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Dedicated to the memory of Major (Ret.)
Christine Simard (1966–2009); Canadian
Forces general surgeon who served
4 times in Afghanistan.

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In late 2005, Canadian Forces Health Services (CFHS) was tasked with the command of the NATO Role 3 Multinational Medical Unit (R3MMU) on Kandahar Airfield in southern Afghanistan. Preparations drew on past experience and planning. Eight complete hospital contingents were trained and deployed in rotation. Near-reality simulation training was undertaken with the combat brigade, including complete deployment of the field hospital in the exercise area. Standard operating procedures (SOP) were developed and applied by each rotation so successfully that they were adopted by the new command in late 2009. The Canadian period at R3MMU had the highest survival rate ever recorded for victims of war. Lessons learned are being applied among victims of the conflict and trauma. The experience of the R3MMU was used to successfully deploy a hospital as part of the earthquake relief effort in Haiti in 2010. The training protocols and SOP are being applied to disaster preparedness in Canadian civilian hospitals.

Vers la fin de 2005, les Services de santé des Forces canadiennes (SSFC) ont eu pour mission de prendre le commandement d'une unité médicale multinationale de rôle 3 (UMMR3) de l'OTAN installée au Terrain d'aviation de Kandahar, dans le sud de l'Afghanistan. L'expérience passée et une bonne planification ont facilité les préparatifs. Huit contingents hospitaliers complets ont été formés et déployés en rotation. Des séances d'entraînement en simulation quasi-réelle ont été entreprises avec la brigade de combat, y compris le déploiement complet de l'hôpital de campagne dans l'aire d'exercice. On a mis au point des procédures normalisées de fonctionnement (PNF) qui ont été appliquées à chaque rotation avec tant de succès que le nouveau commandement les a adoptées à la fin de 2009. La période canadienne de l'UMMR3 a produit le plus haut taux de survie jamais enregistré chez des victimes de guerre, et les leçons tirées de l'expérience sont maintenant appliquées chez les victimes de conflits et de traumatismes. L'expérience de l'UMMR3 a aussi servi de base au déploiement réussi d'un hôpital de campagne pour le secours aux victimes du tremblement de terre à Haïti, en 2010. Les protocoles de formation et les PNF servent désormais à la préparation aux catastrophes dans les hôpitaux civils canadiens.

Since August 2003, Canada has been 1 of 41 countries participating in the International Security Assistance Force (ISAF), a North Atlantic Treaty Organization (NATO)-led formation that operates in Afghanistan under the authority of the United Nations.¹ The ISAF was created in 2001 after the fall of the Taliban regime, and it became a NATO mission in August 2003. Its primary objective is to help the Afghan government establish a stable and secure environment that will allow sustainable reconstruction, development and good governance to take root and flourish. The ISAF mandate was initially limited to providing security in and around Kabul, but in October 2003, the United Nations extended the mandate to cover the whole of Afghanistan (UN Security Council Resolution 1510).²

The ISAF began expanding across Afghanistan from its initial base in and around Kabul in 2005, and since then Canada has conducted operations in the southern province of Kandahar. The new role includes leadership of a combat mission, a mentoring mission and responsibility for the principal military hospital in the region. Canada's military medical services were to provide comprehensive medical services to combat troops and to all victims of conflict on a scale not seen since the Korean War. Transition to the new role was unexpected and swift.³

In 1959, the Canadian Forces Health Services (CFHS) was formed by the union of the Royal Canadian Army Medical Corps and the medical services of

the Royal Canadian Air Force and the Royal Canadian Navy.⁴ 1 Canadian Field Hospital, a unit of CFHS, had deployed fully during the First Gulf War (1990–1991), and had deployed surgical detachments to the former Republic of Yugoslavia (1993–1996) and to Kabul (2003–2005). The principal mission of these deployed surgical teams was to resuscitate and stabilize wounded soldiers and to perform damage control surgery to permit evacuation.

These surgical detachments would be classified as Role 2+ hospitals. The term “Role” or “Echelon,” is used to describe the stratification of the 4 tiers in which medical support is organized within NATO operations, on a progressive basis, to conduct treatment, evacuation, resupply and functions essential to the maintenance of the health of the force. Role 1 medical support refers to care that is integral or allocated to a small unit (battalion) and includes the capabilities for providing first aid, immediate lifesaving resuscitation and triage. Role 2 support, normally provided at a larger unit level (brigade), is prepared to provide evacuation from Role 1 facilities as well as triage, resuscitation, treatment and holding of patients until they can be returned to duty or evacuated. Normally this level does not include surgical capabilities except for emergency dentistry. However, if the facility is augmented to provide emergency surgery capability, the facility will be often referred to as Role 2+. Role 3 support is normally provided at the division level and above. It includes additional capabilities, such as specialist diagnostic resources, specialist surgical and medical capabilities, preventive medicine, food inspection, dentistry and operational stress management teams when not provided at level 2. Role 4 medical support provides definitive care of patients, usually in the country of origin. Under unusual circumstances, this level of care may be established in a theatre of operations.⁵ Previously, the Canadian Forces (CF) had only deployed Role 2+ facilities on operations in the former Yugoslavia and Afghanistan (Kabul). Now, CFHS deploys and leads a Role 3 facility to support combat operations in southern Afghanistan and to provide care to local civilian victims of the conflict.

RECCE, TRAINING AND DEPLOYMENT

On Sept. 15, 2005, a teleconference was held between the Operations/Mission planners and senior specialist medical officers (called specialist advisers). On Sept. 22, 2005, the advisers used email to brief all the CFHS specialists. A “Recce” (reconnaissance) was completed by the last surgical team in Kabul, and its report was circulated on Oct. 22, 2005. Canada was to be the lead nation commanding and staffing the Role 3 hospital, which would be based at Kandahar Airfield; however, it would be a multinational medical unit and would receive support from military medical teams from several other nations, including the Netherlands, Denmark, the United States, the United Kingdom and New Zealand. The Role 3 Multinational Medical Unit

(R3MMU) was to take over from a surgical detachment of a United States Army Combat Support Hospital that had been deployed under Operation Enduring Freedom.⁶ The mission of the R3MMU was 3-fold: first, to treat coalition soldiers, including Afghan National Security Forces; second, to treat civilians injured as a result of the conflict; and third, to treat any civilians who presented to the hospital with any life-, limb- or eye sight-threatening medical problem that was within the capability of the hospital to treat.

Training and logistical preparation for the R3MMU staff was undertaken by 1 Canadian Field Hospital, based in Petawawa, Ontario. Participants were required to complete 3 aspects of military training:

1. a battle fitness test, including a 13-km march carrying almost 55 lbs of equipment in about 2 and a half hours, a fireman-carry of another soldier for 100 metres in less than 60 seconds, weapons handling and chemical/biological/radiological/nuclear (CBRN) training;
2. theatre- and mission-specific training, including cultural awareness and self defence; and
3. R3MMU scenario training.

Between training sessions, work groups met to review equipment requirements for the new mission. For example, the logistical challenges involved with deploying fluoroscopy and a computed tomography (CT) scanner were identified and solved. In addition, there were significant discussions about required equipment. For example, internal fixation is not standard for battlefield care because wounds are often contaminated, and soldiers can be evacuated home for definitive care; however, definitive care of local patients would require equipment for internal fixation.

THE HOSPITAL

When Canada first assumed command of the R3MMU on Feb. 7, 2006, the facility consisted of an inpatient ward of 11 beds, each one a stretcher mounted on trestles. Three beds were designated high-intensity/critical care, and these were marked only by having a ventilator associated. Basic laboratory support was available, but microbiology was not. Computed tomography was not available initially, though plain film radiography was available. Ultrasonography was available using a portable machine (Sonosite). There were 2 surgical teams, each consisting of 1 general surgeon, 1 orthopedic surgeon, 1 anesthesiologist, 2 operating room (OR) nurses and 2 technicians. Additional medical specialists included a general internist, an oral surgeon and a radiologist. Initially, there was only 1 OR, which contained 2 tables.

Over time, the hospital expanded. By the time the CF handed over command of the hospital to the US Navy on Oct. 15, 2009, the hospital had about 20–30 ward beds and 5–8 high-intensity/critical care beds. The hospital boasted 2 CT scanners, 3 ORs, endoscopy capability, digital radiography and

ultrasonography. The hospital also had a robust blood bank. At hand-over, the hospital medical specialist staff included 2 general surgeons, 2 orthopedic surgeons, 1 neurosurgeon, 1 oral/maxillofacial surgeon, 1 radiologist (with interventional radiology expertise), 1 intensivist-internist and a robust mental health team.

The daily routine of the hospital began with an administrative meeting followed by clinical ward rounds attended by all the clinical staff. One surgical team assumed primary responsibility for the day, but both teams operated if required by the work load. Each section used standard operating procedures developed in training, particularly for mass casualty incidents. Trauma care was provided according to the Joint Theatre Trauma System guidelines.⁷ From Feb. 7, 2006, to Oct. 15, 2009, the R3MMU staff performed 6735 procedures on a total of 4134 patients (Table 1). About one-quarter of these patients were NATO military forces; the majority were Afghan civilians and Afghan security forces.⁸ Combatant survival has increased with each major conflict over the last 100 years. Survival rates at the R3MMU include civilians injured in the conflict as well as combatants. Ninety-eight per cent of coalition soldiers and 95% of local national patients (security forces and civilians) were transferred or discharged from hospital alive. Similar combatant survival rates have been reported from other military medical facilities elsewhere in Afghanistan and in Iraq.⁸

EVACUATION

Canadian casualties were treated at point of injury by Canadian combat medical technicians. Casualty evacuation to the R3MMU was performed using CF armoured ambulances or US army rotary wing aircraft. After stabilization at the R3MMU, critically injured CF members were evacuated to Landstuhl Regional Medical Center (LRMC) in Germany by the US military Critical Care Air Transport (CCAT) teams consisting of a physician with certification in critical care, pulmonology, anesthesiology or emergency medicine; a critical care nurse; and a respiratory therapist. The team is designed to manage up to 3 patients requiring mechanical ventilation or 6 lower-acuity stabilizing patients in a critical care setting during transport. After further stabilization at LRMC, a Canadian critical care transport team evacuated CF members from LRMC to tertiary care trauma centres across Canada using CF aircraft. All transfers were discussed at a weekly teleconference involving all of the centres in theatre and all of the North American receiving centres.

LESSONS LEARNED

Detailed preparation for R3MMU clinical staff

Every CFHS member working at the R3MMU was pre-

pared in Canada for deployment. Baseline clinical competency was achieved according to the CFHS policy of “maintenance of competence” for clinical staff, such that they maintain their clinical skills in high-volume civilian hospitals on an ongoing basis. Many of the CFHS medical and surgical specialists work at tertiary-level trauma centres across Canada. Our experience at the R3MMU reinforced the importance of ongoing maintenance of competence at civilian institutions, not just for the physicians, but also for the nursing staff, including critical care, emergency, ward and OR nurses.

In preparing for deployment, the CFHS then sent its clinical staff to one of its Trauma Training Centres for Intensive Trauma Team Training Courses (ITTTTC). The

Table 1. Surgical procedures performed in the Canadian-led hospital at Kandahar Airfield

Surgical specialty; procedure	No. procedures (% of surgical specialty)
General surgery	
Soft tissue	770 (37.5)
Laparotomy	448 (21.8)
Endoscopy	208 (10.1)
Appendectomy	133 (6.0)
Burn/split thickness skin graft	106 (5.2)
Vascular repair	101 (4.9)
Thoracotomy/sternotomy	51 (2.5)
Tracheostomy	50 (2.5)
Perianal procedures	46 (2.2)
Neck exploration	21 (1.0)
Nerve repair	16 (0.8)
Other	182 (19.7)
Oral/maxillofacial surgery	
Soft tissue	348 (37.4)
Open reduction internal fixation	184 (19.8)
Tracheostomy	86 (9.2)
Dental extraction	42 (4.5)
Eye enucleation	36 (3.9)
External fixation/intermaxillary fixation	34 (3.7)
Neck exploration	18 (1.9)
Orthopedic surgery	
Soft tissue	1739 (52.2)
Open reduction internal fixation	423 (12.7)
External fixation	418 (12.6)
Amputation	227 (6.8)
Fasciotomy	146 (4.4)
Split thickness skin graft	67 (2.0)
Closed reduction	63 (1.9)
Hardware removal	63 (1.9)
Other	154 (4.6)
Neurosurgery	
Craniectomy	156 (57.4)
Soft tissue	59 (21.7)
Spinal decompression/fixation	35 (12.9)
External ventricular drains/shunt	12 (4.4)
Other	10 (3.7)

Note: Procedures were defined by the specialty that would perform the operation in Canada, as surgeons had to perform another specialty's procedures if the specialist was not available.

ITTTTC is a 10-day training program that focuses on multi-disciplinary team skills and the clinical basics of battlefield trauma. It is offered to teams of physicians (including general duty medical officers and specialist surgeons), nurses (including critical care, OR and generalist nurses), physician assistants and some medical technicians immediately before deployment to the R3MMU. The ITTTTC achieves its learning objectives through didactic lectures, case studies and clinical simulations with both surgical skills laboratories (animal/cadaver models) and mechanical human patient simulators. The lectures and case studies focus on building the trauma knowledge base of participants, whereas the surgical skills laboratory and human patient simulators are meant to develop clinical trauma skills.

Finally, the CFHS members prepare for their deployment by participating in military exercises with the group with whom they would deploy using close-to-reality simulation. Field exercise training has played an integral role in Canadian military medical preparation for 100 years. In 1911 in London, Ontario, the Canadian Army Medical Corps held its first exercise, which allowed it to prepare for unimaginably difficult tasks during World War I.⁹ Training was divided into 3 phases: Ex Walking Serpent (introductory), Ex Able Serpent (complex scenario training) and Ex Ready Serpent (validation). This pattern of training was adopted for each subsequent rotation with the exception that the exercise was moved to Alberta and incorporated into the combat training undertaken by the brigade (Ex Maple Guardian). Eight complete hospital teams have been trained and deployed for up to 9 months in rotation. The thorough preparation of the R3MMU clinical staff was an essential factor contributing to the success of its mission. This type of training experience is now being offered to civilian hospitals in Canada to improve emergency preparedness.¹⁰

Preparation for and management of mass casualties

Mass and multiple casualties were common occurrences at the R3MMU. The lessons learned regarding mass casualty management at the R3MMU should influence how mass casualties training is conducted in both the civilian and military settings. The emergency department management and triage of these casualties represented only the initial stages of managing mass casualties. Managing in-hospital resources, such as imaging, laboratory, blood bank, OR, intensive care and stratevac resources, are all critical components that require central coordination to effectively deal with mass casualties.

A mass casualty event at the R3MMU began with notification of the event to the Tactical Operations Centre (TOC). The chain of command was notified immediately, and the efficient call out of the entire medical staff of the R3MMU was conducted. A mass casualty kit was prepared, and key personnel were given specific hats to wear, designating their role in the mass casualty management.

Most importantly, the number and nature of the casualties were communicated to the TOC by the prehospital team, and updates were received regularly. This allowed preparation of the various trauma bays; the 5 trauma bays were reserved for the most critically injured patients. Separate spaces were designated for the less critically injured patients who were stretcher-bound and for the walking wounded. Trauma team leaders and staff were assigned to each of the trauma bays, and personnel were assigned to supervise/assess the walking wounded. In addition, fore-hand knowledge of the number and types of casualties allowed the chain of command to begin emptying the hospital of inpatients and notifying air assets about the possibility of evacuating patients from the hospital to other Role 3 hospitals in theatre or to LRMC in Germany.

On arrival of the casualties, the key manager of the event was the "trauma czar." This person was usually a senior trauma surgeon. Based on the preparations, the trauma czar would direct each patient to the appropriate bay for treatment. As information about each patient's condition and injuries became known, the trauma czar would be updated, he or she would direct an assistant to update a large chalkboard with enough room to list the details and plans for 20 patients. The purpose of the chalkboard was to ensure that all hospital personnel were aware of the plan and prioritization for each patient. Based on this continued feedback of clinical information from the trauma team leaders, the trauma czar decided which patients would be prioritized to have their blood work run first by the laboratory technician; to undergo plain film radiography, ultrasonography or CT scanning first; or to go straight to the OR. In some cases, because of competing demands, the trauma czar might alter the treatment plan for a patient based on an assessment of the total situation; for example, the trauma czar might have decided to send a stable patient with a small penetrating injury to the neck for surgical exploration instead of CT owing to a long backlog of patients needing CT more urgently. In addition, the trauma czar would constantly discuss the situation with the hospital commander, who may have been communicating with other hospitals in the area of operations to take other patients or arranging early evacuation out of Kandahar for some of the injured NATO soldiers.

Another lesson learned during mass casualty situations was that trauma team leaders could not be members of the surgical staff because the surgical team would often disappear to the OR with the first casualties. Therefore, a cadre of well-trained general duty medical officers with training in leading trauma teams was an absolute prerequisite to managing these situations well.

Working outside of the comfort zone

An expanded scope of practice

The R3MMU clinicians often had to work outside the

normal scope of their medical or surgical specialties, as defined in Canada. As such, military clinicians should have as broad a base of training as possible. Most commonly, non-neurosurgeons performed craniectomies for extra-axial bleeding and/or decompression. Later in the mission, neurosurgeons joined the team, increasing the range of surgical options for patients with head injuries.¹¹ Eye surgery was performed by surgeons with general surgical or maxillofacial surgical training.¹² In addition, the complex care of severely burned child and adult civilians was accomplished by general and orthopedic surgeons.¹³

Adapting care to the situation on hand

In many situations, care was adapted to the tactical situation on hand. In many instances, the need for adaptation was anticipated. In 2006, the initial R3MMU staff deployed with a blood bank that consisted only of packed red blood cells and fresh frozen plasma. There was no provision for platelets or cryoprecipitate. In addition, mass casualties could potentially drain the blood bank, leaving the hospital without blood products and no immediate chance for resupply. The CFHS anticipated this situation and deployed with a “walking blood bank.” Volunteers from the deploying CF contingent were identified and screened as potential blood donors before deployment, as per Canadian Blood Services guidelines. In theatre, if fresh whole blood was desired, a camp call-out was made for the walking blood bank. The donors would arrive, receive rapid screening again in theatre and would donate blood for immediate transfusion. Excess blood would be stored.

In other cases, care was adapted as the clinical need was identified or if a problem was noted. No renal replacement therapy was available at the R3MMU or anywhere in Afghanistan. A system of peritoneal dialysis, including the catheters, dialysate recipe and exchange protocol, was improvised and reported.¹⁴ Another example where care was modified was the repair of open fractures in Afghan nationals. External fixation or traction remain the standard of care for open fractures in austere or combat conditions for Canadian soldiers. However, the shortage of hospital beds and the absence of adequate medical care outside the R3MMU led the orthopedic team to adopt a program of early internal fixation and rapid mobilization for Afghan patients.¹⁵ This approach saved many limbs in a society where posthospital care of externalized hardware or care of amputees is difficult. Another reason why Canadian civilian trauma guidelines were modified at the R3MMU was because of long transport times from Kandahar to LRMC, which rendered patients surgically inaccessible for up to 18 hours. The R3MMU surgeons were more likely to perform a laparotomy, splenectomy or extremity fasciotomy because patients could not be observed reliably for clinical changes during evacuation.

Ongoing performance improvement and patient safety efforts

As the trauma centre for the area of operations, R3MMU staff were heavily involved with performance improvement and patient safety (PIPS) efforts. For the R3MMU, this resulted in participation in the US-led Joint Theatre Trauma System and the Joint Theatre Trauma Registry, discussed in more detail in another article in this supplement.⁷ Quality of care was assessed using many different methods, including regular morbidity and mortality rounds, through case discussion during a weekly teleconference involving different echelons of care (including Role 2, Role 3, CCAT, LRMC and North American centres). Lessons learned were quickly processed, and treatment guidelines were changed if necessary. One example of such a process was a review performed at the R3MMU of all prehospital trauma interventions performed on soldiers on the battlefield. This review determined that tourniquets saved lives, whereas needle decompression of presumed tension pneumothoraces occurred for inappropriate indications and was being done incorrectly. This has led to a revision of the training standards for performing needle decompression in the field.¹⁶

CONCLUSION

The CFHS staffed and led the R3MMU from Feb. 7, 2006, to Oct. 15, 2009. During that time, the hospital personnel treated more critically injured casualties than it had since the Korean War. Excellent predeployment training was a key factor contributing to the success of the Canadian-led R3MMU. Important lessons were learned during deployment, including mass casualty management, which may benefit both civilian institutions and future military missions. Flexibility of practice allowed for innovative care and novel solutions, such as the “walking blood bank.” Involvement of all CFHS personnel in performance improvement and patient safety initiatives maintained high standards of care even though care was given in an austere environment. The experience of the R3MMU was used to successfully deploy a hospital as part of the earthquake relief effort in Haiti in 2010. The training and operating protocols developed by the R3MMU are being applied to disaster preparedness and trauma care in Canadian civilian hospitals.

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