

2001

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Bill Rawling

Directorate of Heritage and History, Department of National Defence

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Recommended Citation

Rawling, Bill "Providing the Gift of Life: Canadian Medical Practitioners and the Treatment of Shock on the Battlefield." Canadian Military History 10, 1 (2001)

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Providing the Gift of Life

Canadian Medical Practitioners and the Treatment of Shock on the Battlefield

Bill Rawling

The story of Ambroise Paré's discovery has been told often; of how, during Francis I's campaign against Turin in 1536-37, he ran out of the oil medical practitioners used to cauterize the stumps of amputees and used an herbal remedy and ligatures instead; and of how the patients treated by the latter method did so much better than those tortured with the former. The tale has much to commend it to the popular imagination: a medical hero makes a serendipitous discovery to relieve the suffering of thousands. However, the story is an exception to a steadfast rule in warfare, for in medical matters, change comes slowly. This state of affairs could be ascribed to an unthinking conservatism, but one should not rush to pass judgement. Military commanders are not so much mule-headed as wedded to techniques that, in their eyes, have worked well in the past; innovation means experiment, with perhaps catastrophic results. As we shall see in a study of how Canadian medical practitioners dealt with shock from the First World War to Korea, bringing about change is less a matter of conflict against the establishment and more of reaching a consensus on how to solve complex battlefield problems.

Disease has killed far more soldiers than battle wounds, but the latter represents the most dramatic evidence of the costs of war, and their treatment has thus been of some importance to commanders who wished to see as many injured soldiers as possible return to the fighting. Surgeons worked to that end – the rights of the patient being usually a secondary consideration – and in dealing with the ravages of bullet, shell

fragment, or blade, doctors faced three main challenges. As J.A. MacFarlane, consulting surgeon to the Canadian Army Overseas, suggested in 1942: "The management of wounds presents the same problems to-day as through the generations of military surgery – shock, haemorrhage, infection."¹ It is the first of these that is of interest here. Shock is defined as circulatory failure brought on by hemorrhage or other traumas; it can be fatal if not treated in time.

Though Canadian surgeons had accompanied the campaign against Louis Riel in 1885 and set up a hospital in South Africa during the Boer War, it was not until the 1914-1918 conflict that the country's medical corps, formed in 1903, faced the full challenge of industrialized warfare. Fully aware of the problems posed by shock, practitioners nonetheless had never experienced them on such a huge scale. At Second Ypres, for example, in April and May 1915, the Canadian contingent saw a third of the division's 18,000 troops become casualties in just a few weeks. It was but the first of many such engagements. Learning mainly from the British, but also from the French, Canadians adopted a system of evacuation and treatment that assumed many of the characteristics of an industrial enterprise.

Dealing with shock was, however, very much a matter of experiment in that war. Blood transfusions had become far safer as early as 1900 when Karl Landsteiner of Vienna discovered the blood groups A, B, and O. Landsteiner's work

would eventually win him a Nobel prize. Though European and North American medical practitioners of the time used saline and not blood to restore fluids, the Austrian's work would prove useful in wartime. Another problem, however, was preserving blood in order to transport or store it for future use. Ironically, just as a conflict broke out in Europe that would spill the blood of millions, sodium citrate was found to act as an anti-coagulant (and hence a preservative), and "the modern era of transfusion began," according to Orville F. Denstedt.² The war was thus in its early days when "everyone who had any interest in blood transfusion, or knew of the researches...on shock, appreciated the need of blood replacement in the prevention and treatment of shock from blood loss, fractures and burns among the battle casualties."³

Science and technology, whether medical or otherwise, do not necessarily advance quickly in war. Chemical refrigeration dated only from 1915 and in 1917, the storage, transportation, and transfusion of blood were still experimental. Attempts to alleviate shock by administering blood products began gaining currency only after the conflict was well under way. Surgeon Norman Guiou later recalled, "a blood transfusion in the 3rd Field Ambulance Main Dressing Station at Albert on the Somme in the fall of 1916," which proved successful.⁴ In May of 1917 the French Army posted some success with transfusions, while O.H. Robertson of the Harvard Medical Unit attached to the British Third Army, also worked on the problem:

Blood was collected into citrate-dextrose and stored in an improvised refrigerator consisting of a sawdust-insulated box with the blood bottles surrounded with ice brought daily from a nearby village. The blood was used with great success in the treatment of casualties in the battle of Cambrai.⁵

Cambrai is better known to military historians as the first attempt to use tanks *en masse*, in October 1917.

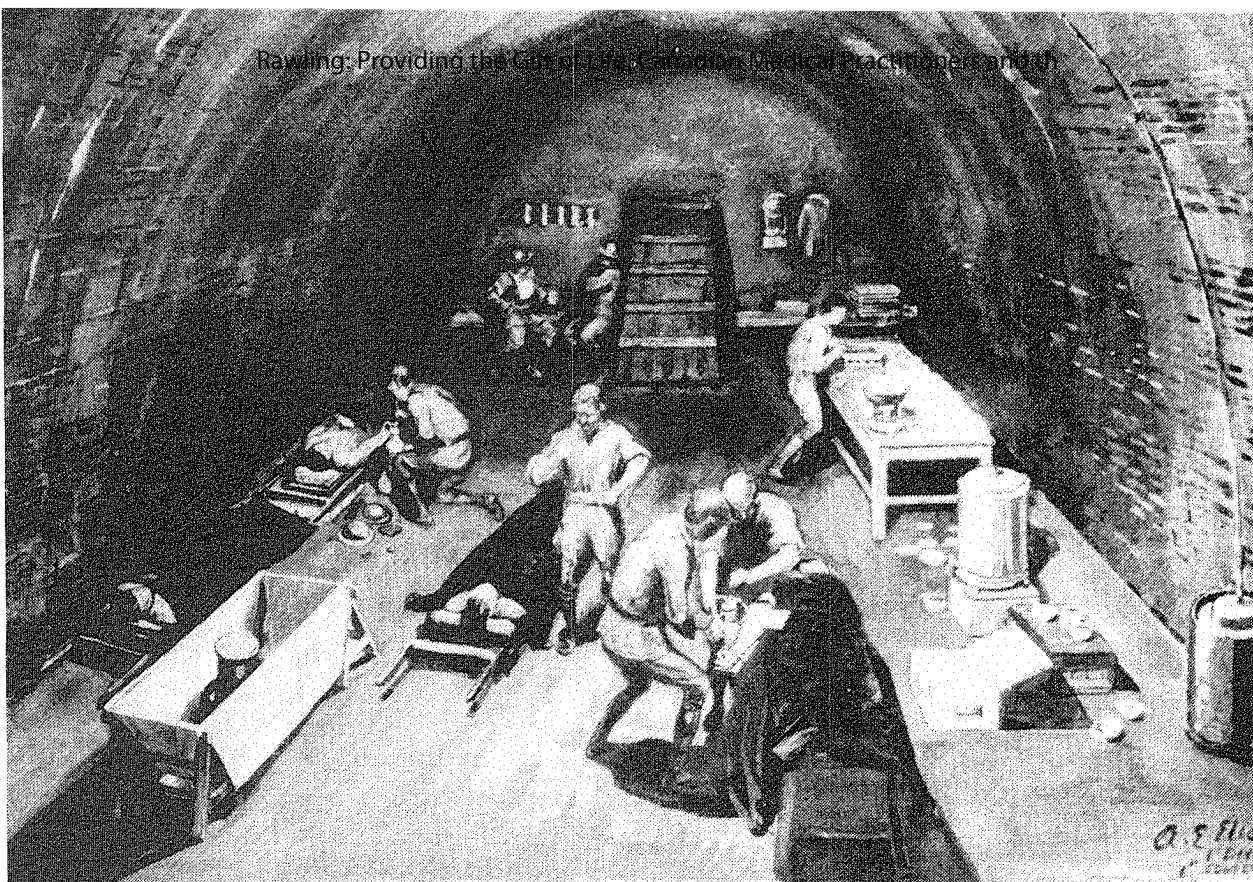
Transfusion gained greater currency after the campaigns of that year. Norman Guiou recalled how, in January 1918, he was sent to a Royal Army Medical Corps School at No.22 Casualty Clearing Station. "There, lectures on blood transfusion by Major McNee and Captains Gladden and Cowell of the RAMC and Major

Harrison of the Canadian Army Medical Corps, convinced me that blood transfusion was distinctly feasible in the forward area."⁶ Soon, "the first opportunity for a transfusion came at a main dressing station. A man was brought in with a shell wound to the chest. It was audibly sucking air and the man was in severe shock. It was an order to close air sucking wounds as soon as possible...The man had lost a lot of blood and was probably bleeding internally." A transfusion was carried out, "The wounded man rallied a bit, we kept him warm for awhile, but he died." It was not cause for celebration: "I was severely reprimanded by a senior officer and was told I had killed a man. This hit me very hard. Sleep deserted me that night."⁷

Dr. Guiou rallied. In April 1918 he reported how,

We had our first opportunity to do several transfusions. The dressing station was set up in a Nissen hut, the stretchers were supported on trestles. There were a number of seriously wounded...One lad was brought in on a blood-soaked stretcher, with a shattered humerus – his upper arm swathed in copious blood-soaked dressings. A flicker of pulse was present. He was pale, "starey-eyed", and tossed about and pulled his wound tag off...We bled a donor about 750 cc while the chaplain talked to him. If there is a dramatic procedure in medicine it is the blood transfusion. Color came into that lad's cheeks. He raised himself on his good elbow, drank tea, and ate some YMCA fancy biscuits, then was on to the casualty clearing station.⁸

Such miracles were the exception, however, Guiou noting that "We were able to trace our three cases that were transfused. One died just before reaching the casualty clearing station; another reached there in splendid condition, had a thigh amputation and later died of gas gangrene." There was a lesson to be learned, or perhaps relearned. "These cases had had a long journey before they got to us at the main dressing station. We felt they should be resuscitated closer to the main front." As a result, "Blood transfusion was then started in our Advanced Dressing Station." The donor was "Private Bryant of the 6th Field Ambulance," who "gave 850cc of his blood to Private A.J. Hunt of the 32nd Division Machine Gun Company (British), who had a severe shell wound of the back. In five hours he was evacuated to the Main Dressing Station."⁹



Interior view of transfusion cellar. An NCO is reading an agglutination test under the light. Patient on the right is being transfused with refrigerated blood brought up from a CCS. A donor is being bled on the extreme left. Painting by Arthur E. Elias, taken from *Transfusion: A Canadian Surgeon's Story in War and Peace* by Norman Miles Guiou. Permission to reproduce kindly provided by Stoneycroft Publishing.

It might be useful here to provide a brief description of the chain of evacuation as it developed during the First World War and was retained, with minor variations, for the following decades. If a casualty were to go through them all, the victim would first be picked up by stretcher-bearers or comrades on the battlefield, be taken to a Regimental Aid Post (RAP) and then to an Advanced Dressing Station (ADS), Main Dressing Station (MDS), Casualty Clearing Station (CCS), and then to one or more types of hospital. The RAP was the responsibility of the battalion concerned, the aid stations were set up by field ambulance units and the CCS was an autonomous organization. As we shall see, various other units were formed in the years that followed, but all were tied in to the chain of evacuation described above in one form or another.

While blood transfusions moved closer to the fighting, basic techniques were evolving. Until 1918 transfusion had generally relied on the syringe method. Blood was drawn from the donor through tubing into a syringe, then injected directly, through more tubing, into the recipient. As Guiou explained, "This method required two operators, and necessitated placing the donor

close to the patient which was often difficult to accomplish." An alternative was "The citrate method," as "fully described in the *British Medical Journal* of April 27, 1918, by Captain Oswald Robertson of the American Base Hospital at Boulogne."¹⁰ When on 22 June the 19th Battalion staged a raid, "The citrate method showed its usefulness. The donors were bled lying on a blanket on the ground in an adjacent dugout. The blood was then carried to the Regimental Aid Post,"¹¹ where the raid's wounded were being treated. Of the two patients treated, one survived.

Further work had to wait until after the war when transfusions became sufficiently popular to prompt the creation of systems for recruiting and rewarding blood donors; one blood bank was organized by a B. Fantus of Cook County Hospital, Chicago, in 1937.¹² A pioneer in the use of blood transfusions in battle at this time was Dr. Norman Bethune of Montreal, a Canadian communist who worked for the Loyalists in the Spanish Civil War. Though blessed with an excellent reputation as a chest surgeon – he had helped develop new techniques and instruments for dealing with tuberculosis – Bethune decided that what was really needed was a blood



Mackenzie-Papineau Battalion collection; NAC C67451

transfusion service. While in London before leaving for Spain, he prepared as best he could, purchasing a station wagon, complete with a kerosene-operated refrigerator.¹³

Why a renowned surgeon should try his hand at something outside his area of expertise is of some interest to our story. Norman Bethune saw the Spanish Civil War as the first stage in the campaign against fascism, and so decided for propaganda purposes to engage in activities that would be seen as uniquely Canadian. Surgeons were reasonably plentiful in the Spanish government's army, but blood transfusion units were non-existent. According to Hazen Sise, one of Bethune's comrades,

I don't remember exactly what the first releases were but Bethune as I say had a brilliant sense of public relations and he also realized it was extremely important that our presence should be announced and he easily made friends with a lot of the correspondents. Herbert Matthews of the New York Times became a great friend of ours and was around at our headquarters quite a lot. And I remember Sefton Dalmer of the Daily Express, a fellow named Gallagher, I think his name was. He was a UP [United Press] man. We were very palsy-walsy with them and they were very interested in this Canadian blood transfusion unit you know it caught people's imaginations.¹⁴

Over three decades after doctors made the link between shock and the need for blood, a Canadian specialist in tuberculosis treatment created a niche for himself in transfusion work.

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NAC PA 117423

Left: Dr. Norman Bethune, assisted by Henning Sorensen, performing a transfusion during the Spanish Civil War, 1936-1938.

Above: The Canadian Blood Transfusion Unit in Spain during the Spanish Civil War, 1936-1938. Dr. Norman Bethune on right.

Like so much else surrounding the operations of the International Brigades in Spain, Bethune's transfusion unit had a certain amateurish quality to it. Bethune was the only medical practitioner on the team, which was rounded out by Sise, an architect, and Henning Sorensen, a journalist. The first step was to gather blood, no great difficulty when it was advertised as being for soldiers at the front; universal donors (type O) made up about 75 per cent of the total, with group 2, or type A, accounting for the remainder. Working in a war zone called for some difficult choices, however:

Syphilis is endemic in Spain and so is Malaria. Normal medical procedure would be that every donor would be tested for syphilis and malaria. We didn't have the means at that point. We didn't know how to go about getting this testing done and we coldly made the decision that a man would prefer to have his life and possibly a dose of syphilis than lose his life. The syphilis might be cured later.¹⁵

Furthermore, the team was "completely innocent of any knowledge of various sub groups, Rh factors and all these things that we worry about these days"¹⁶ This may have led to serious complications later on.

If collection relied mainly on the health and willingness of the general populace, storage and transportation required equipment not easy to acquire or maintain in the midst of battle. On their first night's run to deliver blood the kerosene engine on the refrigerator quit, and from

then on the team simply plugged it in whenever they ceased operations for the day. Results could be catastrophic, as Sise admitted after describing how four French fliers were transfused after being evacuated from a plane crash: "two of them died and frankly they might have died from hemolysis [breaking down of red blood cells] because...when I finally got this blood back to Madrid, it must have been at least a week later, I put it in a centrifuge to test it and it was very badly hemolyzed and would have killed anybody who'd put it into. At any rate I remember visiting those French fliers in hospital there and I remember one of them was suffering quite a lot and he kept yelling 'Ah que je souffre, ah que je souffre, ah que le diable!'"¹⁷

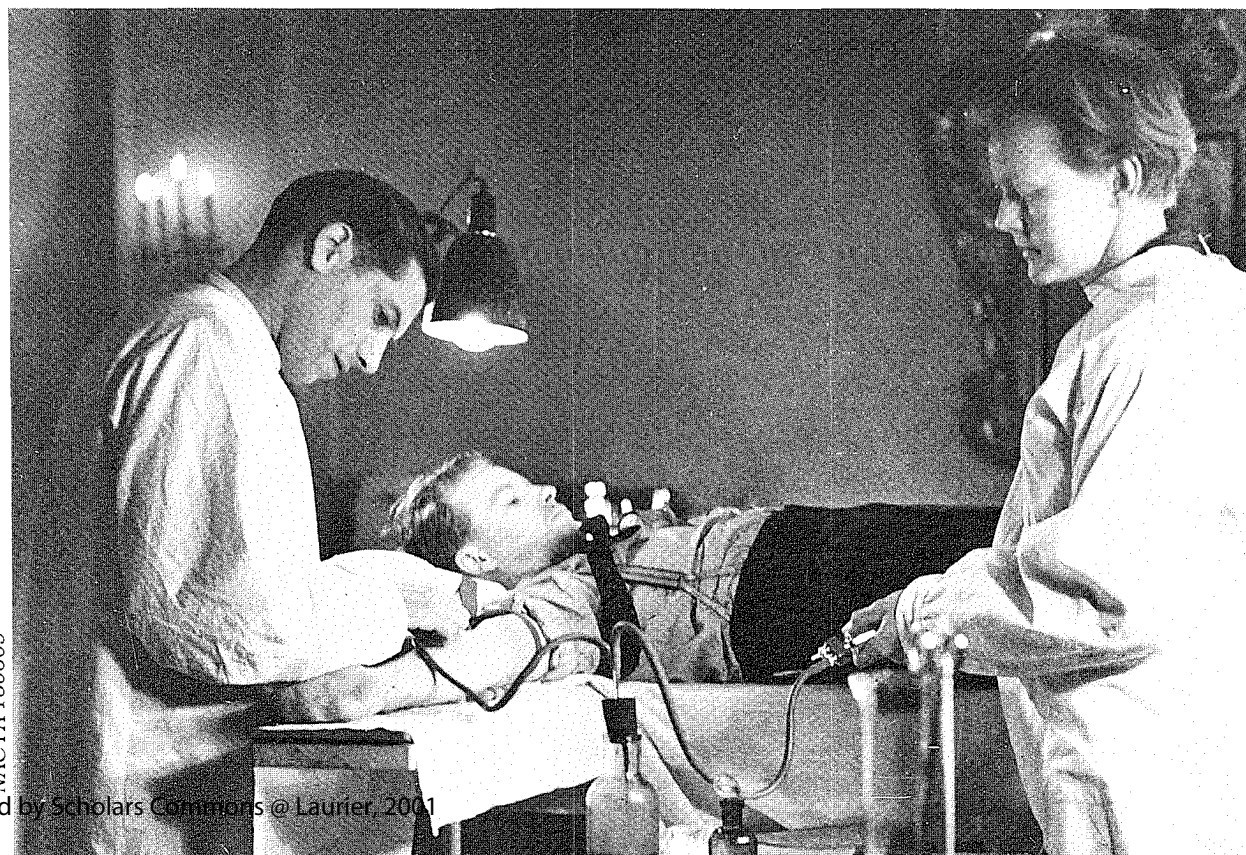
The architect-turned-transfusion practitioner also admitted that, after a while, theirs was not the only such operation in Loyalist Spain, and another was perhaps superior to their own. It was on a trip to Catalonia "that we learned of the blood transfusion work of a Dr. Durand Horda who had set up a highly advanced blood bank system in Barcelona from which he distributed blood to the fronts around there, the Aragon front particularly which was rather quiescent during that period of the war. But Durand Horda I think deserves the real credit for being the first man to set up a modern, streamlined blood transfusion

system."¹⁸ Barcelona was more industrialized than Madrid and allowed for better equipment, Sise suggested, but perhaps experience and training made more of a difference.

By the time Nazi forces had invaded Poland in September 1939, Norman Bethune had been in China for over a year, and was to die within a few months. If his efforts to deal with the casualties of war were isolated, in Canada medical research was coming of age. In 1923 Frederick Banting and J.J.R. Macleod shared the Nobel prize for medicine/physiology, and by 1939 research institutes had been set up at the University of Toronto, McGill University, and elsewhere. Well before Canada was at war, some medical research was focussed on military matters. An Associate Committee on Medical Research had been formed at the National Research Council in 1938. Of its four sub-committees that examined war problems, one of them examined shock and blood substitutes.¹⁹ When the Associate Committee offered its services to the British government, the latter responded that two areas needed the most work; one was Sir Frederick Banting's research in high altitude aviation; the other was blood storage.

In the first days of the European War one institution working on the subject was McGill

A doctor and his assistant collect blood from a donor.



NAC PA 160609

University. There, biochemists J.B. Collip and O.F. Denstedt managed to develop a solution that preserved blood satisfactorily for six to eight weeks. As an experiment, some of this blood was shipped to Great Britain, but not in sufficient quantities for clinical use.²⁰ As the blood was at its optimum for only 20 days, it was unlikely that products collected in North America could supply far-flung battlefields.

Dr. Charles Best of the University of Toronto, who had helped Banting in his Nobel-winning research, took a different tack. Collecting blood from 300 student volunteers, he separated and concentrated the serum, or plasma, the part of the blood in which white and red cells are suspended, and used it to treat shock. This was the first Canadian experiment in blood derivatives, and the Associate Committee on Medical Research saw fit to give him a grant for further work in December 1939. Attempting to develop a process by which the serum could be concentrated, he and his staff found ways to dry it. The Associate Committee suggested it be put into production for Canada's army. In October 1940 the Committee also recommended sufficient serum be produced to deal with large numbers of civilian casualties, suggesting the production of 20,000 "shock treatments."²¹ The Red Cross would be made responsible for rounding up donors.

During the course of the war about a dozen grants were issued to teams that studied the problem of shock by inducing it in laboratory animals. According to the Associate Committee's own history,

The results of these various investigations contributed materially to the present-day knowledge of shock. Drs. Noble and Collip devised a standard method of producing shock by revolving rats in a drum. This method was adopted by other laboratories in the United States. They found that some animals resisted shock, while others did not. Resistance could be built up by repeated mild traumatism, or by an increase in the protein in the diet – a kind of commando training.²²

By measuring such things as histamine levels, researchers hoped to devise an alternate treatment to infusing whole blood, which still posed severe logistical difficulties, especially as regarded refrigeration.

Research continued on dried serum, but even after three further years of work results were not encouraging. At the Basingstoke Neurological and Plastic Surgery Hospital, 29 volunteers were treated with the product from 20 to 27 July 1943. "In no case was there a really serious reaction, but there were quite a large number of annoying symptoms in the group," including high temperature and rapid pulse. The conclusion was

Photo by Donovan James Thorndick, NAC PA 143829



German prisoners from a sunken vessel receiving treatment in the Sick Bay of HMCS Prince David. While the patient receives dried serum, the dead skin is being removed and a burn dressing applied. Mediterranean Sea, 15 August 1944.

*Sergeant Hubert Challis donating
blood at the Canadian Red Cross
Blood Donor's Clinic in Ottawa,
ca.1943.*

obvious: "There is evidently present in Canadian dried serum a substance or substances which give rise to minor types of reaction," so "It is recommended that an effort be made to produce a less toxic serum than at present supplied, though it is emphasized again that none of the reactions were of a really serious character."²³ More research was needed.

The Canadian dried serum project seemed headed into a dead end; not only were alternatives available, some of them produced in Britain, closer to where Canadians were fighting anyway, but other work pointed out the advisability and feasibility of using whole blood. The NRC's sub-committee on shock and blood substitutes chose at the end of 1943, "to emphasize as strongly as possible the need for the use of whole blood in the treatment" of shock.²⁴ The main difficulty practitioners had faced with using the fluid was logistical, but "This has now been to a great extent overcome as it has been amply demonstrated that under optimum conditions it can be preserved up to at least seventy days and still remain physiologically active. The vicissitudes of transport by plane, ship or truck can be to a great extent circumvented by proper preservative solutions and modern refrigeration."²⁵

Research was not only the domain of the university or National Research Council scientist. It was also carried out by officers of the Royal Canadian Army Medical Corps closer to the front. Captain D.E. Cannell and Lieutenant F.G. Kergin of the Army Blood Transfusion and Surgical Research Unit, at Southmead Hospital in Bristol, aimed "to obtain blood from voluntary civilian donors in England and to transfer it abroad in such a manner, and at such a rate, as to provide a continuous supply of blood" for British and Commonwealth forces.²⁶ Some of their work repeated that of Bethune's team in Spain, the Canadians deciding to concentrate on supplying



Photo by F.C. Tyrell, NAC PA 112748

Group O, as it could be given universally and would simplify administration. The group also experimented with a variety of alternatives, trying out such substances as citrated blood, haemoglobin Ringers' Solution, Ringers' Solution *tout cour*, glucose in saline, and simple plasma.

The group's focus on the treatment of shock brought on by blood loss (or haemorrhagic shock) determined that the rate of bleeding was more important than the amount lost. In their report of June 1940, Cannell and Kergin insisted that "There is no serious question of the commonly accepted fact that blood is, and probable [sic] always will be the best substance for infusion in cases of shock associated with haemorrhage – since these cases occur in war with relative frequency we may assume at the outset that there will be a field for blood transfusion."²⁷ Traumatic shock, however, was a different matter, being brought on not by haemorrhage but by trauma to the central nervous system, and much less was known about how to mitigate it. Until further experimentation, it could also be treated through blood transfusions.

What remained were the logistical problems that had so dogged efforts at getting blood to those who most needed it. Administering blood at the front posed no technical difficulties, but it still had not been determined whether it was wise to transfuse blood to a seriously wounded casualty at a front line Regimental Aid Post, or an Advanced Dressing Station, or whether it was better to evacuate the patient to more complete facilities first. In 1940 British and Commonwealth forces planned to move the blood in refrigerated trucks as far forward as Casualty Clearing Stations (or CCSs), the last stage in the evacuation of a wounded soldier before his arrival in hospital. If possible, small amounts of blood could be delivered closer to the front, to Main Dressing Stations or even Advanced Dressing Stations.²⁸

After the fall of France in June 1940, Canadian land forces in Great Britain concentrated on defending England against invasion. Aside from the disastrous raid on Dieppe, the Canadians suffered casualties from illness and accident, and if transfusions were necessary they were able to rely on British supplies, but they also had to prepare for operations in other theatres.

Able to learn from British experience, in April 1942 the Canadians thus considered the formation of Field Transfusion Units, or FTUs.²⁹ By coincidence, these units very closely resembled Bethune's team in Spain.

It was not until January 1943, however, that a Captain Bigelow of the Royal Canadian Army Medical Corps became the first Canadian transfusion officer. He was sent to already-formed British units to familiarize himself with procedures and equipment. The following month authority was granted to mobilize Numbers 1 through 4 Field Transfusion Units and Numbers 1 through 5 Field Surgical Units. Also required was a Base Transfusion Unit, which would receive whole blood from English sources and distribute it to the FTUs for use closer to the front. The British would provide the military and medical supplies, but the Canadians would need to carry out their work.³⁰

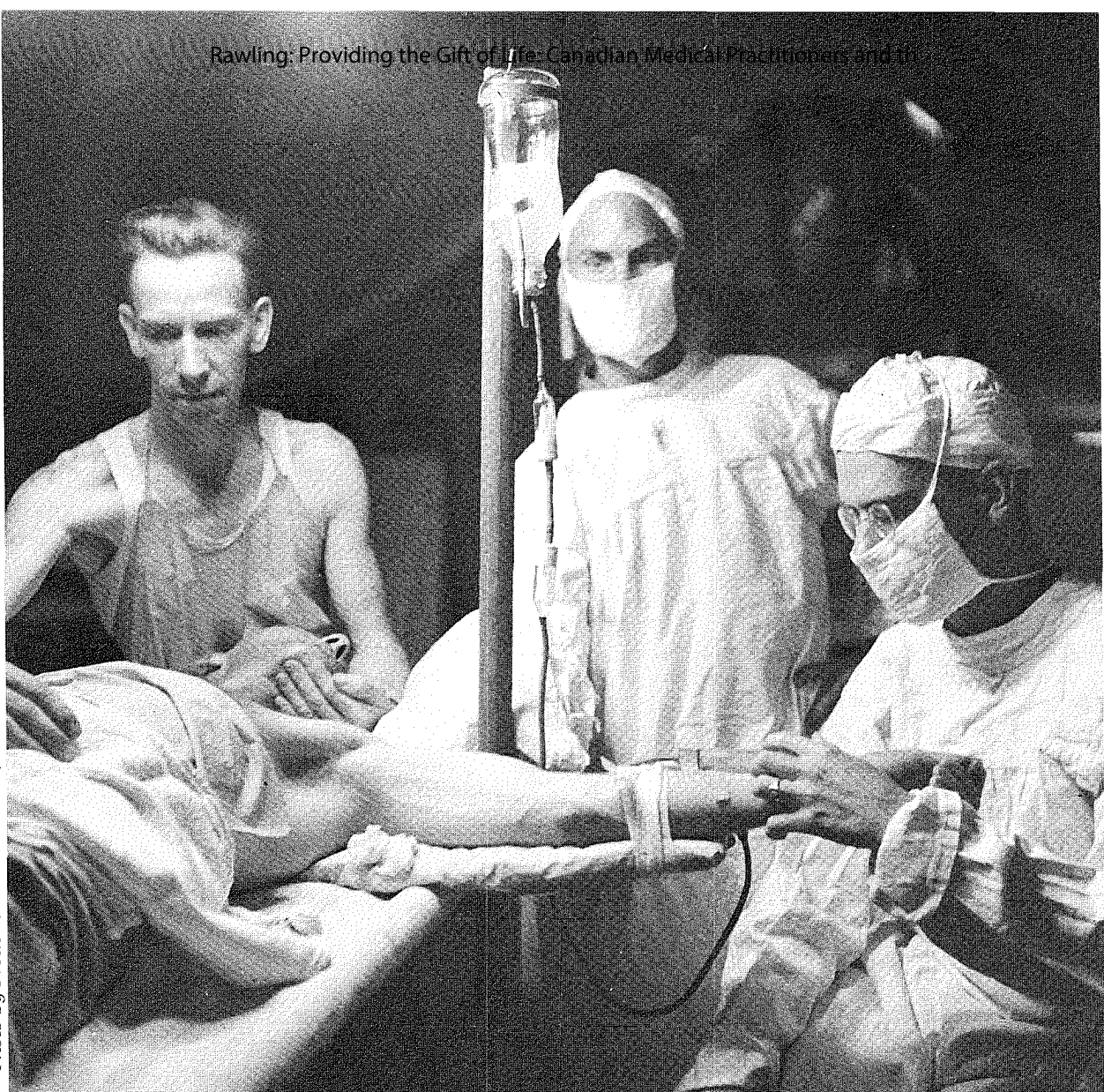
When No. 1 Field Transfusion Unit went to Sicily it did so as part of a large, sophisticated medical system. At the front were regimental aid posts, from which casualties were evacuated by

field ambulance units; the latter were responsible for triage, sorting out those who needed immediate care, those who could carry on to more elaborate facilities, and those who could be treated on site and sent back to their units. Personnel at the field ambulance units also decided which patients were in need of resuscitation, these being sent to a special ward where the FTU performed its work; the transfusion officer also advised the surgeon on how to proceed since shock seriously increased the risks normally attending surgery.³¹

As part of a much larger British organization, the Canadians had the benefit of learning from the campaign as a whole, especially when comparisons were made between different areas or theatres. Just as operations began in Sicily, for example, the Allies were comparing different approaches to blood transfusion in North Africa and the Mediterranean, involving some 45 medical units. Choosing between plasma and blood was one issue, for though, "The merits of plasma are that it is an efficient and safe fluid for blood volume restoration, with no hazards of group incompatibility or transmission of syphilis or malaria," it did not carry oxygen as well as whole blood. As for the latter, "it is a highly dangerous fluid unless carefully collected, continuously and securely refrigerated and scrupulously supervised; a number of deaths have been caused by the use of unsuitable blood."³²

Whichever was transfused, the amount needed depended, of course, on circumstances. An analysis of 30,000 wounded in North Africa and Sicily showed that about 10 percent of them required transfusions to treat shock. The average for these men was three pints. Land mines doubled the number of patients needing resuscitation, though the amount of fluid required remained the same.³³ One of the lessons the Canadians learned in the Sicilian campaign was that their transfusion units had to carry more plasma.³⁴ So did field dressing stations that were designed to resuscitate severe and serious casualties before evacuating them further back for surgery. Often these units were located beside field surgical units, much to the patients' benefit. As one report insisted, "In our opinion casualties requiring early resuscitation also require early surgery and it is a mistake to move the casualty miles in order to get the latter."³⁵ Thus, in its

Photo by Frederick G. Whitcombe; NAC PA 141311



Plasma being given under the direction of Major F.G. Smith at the 15th Canadian General Hospital, El Arrouch, Algeria, September 1943. Left to right are Private M. Courtney, Major Smith and Captain F. Walton.

very first major campaign, the RCAMC began spreading responsibility for transfusions, so that the FTU was one unit among many able to resuscitate soldiers suffering from shock.

Sicily fell to the Allies in mid-August 1943 and when mainland Italy was invaded in early September, the Canadians were among them. In the field by this time was Number 1 Royal Canadian Army Medical Corps Research Unit, which stumbled upon a little-known phenomenon. Though blood typing had been discovered at the turn of the century, the Rhesus factor (yet another discovery by Karl Landsteiner) was not known until 1940, and its influence on blood transfusions not until much later. Those who lack the factor (and who are thus Rh negative) may form antibodies if it is introduced

into the blood stream, causing an immune reaction. The research unit first became interested in the possible consequences when the frequency of jaundice increased, leading to multiple transfusions and the possibility that some patients might become sensitized to the Rh factor as a result. After the war some 40 per cent of men with Rh negative blood who had received whole blood had developed antibodies against the factor. The phenomenon was independent of the number of transfusions each had received. "This survey established the importance of administering none but Rh compatible bloods. Only by the Rh typing of all donors and recipients can haemolytic reactions be avoided in men who have received previous transfusions. The danger of sensitizing men by an initial transfusion can be prevented in this way too. The very high

incidence of Rh sensitization after blood transfusion was a surprise to all,"³⁶ including, no doubt, many a suffering patient.

On 4 June 1944 Rome fell to Allied forces. The capture of the Eternal City was eclipsed in the public imagination by events in Northwest Europe when American, British, and Canadian divisions stormed the beaches of Normandy two days later. The campaign that followed was a difficult one for II Canadian Corps, which suffered some 18,000 casualties, of whom 5,000 died, almost the same number as in the entire 22-month campaign in Italy. Such intensity was a severe test for the medical services, and the lessons of the Mediterranean, in which Canadians would fight until early 1945, were no doubt an important element in helping field ambulances, field surgical units, field transfusion units, and others face the challenge.

Sicily had taught that resuscitation, though usefully performed by the specialists of FTUs, could also be made the responsibility of field dressing stations, the most versatile units of the RCAMC. Number 4 FDS, for example, functioned in five different roles through the Normandy campaign. Located alongside a field ambulance (on one occasion the 10th, on three others the 11th), No.4 FDS was responsible for admitting patients and performing triage. As the commanding officer reported, "If the FDS is to operate as a transfusion unit, this would appear to be the only satisfactory arrangement that they are set up in the same field or same building as the Field Ambulance and casualties sent direct from their admitting room."³⁷

That resuscitation techniques were now widely disseminated throughout the RCAMC was obvious in the commanding officer's note that "in the majority of times all resuscitation could be done by the Field Ambulance or at least with a section of the Field Dressing Station attached,"³⁸ so that the FDS as a unit was not needed for this type of work. In comparison, 12th Light Field Ambulance reported that "No separate section of the ADS was reserved for resuscitating shocked casualties. When required, plasma was administered on the treatment table while the patient's wounds were being dressed. In this way, the average time of delay in evacuation of the patient caused by giving plasma was only about fifteen minutes,"³⁹ so that the field ambulance as

a whole incorporated resuscitation as part of its casualty clearing procedures. Usually two pints were transfused while the patient was on the table, another pint given on his journey to hospital. "All our ambulance orderlies were capable of changing plasma bottles en route and discontinuing the transfusion if necessary."

Preventative measures were thus taken at every stage possible in the evacuation of a wounded soldier, and according to Number 4 Field Dressing Station's commanding officer, "In the treatment of shock, it was found that all the apparent "small" principles of treatment are of inestimable value and must not be overlooked at any time."⁴⁰ After having gone through a regimental aid post or come directly to the FDS, a patient was stripped of wet clothing, including boots, provided with hot water bottles and blankets for warmth, and even given a pillow if necessary. Orderlies provided not only cigarettes but reassurance as well, while giving the patient hot sweet tea unless he suffered from an abdominal wound; he might also get hot stew if such was available. While continually on the alert for fresh haemorrhage, all fractures were splinted, sucking chest wounds closed, burns treated with sulfanilamide cream, and morphia given for pain. "Blood plasma transfusion was given if indicated by Blood Pressure, which was taken on all severe wounds, or general condition of patient or as routine in wounds with extensive tissue damage."⁴¹ Number 5 Field Surgical Unit reported in similar fashion, insisting that "Cases with abdominal eviscerations, rectal injuries, and gross intraperitoneal damage, should be resuscitated rapidly, i.e. with 2 to 4 bottles of blood and plasma, and operated on. Delay, especially where the gut is strangulated in the wound, is only asking for a fatal result."⁴²

The FTUs were intended to ensure blood transfusions could be carried out as soon after wounding as possible, but the intensity of the Normandy battlefield often made this task difficult to carry out. Number 4 Field Transfusion Unit, for example, worked with an advanced surgical centre for much of the campaign. Its report after the campaign emphasized the time lag between wounding and resuscitation. It maintained that "Both FSU and FTU officers agree that this factor is all-important,"⁴³ as demonstrated when the fighting became particularly vicious. When moving on Caen in

*Sergeant T.F. McFeat and
Private J. Viner, 23rd Field
Ambulance, R.C.A.M.C.,
administering plasma to a
casualty. Basly, France, 27
June 1944.*

early July, "the time lag was 2-3 hours, nearly all cases under 6 hours. These cases were, on the whole, easy to resuscitate and did well before, at, and after operation. When the front opened out and our cases started arriving 12-16-24 hours after wounding, they were difficult to resuscitate," and the fatality rate rose as a result. There was, however, an ironic anomaly associated with time lag, as some of those more seriously wounded early in the campaign made it to the advanced surgical centre only to die there, while later they succumbed to their injuries while in transit and thus did not figure in the centre's death statistics.

As battles increase in intensity, so does confusion, and commanders cannot always ensure their resources are used to best effect. Number 7 Field Transfusion Unit seems to have fallen victim to this phenomenon, complaining that "On the whole it was felt that in general not enough use was made of the high mobility of the FTU in contrast to the parent unit."⁴⁴ Meanwhile, some five to ten miles away, other CCSs were working to capacity with overworked resuscitation personnel. One of the latter, Number 6 FTU, concluded that two particularly busy periods "made one thing obvious, that an FTU is grossly under staffed and must draw, at times very heavily, on the parent unit for extra hands which includes, without equivocation, at least one nursing sister by day and one by night."⁴⁵

One important reason why FTUs were so busy was due to the increased generalization that was affecting the RCAMC as a whole, so that these units dispensed not only blood and plasma, but

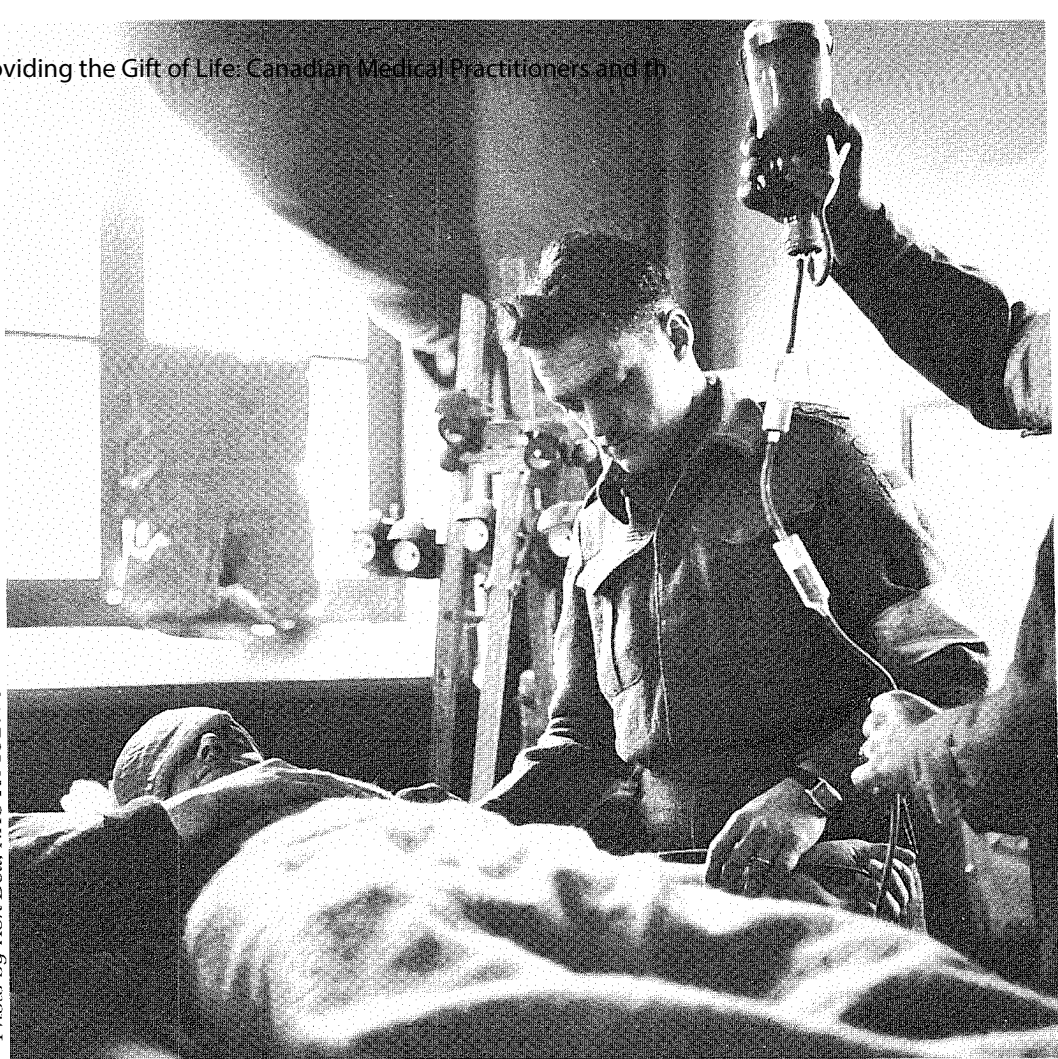


Photo by Ken Bell; NAC PA 132723

also penicillin, anti-gas gangrene serum, tetanus toxoid, alkaline solution for those with large tissue wounds, and morphine.⁴⁶ Just administering these narcotics, medicines, and fluids required "for that sole purpose alone one pair of skilled and speedy hands,"⁴⁷ according to Number 6 FTU; and though resuscitation was becoming less of a specialty, it still required highly knowledgeable personnel. The above unit, in perhaps an overly-harsh assessment, opined that,

The difficulty in trying to employ non-FTU orderlies is painfully clear. They are not properly trained and are, in a relative sense, laymen trying to perform a highly specialized technical duty. Equipment used, though simple, seems to baffle all and sundry including Nurses and a good many Medical Officers. Bearing in mind one cardinal principle underlying forward transfusions – rapidity – the point has been forcibly made that unless medical units required to do much Class I work train their men so that the technical side of IV therapy with its many snags and pitfalls is thoroughly understood, much work will be little short of wasted...⁴⁸

It is perhaps a truism that in war one is always short of the necessary resources and personnel.

The front broke in the Canadian sector in the last days of August, effectively bringing the Normandy campaign to an end as German forces retreated through France and the Low Countries. By then the RCAMC could rely on over a year's experience in the Mediterranean as well as lessons learned in the Canadian army's three most intensive months of the war. Ahead were two major campaigns in Italy as well as operations to clear the Scheldt Estuary in October 1944 and the left bank of the Rhine in February and March 1945. In the course of these battles some procedures were determined more by logistics than by strict medical considerations; for example, Number 7 FTU noted that in January 1945, when the Canadian front was relatively static, more whole blood was used, as "the casualties being treated were from the odd patrol, or accidental. In any case, very sporadic. Under such circumstances there was no advantage to be gained from using plasma and allowing blood stocks to go out-of-date."⁴⁹ In the Rhineland battles that followed, however, "a higher ratio of plasma was used, as the casualties came in batches and in addition, a large quantity of plasma was used in the post-op care of abdominal cases."⁵⁰ By early 1945 practitioners had still not agreed whether whole blood or plasma was best. All agreed that both should be plentiful, to the point where, at least where whole blood was concerned, "wastage should be in excess of that used."⁵¹ If necessary, medical personnel could also act as donors, and field ambulances, which stocked plasma exclusively, could also rely on their own people to donate whole blood if need be.⁵²

Whichever of the life-giving fluids was used, the result was to alleviate the symptoms of shock, a major challenge not only because of its frequency on the battlefield but also because it:

continues to be a puzzling problem at times. Casualties in whom wounding appears not to be serious enough to cause death terminate fatally while others recover when according to all rules they should not. The above adds a fascination [sic] to this work which might otherwise become a dull and monotonous routine of sticking needles into veins and watching blood pressures rise...⁵³

Patients might have had a different perspective. Within field ambulances, who were the first to minister to a wounded soldier, "the basic principle of treatment...is the assumption that every wounded soldier is a potential case of shock."⁵⁴ If the diagnosis was rather simplified, the procedure that followed had reached a high level of sophistication. As soon as the casualty's blood pressure reached 100, he was deemed ready for transport with a travelling transfusion, ambulance orderlies being trained in its use. For a time, Number 11 Field Ambulance only gave one bottle to a patient, as a field surgical unit and resuscitation unit were nearby, though a second bottle was often started during evacuation just in case.⁵⁵

As the war neared its end the pace of operations increased. I Canadian Corps transferred from Italy, so the Canadian army liberated the Netherlands in April operating with all five Canadian divisions. The first five days of April marked "the end of the toughest, most exacting phase in our experience"⁵⁶ for Number 6 FTU. "Consumption of transfusion stocks, particularly blood, was enormous." For Number 10 Field Surgical Unit, the speed of the advance led to poor working conditions that "did not facilitate rapid resuscitation and it is felt that in some instances operation was too long delayed on this account. Liquid plasma was not available during the month and numerous reactions resulting from the use of dry plasma were noted. Blood, especially during the latter part of the month carried borderline or questionable dating, and again reactions were much more frequent than we have heretofore encountered."⁵⁷ April 1945 was the unit's busiest month of the conflict.

For the Canadian army, the Second World War ended on 4 May 1945 with the surrender of German forces in the Netherlands. The peace that followed was broken in June 1950 when North Korea invaded its southern neighbour. By early 1951 Canada was sending troops to South Korea. A Canadian field surgical team joined the US 8055th Mobile Army Surgical Hospital (MASH). As for the use of blood products, little changed from the last months of the Second World War, as Major R. Pillsbury of the 43rd MASH made clear in a talk to the medical officers of the 25th Canadian Brigade Group. "He recommended that blood be administered cold rather than warm to

Royal Canadian Army Medical Corps Major B. Dave Jaffey and RCAMC medical aid L/Cpl. Bob Berry (r.) give blood plasma to soldier of the Royal Canadian Regiment suffering multiple wounds received during a patrol in Korea, June 1952.

prevent multiplication of any contaminant bacteria, and warned against the risk of Infective Hepatitis from plasma,"⁵⁸ and little more. Units also emphasized getting blood as far forward as feasible, Number 37 Canadian Field Ambulance insisting "that with some seriously wounded patients early transfusion with whole blood at the RAP would be extremely beneficial."⁵⁹ This did not mean that blood had to be stored that close to the front. Instead, a local American forward clearing post supplied the Canadians with blood in an emergency, since delivery would require only about 15 minutes.

As for the choice between whole blood and plasma, given some of the difficulties the former had caused in the Second World War it is ironic that in Korea it was the latter that proved problematic. A field ambulance unit reported in September 1952 that:

During those occasions when it was necessary to give plasma to seriously wounded patients, difficulty was encountered practically every time in getting all the plasma completely dissolved in homogeneous state. As a result small lumps of fatty material remained in the solution which eventually blocked the delivery tubing and stopped the transfusions. 5 different batches of plasma have been used with the same result. Latterly plasma strained through muslin has been used but this is a time consuming process. It is hoped that Dextran will soon be available.⁶⁰

Dextran was perhaps the most important development in the area of blood research during the Korean War. As Number 25 Canadian Surgical Team, working at the 8055th MASH, explained, Dextran was not, in fact, a substitute for plasma, but helped increase its volume by drawing fluid into the blood stream, tiding a patient over until blood was available. Studies done by American researchers at the 8055th MASH concluded that Dextran "may prove to be very useful in future resuscitative measures...Their interest was aroused mainly because of the ever increasing possibility of a large scale war in which case adequate supplies of plasma and whole blood



Photo by Paul E. Tomelini; NAC PA 129738

would not be available. This would be especially true in event of a large number of casualties from Atomic explosion or any disaster causing extensive burns or body trauma."⁶¹

Thankfully, the mass casualties from nuclear war the American researchers considered possible never came to pass. Though the RCAMC had to prepare for such a terrible eventuality, it saw no need to radically change its organization and procedures surrounding resuscitation, the latter having become common knowledge within the medical profession as a whole, civilian as well as military. One can note the lack of specialist transfusion units in Korea, the move being an obvious result of such generalization; with nearly all doctors, nurses, and medical assistants able to deal with the symptoms of shock, specialists in that field had become obsolete. A concomitant development was the availability of blood products ever further forward, so that, ironically, the very battlefields where lives were being taken in large numbers were also sites where a few lives could be saved.

Notes

The author would like to thank Kim Pelis of the Uniformed Services University of the Health Services, who helped eliminate certain embarrassing errors from this study. Any remaining mistakes are, of course, the fault of the author.

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2. NAC MG 30, D187, v.35, f.7, Orville F. Denstedt, "The Evolution of the Clinical Use of Preserved Blood," *Medical Meetings, Montreal Physiological Society*.
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4. Norman Guio, *Transfusion: A Canadian Surgeon's Story in War and Peace* (Yarmouth, 1985), p.29.
5. NAC MG 30, D187, v.35, f.7, Orville F. Denstedt, "The Evolution of the Clinical Use of Preserved Blood," *Medical Meetings, Montreal Physiological Society*.
6. Guio, p.30.
7. *Ibid.* p.31.
8. *Ibid.* pp.34-35.
9. *Ibid.* p.36.
10. *Ibid.* p.36.
11. *Ibid.* p.43.
12. NAC D187, Sise Papers, v.35, f.7, Orville F. Denstedt, "The Evolution of the Clinical Use of Preserved Blood," *Medical Meetings, Montreal Physiological Society*, p.90.
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15. *Ibid.* p.31.
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17. *Ibid.* p.53.
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37. NAC RG 24, v.12,592, 11/4 FDS/1, Reports by Officers Commanding Medical Units, 4 Cdn Field Dressing Station, 1 July - 30 September 1944.
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43. NAC RG 24 v.12,596, 11/4 FTU/1, Quarterly Report, 30 September 1944.
44. NAC RG 24 v.12,596, 11/7 FTU/1, Quarterly Report, 30 September 1944.
45. NAC RG 24 v.12,596, 11/6 FTU/1, Quarterly Report, 30 September 1944.
46. *Ibid.*
47. *Ibid.*
48. *Ibid.*
49. NAC RG 24 v.12,596, 11/7 FTU/1, Quarterly Report, 31 March 1945.
50. *Ibid.*
51. NAC RG 24, v.12,593, 11/18 Fd Amb/1, 18 Fd Amb, Quarterly Report, 31 March 1945.
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53. NAC RG 24, v.12,596, 11/5 Cdn Fd Transfusion Unit, Quarterly Report, 31 December 1944.
54. NAC RG 24, v.12,617, 11/17 Lt Fd Amb/1, Quarterly Report, 31 March 1945.
55. NAC RG 24, v.12,593, 11/11 Fd Amb/1, 11 Fd Amb, Quarterly Report, 31 March 1945.
56. NAC RG 24 v.12,596, 11/6 FTU/1, Quarterly Report, 30 June 1945.
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58. NAC RG 24, v.18,393, 38 Fd Amb, 11 June 1953.
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60. *Ibid.*
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Bill Rawling is an historian at the Directorate of History and Heritage, National Defence Headquarters, Ottawa, Ontario. He is the author of *Surviving Trench Warfare: Technology and the Canadian Corps, 1914-1918*. He is currently finishing a book on the history of military engineers and is seeking funding to publish it.