Journal of
Archeology, History and Anthropology
Volume 2, Issue 1, 2008

How did blood transfusion in Britain work during WWII and its significance

Sreedhar Krishna, Student, Faculty of Medicine, Imperial College London, skk04@imperial.ac.uk

Abstract

The process of blood transfusion has gained credibility since early, and often, lethal experiments with fluids. This project discusses how transfusion evolved within the first half of the 20th century from a perceived 'encumbrance' to an invaluable resource. As war has punctuated this period, wartime necessity is often misconstrued as the sole stimulus for medical innovation. Existing accounts portray military medicine as being characterised by radical wartime breakthroughs, punctuated by periods of relative stasis during peacetime. Instead, this paper suggests that military medicine simply reflects civilian practice, albeit with a different hierarchy of priorities. This essay will show that war did not stimulate technological innovation, but merely necessitated the implementation of existing technologies, sometimes at an experimental stage. Drawing on minutes of wartime meetings and contemporary medical journals, this essay argues that war preparations synthesised an organised donor panel and improved the logistics of blood transport but did not directly improve clinical medicine. Furthermore, this essay explores how incremental progress in wartime can be partially attributed to the liberalised flow of information.

"If red blood cells were a new drug today, it would be very difficult to get it licensed."

Dr. Jeffrey McCullough

Introduction

Blood transfusion is often listed, along with antisepsis and anaesthesia, as one of the key innovations that enabled medical treatment to keep up with the technological advances in military warfare's ability to kill or maim.[1] As early as the ancient Greek idea of blood as a humour, blood was recognised as the bearer of life, carrying its 'vital spirit' throughout the body. Loss of blood was known to lead to death, yet it took Western medicine a long time to equate the replacement of blood with the saving of life.[2]

World War II brought destruction and death on an unprecedented scale, thereby provoking a consequent medical response, characterised by Cooter as the 'medical goodness of war'.[3] While other wartime advances (such as orthopaedic surgery and shellshock) have been traced in detail, there is a conspicuous lack of coverage on blood transfusion.

Curiosity over blood has led to many attempts to replace blood with various fluids via numerous techniques. Most of these were fruitless (and often deadly) but by the outbreak of WWI there were doctors in many Western countries extolling the miraculous properties of blood transfusion. Landsteiner's crucial discovery of blood groups was made in 1901[4] with technology for blood storage conceived 13 years later. Unfortunately, these breakthroughs which would prove to be milestones in haematology, were largely ignored by the British medical establishment. However, the reality of war necessitated that these existing technologies were implemented broadly and promptly.

---

[1] Gabriel RA, Metz KS. *A History of Military Medicine* (Westport, 1992). p. xiii
[2] Roux JP. *Sang: Mythes, symboles et realités* (Paris, 1988), p. 57
[3] Cooter R. "War and Modern Medicine", in Bynum WF, Porter R (eds.) Contemporary Encylopaedia of the History of Medicine (London, 1993), p. 1536-73
[4] Landsteiner K. "Uber agglutinationserscheinungen normalen menschlichen blutes", *Klin. Wschr* 14 (1901) 1132-1134

Drawing on a wide array of primary as well as secondary sources, I will argue that war did not especially stimulate innovation, rather it demanded the utilisation of existing technologies and via a process of trial-and-error, enhanced existing knowledge. Furthermore, war diffused these technologies efficiently in a culture of cooperation. I will go on to show that the greatest improvements in blood transfusion were the robust donor organisations and a meticulously planned logistic system.

I begin by outlining the pre-WWII British blood 'system' and proceed to discuss the British preparations for WWII, contrasting with those of the Germans, showing how these led to their respective success and defeat. I emphasise the progression of Vaughan's idea through the British bureaucracy and describe the organisation of the resultant product.

Many modern accounts of military medicine simply suggest that war stimulated innovation and that any improvements were borne out of wartime necessity.[5,6,7] I believe that these accounts neglect the fact that many perceived 'wartime innovations' have their origins firmly in peacetime. In summary, wartime, despite its own unique needs, tends to reflect civilian practice.

The source material I have drawn upon includes first-hand accounts, minutes of wartime meetings, contemporary medical journals, transcripts of interviews as well as secondary sources including review articles. Primary sources, such as the journals of the day, enable one to see the picture as it was portrayed in its day, while minutes of meetings provide an insight into the war preparations – a traditionally confidential area. Review articles and books which I have used have provided me with ideas and arguments but it is unfortunately easy to absorb their fallacies also.

Before WWII

From the beginning of the 20th century to the end of WWI, there was a vast improvement in the understanding of how to remove blood as well as how to inject it safely. This advance was facilitated by the opportunity WWI provided to trial various transfusion protocols in situations where the prognosis was hopelessly poor.[8] The demands imposed by wartime casualties rendered transfusion indispensable and thus expertise was gained. Moreover, the length of WWI meant that every possible promising protocol permutation could be tested without the fear of being branded unethical, thus establishing the best techniques much quicker than would otherwise have been possible. Records show that transfusion became entrenched in military medicine by the end of WWI[9] although its frequency of use varied with location.[10]

Having proven its value in the field, transfusion was perplexingly ignored by civilian practitioners. The transition from WWI to peace brought with it a reduced demand for blood, but unfortunately it removed the impetus and urgency with which advances are made. It is often stated that total war requires a total commitment.[11] As such, the extraordinary mobilisation of entire countries afforded doctors with a plentiful, motivated donor supply. Peacetime, conversely, brought with it an inhibitive influence on both blood demand and supply.

Moreover, peacetime brought new indications for transfusion: Instead of being used to treat wounded soldiers, the technology was utilised effectively in postpartum haemorrhage. However, the expertise gained by British doctors was not transferred to civilian practice as it was not until 1926 that the British Medical Association held a conference on blood transfusion.[12]

---

[5] Samuels RJ. *Rich Nation: Strong Army* (Cornell University Press, 1996)
[6] Daunton M. *The Cambridge Urban History of Britain* (Cambridge University Press, 2001)
[7] Travers T. *Men at War: Politics, Technology and Innovation in the 20th Century* (Chicago, 1981)
[8] Pelis K. "Taking Credit: The Canadian Army Medical Corps and the British Conversion to Blood Transfusion in WWI" *Journal of History and Medical Allied Sciences* 56 (2001), 238-277
[9] Interallied Surgical Conference on Transfusion. *Arch. Med. Pharm. Mil.* 70 (1918), 121-85
[10] Macpherson WG. *Medical Services Surgery of the War* (London, 1922) p. 108-133
[11] Shaw M. *Dialectics of War: An Essay in the Social Theory of Total War and Peace* (Pluto, 1987)
[12] "Discussion on Blood Transfusion in the Treatment of Disease", *British Medical Journal* ii. (1926) 969-83

Despite the paucity of interest in transfusion, peacetime advances were made, but were not adopted as quickly as war might have forced otherwise. The rate of improvement remained roughly constant, as can be attested to by Unger's stopcock and the conception of citrate both having their roots firmly in peacetime.[13] However, doctors' ethical concerns over tampering with blood (which still retained some allegorical meaning) as well as mild fevers delayed the uptake of storage technology.

Contrary to the common belief that innovation is borne out of wartime necessity, the anticoagulant application of citrate was discovered, independently, in Argentina, Belgium and the US, during 1914, indicating that peacetime interest in transfusion was sufficient to bear dividend.[14]

Civilian transfusion before WWII was a thoroughly haphazard affair. Doctors who needed blood depended upon an unreliable donor supply, comprising the patient's family and personal network. Percy Lane Oliver was confronted by this situation in London in 1921. As secretary of the Camberwell Division of the British Red Cross, he received a call urgently requesting blood. Having no other sources of blood from which he could draw, he along with three colleagues rushed to the hospital, and the patient survived.[15] This experience inspired Oliver: An established bureau of screened, pretested volunteers could save hundreds of lives by providing donors of various blood types with little notice.

This was exactly what Oliver constructed, beginning with his tentative twenty-strong initial donor panel composed of professional acquaintances. As news of his innovation grew, so did his panel size and frequency of uptake by doctors. During its first year of operation, 1922, he was called only thirteen times. However, during 1925 he fielded 428 calls from hospitals.[16] Having tapped into a precious resource which enjoyed growing demand, he further expanded his donor base into the YMCA and Rover Scouts and established the world's first municipal donor panel: the Greater London Red Cross Blood Transfusion Service.[17]

A significant proportion of the blood requests can be attributed to Dr. Geoffrey Keynes, one of the most prominent British surgeons of his period. Having become familiar with sodium citrate, an effective anticoagulant, during his work with American physicians he became a tireless proponent of the storage technology. Utilising blood transfusion to restore blood volume he "had the satisfaction of pulling many men from the jaws of death".[18] However upon returning to civilian practice, he was deeply disappointed in the attitudes of his peers towards transfusion who regarded it as an encumbrance. The general nature of the British medical establishment's indifference to blood and its use as a therapeutic tool remains a recurring theme up until just before the outbreak of WWII. Moreover, despite Keynes's early advocation of citrate technology[19], this technology was completely ignored for almost 20 years in the UK, thereby restricting blood to immediate use and direct transfusions – otherwise known as "donors-on-the-hoof."

Blood in 1912 was the same blood which coursed through veins in 1915; however, war drew upon different facets of the same life-saving fluid. Research on blood had established the presence of blood groups at the beginning of the 20th century yet the risk of agglutination due to blood incompatibility was ignored.[20] Just as would be seen with the uptake of citrate technology, the context and needs of war influenced blood typing. The primary impedant to routine blood typing was the time needed to conduct the tests, which was rarely available in the immediately life-threatening war casualties. The

---

[13] Robertson OH. "Transfusion with Preserved Red Blood Cells", *British Medical Journal* i. (1918) 691-95
[14] Maluf NSR. "History of Blood Transfusion", *Journal of the History of Medicine* 9 (1954) 59-109
[15] British Red Cross Society. *Report of the Blood Transfusion Service for the Year Ended Dec. 31st, 1926* (London: Petley & Co. Printers) p. 5-9
[16] British Red Cross Society. *Report of the Blood Transfusion Service for the Year Ended Dec. 31st, 1926* (London: Petley & Co. Printers) p. 4
[17] Proger, L. W. "Development of the Emergency Blood Transfusion Scheme", *British Medical Journal* 2 (1942) 252-253
[18] Keynes G. *The Gates of Memory* (Oxford: Clarendon Press, 1981), p. 144
[19] Conference on Shock and Transfusion, 25 May 1945.
[20] Smekal F, Speiser P. *Karl Landsteiner trans. Richard Rickett.* (Vienna, 1975)

tales of blood typing and sodium citrate interweave, since if citrate were used, then the blood could have been tested and typed prior to use, but alas this was not the case.

Despite surgeons' ambivalence towards these two technologies, advice on blood typing and admonition to follow it grew increasingly prominent in post-WWI medical literature. British doctors, who were once indifferent to blood typing, were spurred on by their experiences to demand faster and simpler mechanisms of blood typing. With the increased visibility afforded to it, a blood typing test was soon developed and heralded by British surgeons: "The test is so simple, precise and rapid that no excuse is valid for its omission."[21]

Blood and Germany

555 miles from Camberwell, in Niederlungwitz, Germany, a physician encountered a patient with an urgent need for blood. Without any available donors, he cut into his own arm and donated his own blood which happened to be compatible. This act of quiet heroism was not heralded as such since Dr. Serelman, a Jew, had donated blood to an Aryan. As punishment for "defiling the blood of the German race" he was sent to a concentration camp for six months.[22]

German medical research, renowned for its rigorous standards and advanced nature, fell backward into myth and superstition. Under the Nazi regime, blood was not only a life-saving resource but had gained some symbolic status: A resource signifying the racial purity that could be used as 'scientific' justification for Aryan superiority.[23,24] Furthermore, the Nazis had conducted a systematic cleansing of the "Jewish influence" from medicine,[25] which culminated in the triumphant declaration, "No man of German blood is treated by a German doctor".[26,27] However, the allegorical meaning attributed to blood by the Nazis, supplemented by the removal of Jewish doctors, would prove to be a horrendous tactical error. By removing many of their most learned doctors, the Nazis had created a knowledge vacuum which was filled by quackery and folk remedies.[28] Training of new Aryan students could not suffice for Germany's wartime needs and the Nazis rapidly backpedalled, ordering the remobilisation of Jewish doctors. Their cleansing, however, had proved too effective and this would eventually prove self-defeating in the field.

Furthermore, Nazi racial theories killed many of those who believed them, for many "Germans refused blood transfusion for fear that non-Aryan blood might be poured into them to poison them". This is in contrast to the rational perspective taken by the British, frankly illustrated by a statement issued to the British public to encourage donation, "The reality is this. Your blood, properly poured into a sick or wounded man's veins may be his one chance of life, and on the other hand may mean certain death for him."

Dame Janet Vaughan

London was at peace in the spring and summer of 1939, although there was a general admission that war with Germany was inevitable. As such, the solidarity conferred by a common enemy and impending attack was nicely demonstrated by banners proclaiming "Be proud of our glorious empire." In the likely eventuality of war, government intelligence estimates projected that the German air force could drop 1200 tonnes of bombs within the first 24 hours alone, followed by a sustained bombing of 600 tonnes a day. Clearly, bombing of this ferocity combined with the population density of British

---

[21] Crile GW. *George Grile: An Autobiography* (Philadelphia, 1947) p. 164-7
[22] "Dr. Serelman Says Transfusion Can't Alter Race", *New York Times*, Oct. 20, 1935.
[23] Mazumdar MH. "Blood and the Soil: The Serology of the Aryan Racial State", *Bulletin of the History of Medicine* 64 (1990) 209
[24] Schneider WH. Chance and Social Setting in the Application of the Discovery of Blood Groups. *Bulletin of the History of Medicine* 57 (1983) 545-62
[25] Coleman W. The Physician in Nazi Germany. *Bulletin of the History of Medicine* 60 (1986) 236.
[26] Proctor R. *Racial Hygiene: Medicine under the Nazis* (Harvard University Press, 1988) p. 150
[27] Lifton RJ. *The Nazi Doctors: Medical Killing and the Psychology of Genocide* (Basic Books, 1986)
[28] Coleman W. The Physician in Nazi Germany. *Bulletin of the History of Medicine* 60 (1986): pp. 236-7

cities would result in a catastrophic death-toll. Fortunately, the prediction of 600,000 civilian deaths was somewhat pessimistic.

In preparation for this Doomsday scenario, the government made robust preparations: Thousands of gas masks, or " 'Itlers," as they were colloquially referred to, were provided. The civilian population was mobilised to serve as bomb spotters, air raid wardens and firefighters amongst many other vital roles. Public swimming pools were emptied to store makeshift papier-mâché coffins, and voluminous pits were dug to serve as mass graves. Surprisingly, in preparation for such terrible bloodshed, the British were naïve in their blood transfusion policy.

As mentioned earlier, London still relied on donors-on-the-hoof, a scarcely adequate mechanism during peacetime which would be utterly swamped in the first days of any conflict. Having no impetus to gain expertise in this sector, the British medical establishment, like many others worldwide, learned little of the pioneering technologies that would enable blood storage in bottles. In 1937, during a hearing on wartime preparations the Secretary of War was asked about the nation's proposed blood supply in wartime. He summarised the government's policy was "not to store blood for large scale treatment," attributing this to the erroneous notion "[that the] period for which this can be done is very limited."[29] Sensing the minister's faltering knowledge of current research, an MP asked the minister if he was aware that the Russians were stockpiling blood in bottles for extended periods. Reiterating his faith in donors-on-the-hoof, the minister curtly and somewhat humorously replied "It was more satisfactory to store our blood in our people." Complacency, it seems was not restricted to this minister, rather it was almost uniformly disseminated throughout the London medical establishment. Shockingly, in response to the 1938 prediction by the Ministry of Health of 37,000 casualties during the first week of war, the staff at four hospitals stockpiled a grand total of eight pints.[30]

Thus stepped into the breach, the one person with the prescience and courage to challenge the assured nature of the status quo: Dame Janet Vaughan. Dr. Vaughan, as she was known then, was a young pathologist at the Royal Postgraduate Medical School and Hammersmith Hospital in London. Described by Virginia Woolf as "an attractive woman"[31] and dismissed by her school headmistress as "too stupid to justify further education,"[32] she sought to shatter the Girton girl stereotype[33] and went on to receive a medical degree from Oxford. Unfortunately, in keeping with societal norms of the time she found that her superiors would not allow her to interact with their patients, and thus was restricted to conducting laboratory experiments with pigeons. Nevertheless, she excelled in this arena and made significant contributions to the study of anaemia writing the first British textbook on blood chemistry.

During her residency at Camden Town, she had seen the inequalities of the British class system first-hand and vowed to correct them. Spurred on by what she had seen, she joined the Communist Party and took part in a British physicians' group that supported the Republicans in the Spanish Civil War. In a fortuitous twist of fate, it was during this endeavour that she became familiar with Duran-Jorda and became convinced that the Secretary of War's position was folly.

Testament to her determination and perseverance, she almost single-handedly established her own mini 'blood depot' in 1938 as a response to Hitler's repeated threats of invasion. Vaughan and a colleague from the Hammersmith Hospital collected 50 bottles of blood from volunteers, successfully preserving them with sodium citrate. Although 50 bottles may sound a meagre figure, it is important to remember that this was achieved by an isolated strong-willed pathologist and yet it was the largest blood storage in the whole of London at the time. After the Munich pact was signed and the crisis abated, the stored blood was successfully used in patients; developing in Vaughan an unshakeable confidence in this technology.

---

[29] Masson AHB. *History of the Blood Transfusion Service in Edinburgh*, p.24.
[30] Masson AHB. *History of the Blood Transfusion Service in Edinburgh*, p.24.
[31] Adams P. Janet Maria Vaughan, 1899-1993: A Memorial Tribute
[32] Dodsworth H. *Dame Janet Vaughan*, p.31
[33] Allen G. *The Woman Who Did* (Kessinger, 2001)

Vaughan realised that a city under aerial bombardment would make the donors-on-the-hoof system unworkable. She had the foresight to recognise that doctors involved in emergency surgery would not be able to bleed donors and had the courage to say so. In a lecture to the Postgraduate Medical School, she argued "They must administer blood and not spend time withdrawing blood"[34]. Perhaps due to the stigma of an oversight being spotted by a woman, no action was taken by the Health Ministry. After six months of inactivity Vaughan's patience wore thin and she inimitably swept into action. In the spring of 1939, she convened a series of meetings of young doctors to discuss appropriate preparations for London. Although entirely unofficial, these meetings would formulate the backbone of the blood transfusion scheme of London. It was eventually agreed "to use milk bottles that would be readily available in large quantities and could be handled in milk crates." In another memorable example of the ingenuity required by war, they decided that Wall's ice-cream trucks would provide suitable transport.

Two pioneering foreigners would inspire the British blood transfusion system. The first of these, Norman Bethune, a self-described man of action and surgeon, recognised the inefficiency of current protocol. He wondered 'Why bring the bleeding men *back* to the hospital when the blood should travel *forward* to them?' Thus, the progression from donors-on-the-hoof irrevocably started.[35] In the spirit of wartime cooperation, the efficient flow of information across borders would prove to be vital in establishing a robust British transfusion system.

During the endgame of the Spanish Civil War, General Franco's troops occupied Catalonia and Duran-Jorda fled to the United Kingdom as an invitee of Vaughan, on behalf of the British Red Cross. This invitation was the only legal mechanism by which Duran-Jorda could enter the UK and, as such, he was one of a very small minority who were granted permission to stay. Residing with Vaughan's family, he shared his significant expertise helping shape the eventual proposal that would be submitted, unsolicited, to the Medical Research Council.[36,37,38]

They conceived a system involving four depots situated around London, each staffed by a haematologist, stocked with blood and the necessary transfusion equipment. Amazed at the temerity of Vaughan and her independent plans, she was branded as "pretty naughty" by her department chairman. She recalled being questioned, "What was I doing sending memoranda to influential places?"[39] and duly apologised. Despite having leapfrogged her superiors, the Medical Research Council recognised the value of her proposal and promptly requested cost estimates.

Having cleared this significant hurdle, the proposal was delayed for weeks by a Treasury Ministry that sought reassurance: "[We] cannot help feeling that the proposals in your letter are rather expensive and we should like to be assured that they represent the absolute minimum cost."[40] However, the glowing recommendation of Health Ministry officials provided the final weight, tipping the balance and the project was given the green light on June 5, 1939.

Under the circumstances of war, funding plays a vital role. Money that would ordinarily be spent on civilian infrastructure and services are instead diverted into the direct needs of war (e.g. weaponry and military logistics). Thus, Vaughan was forced to adapt creatively in her use of available materials as demonstrated by the milk bottle, also termed the "MRC bottle" or more affectionately, the "Janet Vaughan." In the tight-squeeze of war, the Treasury balked at the estimation that the £20,000 scheme

---

[34] Vaughan JM. "War Wounds and Air Raid Casualties", *British Medical Journal* (1939) 933-36
[35] Stewart R. *The Mind of Norman Bethune* (Westport, 1977)
[36] Duran-Jorda F. El Servicio de Transfusio´n de Sangre de Barcelona. Te´cnicas y Utillaje. *Rev Sanid Guerra* 8 (1937) 307-321
[37] Duran-Jorda F. La transfusio´n de sangre citratada conservada. El problema de la dosis. *Rev Sanid Guerra* 8 (1937) 322-328
[38] Duran-Jorda F, Margarit-Aleu C. Contribucio´n al studio del metabolismo in vitro de sangre citratada-conservada. Estudio sobre la cifra de hematı´es, leucocitos y hemoglobina. *Rev Sanid Guerra* 8 (1937) 329 - 330
[39] Dame Janet Vaughan, Interview, Wellcome Collection GC/186
[40] Masson AHB. *History of the Blood Transfusion Service in Edinburgh*, p.26

could save a projected 5,500 lives per day. However, when confronted with the reasoning that the proposal could be inadequate for wartime needs, the Treasury quickly accepted the missive as a sign of fiscal conservatism. Moreover, the needs of war appealed to compassionate persons such as Dame Vaughan. "Just before D-Day, Francis Fraser rang [her] up: Janet, we have made no arrangements for the Ports, will you look after them? 'Yes of course' [she] replied, having no idea what looking after the Ports might entail." In the climate of war, talented individuals such as Vaughan wholeheartedly committed to the effort, and as she succinctly states "Sometimes the demands were tough, but we always said yes"[41]. In this matter, war forced an increase in productivity stretching the capabilities of even the most industrious worker. Furthermore, many years had passed since Robertson's initial conception of citrate as an effective anticoagulant. In the circumstances of war, Vaughan deemed the adverse reactions as outweighed by the necessity of blood storage in wartime. In this way, war facilitated the uptake of available technology.

British Blood Transfusion System in WWII

With the realisation that the pre-war position, by which the organisation of donor panels was under a large number of bodies, was unsatisfactory[42], there was a concerted effort to establish a reliable machinery for the dispensing of blood. Following Vaughan's proposal, her four depot plan was established in four suburbs of London designed to meet civilian needs. The Army established its own scheme which would complement the MRC program, additionally serving civilians.

The head of the British blood program, Brigadier Lionel Whitby, was responsible for the decision to create a distinct and separate blood transfusion service in the Army.[43] Casting an astute eye over military logistics, he recognised that the transportation of potentially dangerous biologic fluids over long distances (and under risk of attack) requires close supervision and cannot be trusted to civilian supply routes from the base depot.[44]

The efficiency of the British blood program is undoubted and its ingredients were soon entrenched into the policies of other countries. The success which it achieved can be attributed to two main causes:

1. Despite the faltering start, the catalysis provided by Vaughan culminated in a detailed program, diligently prepared prior to the outbreak of hostilities.

2. Whitby's recognition that blood is a perishable commodity, as potentially lethal as it is lifesaving, meant that blood was to be handled in special channels by personnel with the knowledge to do so.

The extreme caution with which the British handled blood ensured that accidents were held to an absolute minimum, so much so that Whitby later recalled not a single case of incorrectly typed blood. Considering the pressure and climate in which this scheme existed only serves testament to its efficiency, especially when juxtaposed with 130 known cases of blood incompatibility occurring within the NHS between 1999 and 2003.[45]

With the blood came a fixed protocol on how to dispense it. The centralisation of blood transfusion provided a uniform apparatus, simple in construction and use. It disposed of the multiplicity and complexity of previous apparatus, which had deterred many clinicians from transfusion and led to its

---

[41] Dame Janet Vaughan, Interview, Wellcome Collection GC/186

[42] Organisation of donor panels – Note of a Conference on the 23rd November 1943, at 3pm in the Main Conference Room, Ministry of Health, Whitehall National Archives MH/76

[43] Whitby, L. E. H. "The British Army Blood Transfusion Service", *Journal of the American Medical Association* 121 (1944) 421-424

[44] Conference on Shock and Transfusion, 25 May 1945.

[45] Stainsby D. "ABO incompatible transfusions—experience from the UK Serious Hazards of Transfusion (SHOT) scheme Transfusions ABO incompatible", *Transfusion Clinique et Biologique* 12 (2001) p. 385-388

dismissal as an encumbrance. The mechanical vacuum technique, once learnt, empowered clinicians to transfuse in the harshest conditions, with many subsequent tales of miraculous recovery.

Donors

Wartime demanded an increase in the supply of blood, which provided an irrefutable impetus for an organised donor panel. The stark contrast between the chaotic scene encountered by Oliver and that of wartime is particularly insightful. The donor panel accumulated in WWII was in fact so large that the limiting factor on blood accumulation was the numerical strength of the technical staff.[46] Furthermore, the needs of war meant that skilled drivers became so scarce that women were hastily trained to serve as Voluntary Assistant Drivers.

The British accumulated not only a large donor panel, but their constant appeals in various media (including posters, leaflets, cinema slides before films) meant that this panel was highly motivated and "appreciative of its responsibilities."[47]

The British public were bombarded with emotive images and mottos, to such an extent that donor responses remained defiantly high in spite of air raids. Glowing recommendations of transfusion enabled the civilian public to feel empowered in the war effort, appealing to the civilian public. The romantic appeal of saving the lives of men in the field served as a powerful incentive for donation. Furthermore, transfusion had been embraced by all groups of the British public, including the traditionally disenfranchised, such as criminals. In these circumstances, blood transfusion was used as a defence by a defendant in court to explain that what a good fellow he was.[48] However, when it was particularly necessary, the "unofficial reward of a fortnight's leave in England proved a potent inducement."[49]

Organisation

The Army Transfusion Service was organised into three levels:[50]

1. Home depot
2. Base Transfusion Unit (BTU)
3. Field Transfusion Unit (FTU)

- The home depot served principally as a production and training centre. In addition to supplying transfusion fluids, the depot was ultimately responsible for the mobilisation, equipment and training of transfusion units.
- The BTU served as the link between the home depot and the FTUs. Its duty was to estimate needs for replacement fluids, obtain supplies from the depot and supply them to the FTUs. Additionally they were responsible for maintenance of refrigerators and obtaining blood donations from local troops.
- The FTUs, which were the smallest units in the British Army, served as the ultimate source of delivery, being attached to wherever they were they were most needed.

---

[46] Emergency Blood Transfusion Depots Committee, 30th May 1940, National Archives FD 1/5880
[47] MRC Progress Report covering the period from the outbreak of war to the 30th September 1940, National Archives FD 1/5880
[48] Memorandum by the Chairman of the "Voluntary Blood Donors" Association, Wellcome Collection, GC/108
[49] Keynes G. *Blood Transfusion* (Oxford University Press, 1922), p.98
[50] Kendrick DB. *Blood Program in World War II* (Army, 1989)

As discussed earlier, Vaughan's four depot vision formed the backbone of the eventual final scheme. The civilian transfusion system involved four suburban depots situated around London, responsible for the collection and storage of blood. The setup of the depot was such that the pathologists, laboratory assistants and Voluntary assistant drivers (VADs) would work seamless 12 hour shifts. Again, under the circumstances of war and the prevailing spirit of solidarity, there were no complaints of this demanding rota[51]. The city was further subdivided into ten sectors to enable the economical routing of the wounded to hospitals. As soon as bombs were dropped, the hospitals in each sector would phone the depot with an estimate of their needs. Analogous to the army FTU, the VADs (who were mostly women) would race at breakneck speed, avoiding bomb craters and rubble from collapsed buildings, delivering their precious cargo to the hospitals.[52] Reflecting the quality and tenacity of these brave VADs, they drove so fearlessly that they often arrived at the hospital before the casualties.[53]

Although doctors worked in terrible conditions, usually lacking heat, light and water supplies, they had greater access to blood than ever before – including peacetime. The shocking 8 pint stockpile and the ignorant view of transfusion as an encumbrance had been eroded. By virtue of the nature of wartime injuries – crush injuries, traumatic shock and massive lacerations – doctors quickly became expert in their treatment and convinced of the value of transfusion. In contrast to the pre-war situation, Brigadier Whitby had established an organised set of indications in which transfusion was to be used. These included the aforementioned conditions and most prominently burns patients.

Dr. Vaughan came upon a little girl burnt so severely that she could find no place into which she could insert a transfusion needle. Having read about the experimental procedure of blood giving via bone marrow, she inserted the biggest needle into the girl's sternum. In her own words "That was the great thing about medicine in wartime; you could take risks." Freed from the protocol of peacetime treatment, "if people died they were no worse off because of what you did." Miraculously, this girl who would have undoubtedly died without Vaughan's gamble and her blood transfusion scheme, survived.[54] The lower expectations of wartime treatment empowered doctors to try the unusual, catalysing the rate of learning.

In the spirit of wartime collaboration, the Americans conceived the "Blood for Britain" programme in which plasma would be transported across the Atlantic to treat shock in battle casualties.[55,56] Many mistakes were made in this operation, but just as would be seen with citrate, the needs of the program outweighed the risks. In this climate, lessons on the handling of biological material were absorbed very fast. Primarily, it was found that the maintenance of blood and plasma in an uncontaminated state demanded an entirely contained system. The vacuum system devised by Elliott in 1936 (i.e. peacetime) was ignored until the harsh conditions of war necessitated its uptake.[57]

Success in war required seamless coordination and, in these circumstances, information was freely shared amongst the Allies, diffusing knowledge more efficiently to countries than would otherwise be expected. Illustrative of this phenomenon is the account recalled by Elmer DeGowin, a pioneer of American transfusion medicine. Hearing of the horrendous British casualties from bombing raids, he took it upon himself to publicise storage technology (which would be invaluable in wartime) in the *British Medical Journal*. Ironically, this same journal featured Robertson's citrate breakthrough in

---

[51] Emergency Blood Transfusion Scheme for London & The Home Counties, Wellcome Collection, GC/107
[52] Fitzgibbon C. *The Winter of the Bombs* (New York, 1958), p.45
[53] Committee of Privy Council for Medical Research *Medical Research in War*, p. 184-7
[54] Dame Janet Vaughan, Interview, Wellcome Collection GC/186
[55] "Report of the Blood Transfusion Association Concerning the Project for Supplying Blood Plasma to England, Which Has Been Carried on Jointly With the American Red Cross: Narrative Account of Workand Medical Report", *New York Blood Transfusion Association*, 31 Jan. 1941
[56] Stetten, D. "The Blood Plasma for Great Britain Project", *New York Academy of Medicine* 17 (1941) 27-38
[57] Elliott, J. "A Preliminary Report of a New Method of Blood Transfusion", *Southern Medicine & Surgery* 98 (1936) 643-645

1918, but yet the impetus of war and the liberalised information flow of wartime were necessary to bring theory to practice.

Timeline of Key Events

Event	Date
Landsteiner's discovery of blood groups	1901
Anticoagulant application of sodium citrate discovered	1914 (3 separate discoveries)
Britain declares war on Germany (WWI)	August 4, 1914
Percy establishes blood donor panel	1921
First British blood transfusion conference	1926
Serelman punished for blood donation	1935
Vaughan establishes 'mini' blood depot	1938
Official civilian blood program for London established	June 5, 1939
Outbreak of World War II	September 1, 1939

Conclusion

Historically, the needs of wartime's wounded are perceived to have led to major advances in blood transfusion. At first glance, this appears to be true. However, upon closer inspection, it appears that the major improvements in this sector were logistical. Compared to the desultory pre-war arrangement, war provided an undeniable stimulus for an organised donor panel and a meticulously planned blood transport and storage system. Meeting these wartime demands, while working within their respective ideological frameworks, would prove to be crucial in determining the winners and losers of WWII.

The events recounted in this essay, I hope, dispel the oft-propagated myth that war is necessarily good for clinical medicine. In my opinion, war did not stimulate medical innovations at any greater rate than peacetime. Rather, WWII demanded the implementation of existing technologies faster than they may have been otherwise. The needs of wartime medicine differ from their peacetime equivalent, and

as such when the needs became grave enough, existing technologies were utilised regardless of adverse effects.

The mobilisation of entire countries, and the solidarity of war, produced a motivated donor supply which provided doctors with an as yet unseen access to blood. In this plentiful military context, the needs and conditions of war provided doctors with patients on whom novel treatments could be trialled, thereby accelerating the accumulation of knowledge. While, military medicine is based on peacetime innovation, the lessons of wartime are unfortunately poorly transferred to civilian practice.