

The University of Toronto's lasting contribution to war surgery: how Maj. L. Bruce Robertson fundamentally transformed thinking toward blood transfusion during the First World War

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SUMMARY

During the Great War, Canadian military surgeons produced some of the greatest innovations to improve survival on the battlefield. Arguably, the most important was bringing blood transfusion practice close to the edge of the battlefield to resuscitate the many casualties dying of hemorrhagic shock. Dr. L. Bruce Robertson of the Canadian Army Medical Corps was the pioneering surgeon from the University of Toronto who was able to demonstrate the benefit of blood transfusions near the front line and counter the belief that saline was the resuscitation fluid of choice in military medicine. Robertson would go on to survive the Great War, but would be taken early in life by influenza. Despite his life and career being cut short, Robertson's work is still carried on today by many military medical organizations who strive to bring blood to the wounded in austere and dangerous settings. This article has an Appendix, available at canjsurg.ca



L. Bruce Robertson next to a Canadian Red Cross vehicle, circa 1915–16. L. Bruce Robertson fonds, F 1374, Archives of Ontario, I0050290.

of every British subject to volunteer and support the war effort. Within Canada, Toronto was a hotbed of pro-British sentiment, and the University of Toronto's Faculty of Medicine was no exception. By the spring of 1915, the University of Toronto had created the No. 4 Canadian General Hospital, which was a fully equipped and staffed 1040-bed hospital (see Appendix 1, available at canjsurg.ca, for a full description). In addition to this institutional contribution, many Toronto medicine alumni volunteered, including such medical luminaries as John McCrae, Frederick Banting and Norman Bethune, whose lasting accomplishments are now part of the Canadian legend. McCrae, Banting and Bethune all volunteered to serve Canada in the Great War, the latter 2 as medical students from the class of 1916.

One of the most important medical advances was made by a University of Toronto surgeon during the Great War, and this contribution to war surgery and medicine is often overlooked.¹ Specifically, the use of transfusion of fresh whole blood for the treatment of hemorrhagic shock, as championed by

In the spring of 1914, the prospect of a war between Great Britain and Germany loomed as a likely possibility. This possibility turned to certainty with the German invasion of Belgium. When Great Britain declared war on Germany on Aug. 4, 1914, the ramifications were felt throughout the British Empire, including in the Dominion of Canada. It was widely seen as the patriotic duty

Dr. L. Bruce Robertson is often relegated to a footnote in medical history, but this advance was pronounced “the most important medical advance to come from the First World War” by the Royal Army Medical Corps (RAMC).² Robertson’s pioneering work in the field and his fierce advocacy for its use on the front lines continues to have ramifications both in present-day trauma centres as well as on the modern battlefield. This article will summarize his work, which has been expertly and extensively reviewed in a series of articles by Pinkerton^{3,4}

Born in Toronto in 1885, Lawrence Bruce Robertson, who went by his middle name, studied medicine at the University of Toronto and graduated in 1909. He then went on to pursue a 1-year surgical internship at The Hospital for Sick Children. The next step in his studies was pivotal, as he travelled to Bellvue Hospital in New York. During his 18 months there, he trained with Dr. Edward Lindeman, who had developed a multiple syringe technique for blood transfusion.⁵ At this time, transfusion techniques were still in their infancy, with some advocates requiring a direct donor (artery) to recipient (vein) vascular anastomosis.⁶ Since then, other methods had been attempted and refined, including Lindeman’s technique. Following his stint with Lindeman in New York, Robertson then went to Boston to complete his surgical training, armed with this newly acquired familiarity with blood transfusion techniques.

Robertson returned to Toronto and took up a staff position at The Hospital for Sick Children in 1913. He continued to practise transfusion (considered a surgical procedure at the time) using a systematized approach. Indeed, after his arrival at The Hospital for Sick Children, he and his colleague Dr. W.E. Gallie began performing blood transfusions in a series of surgical patients.⁷ Upon the declaration of war against Germany, Robertson’s response was immediate; his commission is dated Aug. 5, 1914, the day after war was declared, and is evidence of Robertson’s patriotic fervour.

Despite his early eagerness, he was not deployed overseas until April 1915, when his unit, No. 2 Canadian Casualty Clearing Station, arrived first in England and moved on to Aire, France, in September of the same year. Almost immediately after his arrival in France, he was seconded to a British unit near Boulogne, No. 14 General Hospital, commencing Oct. 5, 1915. It was here that the impact of Robertson’s contribution became evident.

At this point, the practice of blood transfusion had been developed and gained acceptance as a life-saving

intervention among the civilian American surgical community. However, it was not well received and was even denigrated within the prevailing British surgical thinking. The *British Medical Journal* had gone so far as to publish a review stating that “surgeons, we imagine, will find no good reasons ... for abandoning the safe and simple method of saline injection.”⁸ Thus, Robertson found himself in a unique position. As the Americans did not enter the war until April of 1917, the predominant attitude in most Allied military units was to rely on saline as a resuscitative fluid. Robertson’s familiarity with blood transfusions allowed him to be the first to demonstrate the benefits of blood transfusion on the battlefield. Indeed, one could argue that this is yet another example of a historical Canadian advantage that facilitated the

confluence of ideas between the receding British Empire and the rising American superpower. By virtue of its geographic proximity to the United States and its cultural and political ties to Great Britain, Canada has been able to benefit from both societies.

In typical fashion, Robertson lost no time and performed his first blood transfusion on Oct. 30, 1915. He published a case series of 4 patients who received uncrossmatched blood transfusion as a proof of concept

in 1916.⁹ One of the patients in this series died from what was likely an acute hemolytic reaction. Although Robertson initially argued that the risks associated with using uncrossmatched blood were outweighed by the acute need for blood transfusion in cases of hemorrhagic shock, he would later moderate his stance to recommend test injections of blood before larger volume transfusion. As the war continued, Robertson rejoined No. 2 Canadian Casualty Clearing Station, was then seconded to another British unit, and finally returned to his home unit for the remainder of his service in the war. During his time at the Western Front, Robertson treated Allied forces from the sites of several famous and horrifying battles, including Ypres and Passchendaele. Robertson continued to advocate the importance of and practise blood transfusion, publishing further papers on the subject in 1917.^{10,11} One of these articles, which was published in the *British Medical Journal*, summarized a further series of 68 patients in whom blood transfusion was used.¹⁰ The effects on patient outcomes were outstanding and galvanized interest among the British medical community in blood transfusion. A commentary by Col. C. Watson on the importance of Robertson’s work accompanied the article:



L. Bruce Robertson (centre) operating circa 1917.
L. Bruce Robertson fonds, F 1374, Archives of Ontario, 10050276.

The stimulus of war and the urgent need for blood transfusion has resulted in greater familiarity with the technique. For many years past we have, in England at any rate, trusted to saline infusion to restore the balance after haemorrhage. So far as my experience goes, there is no comparison between the results of blood transfusion and saline infusion. The effects of blood transfusion are instantaneous and usually lasting; the effects of saline too often transitory — a flash in the pan — followed by greater collapse than before. Many cases admitted in an inoperable condition from severe haemorrhage have been rendered operable by blood transfusion.

In discussing hemorrhagic shock, the Surgeon General of the British RAMC cited Robertson's work and stated that "The main advance in treatment has consisted in a return to the practice of transfusion of whole blood ... For the popularization of this method, we are mainly indebted to our Canadian colleagues in France."¹² Taken together, these comments illustrate the profound impact of Robertson's work and how it completely transformed the opinion of the time. Only 10 years earlier, commentaries in the *British Medical Journal* derided the practice of transfusion; after Robertson's work, blood transfusion was recognized as a life-saving treatment for traumatic hemorrhage. Robertson had been overseas for only 2 years at this point, though the murderous nature of the Western Front provided him with more than enough clinical cases to argue his point. Thanks mostly to Robertson's continued work on transfusion on the Western Front and his ongoing scholarly publications of his results, the RAMC adopted transfusion as standard practice.

In December 1917, Robertson was invalided home, bringing his wartime experience to an end. After the war ended in 1918, Robertson returned to his surgical practice at The Hospital for Sick Children and continued to practise and study blood transfusion. His life was tragically cut short 5 years later in 1923 when he died from pneumonia as a complication of influenza. He was 37 years old.

Despite his early death, Robertson's legacy was profound. Blood transfusion for traumatic hemorrhage continued to be practised after the Great War. During the Spanish Civil War, a centralized blood transfusion service was organized under the direction of Dr. Norman Bethune, another First World War veteran and University of Toronto Medical graduate. Blood transfusion continues to be the cornerstone of modern trauma management to this day and, not surprisingly, "what is new is old, and what is old is new." The importance of having a walking blood bank was reintroduced to the Canadian Forces Health Services in 2006 while Canada was fielding a combat hospital in Afghanistan. Recently, a permanent Canadian Forces Blood Program was created to support Canadian operations globally. One hundred years after Robertson's transformative studies, the

importance of blood products for resuscitation close to the battlefield is still paramount, and Canada is still making contributions to the study of hemorrhagic shock and resuscitation.^{13,14}

During the First World War, the University of Toronto's Faculty of Medicine and Department of Surgery contributed both institutionally and individually to the war effort. One of those individuals, L. Bruce Robertson, almost single-handedly changed the management of combat casualties by demonstrating the efficacy of blood transfusion for resuscitation of shock due to hemorrhage. He was a dutiful soldier, a skilled surgeon and a determined scientist. Let us remember him.

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References

1. Daubs KA. Canadian kept blood flowing in WWI. An American got credit. *Toronto Star*; 2016 Jul. 9. Available: www.thestar.com/news/insight/2016/07/09/a-canadian-kept-blood-flowing-in-wwi-an-american-got-credit.html (accessed 2017 Apr. 20).
2. Stansbury LG, Hess JR. Blood transfusion in World War I: the roles of Lawrence Bruce Robertson and Oswald Hope Robertson in the "most important medical advance of the war". *Transfus Med Rev* 2009;23:232-6.
3. Pinkerton PH. Canadian surgeons and the introduction of blood transfusion in war surgery. *Transfus Med Rev* 2008;22:77-86.
4. Pinkerton PH. Canada's transfusion medicine pioneer: Lawrence Bruce Robertson. *Transfusion* 2001;41:283-6.
5. Lindeman E. Simple syringe transfusion with special cannulas, a method applicable to infants and adults. *Am J Dis Child* 1913;6:28-32.
6. Carrel A. Anastomosis and transplantation of vessels. *Am Med* 1905 10:329-332.
7. Gallie WE, Robertson LB. Pyloric stenosis in infants. Presentation to Ontario Medical Association. June 1916. Archives of Ontario, Bruce Robertson fonds. F1374.
8. The transfusion of blood. *BMJ* 1907;2:1006-7.
9. Robertson LB. The transfusion of whole blood: a suggestion for its more frequent employment in war surgery. *BMJ* 1916;2:38-40.
10. Robertson LB. Further observations on the results of blood transfusion in war surgery, with special reference to the results in primary haemorrhage. *BMJ* 1917;2:679-83.
11. Robertson LB. Further observations on the results of blood transfusion in war surgery: with special reference to the results in primary haemorrhage. *Ann Surg* 1918;67:1-13.
12. Makins G. The development of British surgery in the hospital on the lines of communication in France. *BMJ* 1919;1:789-92.
13. Brisebois R, Hennecke P, Kao R, et al. The Role 3 Multinational Medical Unit at Kandahar Airfield 2005-2010. *Can J Surg* 2011;54:S124-9.
14. Beckett MA, Callum J, da Luz LT, et al. Fresh whole blood transfusion capability for Special Operations Forces. *Can J Surg* 2015;58(Suppl 3):S153-6.