The Cost of Providing Health Care to Injured Soldiers in War

Homer C. N. Tien, MD, MSc, Sanjay Acharya, MD, and Dylan Pannell, MD, PhD

Background: As the Global War on Terror progresses, the total health cost for treating wounded soldiers continues to rise. Although some reports have estimated the total cost of soldiers’ health care, no study has attempted to rigorously quantify this amount. We sought to quantify the cost of providing health care to soldiers injured while on duty in a conflict area.

Methods: Retrospective study of all Canadian Forces (CF) soldiers injured in Afghanistan from February 7, 2006, to February 6, 2007. CF trauma registry was used to identify all injured Canadian soldiers and hospitalized at the military field hospital in Kandahar. Financial reports from the Canadian Forces Health Services were used to quantify the cost of providing care to these soldiers in Kandahar at Landstuhl Regional Medical Center and during evacuation back to Canada. Insurance claims paid (as of October 15, 2007) to a third-party insurer by the CF were used to quantify the charges and costs of health care in Canada. All dollar figures are in Canadian dollars.

Results: During the 1-year period, the CF spent more than $24.3 million to provide health care to 1,245 patients at its field hospital in Kandahar. One hundred twenty-seven of these patients were injured Canadian soldiers who required admission to the field hospital. A total of 93 soldiers required evacuation to Landstuhl Regional Medical Center, and of these, 75 required further care at the Canadian civilian hospitals. The CF spent approximately $2.5 million to provide trauma care in Kandahar to its 127 injured soldiers. Caring for 93 wounded soldiers at Landstuhl Regional medical center cost approximately $2.0 million. Air evacuation costs of 75 wounded soldiers back to Canada cost $3.9 million. The CF were charged approximately $2.4 million for further care in Canada for 75 severely wounded soldiers. The estimated actual cost of this care in Canada was $1.4 million.

Conclusions: Estimating the financial cost to properly care for soldiers wounded on overseas duty in the conflict areas is critical for future planning and forecasting. We estimated on average, it costs approximately $20,000 to care for a wounded soldier at a field hospital who is subsequently returned to duty, $42,000 for the case of a wounded soldier treated at an out-of-theater regional referral hospital and subsequently returned to duty, and $113,000 to care for a wounded soldier who is repatriated and finally treated in Canada.

Most of the costs are from establishing and staffing field hospitals in the conflict area and from evacuation costs.

Key Words: Military medicine, Cost, War.

(J Trauma. 2009;67: 376–380)

 Tremendous attention has surrounded the financial cost of conducting the Global War on Terror, including the cost of soldiers’ health care. One report estimated that the lifetime health care of US soldiers deployed to Iraq could cost approximately $650 billion.¹ We analyzed the cost of health care for Canadian soldiers injured in Afghanistan during the 1-year period.

METHODS

Study Population

In February 2006, 2,300 Canadian Forces (CF) soldiers deployed to Kandahar, Afghanistan in support of the Global War on Terror and to prepare for a NATO mission.² A Canadian military field hospital was established on February 7, 2006, at Kandahar Airfield Base in the building previously occupied by the United States Combat Support Hospital. Injured CF members are first treated by medical technicians belonging to one of the three CF primary care medical units and then transported to the field hospital by the US helicopters or by the Canadian ambulances. If required, they are then further evacuated back to Landstuhl Regional Medical Center (the US Army hospital in Germany) by the US Air Force. The final step, if required, is evacuation to the Canadian civilian hospitals by the CF aircraft and medical teams for further care and rehabilitation.

Data Sources

The admission and discharge ledger from the Canadian field hospital was used to identify all patients admitted to the hospital from February 7, 2006, to February 6, 2007. Demographics and injury data of the injured Canadian soldiers were then obtained using the CF trauma registry. This is a local trauma registry established at the field hospital as a quality improvement initiative. Simple demographic information (age and sex), injury data (mechanism of injury and Injury Severity Scores [ISS]), operative procedures, length of stay, and outcomes are recorded. Blood products issued to the field hospital were obtained from the hospital’s blood bank database. The injured Canadian soldiers evacuated to Landstuhl Regional Medical Center and requiring repatriation back to the Canadian civilian hospitals were identified using the Canadian Forces Health Services (CFHS) operational data.

Submitted for publication July 7, 2008.
Accepted for publication March 30, 2009.
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Presented at the Annual Scientific Meeting of the Trauma Association of Canada, April 3–5, 2008, Whistler, British Columbia, Canada.
Tien had full access to all of the study data and takes responsibility for the integrity of the data and the accuracy of its analysis. All of the authors contributed to the design and conduct of the study. Tien performed the data collection and, with Acharya and Pannell, analyzed and interpreted the data. All of the authors participated in the preparation of the manuscript, revised it critically for important intellectual content and approved the version submitted for publication. All authors are serving medical officers in the CFHS.
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DOI: 10.1097/TA.0b013e3181ae80b2
Helicopter evacuation from the battlefield to the field hospital in Kandahar was performed by the US Army. The CF were not charged for this service, and so no estimate of this cost was made. From the finance section of the CFHS, we obtained the total book cost of all field hospital and other health services assets in Afghanistan and calculated 1-year costs using a standard government depreciation policy. Salary costs for hospital, primary care, and prehospital military personnel were estimated using published pay rates and organizational staffing data. We assumed that this total cost of care in Kandahar was equally distributed to all admitted patients. We then calculated costs of caring for the injured Canadian soldiers by stripping out all noninjury admissions and all injury admissions for coalition and Afghan personnel.

Blood products were supplied by the Canadian Blood Services at no charge. However, there remains a societal cost associated with the production of these products. We used the hospital’s blood bank database to obtain the number of units of both packed red blood cells and fresh-frozen plasma (FFP) that were issued to the hospital during the study period. Data were only available for the last 5 months of the study period. We assumed that blood use was consistent for the whole period and estimated the annual blood product usage by the facility. Total cost of blood products used was then calculated.

Canadian soldiers were transported to Landstuhl Regional Medical Centre from Kandahar by the US Air Force teams; again, the CF were not charged for this service, and so we were not able to estimate a cost for this service. The costs incurred at Landstuhl Regional Medical Centre were obtained from the finance section of the CFHS. The cost of all air evacuation missions from Landstuhl Regional Medical Center back to Canada was estimated using the Canadian Air Force and Health Services financial data. Care in Canada was billed back to the CF through a third-party insurance company. Health care charges by civilian hospitals in Canada were therefore obtained by accessing insurance company. Charges were included if claims were paid as of October 15, 2007. We distinguished between charges and costs for caring for these injured soldiers. We assumed that care rendered by the CF in Kandahar and by the US Army at Landstuhl Regional Medical Centre was nonprofit; therefore, the cost-to-charge ratio was assumed to be 1. Likewise, we assumed that no profit was realized by the Canadian Air Force in the air evacuation of casualties from Landstuhl Regional Medical Centre to Canada; therefore, the cost-to-charge ratio was also assumed to be 1. Although Canadian hospitals are all publicly funded, most cost-effective analyses performed within the Canadian health care system still use a cost-to-charge ratio to convert charges to cost. For this study, we used a cost-to-charge ratio of 0.6 to convert charges at the Canadian civilian hospitals to actual costs.

This study was approved by the Surgeon General of the CF and our institutional review ethics board. Descriptive statistics are presented (means ± SD). All p values are two-tailed, and all data were analyzed using SAS software version 8.02 (SAS Institute, Cary, NC). All currencies are in Canadian dollars.

### RESULTS

During the 1-year period, 1,245 patients were seen at the Canadian field hospital. Eight hundred eighty-nine were acutely injured patients and 356 suffered from medical or surgical diseases (Table 1).

One hundred ninety-five of these were the CF soldiers; 68 CF soldiers suffered from medical diseases, whereas 127 were injured. Of the injured, 71% suffered blast injury, 21% suffered blunt trauma, and 8% suffered penetrating trauma. Ninety-seven were evacuated to Landstuhl Regional Medical Center; 93 of these suffered injuries. Seventy-five of these were severely injured enough to require further treatment in the Canadian civilian hospitals. The mean age of these 75 patients was 28 (±5) years and all were men. Sixty-three patients were mildly injured (ISS between 0 and 15); six were moderately injured (ISS 16–24) and six were severely injured (ISS 25–75).

### Costs in Kandahar

The Canadian field hospital was established in an existing hospital building, and so no charges were incurred for constructing, buying, or renting the building. The total book value of the Canadian medical assets brought to the field hospital was $6,858,500 on February 7, 2006. In accordance with federal government accounting practices, only medical assets worth more than $30,000 are depreciated (approximately 15% per year). The rest are considered consumables. As well, the book value of three Canadian military primary care facilities in Kandahar was $886,153.00; these had only consumable items (Table 2).

The overall cost of the drugs used by the Canadian medical facilities in Kandahar during the 1-year period was $3,976,828.10. We were unable to distinguish medication costs for the hospital versus primary care facilities. Of this total, $264,667.20 (6.7%) was spent on recombinant-activated coagulation factor VII (acquisition costs), which was exclusively used to treat exsanguinating trauma patients (Table 2).

One hundred ninety-three units of packed red cells were issued to the Canadian field hospital during the last 5 months of this study period. Likewise, 112 units of FFP were issued to the hospital during the same time. Assuming that blood products were issued at the same rate for the entire year, 463 units of packed red cells and 269 units of FFP would have been needed during the year. The total cost of blood products used in Kandahar was approximately $264,667.20 (6.7%).

### Table 1. Hospital Admissions in Kandahar (February 6–7, 2007)

<table>
<thead>
<tr>
<th>Nationality</th>
<th>Injury</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian forces</td>
<td>127</td>
<td>68</td>
</tr>
<tr>
<td>Coalition forces</td>
<td>241</td>
<td>120</td>
</tr>
<tr>
<td>Civilian contractors</td>
<td>19</td>
<td>126</td>
</tr>
<tr>
<td>Afghan civilians/security forces</td>
<td>502</td>
<td>42</td>
</tr>
<tr>
<td>Totals</td>
<td>889</td>
<td>356</td>
</tr>
</tbody>
</table>

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been issued to the hospital. The average production costs of a unit of packed red cells in Canada in 2006 was $354 (Dr. J. Callum, personal communication, 2008). Likewise, the average production costs of four units of FFP was $875 (Dr. J. Callum, personal communication). Therefore, the total calculated costs of blood products used during the first year in Kandahar was $222,745.75 (Table 2).

One year of salary costs for the Canadian military staff for the hospital was $8,232,366. One year of salary cost for staffing the primary care facilities and prehospital teams was $6,303,996. See Table 2 for a summary of all health care costs from Kandahar. The total 1-year amount spent by the CFHS on health care provision to 1,245 patients in Kandahar was $24,338,588.85. Therefore, the fractional cost of providing treatment to 127 injured CF soldiers in Kandahar was $2.5 million, or approximately $20,000 per injured soldier.

Costs in Landstuhl

Ninety-seven CF members were treated at Landstuhl Regional Medical Center during the study period. Ninety-three of these soldiers had been injured, whereas four suffered from illness. The total cost for treating CF members at Landstuhl Regional Medical Center during the study period was $2,101,539.52. The fractional cost of providing treatment to 93 injured soldiers at Landstuhl was $2,014,878.10, or approximately $22,000 per injured soldier.

Costs for Evacuation From Landstuhl

Two types of the CF aircraft were used to transport injured CF members from Landstuhl Regional Medical Centre: the Airbus A320 (CC150) and the Challenger aircraft (CC144). Based on 14 flying hours for the Airbus and 18 flying hours for the Challenger, the average cost of a 3 day Airbus mission to Landstuhl Regional Medical Center from Canada was $245,574.63. A 3-day Challenger mission was $201,734.63. The costs were slightly higher if a critical care capability was required: $250,611.93 and $206,771.93 for the Airbus and the Challenger, respectively.

During the study period, 23 air missions were conducted to transfer 75 wounded CF members from Landstuhl Regional Medical Centre to the civilian Canadian hospitals. Three missions were contracted out to civilian companies at a total cost of $76,097. Of the remaining 20 missions, 18 were conducted solely for the purpose of transporting wounded soldiers and therefore contributed incremental costs to the CF; the CC150 Airbus was used for five missions and the CC140 challenger was used for 13 missions. The total cost of transporting these 75 injured CF members back to Canada was $3,926,520.34, or approximately $52,000 per injured soldier.

Costs in Canada

These 75 CF members required further treatment at one of 22 civilian hospitals across Canada. The CF were charged a total of $2,373,550.30 for their care, or approximately $32,000 per injured soldier. See Table 3 for a breakdown of these charges. Assuming a charge-to-cost ratio of 0.6, the cost of care was $1,424,130.18 or $19,000 per injured soldier.

Summary of Costs

The CFHS spent approximately $2.5 million to provide trauma care to 127 soldiers injured in Kandahar. The CF then spent approximately $2.0 million dollars during this year for health care at Landstuhl Regional Medical Center for 93 wounded CF members and another $3.9 million to evacuate 75 of the more severely wounded of these soldiers back to the Canadian civilian hospitals for ongoing care. Since returning to Canada, another $2.4 million was charged to the CF to provide inpatient, outpatient and rehabilitative care to these 75 wounded soldiers (up until October 15, 2007). The estimated cost of the health care in Canada was estimated to be $1.4 million.

The average cost of caring for a wounded soldier treated at the field hospital and then returned to duty was approximately $20,000 per soldier. If a wounded soldier required further treatment at Landstuhl Regional Medical Center but was then returned to duty, the average cost of

<p>| TABLE 2. Total Health Care Costs in Kandahar (February 2006 to February 2007) |
|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Asset</th>
<th>Number</th>
<th>Costs (Cdn $)</th>
<th>One-Year Costs (Cdn $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital equipment over $30 K</td>
<td>34 items</td>
<td>2,520,000.00</td>
<td>378,000.00</td>
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<tr>
<td>Hospital equipment less $30 K</td>
<td>785 items</td>
<td>4,338,500.00</td>
<td>4,338,500.00</td>
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<tr>
<td>Primary care facilities</td>
<td></td>
<td>886,153.00</td>
<td>886,153.00</td>
</tr>
<tr>
<td>Drug costs (including rFVIIa)</td>
<td></td>
<td>3,976,828.10</td>
<td>3,976,828.10</td>
</tr>
<tr>
<td>rFVIIa (4.8 μg vials)</td>
<td>53 vials</td>
<td>264,667.20</td>
<td>264,667.20</td>
</tr>
<tr>
<td>Primary care/prehospital salaries</td>
<td></td>
<td>6,303,996.00</td>
<td>6,303,996.00</td>
</tr>
<tr>
<td>Blood products</td>
<td></td>
<td>222,745.75</td>
<td>222,745.75</td>
</tr>
<tr>
<td>Hospital staff salaries</td>
<td></td>
<td>8,232,366.00</td>
<td>8,232,366.00</td>
</tr>
<tr>
<td>Total health care cost (Kandahar)</td>
<td></td>
<td>26,480,588.85</td>
<td>24,338,588.85</td>
</tr>
</tbody>
</table>

| TABLE 3. Total Health Care Charges Incurred in Canada (As of October 2007) |
|-----------------|-----------------|
| Description     | Costs (Cdn $)   |
| Acute care hospitalization | 1,306,505.00 |
| Physician fees | 280,120.03 |
| Rehabilitation | 46,131.16 |
| Prostheses | 775.00 |
| Home care | 18,117.00 |
| Other | 721,902.11 |
| Total | 2,373,550.30 |
his/her health care increased to approximately $42,000 per soldier. If a soldier was severely wounded and required ongoing care in Canadian civilian hospitals after treatment at Landstuhl Regional Medical Center and the field hospital, the average cost of health care for this soldier increased to approximately $113,000 per soldier.

**DISCUSSION**

During the first year of its deployment to Kandahar province in Afghanistan, Canada spent over $24 million to provide health care in Kandahar. The majority of this cost was from establishing and staffing the field hospital. As well, the CF were responsible for organizing and paying for all aspects of care for its wounded soldiers from point of injury to rehabilitation back in Canada. The estimated cost of caring for one severely wounded Canadian soldier was approximately $113,000 per soldier, if he required evacuation back to Canada.

This is the first study to attempt to directly estimate the actual costs of providing trauma care to injured soldiers in a conflict area and follow them to the rehabilitative phase of their care. Many studies have examined the cost of trauma in a civilian health care system. Such studies suggested that the financial cost of hospitalization from injury is high. In 1990, the institutional costs at one major hospital in New Zealand for inpatient and outpatient care for injured patients amounted to 15% of the hospitals annual operating budget. The cost of one inpatient hospitalization for injury in this study was approximately $3,000 (US). In Canada, the average cost for a patient hospitalized with a gunshot wound in 1993 was $29,000 per patient. For the United States, the average cost for a patient hospitalized with a gunshot wound in 1994 was $17,000 (US) per patient. In a separate study conducted in the early 1990s, Kizer et al. found the average mean cost of hospitalization for patients suffering gunshot wounds in California was $52,000 (US).

More recent work has shown that the costs of providing trauma care have correspondingly increased with time. McGarry et al. showed that the cost of caring for patients with critical brain injuries was approximately $33,000 (US) in the late 1990s. Davis et al. analyzed insurance claims for adult patients hospitalized from either blunt or penetrating trauma between 2003 and 2005. The mean charge per patient was $72,071 (US) and included charges incurred during a 6-month post-injury follow-up period.

Our findings suggest that caring for severely wounded soldiers is expensive. Providing trauma care for soldiers deployed in the conflict areas around the world is perhaps even more challenging than in the civilian environment. Field hospitals must be established and staffed in the conflict area. Patients require evacuation over long distances to be repatriated home and require care at multiple facilities. Follow-on care in national hospitals only consists of a small proportion of total costs. Much of the total costs relate to patient evacuation. However, direct comparisons of costs between civilian and military trauma care are difficult to make because of the differences in injury mechanisms and severity seen in each setting.

**Strengths and Limitations**

For this study, we were able to access official CF financial data, giving an accurate accounting of all monies actually charged to the CF to provide health care to soldiers deployed to Kandahar. Therefore, our estimate of the total financial expenditure by the CFHS is accurate.

One major limitation of this study is that some aspects of the overall trauma care were not directly charged to the CFHS and were therefore not included in our estimate. For example, we did not factor in the costs to the US Air Force for evacuating Canadian casualties by helicopter to the field hospital in Kandahar, or costs to the US Air Force for evacuating CF members from Kandahar to Landstuhl Regional Medical Center. Furthermore, even if the CF were directly charged for these services, the charges would likely neither reflect the actual costs of setting up an entire casualty evacuation system on the battlefield to the field hospital nor the cost of establishing and maintaining a critical care air transport system to Landstuhl Regional Medical Centre. These system costs are likely substantial; therefore, we underestimated the total cost of establishing the trauma system that provides the framework for trauma care.

As well, the depreciative costs of major “nonmedical” assets such as ambulances are not included in the estimation of costs. Finally, we did not attempt to estimate the costs associated with ancillary aspects of trauma care in a combat environment. The hospital required security. As well, hospital personnel needed to be trained, housed, transported to and from Kandahar, and fed while in Kandahar. These costs are likely substantial and not included in our estimate.

Another limitation is that these results cannot be extrapolated to different countries. While in Canada, injured CF members are cared for in civilian hospitals, and care is billed directly to the CFHS on a fee-for-service basis. Therefore, the incremental cost to the CF for care is relatively small. In countries with military hospitals, the costs are likely much higher because of the fixed costs of operating hospitals.

**SUMMARY**

Nations have a moral responsibility to provide the best health care to soldiers injured on duty in the war. Estimating the financial costs to properly fund this care is critical for future planning and forecasting. We estimated on average, it costs approximately $20,000 to care for a wounded soldier at a field hospital who is subsequently returned to duty, $42,000 for the case of a wounded soldier treated at an out-of-theater regional referral hospital and subsequently returned to duty, and $113,000 to care for a wounded soldier who is repatriated and finally treated in Canada.

**ACKNOWLEDGMENTS**

We acknowledge the Canadian Forces Health Services for its help and support. We also acknowledge Commander R. Young who was instrumental in obtaining the financial data to complete this study.

**REFERENCES**

Tien et al.  The Journal of TRAUMA® Injury, Infection, and Critical Care • Volume 67, Number 2, August 2009


EDITORIAL COMMENT

Dr. Tien and colleagues have performed a novel analysis investigating the costs of providing health care to injured soldiers. The analysis is based on financial reports from the Canadian Forces Health Services, insurance claims paid, and averages of other costs, which include salaries, equipment, blood products, and drugs. The authors should be congratulated for attempting to estimate the cost incurred to treat combat casualties but one must interpret this article with serious limitations in mind. The authors have chosen to only include those costs incurred by Canada and exclude other important costs, which are unique to wartime settings. They have made broad assumptions in regard to cost-to-charge ratios, which may or may not be valid.

The costs of performing prehospital care and air transport to the Field Hospital are excluded. These costs are substantial especially because they involve care under fire and tactical situations, which may result in loss of life and expensive military resources. The authors also do not include the costs of defending the hospital from attack, which requires substantial equipment and personnel. The cost of transporting injured soldiers from Afghanistan to Landstuhl is excluded because the transport is performed by the US Air Force. These prolonged transports require highly trained Critical Care Air Transport teams equipped with expensive equipment and the cost is tremendous.

The authors have made a commendable effort of estimating the cost of caring for combat casualties but their analysis is more amenable to civilian practice than military settings. It does not truly take into consideration those factors that are unique to administering care in a combat environment. For this reason, it is likely that they have seriously underestimated the cost of caring for casualties. I look forward to more comprehensive evaluations from this group in the future.

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EDITORIAL COMMENT

In the civilian context, the actual cost of providing health care is seldom known. Health economics publications report data on how much a healthcare institution or system “charged” for the care provided to an individual patient or patient group, and a “conversion factor” is used to estimate the actual cost. Cost accounting systems of US hospitals and health systems are not structured to provide cost of care data. As a result, controlling the cost of health care will always be guesswork, at best, because the ground truth of actual cost is not known.

The article by Tien is extremely important in this light because it reports actual cost data for the care of soldiers in war. This is possible in the military context, because there is no provision for generating a positive operating margin (profit) or generating reserves (the term for profit used by the not-for-profit sector). Thus, the figures in the article are truly the cost, not the charge, for rendering care. The operating costs reported here are both the variable costs (supplies, staff, and some transportation costs) and the fixed costs (physical plant and equipment, which are depreciated over 6–7 years). This is a more rapid depreciation than in the civilian sector (10–30 years) but understandable because much of the military facilities will usually be left in place and not removed when a mission has been completed and some equipment may be destroyed due to hostile acts.

The numbers presented do have limitations. Some specialty care provided to repatriated Canadian soldiers was provided in the civilian sector, and this is a traditional charge data. Other care was provided gratis (helicopter evacuation in the theater). The costs of care provided to Iraqi civilians and hostile combatants were subsumed in the costs of care to Canadian soldiers because care to these other classes of patients is a well-recognized cost of providing care in a battle theater.

The report of Tien stands alone in the recent literature because a PubMed search of the U.S. National Library of Medicine revealed no reports detailing the cost of battlefield medical care. The article is thus an important contribution in both the military and civilian contexts as nations struggle to contain healthcare costs because we now have some concrete numbers to estimate, at least, the true cost of medical care to injured soldiers in war.

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