

Sir Charles Ballance Removes a Bullet from the Heart: An Audacious Venture

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Abstract

Colonel Sir Charles Ballance (1856-1936), an eminent Ear, Nose and Throat surgeon stationed in Malta as senior consulting surgeon during World War 1, removed a bullet from the heart of a soldier on 16 February 1918 at St Elmo Hospital, Malta. This momentous event, performed within a year of the first-ever recorded case, and the third such intervention worldwide, inaugurated cardiac surgery on the island.

This paper explores the circumstances that enabled major complex surgery to be performed in a small island state, focusing on the dissemination of knowledge in the pre-information technology era and the support services then available. The persona of the surgeon and his audacity were major factors making this pioneering surgery possible.

Keywords

Ballance, Bullet, Heart, Operation, Malta, World War 1

Introduction

The credit belongs to the man who is actually in the arena ... who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.¹

– Theodore Roosevelt

¹ Quoted from the ‘Citizenship in a Republic’ speech by Theodore Roosevelt (1858-1919), delivered at the Sorbonne in Paris on 23 April 1910 and commonly known as the ‘Man in the Arena’ speech. Theodore Roosevelt Center at Dickinson State University. <https://www.theodorerooseveltcenter.org/Learn-About-TR/TR-Encyclopedia/Culture-and-Society/Man-in-the-Arena.aspx> (accessed 27 July 2023).

The Great War of 1914-18, now better known as World War 1 (WW1), was among the deadliest of human conflicts with over sixteen million deaths and twenty million wounded.² Among the medical advances were blood storage and transfusion,³ orthopaedic splints,^{4 5} speed of treatment on the battlefield,⁶ wound treatment,^{7 8} and management of post-traumatic stress disorder, then known as shell shock.⁹ What is not so well recognised is that it also saw the birth of cardiac surgery for trauma to the heart.

In today's world of regulated medicine an experienced cardiac surgeon would have to undertake certain measures before adding an operation to his/her repertoire, depending on the novelty of the procedure. If it entailed a minor variation from usual practice, such as implanting a different brand of a prosthetic valve, one would have the comfort of scientific information about the product, published reports from independent surgeons using the product, educational videos highlighting particular steps intrinsic to the valve implantation, and technical backup by way of the parent company representative being present during the first few operations. If the change involved a significant departure from standard practice, such as implanting a rapid-deployment valve through minimal access, one would also spend time at a surgical centre performing the procedure, observing at first hand, and preferably assisting, and being assisted by, a surgical mentor at an actual implantation.^{10 11}

These important steps, nowadays considered essential in the safe practice of surgery, were not available a hundred years ago. Indeed, the incentive to achieve a first precluded any conferring with rivals, keeping in mind that the primary objective was to save the patient's life. A desperate situation was conducive to a certain measure of audacity. As the speciality of cardiothoracic surgery evolved, performing a first became less important, more focus being placed on the risk-benefit ratio of the procedure.

² Cebula A. The legacy and consequences of World War I. *Journal of Military Ethics*. 2020; 19(2): 118-120.

³ Diamond LK. History of blood banking in the United States. *Journal of the American Medical Association*. 1965; 193(1): 40-44.

⁴ Robinson PM, O'Meara MJ. The Thomas splint: its origins and use in trauma. *Journal of Bone and Joint Surgery*. 2009; 91-B(4): 540-543.

⁵ Orr HW. The use of the Thomas splint. *American Journal of Nursing*. 1920; 20(11): 879-880.

⁶ Craig SC, Smith DC. *Glimpsing Modernity: Military Medicine in World War I*. Newcastle-upon-Tyne: Cambridge Scholars Publishing; 2015. p.120.

⁷ McCartney GE, Mewburn FHH. The technique of the Carrel-Dakin treatment. *British Medical Journal*. 1918; 1(2980): 170-171.

⁸ Sabbatani S, Florino S. The treatment of wounds during World War I. *Infezioni in Medicina*. 2017; 25(2): 184-192.

⁹ Myers CS. A contribution to the study of shell shock. Being an account of three cases of loss of memory, vision, smell, and taste, admitted into the Duchess of Westminster's War Hospital, Le Touquet. *Lancet*. 1915; 185(4772): 316-320.

¹⁰ Edmondson AC, Bohmer RM, Pisano GP. Learning new technical and interpersonal routines in operating room teams. The case of minimally invasive cardiac surgery. In: Neale MA, Mannix EA (eds). *Research on Managing Groups and Teams, Vol. 3*. Bingley: Emerald Group Publishing Limited; 2000. p.29-51.

¹¹ Tolis G, Spencer PJ, Bloom JP, Melnitchouk S, D'Alessandro DA, Villavicencio MA *et al*. Teaching operative cardiac surgery in the era of increasing patient complexity: Can it still be done? *Journal of Thoracic and Cardiovascular Surgery*. 2018; 155(5): 2058-2065.

This paper describes the climate in which Ballance practised, his impetus to perform the surgery and the pre-operative groundwork he undertook in the safe preparation and planning for the procedure. The state of dissemination of knowledge that was available in his era influenced his decision-making and this singular operation left a mark on the history of cardiac surgery in Malta.¹²

Charles Ballance (1856-1936): career

Charles Ballance (Figure 1) was born into a non-medical family in 1856 and became a star student at St Thomas's Medical School, winning gold medals in his final examination and in his Master of Surgery the following year.

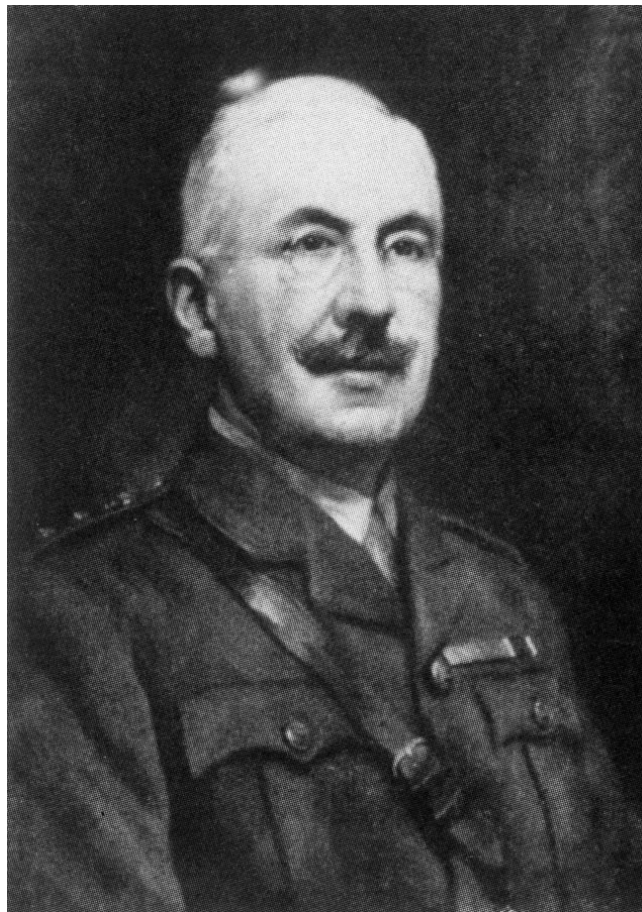


Figure 1. Sir Charles Ballance. Queen Square Library and Archives, London. Reproduced with permission.

¹² Manché, A. Cardiac surgery in Malta: Past, Present and Future. *The Synapse* 2016; 15(2): 19-21. <https://thesynapse.net/cardiac-surgery-in-malta-past-present-and-future-2>

At the age of 32 he was appointed aural surgeon at St Thomas's Hospital, becoming a pioneer in mastoid surgery. His other appointments included surgeon at St Thomas's and consultant to the National Hospital for Paralysed and Epileptic at Queen Square. Ballance performed the second recorded successful splenectomy in 1895, attesting to his broad surgical expertise.¹³ His appointments and awards are listed in Table 1.¹⁴

Appointments

- 1881 House Surgeon, St Thomas's Hospital
- 1882 Anatomy Demonstrator, St Thomas's Hospital
- 1887 Member, Court of Examiners, Royal College of Surgeons
- 1888 Aural Surgeon, St Thomas' Hospital
- 1891 Assistant Surgeon, St Thomas' Hospital
- 1891 Surgeon, National Hospital for the Paralysed and Epileptic
- 1900 Surgeon, St Thomas' Hospital
- 1906 President of the Medical Society of London
- 1908 Captain Royal Army Medical Corps
- 1910 Council Member, Court of Examiners, Royal College of Surgeons
- 1912 Chief Surgeon to Metropolitan Police
- 1915 Temporary Colonel Army Mobility Squadron
- 1918 Erasmus Wilson Lecturer
- 1919 Consulting Surgeon, St Thomas' Hospital
- 1919 Bradshaw Lecturer
- 1920 Vice-President, Court of Examiners, Royal College of Surgeons
- 1921 Vicary Lecturer
- 1927 First President of the Society of British Neurological Surgeons
- 1928 Honorary President of the Society of British Neurological Surgeons
- 1933 Lister Memorial Lecturer

Awards

- 1881 Gold Medal Batchelor of Surgery University of London
- 1882 Gold Medal Master of Surgery University of London
- 1916 Companion of the Bath (military)
- 1918 Knight Grand Cross Commander of the Most Distinguished Order of Saint Michael and Saint George
- 1919 Honorary Doctorate of Medicine, University of Malta
- 1919 Knight of Grace of the Order of St John of Jerusalem
- 1927 Honorary Doctorate of Laws, Glasgow University
- 1928 Honorary Fellow of the American College of Surgeons
- 1933 Lister Memorial Medal

Table 1. Ballance's appointments and awards. Plarr's Lives of the Fellows (Note 14).

¹³ Pitts B, Ballance CA. Three cases of splenectomy for rupture. *Transactions of the Clinical Society of London*. 1896; 29: 77-104.

¹⁴ Ballance, Sir Charles Alfred (1856-1936). Plarr's Lives of the Fellows. Royal College of Surgeons of England. https://livesonline.rcseng.ac.uk/client/en_GB/lives/

Soon after the start of the Gallipoli Campaign, Ballance was posted to Malta where he arrived on 30 May 1915. As senior consulting surgeon he organised and supervised numerous emergency hospitals hurriedly setting up to receive casualties from the Dardanelles.

Eminent doctors stationed in Malta

Charles Ballance was stationed in Malta with other eminent doctors (Figure 2),¹⁵ including Colonel Charters Symonds (1852-1932) surgeon from Guy's Hospital,¹⁶ Colonel Archibald Edward Garrod (1857-1936) physician from St Bartholomew's Hospital,¹⁷ and Colonel James Purves-Stewart (1869-1949), physician from Westminster Hospital.¹⁸



Figure 2. Sir Alfred Keogh and eminent doctors stationed in Malta. From left to right: Sir Charters Symonds, US Library of Congress LC-B2-5926-2; Sir Archibald Edward Garrod, National Portrait Gallery (NPG), London; Sir James Purves-Stewart, NPG; Sir Alfred Keogh, NPG. All images reproduced with permission.

Sir Alfred Keogh (1857-1936), the presiding British Army Medical Administrator, while not stationed in Malta himself, insisted on the highest standards of medical practice: 'We wish to bring to the humblest soldier the best available surgery, and that which is not the best is not good enough'.¹⁹ See Figure 2.

¹⁵ Bonnici W. Military Hospitals Malta 1914-1918. Civilian Consultants in Malta during the Great War. <https://www.maltaramc.com/articles/contents/greatwar.html> (accessed 2 September 2023).

¹⁶ Anon. Sir Charters Symonds K.B.E., C.B. *British Medical Journal*. 1932; 2(3742): 611-612.

¹⁷ Anon. Sir Archibald Edward Garrod (1857–1936). Historic Hospital Admission Records Project. <https://hharp.org/library/gosh/doctors/archibald-edward-garrod.html> (accessed 2 September 2023).

¹⁸ Anon. Sir James Purves-Stewart, K.C.M.G., C.B., M.D., F.R.C.P. *British Medical Journal*. 1949; 1(4616): 1142-43.

¹⁹ Mackinnon AG. *Malta: The Nurse of the Mediterranean*. London: Hodder and Stoughton; 1916. p.155-156.

Building	Opened	Initial Beds	Total Beds	Closed
Cottonera Hospital	Pre-war	167	802	Post-war
Valletta Hospital	Pre-war	36	524	Post-war
Forrest Hospital	Pre-war	20	186	Post-war
Mtarfa Barracks	Pre-war	55	1,853	Feb 1919
Tigné Barracks	2 May 1915	600	1,314	6 Jan 1919
St George's Barracks	6 May 1915	840	1,412	31 Oct 1917
St Andrew's Barracks	9 May 1915	1,172	1,258	21 Jan 1919
Villa Dragonara	14 May 1915	12	20	29 Aug 1917
Floriana Barracks	4 June 1915	600	1,304	30 Apr 1917
Blue Sisters Hospital	6 June 1915	80	120	30 June 1917
Hamrun School	8 June 1915	108	117	5 July 1917
All Saints Camp	12 June 1915	1,465	2,000	Nov 1917
Auberge de Bavière	15 June 1915	105	155	14 Aug 1917
St Ignatius College	2 July 1915	155	196	Jan 1919
Sisters' Hospital Floriana	10 July 1915	12	31	unknown
St David's	25 July 1915	464	1,168	1 May 1917
St Elmo School	12 Aug 1915	218	348	Oct 1918
St Patrick's	15 Aug 1915	1,000	1,168	27 Apr 1917
Ghajn Tuffieha Camp	15 Aug 1915	2,000	5,000	Jan 1919
St Paul's Hutments	25 Aug 1915	240	898	27 Apr 1917
St John's School	1 Sep 1915	400	520	9 Oct 1917
Fort Chambray Camp	4 Oct 1915	400	400	13 Mar 1916
Fort Spinola	6 Nov 1915	1,000	1,168	27 Apr 1917
Fort Ricasoli	6 Nov 1915	800	800	19 Feb 1916
Fort Manoel	16 Nov 1915	500	1,184	21 Dec 1918
San Antonio Palace	8 Dec 1915	50	50	19 Mar 1916
Verdala Palace	9 Dec 1915	30	30	17 Apr 1916
Mellieha Camp	1 Feb 1916	1,250	2,000	5 Sep 1917

TOTAL: 28 medical units by 1916; Pre-war: 278 beds; Maximum: 26,026 beds.

Table 2. Military Medical Units in Malta during WW1, 1914-19. St Elmo School, highlighted, became the hospital where Charles Ballance removed a bullet from the heart of Trooper Martin. Bonnici. *Military Hospitals Malta* (Note 15). Additional data sourced from: Macpherson. *History of the Great War, 1922* (Note 21).

The patient

Robert Hugh Martin, a Derbyshire Yeomanry trooper, was shot in the chest by a Bulgarian sniper in Salonika on his 21st birthday, 14 November 1917 (Figure 4). The bullet passed through his right arm and then between the 4th and 5th ribs without emerging. X-rays revealed the bullet to be moving with cardiac pulsations. Two days later he underwent exploratory surgery at the 40th Casualty Clearing Station Hospital in Salonika where the left subphrenic space was entered via a transverse incision of the upper rectus. Nothing abnormal was found and this wound later suppurred. He was

transferred to Malta aboard the hospital ship *Glenart Castle*, arriving at St Elmo Hospital on 13 January 1918, where he came under the care of Ballance.



Figure 4. Trooper Robert Hugh Martin. Original photograph owned by Sheila Hobson, grandniece of Trooper Martin. Digital image provided by Colonel David Vassallo. Reproduced with permission.

Facilities at St Elmo Hospital

St Elmo Hospital had been converted from a government primary school in Valletta and boasted an X-ray apparatus, but laboratory work was sent to centralised laboratories elsewhere.²⁴ Operative room and recovery conditions were, at best, primitive. Surgical instruments were crude, non-ergonomic and limited in scope. Operating table height was fixed and tilt was not an option (Figure 5). Simple fluorescent bulbs provided poor lighting and high-pressure suction to provide a bloodless operative field was non-existent.²⁵ Anaesthesia was crude, dangerous, and lacked proper monitoring.²⁶ Despite these limitations the hospital was well staffed (Figure 6) and tremendous strides were being made in the treatment of war wounds, which changed attitudes amongst the surgical profession.

²⁴ Bonnici. *Military Hospitals Malta* (Note 15).

²⁵ Vergani C, Venturi M. The Italian mobile surgical units in the Great War: the modernity of the past. *Updates in Surgery*. 2020; 72(3): 565-572.

²⁶ Whipple GH, Sperry JA. Chloroform poisoning. Liver necrosis and repair. *Bulletin of The Johns Hopkins Hospital*. 1909; 20: 278-289.



Figure 5. Operating theatre, St Ignatius Hospital, Sliema, Malta WWI (showing basic facilities identical to those at St Elmo Hospital). Richard Ellis Archives, Malta. Reproduced with permission.



Figure 6. St Elmo Hospital – Staff, Nurses and Orderlies 1916-1917. Father Born Album (photographer unknown), Fort St Elmo Archives, National War Museum, Heritage Malta Collection. Reproduced with permission.

The operation

Further X-rays were performed at St Elmo Hospital to delineate the position of the bullet. On careful analysis, it was thought that the base of the bullet was fixed in the wall of the right ventricle, and that the pointed end was in the cavity of the right ventricle. The diaphragm moved independently of the bullet, which was located behind the fifth left intercostal space at a depth of two inches. The patient was allowed to recover from severe sea-sickness, which was thought to contribute to his distress from palpitations. He was monitored on the ward and found to be repeatedly intolerant to the slightest exertion, which resulted in rapidity and irregularity of the heart. These persistent symptoms, and the known position of the bullet, made it desirable to operate.

After much preparation, which included the surgeons practising the operation on a cadaver provided by the Rector of the University, Professor Enrico Magro (1854-1926), and obtaining Serbian and Bulgarian bullets to test their magnetic properties in case a magnet could be used perioperatively, the operation went ahead five weeks later, on 16 February 1918. Charles Ballance cut into the right ventricle and retrieved the bullet from the inferior interventricular septum, using an artery forceps.²⁷

The approach was via a Kocher's incision with removal of the left fourth to sixth costal cartilages (Figure 7). Stay sutures through the apex steadied the heart and preparatory Albert-Lembert purse-string sutures, inserted along the proposed incision, helped stem the copious bleeding.²⁸

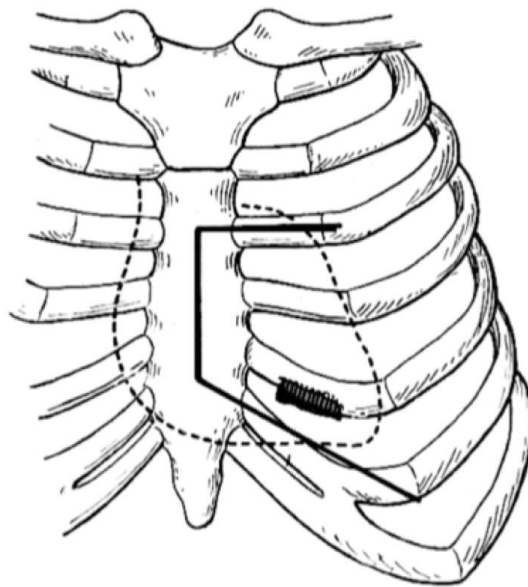


Figure 7. Approach to the heart: Kocher's incision in relation to the bullet. White, Ballance. A case of removal of a rifle bullet, 1918 (Note 27).

²⁷ White M, Ballance C. A case of removal of a rifle bullet from the right ventricle of the heart. *Journal of the Royal Army Medical Corps*. 1918; 31(4): 484-496.

²⁸ Taguchi T, Iwanaka T, Okamatsu T (eds). *Operative General Surgery in Neonates and Infants*. Japan: Springer; 2016. p.56.

Ballance was assisted in this pioneering operation by Dr Sarah Marguerite White (b1883), one of an intrepid group of female doctors stationed in Malta since August 1916.²⁹ She is shown in Figure 8, the only photograph available of her. She was the first author of their co-authored paper, at a time when female surgeons were very rare and fighting for recognition.



Figure 8. Dr Sarah Marguerite White. Graduating Photo, University of Illinois College of Physicians and Surgeons Class 1912. Reproduced with permission. https://collections.carli.illinois.edu/digital/collection/uic_cmc/id/29.

Lieutenant Colonel Herbert John Shirley (1868-1943), shown in Figure 9, administered the anaesthetic.^{30 31}

²⁹ Bonnici W. Lady Doctors of the Malta Garrison: Sarah Marguerite White 1883 – ? <https://www.maltaramc.com/ladydoc/w/whitesm.html>. See also: Sarah Marguerite White. No 10 (24/W/732 [pa 21.10.19]) *Army Book No 82, Record of Special Reserve Officer's Service (Records of 132 Lady Doctors)*. Museum of Military Medicine.

³⁰ Shirley, Herbert John (1868-1943). Plarr's Lives of the Fellows. Royal College of Surgeons of England. https://livesonline.rcseng.ac.uk/client/en_GB/lives/

³¹ Lt Col Herbert John Shirley, C.M.G., M.D., F.R.C.S. 1916. 2nd/5th Bn Lancashire Fusiliers (Territorials) Tours and Posting. <https://www.lancs-fusiliers.co.uk/gallerynew/2-5bnLF1916/2-5bnLF1916.htm> (accessed 27 September 2023).



Figure 9. Lieutenant Colonel Herbert John Shirley, consulting anaesthetist, Malta Command. 2nd/5th Battalion Lancashire Fusiliers (Territorials) Tours and Posting (Note 31). Reproduced with permission.

Post-operative course

The post-operative course was stormy and the patient succumbed to sepsis a month later, in spite of re-exploration and irrigation of the surgical site, blood transfusion and various therapeutic manoeuvres (Table 3). A drain to allow escape of potentially infected fluid was not inserted at operation. Infection had become indolent following the initial exploration in Salonika and flared up after this second operation. Ballance remarked in his paper: ‘it is a common experience that bullets frequently lodge in the tissue and induce neither local nor general infection until attempts are made at removal’.³² In contrast to Ballance’s case, performed three months after the injury in the presence of on-going sepsis, previous successful bullet extractions had taken place long after the injury when infection had completely subsided (see section below on WW1 landmarks in cardiac surgery).

³² White, Ballance. A case of removal of a rifle bullet, 1918 (Note 27). p.491.

- Day 4: Serious collapse. Strychnia, oxygen, mustard baths.
- Day 5: Discharge from wound. Patient unconscious, pulseless.
Subcutaneous ether: revived.
- Day 8: Purulent discharge, sutures removed, pericardium irrigated.
- Day 10: Restless, temp 102, pulse 112, respiratory rate 34.
Morphia and strophanthus.
Streptococcus pyogenes, staphylococcus aureus and an unidentified bacillus cultured from pericardium.
- Day 18: Transfusion abandoned as donor fainted.
Patient infused with saline with brandy and mercury perchlorate.
- Day 22: Patient very weak. Haemoglobin at 58%. 300cc blood transfused and pulse recovered from 130 to 90.
- Day 23: Pericardial pus increased. Continuous Eusol irrigation.
Strychnia and digitalis 3 hourly.
Glucose and brandy 4 hourly, rectally.
- Day 24: Large transfusion administered.
- Day 26: Patient died.

Table 3. Post-operative progress and therapeutic manoeuvres. White, Ballance. A case of removal of a rifle bullet, 1918 (Note 27).

Dissemination of information

Medical journals circulated amongst a restricted readership in the mid-eighteenth century. Such was their rapid growth over the ensuing hundred years that doctors lamented an information overload that was impossible to keep abreast of. Scientific journals jostled with popular publications to influence social and political trends by way of their editorials, reaching a wider audience far beyond the boundaries of the medical profession.³³ Foremost amongst the top journals were the *Lancet* and the *British Medical Journal*.

Surgical firsts received due publicity, in spite of dire warnings from sceptics within the profession. Theodor Billroth (1829-1894) issued a warning in 1883 that ‘any surgeon who operated on the heart should lose the respect of his colleagues’.³⁴ In 1896 Stephen

³³ Ferry G. The art of medicine. Medical periodicals: mining the past. *Lancet*. 2015; 385(9987): 2569-70.

³⁴ Beck CS. Wounds of the heart: the technic of suture. *Archives of Surgery*. 1926; 13(2): 205-227.

Paget (1855-1926) lamented that ‘surgery of the heart has probably reached the limits set by nature’.^{35 36}

That same year Ludwig Rehn (1849-1930) triumphantly inaugurated cardiac surgery when, on 8 September 1896, he successfully sutured a stab wound in the heart,³⁷ after unsuccessful attempts by Axel Cappelen (1858-1919) and Guido Farina (1868-1959).^{38 39} By 1907 Rehn had published a series of 124 cases with a 40 per cent survival.⁴⁰ Luther Leonidas Hill (1862-1946) reported similar success in 1902.⁴¹

Ballance, who attended secondary school in Germany before Medical School, had later visited several German clinics in the course of his postgraduate Ear, Nose and Throat (ENT) training. He would have become acquainted with Rehn’s series in the *Archiv für Klinische Chirurgie*, a journal in print since 1860.⁴²

1809	<i>Proceedings of the Royal Society of Medicine</i>
1812	<i>The Boston Medical and Surgical Journal</i>
1823	<i>The Lancet</i>
1831	<i>Proceedings of the Royal Society of London</i>
1840	<i>The British Medical Journal</i>
1849	<i>Journal of the American Medical Association</i>
1860	<i>Langenbecks Archiv für Chirurgie</i>
1868	<i>The Practitioner</i>
1878	<i>The Journal of Physiology</i>
1885	<i>Annals of Surgery</i>
1891	<i>The Johns Hopkins Hospital Bulletin</i>
1894	<i>The London Hospital Gazette</i>
1903	<i>Journal of the Royal Army Medical Corps</i>
1905	<i>Surgery, Gynecology and Obstetrics</i>
1913	<i>International Abstract of Surgery</i>

Table 4. Scientific journals published in the nineteenth and early twentieth centuries by year of inauguration. Shows the name by which the journal was known in 1918. Collated by the author.

³⁵ Paget S. *The Surgery of the Chest*. Bristol: J Wright & Co; 1896.

³⁶ Ellis H. Suture of a stab wound of the heart. *Journal of Perioperative Practice*. 2015; 25(7-8): 144.

³⁷ Rehn L. Ueber penetrirende Herzwunden und Herznaht. [Concerning penetrating cardiac injuries and cardiac suturing.] *Archiv für Klinische Chirurgie*. 1897; 55: 315-329.

³⁸ Beck. Wounds of the heart, 1926 (Note 34).

³⁹ Alexi-Meskishvili V, Bottcher W. Suturing of penetrating wounds to the heart in the nineteenth century: the beginnings of heart surgery. *Annals of Thoracic Surgery*. 2011; 92(5): 1926-31.

⁴⁰ Rehn L. Zur Chirurgie des Herzens und des Hersbeutels. [On surgery of the heart and pericardium.] *Archiv für Klinische Chirurgie*. 1907; 83: 723.

⁴¹ Hill LL. A report of a case of successful suturing of the heart and table of thirty-seven other cases of suturing by different operators with various terminations, and the conclusions drawn. *Medical Record*. 1902; 62: 846-848.

⁴² Beger HG. From Archiv für Klinische Chirurgie to Langenbeck’s Archives of Surgery: 1860-2010. *Langenbeck’s Archives of Surgery*. 2010; 395(Suppl 1): 3-12.

While we do not know what books Ballance brought with him or consulted in Malta pre-operatively, by 1918 the surgical community had access to at least fifteen scientific journals dealing with surgical and medical advances (Table 4) and several authoritative text books such as Paget's *The Surgery of the Chest* and Billroth's *General Surgical Pathology and Therapeutics*.^{43 44} In his careful preparations for the surgery Ballance would certainly have consulted what was available to him.

WW1 landmarks in cardiac surgery

The progression from simple suture of penetrating injuries to the removal of foreign bodies embedded within the heart took surgery to a new dimension. In 1915 Colonel Henry MW Gray (1870-1938) removed a bullet from the right ventricle under local anaesthetic but the patient died four days later.⁴⁵ In 1917 George Grey Turner (1877-1951) attempted to remove a bullet from the left ventricle but the heart arrested when lifted and the procedure was abandoned after resuscitation.⁴⁶ That same year Henri Hartmann (1860-1952) was the first to successfully extract a bullet from the right ventricle of a French soldier, almost three years after the injury.^{47 48} In 1918 (date unspecified) Lord Berkeley Moynihan of Leeds (1865-1936) removed a foreign body from the wall of the left ventricle adjacent to the interventricular groove, fourteen months after the injury.^{49 50} Moynihan had prior experience of gunshot injuries to the chest.⁵¹

These cases were described in the literature and would have set the scene for others to take their chance. Such surgical extravaganzas were attempted in desperate situations. Shared experiences were non-existent and unsuccessful attempts probably went unrecorded. Ballance was very probably aware of previous attempts from the available literature.

⁴³ Paget. *The Surgery of the Chest*, 1896 (Note 35).

⁴⁴ Billroth T. *General Surgical Pathology and Therapeutics, in Fifty-One Lectures. A Text-Book for Students and Physicians*. Translated by Hackley CE. London: HK Lewis, 1879.

⁴⁵ Birkbeck LHC, Lorimer GN, Gray HMW. Removal of a bullet from the right ventricle of the heart under local anaesthesia. *British Medical Journal*. 1915; 2(2859): 561-562.

⁴⁶ Grey Turner G. Gunshot wounds of the heart. *British Medical Journal*. 1941; 1(4198): 938-941.

⁴⁷ Shumacker HB. *The Evolution of Cardiac Surgery*. USA: Indiana University Press; 1996. p.174.

⁴⁸ Westaby S. *Landmarks in Cardiac Surgery*. Oxford: Isis Medical Media Ltd; 1997. p.26.

⁴⁹ Bateman D. *Berkeley Moynihan, Surgeon*. London: Macmillan; 1940. p.196.

⁵⁰ Macpherson. *History of the Great War*, 1922 (Note 21).

⁵¹ Moynihan B. On the treatment of gunshot wounds. *British Medical Journal*. 1916; 1(2879): 333-337.

Charles Ballance: surgical interests

Ballance was certainly an intrepid and versatile surgeon. He initially specialised in ENT surgery, becoming an authority in his field. He then ventured into neurosurgery where research took him to the cutting edge of nerve reconstruction.^{52,53} Within a few years of the outbreak of war he was at the forefront of cardiac surgery.

His outstanding surgical status was further enhanced by his prolific research into fields as diverse as vascular surgery,⁵⁴ inflammation,⁵⁵ nerve regeneration,⁵⁶ and cancer aetiology.⁵⁷ Ballance perhaps re-introduced the Hunterian scientific method of experiment into clinical surgery.⁵⁸ Some of this research took Ballance to foreign lands, when in 1885, at Leipzig, he worked under the guidance of Birch-Hirschfeld (1842-1899) investigating arterial wall changes after ligation in continuity.⁵⁹ This experience brought him into contact with the foremost surgeons and scientists of his era, enabling cross-fertilization of ideas and techniques.

Charles Ballance: pioneer cardiac surgeon

When called upon to deal with the war wounded Ballance applied his skills within the thorax to great effect, in a new surgical field that was considered off-bounds only two decades previously. For instance, he successfully dealt with a ruptured innominate artery aneurysm by ligating the first part of the subclavian artery and removing the aneurysm on 4 February 1918, just twelve days before he operated on Trooper Martin. He recounted 'the surgeon having this job in hand will take it all in a day's work'.⁶⁰

Ballance's contribution to cardiac surgery was indeed significant. He delivered the very prestigious Bradshaw lecture in December 1919 on the surgery of the heart.⁶¹ In it he discussed the operations that were practiced on the heart and the lecture clearly describes the current state of cardiac surgery.

He was strongly in favour of pericardiotomy over paracentesis in the treatment of pericardial effusion, and of venesection over direct paracentesis of the heart in fluid

⁵² Ballance CA, Purves Stewart J. *The Healing of Nerves*. London: Macmillan; 1901.

⁵³ Ballance CA. Some results of nerve anastomosis. *British Journal of Surgery*. 1923; 11: 327-346.

⁵⁴ Ballance CA, Edmunds W. *A Treatise on the Ligation of the Great Arteries in Continuity with Observations on the Nature, Progress and Treatment of Aneurism*. London: Macmillan; 1891.

⁵⁵ Sherrington CS, Ballance CA. On formation of scar-tissue. *Journal of Physiology*. 1889; 10(6): 550-576.

⁵⁶ Ballance, Purves Stewart. *The Healing of Nerves*, 1901 (Note 52).

⁵⁷ Ballance CA, Shattock SG. A note on an experimental investigation into the pathology of cancer. *Proceedings of the Royal Society*. 1890; 48: 392-403.

⁵⁸ Ballance. Plarr's Lives (Note 14).

⁵⁹ Ballance CA, Edmunds W. The ligation of the larger arteries in their continuity. An experimental inquiry. *Medico-Chirurgical Transactions*. 1886; 69: 443-472.

⁶⁰ Ballance CA. A case of ligation of the first part of the left subclavian artery. *Journal of the Royal Army Medical Corps*. 1918; 31(5): 417-419.

⁶¹ Ballance CA. *The Bradshaw lecture on the surgery of the heart*. London: Macmillan; 1920.

overload. He recounted his pre-war experience in Leipzig when Trendelenburg (1844-1924) demonstrated his operation of pulmonary embolectomy on a cadaver.⁶² Ballance then described open cardiac stimulation for arrest of the heart, discussing recent trans-Atlantic experimental findings.⁶³ Ballance concluded his lecture with a meta-analysis of 452 cases reported until 1919, all dealing with operative interference on the heart after chest wounds, including the series of Rehn⁶⁴ and several other surgeons.^{65 66 67 68} This lecture attests to the wide scope of Ballance's knowledge and networking in the field of cardiac surgery. On two occasions Ballance referred to his own experience of operating on the heart. He concluded his Bradshaw lecture with the observation that 'the immediate results of non-operative treatment are very poor as compared with those obtained by operation'.

A similar situation pertained in abdominal surgery. Experience from the Anglo-Boer War (1899-1902) had given rise to the aphorism 'a man wounded in the abdomen dies if he is operated on, and remains alive if he is left in peace'.⁶⁹ In contrast, during WWI the philosophy changed to 'when in doubt, look and see rather than wait and see'.⁷⁰

The operation of removal of a bullet from the heart was the crowning point of Ballance's foray into cardiac surgery and his Bradshaw lecture served the purpose of a reflective resume. It is also pertinent to note that Ballance was 62 when he performed his famous operation.

Such was the excellence of Ballance's experience that Lord Russel Brock (1903-1980) praised him in his own 1957 Bradshaw lecture entitled 'The Present Position of Cardiac Surgery', commenting on 'the change from fear of the heart to the realisation that it could be operated on in the same way as other organs'. Brock observed that Ballance was ahead of his time when he said: 'one is impressed that it contains little different from what would have been written in 1947', a strong commendation if ever there was one.⁷¹

⁶² Kirschner M. Ein durch die trendelenburgsche operation geheilter fall von bolie der arterien pulmonalis. [A case of pulmonary artery embolism cured by Trendelenburg operation.] *Archiv für Klinische Chirurgie*. 1924; 133: 312-359.

⁶³ Ricketts BM. *The Surgery of the Heart and Lungs: A history and resume of surgical conditions found therein, and experimental and clinical research in man and lower animals, with reference to pneumonotomy, pneumonectomy and bronchotomy, and cardiotomy and cardiorrhaphy*. New York: The Grafton Press, 1904.

⁶⁴ Rehn. On surgery of the heart and pericardium, 1907 (Note 40).

⁶⁵ Borchardt A. Uber Lungenschusse. [Concerning gunshot wounds to lungs.] In: *Sammlung klinischer Vortage*. Leipzig: JA Barth; 1917. Issue 730.

⁶⁶ Vaughan GT. Suture of wounds of the heart. *Journal of the American Medical Association*. 1909; 52: 429-438.

⁶⁷ Peck CH. The operative treatment of heart wounds. *Annals of Surgery*. 1909; 50: 100-134.

⁶⁸ Pool EH. Treatment of heart wounds. *Annals of Surgery*. 1912; 55: 485-512.

⁶⁹ Bennett JDC. Abdominal surgery in war. The early story. *Journal of the Royal Society of Medicine*. 1991; 84: 554-557.

⁷⁰ Giannou C, Baldan M, Molde A. *War Surgery: Working with Limited Resources in Armed Conflict and Other Situations of Violence, Vol. 2*. Geneva: International Committee of the Red Cross; 2013. p.427 & 437.

⁷¹ Brock RC. The present position of cardiac surgery. Bradshaw lecture 1957. *Annals of the Royal College of Surgeons of England*. 1958; 23: 213-237.

Charles Ballance: pioneer neurosurgeon

In 1919 he was appointed consulting surgeon at St Thomas' Hospital and, since 1908, was consulting surgeon to the National Hospital for Paralysed and Epileptic. It was not unusual for surgeons of his era to embrace multiple specialties.⁷² He devoted his subsequent career to neurosurgery, becoming the first President of the Society of British Neurological Surgeons in 1927. The seeds of interest in neurosurgery had been planted years previously.

On 17 December 1915, Ballance read a paper on 'The principles of treatment in gunshot wounds to the head' at the Conference of Medical Officers of the Malta Command. Over the next 18 years he delivered prestigious lectures in this field including the 1921 Vicary lecture 'A Glimpse into the History of the Surgery of the Brain',⁷³ the 1930 Macewen Memorial lecture 'The Dawn and Epic of Neurology and Surgery',⁷⁴ and the 1933 Lister Memorial lecture 'On Nerve Surgery'.⁷⁵ Paediatrician Dr Frederic John Poynton (1869-1943), author of *Heart Disease and Thoracic Aneurysm* (1907), wrote of him: 'He was a man of great parts, and earnest in the advance of surgery. I was his House Surgeon'.⁷⁶

War and surgical advances

World War 1 provided the trauma that beckoned surgical repair. Patients were young and previously fit, presenting ideal surgical material for enterprising surgeons.⁷⁷

Cardiac surgery went into a lull in the inter-war years in the absence of such trauma. Two successful operations on the mitral valve were reported.^{78 79} They were, however, met with scepticism by physicians and continuing controversy over the validity of these procedures stifled further progress.⁸⁰ This may have cemented Ballance's career in

⁷² Ricketts BM. *Surgery of the Prostate, Pancreas, Diaphragm, Spleen, Thyroid, and Hydrocephalus: A Historical Review*. Cincinnati: 1904.

⁷³ Ballance CA. *A Glimpse into the History of the Surgery of the Brain. The Thomas Vicary lecture, 1921*. London: Macmillan; 1922.

⁷⁴ Ballance CA. *The dawn and epic of neurology and surgery. Macewen Memorial lecture, 1930*. Glasgow: Jackson, Wylie & Co; 1930.

⁷⁵ Ballance CA. *On Nerve Surgery. The Lister Memorial Lecture: Delivered in the Theatre of the Royal College of Surgeons of England on April 5, 1933*. Dundee: DC Thompson; 1933.

⁷⁶ Anon. Sir Charles Alfred Ballance (1856-1936). Historic Hospital Admission Records Project. <https://hharp.org/library/gosh/doctors/charles-alfred-ballance.html> (accessed 3 September 2023).

⁷⁷ Treasure T, Hollman A. The surgery of mitral stenosis 1898-1948: why did it take 50 years to establish mitral valvotomy? *Annals of the Royal College of Surgeons of England*. 1995; 77(2): 145-151.

⁷⁸ Cutler EC, Levine SA. Cardiomy and valvotomy for mitral stenosis; experimental observations and clinical notes concerning an operated case with recovery. *Boston Medical and Surgical Journal*. 1923; 188: 1024-1027.

⁷⁹ Souttar HS. The surgical treatment of mitral stenosis. *British Medical Journal*. 1925; 2(3379): 603-606.

⁸⁰ Lewis T. *Diseases of the Heart*, 3rd Edition. London: Macmillan; 1942. p.130 & 148.

neurosurgery. In 1945 the American cardiac surgeon Dwight Harken (1910–93) reported on 139 operations to remove foreign bodies from the heart and great vessels, thirteen from within the cardiac chambers, without any deaths.⁸¹ But this happened a decade after Ballance's death and it set the stage for the next wave of advancement in cardiac surgery.

Conclusion

Charles Ballance, an internationally renowned surgeon, brought his skills to Malta during WWI and removed a bullet from the heart. Ballance was at the peak of his career, prepared exhaustively for the surgery, and understood well the demands and possible hazards of chest surgery. His operation was one of the first of its kind, performed within a year of the first-ever successful report, when the literature describing extraction of foreign bodies from the heart was still in its infancy. As a London surgeon and then senior consulting surgeon and colonel in the Royal Army Medical Corps, Ballance would have had access to, and benefitted from, the widespread scientific material available at the outset of war. His early schooling in Germany, coupled with later visits to specialized clinics there, enabled him to access salient reports in the German scientific literature such as those of Rehn. He was, therefore, well acquainted with the current surgical scene.

His surgical training in centres of excellence endowed him with the ability to deal with a wide variety of challenges. As the pre-eminent surgeon stationed in Malta, he was experienced and resourceful, and commanded an efficient team capable of completing such a demanding undertaking. The infrastructure within which he operated was state-of-the art, being part of the sophisticated war machine of the British Empire.

Details of prior successful bullet extractions are at best sketchy and have come down to us via secondary sources. Ballance's detailed description and exhaustive discussion of his case made an important contribution to contemporary knowledge, as evidenced by Lord Russel Brock's reference to Ballance in his own Bradshaw lecture.⁸² In the end this landmark operation did not receive its deserved recognition because the patient eventually succumbed to sepsis. Ballance objectively analysed the reasons for the unsuccessful outcome and communicated his experience to the surgical community after the war.

It is not easy for a current surgical trainee to comprehend the nature of apprenticeship during the late 19th and early 20th centuries.⁸³ Structured programmes with a fixed tenure and set goals were not yet conceived. Junior surgeons vied to work for masters of repute, frequently without remuneration. They worked all hours, often unsupervised, in the pursuit of valuable experience and the promise of a favourable reference that might secure their next post. Surgeons in training made up their own

⁸¹ Harken DE. Foreign bodies in, and in relation to, the thoracic blood vessels and heart. I. Techniques for approaching and removing foreign bodies from the chambers of the heart. *Surgery, Gynecology and Obstetrics*. 1946; 83: 117-125.

⁸² Brock. The present position of cardiac surgery, 1957 (Note 71).

⁸³ O'Shea JS. Becoming a surgeon in the early 20th century: parallels to the present. *Journal of Surgical Education*. 2008; 65(3): 236-241.

career path as they went along and no two educational programmes were similar.⁸⁴ Attaining consultant status presented further challenges with continuing professional development.⁸⁵ International meetings and the scientific literature were the principal channels of knowledge but they fell short of truly reflecting the clinical situation. As a rule, authors preferentially presented sanitised results from selected populations, and negative outcomes were suppressed.

William Harvey's dictum remains true today: 'I learn anatomy not from books but from dissections: finding out the nature of things by the things themselves'.⁸⁶ John Hunter, the father of modern surgery was equally adamant 'bodies, not books, I prefer to read'.⁸⁷ Attendance and assistance at operations remained the gold standard of surgical education.

Surgery has progressed over the last century as a consequence of dissemination of knowledge, the advancement of technology and the changing needs of an ageing population. Beyond these relentless incremental factors, quantum leaps necessitated an added element, that of a surgeon who was extraordinarily capable, audacious and fortunate. Many of the giants in the history of cardiac surgery displayed these traits.^{88 89}⁹⁰ They frequently experienced initial failure, only to triumph on subsequent attempts. Courage has also been attributed to such individuals, but perhaps this quality should instead be reserved for their patients.

With hindsight one may speculate on the likely prognosis of conservative, non-surgical treatment. Ballance's patient was clearly unwell and deteriorating. The initial exploration in Salonika resulted in a suppurating wound, and in the presence of a foreign body in the pre-antibiotic age, the prognosis was dismal. Surgical intervention provided the only hope.

Ballance deserves the high accolade he received for his efforts. He was well prepared; to be otherwise would have been foolhardy. Above all he was audacious when it was required of him to be so, and he was able to rise to the very considerable challenge that the situation presented.

Surgery is both an art and a science and has been likened to Russian roulette.^{91,92} No matter the degree of preparation in terms of reading and strategic planning the

⁸⁴ Wangenstein OH. Some post-Hunterian schools of surgery. *Surgical Clinics of North America*. 1978; 58(5): 967-976.

⁸⁵ Stewart GD, Teoh KH, Pitts D, Garden OJ, Rowley DI. Continuing professional development for surgeons. *Surgeon*. 2008; 6(5): 288-292.

⁸⁶ Wright T. *William Harvey: A Life in Circulation*. Oxford: Oxford University Press, 2013. p.142.

⁸⁷ Moore W. *The Knife Man*. London: Bantam Press; 2005. p104.

⁸⁸ Miller CA. *A Time for All Things: The Life of Michael E. DeBakey*. Oxford: Oxford University Press, 2020.

⁸⁹ Swartz M. Old Houston salutes an irreverent heart surgeon. *Texas Monthly*. Section A. 30 September 2012.

⁹⁰ Cooper DKC. Christiaan Barnard – The surgeon who dared: The story of the first human-to-human heart transplant. *Global Cardiology Science & Practice*. 2018:11.

⁹¹ Harris I. Surgery: art or science? *Australian Medical Student Journal*. 30 August 2017.

⁹² Doppman JL. Paraplegia after surgery for thoracoabdominal aneurysms: Russian roulette for the vascular surgeon. *Radiology* 1993; 189(1): 27-28.

surgeon is always delving into the unknown. Embarking on a novel and complex procedure brings untold challenges, beyond the capability of the average practitioner. It takes a very special person to triumph under such circumstances.

Historical addendum

Trooper Robert Hugh Martin is buried in the Military Cemetery in Pieta, Malta (Figure 10). This cemetery is one of many relics of Malta's illustrious military past, most recently as Nurse of the Mediterranean in WWI, and as the recipient of the George Cross, awarded to Malta on 15 April 1942 for gallantry during its siege in WWII.



Figure 10. Trooper Robert Hugh Martin's headstone. Photograph by Colonel David Vassallo. Reproduced with permission.

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