 50 years, he has taken an interest in military, naval and surgical history. Although specialising in the French Wars (1793-1815), he also has great interest in earlier and later conflicts. He lectures nationally and internationally and also advises students, researchers, authors and the media. He has published five books and many articles and has acted as medical advisor for diverse media programmes and publications. His principal purpose with history is to promote interest in the human cost of war and the evolution of healthcare in the armed services.

He is an Honorary Curator and Archivist at the Royal College of Surgeons of England and the Association of Surgeons. He coordinated the educational activities for the Bicentenary of the Battle of Waterloo for the Waterloo200 Committee. He has, with the generosity of a local businessman, set up a permanent museum of surgery and medical care relevant to the Campaign of Waterloo, which is situated in the farm buildings at Mont St Jean used as the main Allied field hospital.

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