HUMAN REMAINS & VIOLENCE

Human cadaver blood transfusion: perspectives on its utility in conflict zones

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Abstract

This is the first study dedicated to discussing perspectives on proposals to transfuse blood from people killed in conflict zones. It attempts to present a rounded picture of why the idea has apparently failed to translate into practice. Drawing on a range of sources, from scientific research on 'cadaver' blood transfusions to discussions around planning for mass casualty events, the article shows how professional interest in the transfusion possibilities of blood taken from the battlefield dead evolved from Soviet research in the 1930s, spread internationally and endured after the Second World War. It then demonstrates that a range of issues, from taboos to practicability, require consideration if past challenges to utility are to be reliably understood. It notes, too, that some early obstacles may, today, be outdated.

Key words: blood procurement, blood donation, transfusion medicine, emergency medicine, bioethics

Introduction

In the 1990s, Jack Kevorkian, a retired Armenian-American pathologist, earned international notoriety as an outspoken and hands-on proponent of euthanasia: he assisted in the suicides of over one hundred people and was imprisoned for eight years for second-degree homicide.[1] Not so well remembered is that in the early 1960s, while working as a physician at Pontiac General Hospital, Michigan, he conducted a series of experiments aimed at testing the viability of removing blood from dead people and transfusing it into the living. This included an attempt to explore the potential of direct ('body–body') transfusion: that is, a process of dripping and pumping blood straight into a live recipient through a tube connected to a corpse. Afterwards, in the journal *Military Medicine*, Kevorkian recommended that the US Department of Defense (DoD) consider the 'tremendous potential military value' of that method in the context of resuscitating wounded soldiers. 'The procedure is

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simple enough to be carried out anywhere – in a battalion or regimental aid station, field hospital, base hospital, or even in a foxhole on the battlefield itself.'[2]

This article is an attempt to enhance understanding of the transfusion possibilities of blood taken from casualties killed in conflict zones. More specifically, it is the first study dedicated to reviewing past perspectives on the suitability for transfusion purposes of such blood and to presenting a rounded picture of why ideas around using it have apparently failed to translate into practice. Kevorkian would complain that his call to the DoD went nowhere. He maintained, too, that his method had 'immediate utility on battlefields'.[3] It is also the case that he has not been alone in calling for the bodies of the battlefield dead to be exploited in this way. At the same time, other commentators have considered the idea with less enthusiasm. Douglas B. Kendrick, for example, in his official history of the US Army's blood supply programme in the Second World War, noted that blood *could* be taken from the dead and transfused without harm to the recipient: pre-war research and practice in the Soviet Union had shown that this was possible. As far as he was aware, however, 'cadaver' or 'cadaveric' blood was 'never used widely, even in Russia', and nothing in the available literature suggested to him that the Soviets had used it during the war. Nor did Kendrick think that anyone else was likely to have done so. 'It is doubtful that transfusions with blood secured from cadavers could ever have been employed in any country in the world except Russia,' concludes his dismissal of the topic, 'for the idea, in spite of its logic, is revolting.'[4]

That human blood taken from the dead could be successfully transfused was indeed a matter of record by the outbreak of the Second World War. The Soviet origins and development of the practice were also well established. Kendrick may have been correct, too, in his understanding that it was never used during that conflict by the Soviets or anyone else. Indeed, firm evidence of its use in *any* conflict remains elusive. Also, Kendrick has been far from alone in describing the idea as repellent or in suggesting that its practice was somehow indicative of Soviet barbarism. Yet care must be taken with claims that disgust and taboos are enough to explain its failure to gain wider traction. Drawing on a range of sources, from scientific research on cadaver blood transfusions to discussions around planning for mass casualty events, what follows begins by illuminating how professional interest in the battlefield possibilities of human corpse blood spread beyond the Soviet Union and endured after the Second World War. It then shows that an array of issues deserve consideration if past challenges and concerns around utility are to be reliably understood. In this way, this article illustrates the potential of taboos and taste to shape directions in medical practice and define the meaning and boundaries of that which a society considers acceptable: prominent themes in histories and cultural studies of transfusion and transplantation.[5] But it also demonstrates the extent to which an idea or innovation can attract curiosity when its limitations are little appreciated but lives seem to be at stake. Underlining how cultural mores are particular to time and place, it notes, too, the paucity of past engagement with ethical concepts potentially relevant to utilising cadaver blood for transfusions; that some older concerns around it may today be out of date; and that the practice may retain potential as a method of casualty care.[6]

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HUMAN REMAINS & VIOLENCE

Cadaver blood as a transfusion fluid in civilian and military medicine, 1930–80

The transfusion possibilities of blood extracted from human corpses have rarely featured in mainstream healthcare discourse. Clear periods of professional interest, chiefly the 1930s and 1960s, can be detected in international medical literature, but the peaks are small and a sharp decline occurs from the 1970s. Reports of early Soviet research and practice precipitated the first peak.[7] A series of visits to Moscow by curious medical practitioners from the West seems to account for the second, coupled with a post-war/Cold War spike in interest in the treatment of mass casualties.[8] Yet its use in clinical practice anywhere was mostly confined to Moscow and, even there, would drop out of fashion long before the fall of communism.[9] Today, the classic international handbook, *Mollison's Blood Transfusion in Clinical Medicine*, considers the subject unworthy of much attention: the practice was confined to 'a few centres in Russia' and seemingly 'of prime interest to journalists and reporters'.[10] But dismissing the subject too abruptly risks obscuring the seriousness of the motives of the Soviet surgeon Sergei Yudin for pioneering its use, the professional interest that news of his efforts inspired beyond the Soviet Union and the urgency and enthusiasm with which some observers considered it to be potentially relevant to wartime settings.

Interest in its possibilities for treating battle casualties may pre-date the earliest efforts by researchers to transfuse, in any setting, human blood drawn from corpses. In 1928, according to Soviet era documentation quoted in a recent Russian study, the Ukrainian surgeon Vladimir Shamov, whose experiments in Kharkiv that year with the blood of dead dogs encouraged Yudin's first efforts in Moscow in 1930 with that of dead humans, told a surgeons' conference in Odessa that 'in conditions of war, when there are huge numbers of corpses of just-killed people from whom whole barrels of viable blood can be definitely gained, the question of its use for transfusion to the exsanguinated wounded is of vital importance'. The same Russian study asserts that Yudin, too, felt that it possessed such promise: his 'greatest dream', according to Dmitry Arapov, a distinguished surgeon and colleague at the Moscow clinic where Yudin worked, was 'the use of cadaveric blood during warfare'.[11] Elsewhere, a story is told of how Yudin was confronted early in his endeavours by a forensic specialist shocked to receive a body emptied of blood. '[Yudin] defended himself using all his authority and charisma, and appealed that in a future war the soldiers would have to be transfused in this way.'[12]

It is apparent from Yudin's own writings that his motives for exploring the therapeutic potential of cadaver blood were more complex than that. Shamov's efforts had certainly stimulated his own, he explained in 1936; but also important were 'the special conditions of the work in my clinic, frequently requiring immediate blood transfusion'.[13] Underpinning this was his knowledge and experience that, when patients needed blood, it was not always straightforward to provide it. Yudin was a senior surgeon in Moscow in a central emergency hospital, the Sklifosovsky Institute; and Moscow, then, was a city of four million people where emergencies of all kinds, from car crashes to industrial accidents, meant demand for transfusions

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could be sudden and high. Yet live donors willing and able to provide an immediate and adequate supply were not always to hand, while the shelf life of donated blood was not long. Yudin's personal experience was that cases of injury requiring transfusion could arrive at his hospital at a rate of three or four a day, and he had been forced to draw blood from the same live donor at intervals of just one week. At the same time, opportunities arose 'almost any day' to procure 'fresh cadaver blood of a suitable group': 'the first-aid ambulances very often bring to the Institute cases with trauma or acute cardiac failure so severe that they die in the receiving room or even on the way'.[14]

Yudin's energy, enthusiasm and international contacts were also important in spreading his ideas and results of his work, as well as reports of the related research of colleagues.[15] In addition to writing in the Soviet medical press, he gave lectures in France and Spain,[16] produced a book-length account in French published in Paris in 1933,[17] and penned prominent articles for the *Journal of the American Medical Association*[18] and *Lancet*.[19] But also key to accounting for his reach and impact was the existence abroad of a professional audience similarly anxious about the limits of supplies from live donors and receptive to ideas about remedies.

Amazement was a typical response among those encountering his work for the first time: 'These researches of Judine [*sic*: Yudin's book was published under the name "Serge Judine"] must be regarded as extraordinary,' remarked one reviewer in the American medical press;[20] '*extraordinaire et surprenante*' echoed the journal of the Swiss Red Cross.[21] Other reactions included expressions of distaste and associated doubts about transferability. 'British temperament,' wrote Percy Oliver, founder of London's volunteer blood donation service, 'has a strong aversion to making use of a corpse, and were it even suggested there would be a huge protest.'[22] Geoffrey Keynes, a prominent British surgeon and transfusion specialist, linked 'this rather unpleasant process' to the particularities of Soviet communism: '[T]he technique of using corpse blood has been evolved in the only country where sentiment has no force or meaning,' he wrote in 1933. 'We are not to infer that all the young people in Moscow have committed suicide,' he added, noting that a paucity of living donors had evidently shaped take-up and that blood from people who had drowned or hanged themselves was reputedly among the most reliable, 'but rather that the volunteer spirit does not exist among the free peoples of the Soviet.'[23]

Some readers, though, noted with interest that, to judge from Yudin's writings, blood extracted safely from suitably screened and autopsied corpses seemed to be not only suitable for transfusion but even superior, in some respects, to that taken from the living. One such advantage was perceived to be the fact that, in certain cases of death from sudden causes, blood can re-liquify within an hour or two of clotting and no longer clots again; this natural process of 'fibrinolysis' (the breaking down of clots) was believed to mean that the blood did not require the addition of anticoagulants (which could cause toxic reactions) before being given to someone else.[24] Further perceived benefits of the practice were that more blood could be extracted from a dead body than from a living one – Yudin estimated that up to three and a half litres could be easily and quickly obtained from a corpse – and that

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relying on a single source reduced the risk of introducing into the recipient incompatible or contaminated blood.[25] Impressive, too, were the numbers of successful transfusions with cadaver blood that Yudin was reportedly performing: 400 up to 1933,[26] 1,000 by 1937.[27] By then, a small number of other surgeons, stimulated by Yudin's results, were also using it and recording good results. Shamov, for example, reported in the *Lancet* in 1937 that he had performed forty-two transfusions with cadaver blood and that it seemed to stimulate the production of red blood cells, raise haemoglobin levels and trigger fewer reactions.[28]

Also apparent in pre-war medical literature is evidence of a quick sensitivity among some of Yudin's audience to the possible pertinence of his findings to the battlefield. One was Sandro Machetti, an Italian surgeon working in the Spanish city of Zaragoza. In 1934, inspired by Yudin's research, Machetti transfused cadaver blood into two postoperative patients, apparently without complications. Afterwards, he ventured that the practice would be 'feasible' in settings such as 'war surgery … where the number of exsanguinated wounded reaches a certain number and where the acquisition of donor corpses can be facilitated'.[29] The same year, John R. McMahon, a socialist American journalist with an interest in Soviet science, claimed to have impressed the medical heads of the US War and Navy Departments with an account of Yudin's method: they 'listened with interest' for 'its possible value in reducing mortality in war'. 'Surgeon General Patterson of the War Department sent forthwith for a copy of Judin's [*sic*] book … The army and navy medical chiefs manifestly knew little or nothing about the Judin discovery but they had no prejudice and were willing to be informed.'[30] Possibly, McMahon's report had some effect. 'The value of this method for military surgery in time of war has been pointed out by General Robert U. Patterson, Surgeon General of the U.S. Army,' *Science News Letter*, forerunner of *Science News* magazine, told its readers a few weeks later.[31] 'The special interest of this admirable surgical accomplishment for General Patterson as for all military surgeons lies in its application to the great traumatic emergency of battle,' echoed an editorial in *The Military Surgeon*, a military medical journal, published at about the same time, Patterson himself having called its attention to Yudin's 'remarkable little book'.[32]

In 1937, during the Spanish Civil War, several doctors serving on the Republican side started to explore, for the first time, some of the practicalities of using blood from the battlefield dead.[33] The following year, one of those doctors, a young Englishman, Reginald Saxton, published a brief account in the *Lancet*. His 'check-up on Yudin's work', as he described it, had involved the extraction and examination of blood from the bodies of five recent casualties; three had died from suffocation after being buried by bombing and the other two from battle wounds. Studying the blood from all five, Saxton observed that it did indeed re-liquify after coagulating. Cadaver blood, he concluded, had definite 'advantages' over that from live donors:

> (1) it does not need an anticoagulant and therefore can be used in large doses without toxic effects; (2) it could be made available during military operations on a large scale; (3) it can be obtained without any question of endangering the life of the donor;

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and (4) possibly it keeps longer without autolysis [the biological destruction of cells by their own enzymes] than citrated blood owing to its unadulterated state.[34]

By the early years of the Second World War, cadaver blood was listed in some studies and manuals as one of three sources suitable for transfusion, the other two being placental blood and the blood of live donors.[35] There had also been further expressions of interest in its potential value on the battlefield. 'The practicality of extracting, preserving, and storing cadaver blood in the zone of operations by medical technicians and Sanitary Corps personnel should be studied,' urged one article in an American military surgeons' journal on the eve of the United States' entry into the war; its use might occupy 'a very definite place in military medicine' and deserved serious contemplation in the context of long-term military planning.[36] 'Its use appeals to me particularly in relation to the battlefield,' wrote the American haematologist Rufus E. Stetson, a prominent pioneer in antigen research, in 1940. 'After all, how could a dying soldier better aid a wounded comrade than by contributing the blood which he no longer needs?'[37] In 1944, Paul Moureau and Lucien Brull, two medical professors at the University of Liège, experimented in wartime Belgium with 'around twenty' transfusions of cadaver blood in readiness for the possible effects of air raids and associated blood shortages.[38]

Interest continued after 1945. During the Korean War, according to Douglas B. Kendrick, the US Army Research and Development Board sought advice from the US Army Medical Department about cadaver blood's possibilities.[39] Subsequent concerns around the character of the Cold War's developing threats encouraged others to ponder if an opportunity might be missed. 'What of the possibilities of using cadaver blood for transfusion?' wondered Warner F. Bowers, a senior surgical consultant to the US Army, in 1956, when discussing medical responses to thermonuclear warfare and other disasters. 'Have any plans been made for this? Is it possible that we might someday consider using the moribund and hopelessly injured as exsanguination blood donors? Such ideas are repugnant to us now but so is cannibalism until you are starving.'[40] For William Dameshek – noted American haematologist, one-time president of the American Society of Hematology, founder of the journal *Blood* – in 1960, there were 'obvious' advantages to using corpse blood 'during disasters': 'certainly, for example, during war when a number of fresh young cadavers are available'.[41] In 1962, the American authors of a historical study of cadaver blood confidently asserted that, 'in the face of a national emergency', 'procurement' in the United States would not be a problem.[42] In 1970, West Germany's leading journal of forensic medicine carried an article suggesting that blood from dead bodies might help meet demand in the aftermath of a nuclear attack.[43] The hosting, at Leningrad's Kirov Military Medical Academy, in 1965 of a conference on cadaver blood may indicate some level of ongoing Soviet interest.[44]

Jack Kevorkian's experiments in 1963–64 with transfusing cadaver blood into human volunteers are described in multiple publications as concerned with improving blood supplies to US forces in Vietnam.[45] 'We were working on a solution for Vietnam,' one of his assistants recalled: 'That's why it made sense.'[46] In fact, US combat troops first deployed to Vietnam in March 1965, while Kevorkian's first

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experiments with cadaver blood dated back to 1960.[47] Other important clarifications are that he began that research on his own initiative and later shaped it for a military audience in the hope of securing financial support. Nonetheless, Kevorkian's results retain significance: as a rare and late example of Western research into the possibilities of transfusing blood from dead bodies; as an unusual and perhaps unique attempt to explore the possibilities of direct transfusion from a corpse; as confirmation of the fundamental principle, established by Yudin in 1930, that cadaver blood could be transfused without harm to the recipient; and as evidence that interest in the battlefield possibilities of cadaver blood had endured for over three decades.

Care should be taken to avoid assuming too much of enthusiasm for those possibilities, however. Claims that the Spanish Civil War saw the first application of Yudin's techniques in 'active combat operations'[48] go too far; this had been exploratory research, its scope and results limited to taking blood from a handful of battle casualties and examining its quality: none of it was transfused into the wounded or sick. Despite suggestions to the contrary from a few Western commentators,[49] no evidence for the Soviet Union using cadaver blood on battlefields in the Second World War appears to have come to light. Conceivably, some casualties on the Eastern Front might have received it in Moscow, where, according to Russian sources, Yudin and his clinic handled a number of them; future research among Russian archives may confirm this.[50] But Allied observers who inspected the Red Army's wartime medical set-up found no evidence of blood from dead bodies being used for transfusions; instead, an effective system based on living donors appeared to be in place.[51] Moreover, some Soviet era sources state explicitly that cadaver blood was never used: 'Everyone knows that during World War II we did not manage to implement that,' Dmitry Arapov, of the Sklifosovsky Institute, is said to have remarked in 1965.[52]

Nor do claims seem to have been made for other nations using it in that conflict or on later battlefields, with one exception. In the late 1950s, an account published in West Germany of the medical experiences of German military personnel on the Eastern Front and in Soviet captivity stated that German soldiers had used quantities of cadaver blood while besieged at Stalingrad in 1942–43. According to that account, no blood from live donors had been available, 'since all potential donors were so deteriorated that losing blood could not be expected of them', so, instead, it was drawn from the femoral arteries of the recently killed; these were men 'usually' dead from head wounds, and their blood had been taken 'immediately' and transfused 'directly'.[53] This claim should be treated with care, however. The original source is unclear, evidence for it is anecdotal, and efforts to search for convincing corroboration have, to date, found nothing.[54]

Taboos and taste

Why, then, has interest in transfusing the blood of the battlefield dead failed to translate into practice? In the West, if military deliberations around the subject have ever reached a stage where someone felt that reasons for officially rejecting it should

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be recorded, no such records appear to have come to light. Accessible Soviet era sources seem to be similarly silent. This should warn against placing weight on particular factors when seeking explanations for the absence of take-up. Nevertheless, it is clear from available sources that, throughout the period with which this study is concerned, alarm and disquiet around taboos and taste were evidently at work, albeit among discomfited commentators who provided limited insight into the finer reasons for their unease, confining themselves, like Douglas B. Kendrick, to remarks like 'revolting' and 'repugnant' and leaving the matter at that.[55]

Reticence about deeper feelings and meanings does not mean that that discomfort lacked force, however. Indeed, the efforts of some proponents of the practice to forestall and contest them may provide some indication of the perceived significance of such concerns, as well as a sense of their character. In 1937, writing in the *Lancet*, Vladimir Shamov, the Ukrainian surgeon whose research had inspired Yudin's, took pains to explain objections to 'the bare thought of transfusing into a live person the blood from a corpse' by comparing them to the 'subconscious prejudices' of those who initially rejected the practice of transfusion in general:

> [W]hen I began to introduce the method of blood transfusion into the Soviet Union in 1919 I often met refusal, even from near relations, to give their blood to save the life of a person dear to them. The wife refused to give blood for her husband, the father for his son, and even a mother would not sacrifice a few cupfuls of her blood to save her child. It was due to a natural fear, inherited from primeval ages, of giving away so valuable a part of their organism as blood ... Another prejudice often met during the early stages was the unaccountable animal fear excited in the patients and their relatives by the thought of receiving the blood of another into their veins. Many only allowed blood from near relatives, women objected to the transfusion of masculine blood, men refused to have feminine blood, and many patients took exception to donors of another race.

With regard to cadaver blood, wrote Shamov, 'present prejudices' were 'essentially analogous' to this 'survival of primitive views about blood as the bearer of particular mystic properties': there was 'holy awe' felt by 'friends and relations' at 'the thought of "disturbing the repose of the dead"'; there were ideas that blood taken from dead bodies was 'involuntarily' linked with corruption, putrefaction or 'the personality of its former host'.[56]

'Surely after a certain period man will overcome these prejudices as easily as the numerous others that have arisen during the history of the development of blood transfusion,' Shamov also remarked, noting that early sceptics had come round to its merits eventually.[57] It may be wondered how long he was expecting to wait, especially if thought is given to the aesthetics of drawing blood from dead bodies as distinct from taking it from the living. Graphic descriptions of the bleeding process were common in literature on cadaver blood transfusion and far removed from the gentler methods typically associated with live donations. In 1967, for example, John Vaughn, a US physician who had recently undertaken a tour of Soviet medical

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facilities, recalled a scene at the Sklifosovsky Institute that differed little from that found in accounts published three decades earlier:

> The cadaver is placed on the table and firmly tied to it by cords around the hands and feet; the head is completely wrapped in a sterile towel. The operator, a doctor or nurse, prepares ... the skin of the left side of the head, neck and adjacent thorax with tincture of iodine ... The skin is incised and the jugular vein exposed; into this are inserted two glass cannulae each 4mm in diameter ... one directed towards the head and the [other caudally] ... These cannulae have attached to them rubber tubing ... With the cannulae tied in position and the rubber tubing clamped, the operating table is now steeply tilted, the needles inserted into the bottles and the clamps released. The bottles fill quickly with dark blood though sometimes a little 'milking' is required at the start.

Descriptions, drawings and photographs of the angled table and resulting 'Trendelenburg' position, which allowed gravity to assist with the draining, also left little to the imagination.[58] Today, when a wide range of tissues and organs are routinely removed to help the living, public opinion in many societies is less resistant to transplantation, yet concern for according dignity to the dead endures: 'Few taboos are more deeply entrenched than those against the "improper" handling of corpses,' as one cultural study of transplantation puts it.[59] Observable, too, within particular cultures and societies is the 'symbolic resonance' of 'certain organs and tissues' – eyes and the heart are noted examples – and the 'difficult and potentially irreconcilable emotions' that their 'harvesting' can provoke.[60]

Contemporaneous efforts to make moral arguments for using corpse blood may also point to the power of perceived objections to it. Writing in 1934, Sandro Machetti, the Zaragoza surgeon, implicitly linked the benefits of cadaver blood to ethical arguments for transfusion in general: that is, to its fundamental ability to save lives that would otherwise be lost and to prevent additional suffering ('helpless little orphans ...').[61] Shamov described the transfusion of cadaver blood as an opportunity to 'afford to the relations of the dead person a sense of deep satisfaction': why not embrace the body's potential to perpetuate 'useful life'?[62] In general, however, sensitivity for such themes as consent, beneficence, donation, compensation, ownership, cultural differences and the reactions and interests of bereaved relatives – themes at the heart of bioethical discourse around transfusion and transplantation today – is rare in past studies that offer arguments for and against the transfusion of blood taken from the dead.[63] As late as 1961, in a journal article co-written with a colleague about their first experiments with cadaver blood, Jack Kevorkian felt content to maintain that, because embalming the dead was standard practice in the United States and necessitated the removal of blood anyway, 'permission of next of kin is not necessary if corpse blood is to be taken'. A related advantage was that cadaver blood was free, 'requiring no remuneration on the part of the hospital or the coroner ... Such blood would otherwise have been washed down the drain.' Nor, in the view of Kevorkian and his colleague, did special consent need to be sought from the recipient, reasoning simply that the use of cadaver blood

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was ‘by no means an experimental procedure – having been widely [*sic*] practiced in Russia for 30 years’.[64] ‘The source of supply is inexpensive, and the supply is unlimited,’ was an editorial comment on Kevorkian’s later article on direct transfusion of cadaver blood. ‘Probably the reason it has not been more generally used is because of the prejudice against it. That will undoubtedly diminish especially due to the fact that skin, eyes, arteries, bone, cartilage, fascia, and dura matter are also being used from cadavers ...’[65]

Scalability and practicability

While it is difficult to be precise about the nature and impact of past concerns around the palatability, aesthetics and ethics of cadaver blood transfusion, characteristics of practical issues around availability, risk, quality and safety can be discerned with considerable clarity. These ranged from the specifications of corpses suitable to be tapped for blood, to the capacity of healthcare systems to produce and process sufficient amounts of acceptable bodies. Acknowledgement of these limitations extended to their implications for battlefield procurement and practice. Concerns more pertinent to war zones also came to be identified, with some commentators viewing them as fundamental.

Routinely flagged and accepted in medical literature on the subject, a fundamental and demonstrable restriction on effective transfusions with cadaver blood in civilian medicine was that only a certain type of corpse was suited to providing it. More specifically, an acceptable donor had to be of a compatible blood group, free of abrasions, lacerations, infections and cancer and to have died fewer than six hours before extraction and from an appropriate cause. With regard to the last requirement, Yudin, for example, found that the corpses of people who had died suddenly from coronary thrombosis, cerebral haemorrhage, electrocution, suicide by hanging and certain street accidents typically offered the most potential, and that bodies with intestinal wounds, crushed limbs or severe head injuries, or of people dead by drowning or from disease, were best avoided.[66] Even then, problems could result. In 1934, reacting to Yudin’s first account of his results with cadaver blood, Arnault Tzanck, a renowned transfusion specialist in interwar France, observed that, out of a hundred transfusions with cadaver blood, Yudin had reported two deaths and three cases of jaundice attributable to it. ‘I wonder with horror what we would do if, out of the 4,000 transfusions carried out in one year in [French] hospitals, we obtained such a percentage of complications.’[67]

Some commentators styled the process of determining the previous health and causes of death of dead donors as another advantage over the practice of taking blood from live ones. As Shamov put it: ‘the dead body can be exonerated from the suspicion of diseases with much greater certainty.’ At the same time – and to quote Shamov again – these conditions meant that effective exploitation was practical only with a ‘widespread and efficient organisation’ devoted to procurement, ‘and this is only possible in large centres’.[68] He was not alone in appreciating that point. ‘The organisation of such a transfusion “service” is, of course, only possible in an institution receiving large numbers of fatal casualties, from among which the

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most suitable donors can be chosen,' reads an early assessment in the *British Medical Journal*.[69] The conclusion of one post-war American study was that a medium-sized hospital in the United States, one of five hundred beds, could expect to extract cadaver blood of an acceptable quality from just two patients a month.[70] A *Lancet* commentary in 1963 expressed the opinion that, given the brief period in which blood from a suitable cadaver could be safely collected, this condition, too, could be met only in a large city, 'and then only if the city has a central institute of traumatology, to which, in addition to accidents, all cases of sudden death are referred'. Moreover, within the UK's post-war system of decentralised accident services, 'no one hospital or hospital group would receive enough cases to justify the special equipment and staff which are necessary'.[71] The six-hour window in which to successfully extract cadaver blood was similarly vulnerable to medico-judicial considerations around safety and autopsies. Yudin himself wrote of requiring formal approval to gain access to fresh cadavers prior to autopsy.[72]

Suspicions of such practical challenges also tempered enthusiasm for applying the idea to the battlefield. Indeed, early doubts in this direction were aired on the basis of the first Soviet reports. Published in 1937 by an international association of socialist doctors, a study of transfusion work in Spain warned that cadaver blood would be a poor choice for front-line use 'because extraction would have to be done within the first six hours after death and special facilities would be difficult to obtain'.[73] 'Yudin's method of using cadaver blood is useless when large quantities of blood are needed,' cautioned a survey of global developments in military medicine published by the US Navy in 1940, 'for its efficacy is limited by the difficulties attending the collection of blood and by the need for all samples to be of the same blood-group.'[74] In 1943, noting that the Soviet Union seemed not to have used cadaver blood in its war against Germany, Elmer DeGowin, a blood-banking pioneer and member of an American committee set up to discuss and develop blood substitutes, supposed that the Soviets had found it

> far easier and more satisfactory to secure two liters of blood from four living donors than it is to bleed one selective cadaver by a rather complicated procedure. The donors will appear at the appointed time; the cadavers are uncertain in numbers and in time of demise. The living donor may return in two months to repeat the donation; the cadavers can serve their country only once.[75]

Perhaps the most considered words of warning – in print and in the West anyway – have come from William H. Crosby, a career medical officer in the US Army. Crosby had served in the Second World War as a regimental medical officer in North Africa and Italy before pursuing a distinguished career with interconnecting interests in military medicine and blood: he established haematology as a specialty at the Walter Reed Army Institute of Research, wrote and taught on emergency responses to mass casualty events and, after retirement from the army in 1965, became director of haematology at the Tufts-New England Medical Center in Boston. On two occasions in print in the later stages of his army career – first in 1955, then in 1964 – he turned his attention to the topic of cadaver blood

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transfusions and carefully recorded the problems as he saw them. Crosby's concerns in 1955 were in the context of the Korean War, during which, according to him, the US Army had 'considered but not investigated' the use of cadaver blood.[76] Possibly this alluded to discussions that followed the query about its potential received by the US Army Medical Department from the US Army Research and Development Board in 1952. Douglas B. Kendrick, who briefly recorded that request in a closing chapter to his study of blood supply in the Second World War, had noted that three concerns were duly raised: pre-war experiments in the United States had reportedly encountered 'significant difficulties' while trying to replicate Yudin's work (this was the research of Max Strumia, civilian director of the Department of Pathology at Bryn Mawr Hospital, who, in peacetime Pennsylvania in 1937, had attempted to extract blood from 125 cadavers but found only a dozen to be suitable); 'strong esthetic [*sic*] objections' could be expected from 'physicians and patients' in the United States; and there was no need for it, 'since the country was still far from exhausting its donor supply'.[77] For Crosby, who had deployed to Korea as director of a surgical research team and, while there, concerned himself closely with issues around blood supply, practical problems of a more vital character required consideration. Most battlefield casualties died from haemorrhage, so much blood was likely to be lost, while penetrating wounds risked bacterial contamination of whatever blood remained. In addition, the bodies of those killed in battle tended to be widely dispersed and thus problematic to collect. Also relevant, he felt, were the same concerns in Korea that had steered the US Army away from seeking to procure *any* kind of blood supplies locally. In particular: the difficulty of maintaining the required standards of 'sterility, technical excellence and detachment'; the vulnerability of that effort to enemy action; and the potential implications of losing 'essential laboratory and skilled technicians [who] can not be quickly and easily replaced'.[78]

Those objections are found within Crosby's contribution to a course at the US Army Medical Service Graduate School principally intended to impart 'the professional experiences, problems encountered and lessons learned by the Army Medical Services during the Korean war'.[79] Ten years later he returned to the theme in a paper about current 'trends' in transfusion medicine. This included a lengthy section on the challenges of transfusion in disaster situations – a reflection of some of his professional interests at the time – and it was against that backdrop that he addressed afresh the practical challenges of cadaver blood transfusion. 'It seems [to some] a reasonable expedient,' he wrote, noting that growing interest in 'disaster planning' had sparked some recent interest in its possibilities: 'If the field is covered with dead, why not use their blood to help the living?' But he stressed once again that the majority of the dead in such settings 'have been damaged in ways which disqualify them as donors; the skin is broken'. Plus, there were problems of procurement: 'The bodies are widely scattered; they would have to be collected and brought to the bleeding centers. Under the circumstances it would be preferable to collect the living wounded.' He also noted additional limits that applied equally to its use in more 'ordinary' settings: the process was resource heavy; the blood extracted was of 'doubtful quality',

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since it no longer contained clotting factors; and supply could not be depended upon.[80]

Among professional practitioners of military medicine with specialist expertise in blood, Crosby has not been alone in highlighting issues like these. Another was Derek Robson, a serving officer in Britain's Army Blood Supply Depot. For Robson, writing in 1969, cadaver blood was 'superficially attractive'. One risk was 'cell deterioration' when its removal from a dead body took too long. A further danger was infection, 'particularly following open injury', which meant that 'bacteriological control' would have to be 'standard practice'.[81] Hugh Jeffrey, UK Director of Army Pathology, later echoed Robson's concerns. Extraction had to be quick: 'there is only a brief period when cadavers could be bled'. In addition, 'most of the dead on the battlefield will have been injured and there would be a high risk of infection; this is the greatest drawback'.[82]

Another who came to share doubts on practical grounds was Reginald Saxton, the young British doctor who had experimented with cadaver blood during the Spanish Civil War. In 1938, Saxton had felt that his findings provided 'a brief indication that the method is both practicable and valuable'; what was required for further progress was 'the necessary material and organisation to be able to collect cadaver blood aseptically, to keep it in a refrigerator and to use it in transfusions'.[83] In time, however, he became much less confident in its battlefield usefulness. 'I could see the great advantage of it,' Saxton would recall in the 1980s of his early enthusiasm. 'Here you've got a donor who has no further use for his blood; you can take every last drop that's worth having.' But the principal problem was that 'the possibility of getting suitable donors, suitable *dead* donors, was not very great'. The blood of wartime casualties could be easily contaminated via the injuries that killed them, plus it was difficult 'in field conditions' to subject it to 'elaborate examination'.[84] Certainly his own experiments had not been easy. 'The work was done under the constant and disturbing threat of air-raids,' he had recorded in *The Lancet*, 'and mostly out of touch with the laboratory and in the midst of other medical work.'[85]

The impact, upon professional attitudes to cadaver blood, of Crosby's and others' informed concerns is difficult to detect from available records. Clearer, by contrast, is that Jack Kevorkian's professed confidence in 1964 in the battlefield possibilities of its use in direct 'body–body' transfusions rested on an array of assumptions for which convincing evidence was thin, at best. For Kevorkian, whose confidence was based on a technique that he had tested in clinical conditions with blood taken from just three corpses, his advocated method offered multiple advantages: it required few resources ('there is no conceivable disadvantage to a small sterile package of a 20 or 33 c.c. syringe assembled with short lengths of tubing and with attached needles and a 3-way stopcock'); the simplicity of the technique meant that it could be carried out 'anywhere' and negated 'the need to take the time to gather corpses ... One need only proximate donor and recipient'; 'great volumes' of blood could be transfused; 'cross-matches' were unnecessary ('The surgeon or corpsman need only take a fleeting moment to check blood types listed on "dog tags" and proceed accordingly'); and mutilation had to be 'excessive' to preclude use of a

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corpse's blood on the grounds of possible infection. No evidence was provided to justify any of these claims, save the last. Here, Kevorkian noted simply that one of his three 'donors' had suffered a penetrating head wound but the volunteer recipient showed no ill effects, and that an earlier experiment with blood taken from a dead body with a similar wound – this referenced an occasion when Kevorkian and a colleague had experimented with *indirect* transfusions using blood from seven cadavers – had had no adverse effects on the live recipient either.[86] In short, Kevorkian's contentions for his results are problematic.[87]

Nevertheless, Kevorkian's experiments still point to a method that possesses the potential to save lives in settings where regular therapies are unavailable. It is also the case that the challenges of providing timely and effective battlefield transfusions with blood from living donors remain considerable. While recent conflicts in Afghanistan and Iraq saw innovations in front-line care that transformed the speed and effectiveness of urgent treatments in counter-insurgency settings,[88] Russia's illegal invasion of Ukraine is a reminder that mass battle casualties, and the difficulties of deploying blood supplies quickly and efficiently to front-line positions, are not phenomena confined to the past.[89] It is also possible that some of the practical challenges flagged by Crosby and others are less formidable today, when, for example, injections of component products are commonly used to rectify shortfalls in clotting factors, and portable tests for sepsis and some infections can provide near-instant results.[90] A shift towards accepting and embracing the general possibilities of transfusing cadaver blood might yet be assisted, too, by the simple fact that the recycling in modern medicine of tissues and organs removed from dead bodies has become so commonplace. That said, laws and ethical concerns around consent, ownership, state and medical authority and a host of other issues possess the potential to forge fresh boundaries, and, although no existing study of military medical ethics or military law appears to engage with the subject of cadaver blood transfusion, it can be assumed that any attempt to transplant tissues and organs from the battlefield dead will risk encountering more. For example, the Geneva Convention codifies an obligation for signatory states to respect the dead and prevent remains from being despoiled.[91]

If a time comes when taboos, disgust and ethical and legal objections are resolved or otherwise overcome, the distribution and use of cadaver blood, or elements thereof, collected in clinical conditions far away from the front lines might, perhaps, offer a method with adequate assurances of safety and quality and without the risks and burdens of haphazard collection in a conflict zone. Stimulated by 'the urgent and immediate wartime need of large amounts of plasma', Lowell A. Erf, an American transfusion specialist at Philadelphia's Jefferson Medical College, proposed something like this in 1944 in the form of laboratory procedures for processing cadaver blood into dried plasma and albumin.[92] Paul Moureau, the medical professor who had experimented in wartime Belgium with extracting and transfusing cadaver blood, made a similar suggestion. Described in 1958 for an audience concerned about the threat of nuclear conflict, Moureau's account of that work makes clear the time and trouble required to safely extract blood from dead bodies: the ideal corpse should be free of external wounds; care must be taken to ensure that

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no large cavities are filled with blood; blood tests must not be done too quickly or under vacuum ('we risk seeing the veins collapse which are not as perfectly filled as in the living'); clots can form and obstruct the extraction process, and heavily clotted blood must be discarded; extracted blood must be filtered and bottled ('To prevent the clots, which are always found in cadaver blood, from serving as a trigger for more significant coagulations and again to prevent the fibrinolysis of these clots from forming yields which are relatively toxic'); and blood cultures must be performed afterwards to test for contamination. But he remained positive about the essential validity of cadaver blood as a transfusion fluid and proposed the value of 'harvesting' corpses for supplies of plasma, too. 'We can even consider storing this plasma in coolers at low temperatures between –30° to –40°. This is one of the simplest methods of preserving plasma in a state which is almost as favourable for conservation as dried plasma.'[93]

Conclusion

'The ineradicable instinct of self-preservation in man prompts him to clutch at any straw in a vital emergency,' begins C. W. Grover's preface to *Civil Defence*, a book-length manual, first published in 1938, that urged its British readers to pay attention to the likely threats of modern war and consider them soberly.[94] It is a statement that can speak to early calls to use cadaver blood to save lives on modern battlefields. By the late 1930s, the basic concept of transfusing blood from the dead seemed sound: Sergei Yudin had proved that it could be done successfully and safely. Experience, meanwhile, fuelled expectations that war would bring with it severe shortages in blood supplies. But evidence of the ease with which blood from the battlefield dead could be extracted and transfused to the living was another matter. A sense of revulsion and concerns around transgressing taboos were enough to discourage some observers from embracing its potential, while others attendant to the practical challenges came increasingly to identify obstacles that seemed to rule out any prospect of meaningful take-up. (This is not to say that desperation and a sense of urgency are enough to explain every instance of excessive enthusiasm. Jack Kevorkian's experiments and rhetoric may indicate one example where other factors were at work.)

It should not be assumed that older problems of practicability remain insurmountable, however. In 1938, the *Lancet*, commenting on Reginald Saxton's experiments in Spain, breezily suggested that, despite the 'serious difficulties' that front-line warfare created for the collection and refrigeration of cadaver blood, 'it might well be possible on a large scale to use the dead to save the living' if a 'big and efficiently prepared organisation' existed.[95] When considered next to the later assessments of informed and professional commentators – like William Crosby and Saxton himself – with personal experience of the medical challenges of modern warfare, it is hard not to see that suggestion as optimistic. But if proposals were tabled today to transfuse blood from dead bodies on current and future battlefields, it is not impossible that modern technologies could tackle the practical difficulties with greater effectiveness than was achievable eighty-five

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years ago. Equally, it may be discovered that ethical, legal and psychosocial issues around transfusion and the treatment of the dead – concerns largely absent from past discussions of the topic – pose a fresh set of challenges.

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54 A. Müllerschön, 'Transfusionswesen in den deutschen Streitkräften vom Ersten Weltkrieg bis heute: Die Problematisierung wehrmedizinischer Entwicklungen unter besonderer Berücksichtigung medizinethischer Aspekte' (Doctoral thesis, University of Potsdam, 2021), pp. 144–6; private correspondence with Dr Müllerschön.
55 B. Fantus, 'The Therapy of the Cook County Hospital', *Journal of the American Medical Association*, 109:2 (1937), 128; A. S. Wiener, *Blood Groups and Transfusion* (Springfield, IL, Charles C. Thomas, 1943), p. 69.
56 Shamov, 'The Transfusion of Stored Cadaver Blood', 309. Yudin and his colleagues are said to have preferred 'posthumous' and 'fibrinolytic' to describe blood drawn from corpses, hoping, apparently, to reduce rejection of its source. Igual, 'Sergei Yudin (1891–1954)', 4.
57 Shamov, 'The Transfusion of Stored Cadaver Blood', 309.
58 Vaughn, 'Blood Transfusion in the U.S.S.R.', 214–16. Vaughn illustrated his article with photographs. For more images, see, for example: M. Tarasov, 'Cadaveric Blood Transfusion', *Annals of the New York Academy of Sciences*, 87:1 (1960), 515–18, and Swan and Schechter, 'The Transfusion of Blood from Cadavers', 551–3. For Yudin's description of the process, see, for example: Yudin, 'Transfusion of Stored Cadaver Blood', 362.
59 Russell, *Transplant Fictions*, p. 32
60 F. K. O'Neill, 'Giving from Our Bodily Belongings: Is Donation an Appropriate Paradigm for the Giving of Bodies and Body Parts', *HEC Forum*, 20:2 (2009), 159.
61 Machetti, 'Transfusión de sangre de cadáver', 8.
62 Shamov, 'The Transfusion of Stored Cadaver Blood', 309.
63 For examples of contemporary discourse around ethical aspects of cadaveric organ and tissue donation, see: J. A. Robertson, 'The Dead Donor Rule', *Hastings Center Report*, 29:6 (1999), 6–14; H. E. Emerson, 'It Is Immoral to Require Consent for Cadaver Organ Donation', *Journal of Medical Ethics*, 29:1 (2003), 125–7; J. Harris, 'Organ Procurement: Dead Interests, Living Needs', *Journal of Medical Ethics*, 29:1 (2003), 130–4; P. J. van Diest, N. W. J. Lopes Cardoso and J. Niesing, 'Cadaveric Tissue Donation: A Pathologist's Perspective', *Journal of Medical Ethics*, 29:1 (2003), 135–6; M. M. Rey et al., 'Informed Consent in Research to Improve the Number and Quality of Deceased Donor Organs', *Critical Care Medicine*, 39:2 (2011) 280–3, https://doi.org/10.1097/CCM.0b013e3181feeb04; K. L. Nanwani Nanwani, B. Estébanez Montiel, J. A. García Erce and M. Quintana-Díaz, 'Donación de sangre de pacientes en muerte encefálica: ¿factible y ético?', *Medicina Intensiva*, 46 (2022), 538–9, https://doi.org/10.1016/j.medin.2021.09.001.
64 Kevorkian and Bylsma, 'Transfusion of Postmortem Human Blood', 416–17.

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65 A. R. K., 'Cadaver Blood Transfusions', *Military Medicine*, 129:1 (1964), 72.
66 Yudin, 'Transfusion of Stored Cadaver Blood', 361–3.
67 A. Tzanck, 'A propos de la transfusion de sang de cadavre', *Bulletins et Mémoires de la Société Médicale des Hopitaux de Paris*, 49 (10 March 1934), 341.
68 Shamov, 'The Transfusion of Stored Cadaver Blood', 308.
69 Anon., 'Corpse Blood for Transfusion', *British Medical Journal*, 3930 (2 May 1936), 894.
70 Moore, Pruitt and Meredith, 'Present Status of Cadaver Blood as Transfusion Medium', 367.
71 Anon., 'Cadaver Blood for Transfusion', *The Lancet*, 281:7284 (6 April 1963), 760.
72 Yudin, 'Transfusion of Stored Cadaver Blood', 361. Linda Palfreeman, in her study of blood transfusion in the Spanish Civil War, has wondered if a law banning the extraction of blood from corpses dead less than a day limited Republican interest in exploring its potential for exploitation. Palfreeman, *Spain Bleeds*, p. 121. Early in his researches, Yudin had been anxious, too, of the implications of giving cadaver blood to a patient who subsequently died: would he, the surgeon, be held responsible for killing him? R. Leibovici, review of 'La transfusion du sang de cadavre à l'homme', *Le Sang: Biologie et Pathologie*, 7:4 (1933), 413.
73 Dr M. R., 'Organisation des services de transfusion au front d'Aragon', *Internationales Ärztliches Bulletin: Zentralorgan der Internationalen Vereinigung Sozialistischer Ärzte*, 4:4–5 (May–June 1937), 44.
74 L. W. Johnson, 'Surgical Highlights of 1939', *United States Naval Medical Bulletin*, 38:1 (January 1940), 114.
75 E. L. DeGowin, 'Report on Proposal to Use Cadaver Blood as a Source of Serum Albumin for the Armed Forces' (Appendix 'C' to 'Fourteenth Meeting of the Subcommittee of Blood Substitutes', 24 February 1943), National Library of Medicine, John F. Fulton Papers (MS C 603). DeGowin, member and secretary of the National Research Council's subcommittee of blood substitutes, had prepared his report in response to a proposal received from Dr Lowell A. Erf, assistant director of a blood transfusion unit in Philadelphia, that blood collected from cadavers might be processed for human serum albumin suitable for US military use. The report makes clear DeGowin's grounds for doubting the practicalities and current value of utilising cadaver blood: in addition to suspecting that the Soviets preferred other sources, he felt that American supplies from live donors were adequate for present needs. No discussion of Erf's idea is recorded in the minutes of the meeting, which simply note DeGowin's opinion of it ('the proposal would not prove practical') and that the committee took no action. To judge by its similarities to Kendrick's comments in *Blood Program in World War II*, DeGowin's report was Kendrick's source for his assertions that cadaver blood was 'never used widely, even in Russia', and that its wartime use anywhere was unlikely. But Kendrick's expression of disgust ('revolting') was his own.
76 W. H. Crosby, 'The Safety of Blood Transfusion in the Treatment of Mass Casualties', in *Recent Advances in Medicine and Surgery (19–30 April 1954) based on Professional Medical Experiences in Japan and Korea 1950–1953* Vol 1 (Washington, DC: U.S. Government Printing Office, 1955), p. 196.

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77 Kendrick, *Blood Program in World War II*, p. 785.
78 Crosby, 'The Safety of Blood Transfusion in the Treatment of Mass Casualties', pp. 195–6.
79 F. L. Bauer, 'Preface', in *Recent Advances in Medicine and Surgery (19–30 April 1954) based on Professional Medical Experiences in Japan and Korea 1950–1953*, Vol 1, p. iii.
80 W. H. Crosby, 'Trends in Blood Transfusion', *Annals of the New York Academy of Sciences*, 115:1 (1964), 403–4.
81 D. C. Robson, 'The Present Position and Progress in Research in the Production of Blood for Mass Casualties', *Journal of the Royal Army Medical Corps*, 115 (1969), 126.
82 H. C. Jeffrey, 'Blood Transfusion in War', *Journal of the Royal Army Medical Corps*, 120 (1974), 28. In addition to the factors mentioned above, uncertainty on the battlefield over a casualty's time of death may also have significant implications for the safety of their blood. Confusion may exist not only about the precise length of time since death but also about whether fibrinolysis has occurred.
83 Saxton, 'Towards Cadaver Blood Transfusions in War', 693.
84 R. S. Saxton, interview, November 1984. Sound archive recording no. 8735, Imperial War Museum, London.
85 Saxton, 'Towards Cadaver Blood Transfusions in War', 693.
86 Kevorkian, Nicol and Rea, 'Direct Body–Body Human Cadaver Blood Transfusion', 26–7.
87 For further discussion of Jack Kevorkian's style of argumentation, see: R. W. Kenny, 'The Rhetoric of Kevorkian's Battle', *Quarterly Journal of Speech*, 86:4 (2000), 386–401; and M. DeCesare, *Death on Demand: Jack Kevorkian and the Right-to-Die Movement* (Lanham, MD, Rowman and Littlefield, 2015), especially pp. 15–19.
88 See, for example: A. Cap, 'The School of Hard Knocks: What We've Learned and Re-learned about Transfusion in a Decade of Global Conflict', *Transfusion Medicine*, 4 (2014), 135–7.
89 See, for example: I. Voichuk, 'Ukraine's First Blood Transfusion in Trench Paves Way for Increased Combat Survival Rates', *Euromaidan Press*, 15 November 2023, https://euromaidanpress.com/2023/11/15/ukraines-first-blood-transfusion-in-trench-paves-way-for-increased-combat-survival-rates/ [accessed 9 May 2024].
90 J. H. Levy, I. Welsby and L. T. Goodnough, 'Fibrinogen as a Therapeutic Target for Bleeding: A Review of Critical Levels and Replacement Therapy', *Transfusion*, 54:5 (2014), 1389–405; T. Oeschger, D. McCloskey, V. Kopparthy, A. Singh and D. Erickson, 'Point of Care Technologies for Sepsis Diagnosis and Treatment', *Lab on a Chip*, 5 (2019), 728–37.
91 J.-M. Henckaerts and L. Doswald-Beck, *Customary International Humanitarian Law, Volume I: Rules* (Cambridge, Cambridge University Press), pp. 409–11.
92 L. A. Erf, 'A Note Recommending the Use of Dried Plasma Obtained from Fresh Cadaver Blood', *The American Journal of the Medical Sciences*, 207:3 (1944), 314–16. Interest in cadaver blood as a useful source of plasma can also be detected among Soviet researchers. For example, Sergei Yudin, in 1952, proposed the

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development of a universal cadaver blood produced from plasma combined with washed red cells from O-type blood. More than 250 transfusions of that product were carried out at the Sklifosovsky Institute up to 1960, the same year that the Institute began producing dried plasma derived from cadaver blood. Igual, 'Sergei Yudin (1891–1954)', 9.

93 Moureau, 'La transfusion de sang de cadavres en cas de pertes massives', 481–3.

94 C. W. Grover, *Civil Defence: A Practical Manual Presenting with Working Drawings the Methods Required for Adequate Protection against Aerial Attack* (London, Chapman & Hall, 1942), p. vii.

95 Anon., 'Blood Transfusion in War', *The Lancet*, 231:5981 (16 April 1938), 901.

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