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Summary

Trauma care has evolved similarly in the United States and Canada over the last 3 decades. Like much of modern trauma care, management of vascular trauma has been influenced by combat surgery experiences in recent wars. The American Association for the Surgery of Trauma sponsored the Prospective Observational Vascular Injury Treatment (PROOVIT) registry to document changes in the treatment of vascular trauma and determine outcomes in the US. However, differences in trauma populations and trauma systems between Canada and the US need to be considered. Here we compare the vascular trauma experience at a Canadian level I trauma centre over a 5-year period to the data in the PROOVIT registry.

Data from the United States (US) are often applied to Canada because of similarities between the 2 countries. Trauma care has also evolved in a similar manner in the 2 countries over the last 3 decades. Recent conflicts have required deployed surgeons to address a wide variety of vascular injuries. Canadian surgeons treating trauma patients in Kandahar, Afghanistan, reported more than 100 vascular repairs between 2005 and 2010.[1] This has led to the greater use of tourniquets, intravascular shunts and other damage-control techniques in combat surgery. Noncompressible torso hemorrhage experienced in these conflicts encouraged interest and research into endovascular techniques. Ultimately, war has changed the way military surgeons treat vascular trauma.[2]

Many of the lessons learned have been analyzed at influential meetings, such as the Canadian Surgery Forum and the annual congress of the American College of Surgeons, as well as published in high-impact peer-reviewed surgical journals. This has resulted in the reorganization of trauma care using systems modelled on the military program that was known as the Joint Theatre Trauma System. Surgeons with deployed experience have returned home to civilian trauma practices, where techniques pioneered in Afghanistan and Iraq have been introduced. There have even been efforts to introduce the military concept of buddy care to the prehospital civilian environment with programs such as Stop the Bleed.

However, significant differences exist between the populations at risk, the environments for care, and resources available in combat zones and in North America. Most of the changes to trauma care were made without the benefit of comparative clinical trials. In the military environment, prospectively collected data in the Joint Theatre Trauma Registry were used to monitor care and outcomes. In the US, the American Association for the Surgery of Trauma (AAST) sponsored the Prospective Observational Vascular Injury Treatment (PROOVIT) registry to document changes in the treatment of domestic vascular trauma and to monitor outcomes. The PROOVIT registry collects demographic, diagnostic, treatment and outcome data from 14 American level I and level II trauma centres.[3] While PROOVIT is a comprehensive attempt at monitoring how the civilian use of tourniquets and damage-control techniques affect outcomes such as amputation rate and mortality, the question remains: Do these data apply to Canada?

Considerable differences exist between Canada and the US regarding patterns of injury and availability of trauma care resources. In particular, US trauma centres are more likely to received gun-related, penetrating traumas than Canadian centres,[4] and specifically trained trauma staff surgeons are more likely to be in house in US centres. How should Canadian trauma programs use PROOVIT data to plan, and how should Canadian trauma surgeons use them to guide their practice? And, if vascular surgeons are more likely to care for vascular trauma in Canada, how should our general surgeons be trained? With the centralization of vascular surgery resources, what skills should a community general surgeon have to deal with vascular injury?

We retrospectively reviewed the cases of all patients with traumatic vascular injury at London Health Sciences Centre (LHSC), a Canadian level I trauma centre. We searched the LHSC medical records for all patients with the International Statistical Classification of Diseases and Related Health Problems (ICD) codes for vascular injury for the period of Jan. 1, 2011, to Dec. 31, 2015. All adult trauma patients with injuries to named arterial or venous vessels in the legs, arms, torso and neck were included. It should be noted that, as a retrospective search, this strategy may have inadvertently excluded certain types of injuries; e.g., a middle colic artery injury coded as a colonic injury. These are the same inclusion criteria used in the PROOVIT registry, chosen to allow for the most direct comparison possible. We could then compare these data to those available from the PROOVIT registry for 2013–14. This would give us some context with which to comment about our Canadian experience with vascular trauma.

Patients in both jurisdictions were of similar age and sex: 40.8 v. 37.7 years and 70.1% v. 70.5% male at LHSC and in the US, respectively (Appendix 1, available at www.canjsurg.ca/002317-a1). The mean Injury Severity Score was similar between the LHSC and the US (21.8 v. 20.7), as was the rate of hypotension on admission (11.3% v. 11.8%). However, the number of patients with ISS greater than 15 was higher at LHSC (63.3% v. 32.1%).

The populations differed with respect to mechanism of injury. LHSC patients were more likely to have had a blunt mechanism of injury (61.4% v. 47%); motor vehicle crash was the most common mechanism of blunt injury in both populations (33.1% v. 28.0%). In contrast, the most common penetrating mechanism was stabbing at LHSC (18.1%) and gunshot in the US (23.8%). Our review confirmed the reputation for gunshot trauma occurring more often in the US than Canada.

The use of tourniquets differed significantly between the 2 populations. Prehospital tourniquets were less likely to be deployed at LHSC (12.2% v. 22.2%). In PROOVIT, 25% of cases lacked documentation of tourniquet time and 40.4% of tourniquets were on for less than 1 hour. Only 1 tourniquet application time was formally recorded in the LHSC data. Given that there may be longer transfer times in Canada owing to its geographic realities, documenting tourniquet application times and monitoring outcomes is important.

Some peripheral arterial injuries can be controlled safely with direct pressure; however, military protocol such as Tactical Combat Casualty Care, which may have wider adoption in the US, promotes liberal use of tourniquets because they have been shown to be effective and safe.[5] Documenting tourniquet times is essential to good patient care and program planning. Military patients are usually airlifted quickly to a surgical facility.[6] If civilian tourniquet application times are consistently longer, then the algorithm for civilian tourniquet use will likely differ from that in the military. Implementation of an effective tourniquet protocol will require education and buy-in from our prehospital care providers and front-line clinicians.

Thirteen different subspecialty disciplines were involved in managing patients with vascular injuries (Table 1). Vascular surgeons managed the majority of vascular trauma at LHSC, with only 3 injuries in 5 years being repaired by a trauma fellowship–trained surgeon. This may be very different than in US trauma centres, where vascular injuries may be repaired by trauma surgeons who are often stationed in house when on call. LHSC's lack of intravascular shunt use may be related to vascular surgeons' comfort with definitive repair, whereas trauma surgeons may practise a damage-control approach.

In Canada, the availability of vascular surgeons in community hospitals has declined as endovascular care becomes more popular and vascular surgeons become more centralized. This trend will require Canadian community general surgeons to also become responsible for damage-control vascular surgery. A community surgeon must be able to temporize or treat a patient with vascular

Table 1. Disciplines of physicians who managed the vascular injuries included in the chart review

Discipline	No. of patients (n = 127)
General surgery	9
Trauma surgery	3
Vascular surgery	77
Orthopedic surgery	2
Thoracic surgery	3
Cardiac surgery	2
Plastic surgery	11
Otolaryngology	3
Urology	1
Gynecology	1
Neurosurgery	2
Interventional radiology	11
Neurology	2

trauma to be able to transfer them to a trauma centre. This would suggest that vascular training of general surgeons should be to a high standard. In this data set, most vascular trauma was managed by vascular surgeons, 40% was managed with endovascular or nonoperative techniques, and only 9% was managed by general surgeons. Will a graduating general surgeon be comfortable performing damage-control vascular surgery in the community? Will they have had sufficient exposure during their training to open damage-control techniques?

The American College of Surgeons offers the Advanced Surgical Skills for Exposure in Trauma (ASSET), Advanced Trauma Operative Management (ATOM), and the Basic Endovascular Skills for Trauma (BEST) courses, which use cadaveric, porcine, perfused cadaveric and non-tissue models, to teach different trauma vascular skills and exposures. We piloted a damage-control vascular surgery course for military general surgeons that was well reviewed by participants who have since deployed and used these skills overseas. Familiarity with vascular exposures and repairs could also be obtained via experience in non-trauma services such as transplant surgery. General surgeons may still be on the front lines of vascular trauma; our surgical education programs should find creative ways to get them the skills they need.

The LHSC retrospective data and the PROOVIT registry show similar amputation rate and mortality. This suggests that we are providing comparable care, despite the differences in practice and trauma systems. That is not to say that we cannot learn from each other to further improve our care.

Trauma patients deserve high-quality care guided by evidence. Emergency care is a difficult environment in which to conduct randomized controlled trials. Registry data are often the best available to test the effect of interventions on the outcome of trauma care. For instance, the PROOVIT registry is being used to evaluate the use of vascular shunts in the US; we found no instance of vascular shunt use in our cohort.[7] If the PROOVIT registry data demonstrate efficacy of shunts and tourniquets in damage-control vascular surgery, these techniques could be more widely used in Canada. While it is important that we learn from military and US registries, we believe it is essential for Canadian programs to adapt our own trauma registries to verify the applicability and generalizability of lessons learned for our population. Our training programs must evolve to give our graduates the tools they need to provide care in the Canadian trauma environment.

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