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ATLS adherence in the transfer of rural trauma patients to a level I facility

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ABSTRACT

Background: Injury sustained in rural areas has been shown to carry higher mortality rates than trauma in urban settings. This disparity is partially attributed to increased distance from definitive care and underscores the importance of proper primary trauma management prior to transfer to a trauma facility. The purpose of this study was to assess Advanced Trauma Life Support (ATLS) guideline adherence in the management of adult trauma patients transferred from rural hospitals to a level I facility.

Methods: We performed a retrospective analysis of all adult major trauma patients transferred ≥50 km from an outlying hospital to a level I trauma centre from 2007 through 2009. Transfer practices were evaluated using ATLS guidelines.

Results: 646 patients were analyzed. Mean age was 40.5 years and 94% sustained blunt injuries with a median Injury Severity Score (ISS) of 22. Median transport distance was 253 km. Among all patients, there were notable deficiencies (<80% adherence) in 8 of 11 ATLS recommended interventions, including patient rewarming (8% adherence), chest tube insertion (53%), adequate IV access (53%), and motor/sensory exam (72%). Patients with higher ISS scores, and those transferred by air were more likely to receive ATLS recommended interventions.

Conclusions: Key aspects of ATLS resuscitation guidelines are frequently missed during transfer of trauma patients from the periphery to level I trauma centres. Comprehensive quality improvement initiatives, including targeted education, telemedicine and trauma team training programmes could improve quality of care.

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Introduction

Trauma is the leading cause of death for children and young adults in North America, with a disproportionate number of injuries and deaths occurring in rural settings.1–4 This is due to a combination of factors that includes higher-risk mechanisms of injury, delayed discovery, limited resources, increased geographic distance from definitive trauma centres and prolonged transport times.4–8 Regionalized trauma systems, emphasizing resource integration and streamlined transitions in care, have been shown to improve patient outcomes; however even with robust trauma systems in place, there is a threefold increase in the risk of emergency department (ED) death, making the ED an ideal target for intervention in rural trauma care.9–11

ATLS training provides a framework for the immediate management of the injured patient and has been shown to improve clinical outcomes in both high and low resource settings.12–14 Accurate assessment and stabilization of trauma patients is of paramount importance, with up to 91% of avoidable trauma deaths estimated to occur during the initial stage of resuscitation.15 In rural and remote areas, the equivalent resuscitative phase is often dramatically lengthened during prolonged transport to first the community hospital and eventually the tertiary centre, underlining the importance of adherence to ATLS guidelines throughout this process.16

Our primary objective in this study was to evaluate ATLS guideline adherence in the management and transfer of acutely injured trauma patients from a range of rural and remote hospitals to a level I trauma centre. A secondary objective was to assess the effect of ATLS adherence on mortality. Ethical, administrative and operational approval was obtained from the University of Alberta and Alberta Health Services.

Methods

We performed a retrospective analysis utilizing data from the Alberta Trauma Registry (ATR) and the corresponding patient charts. The ATR collects data on all trauma patients with an Injury Severity Score (ISS) > 12 who are admitted to one of ten participating trauma centres across Alberta. We studied all
admissions to a high-volume academic trauma centre, receiving patients from northern Alberta and British Columbia, the Northwest Territories and Nunavut – one of the largest catchment areas in North America.

Our study population and inclusion criteria were: all adult major trauma patients that were reported in the ATR (≥18 years) and transferred from a peripheral health centre ≥50 km to the level I centre between January 1, 2007 and December 31, 2009 inclusively. Distance between hospitals was determined using Google Maps Geographic Information System. Modes of transport included ground ambulance, fixed wing air ambulance and rotary air ambulance. Our exclusion criteria were those patients with a diagnosis of chronic subdural haematoma, fall from standing height, and asphyxiation or drowning as the traumatic mechanism. We also excluded patients who were transferred more than one week after their injury, as they were no longer in the acute phase of their injury requiring resuscitation and stabilization.

Data collected including age, sex, ISS, mechanism of injury, transfer site, distance, mode and duration of transport, ATLS endpoints (total of 11), vital signs (including temperature) on arrival to the level I ED, survival status and length of stay at the tertiary centre. We selected our endpoints in accordance with the interventions recommended in the ATLS primary assessment and stabilization pathway, which were subdivided into three categories: resuscitation interventions, neurological exam and procedures. Resuscitation interventions included: adequate airway management, C-spine stabilization, application of supplemental oxygen, adequate intravenous access (≥2 sites of 18 g or the placement of central venous catheters), placement of a foley catheter, and documentation of rewarming efforts. Rewarming was defined as any documented effort to minimize heat loss (i.e. warm blankets, Bair Hugger, warmed IV fluids, etc.) Neurological exam included: documentation of the patient’s GCS, pupil sizes, and a motor and sensory exam. Procedures assessed were correct chest tube placement and fracture immobilization. Information for each of these endpoints was collected as complete or incomplete. Lack of documentation of an endpoint was considered as being incomplete. Based on the consensus of a multidisciplinary trauma group comprised of emergency physicians and surgeons, we considered there to be a deficiency in a particular ATLS intervention if it was completed in <80% of cases, and a serious deficiency if it was completed in <60% of cases. Data were entered in a spreadsheet format using Excel for Microsoft Windows (Redmond, Washington).

As we suspected that guideline adherence could vary with severity of injury (providers may be more comprehensive and aggressive in resuscitation efforts for more severely injured patients), or mode of transport (as air crews are required to have advanced life support training), we performed two subgroup analyses. We first compared the patients with an Injury Severity Score (ISS) ≥30 (a cutoff approximating the top quintile of our study population) with those with an ISS <30. We then compared guideline adherence in patients transferred by ground ambulance with those transported by air (fixed wing or rotary). As the relationship between either mode of transport or ISS and guideline adherence could be confounded by transport distance (more severely injured patients and those transferred longer distances are more likely to be transported by air), we used multivariable linear regression to examine the significance of these three covariates (ISS, mode of transport, and distance) as predictors of guideline adherence.

Finally, we used logistic regression to evaluate the relationship of ATLS guideline adherence to mortality and linear regression to evaluate its relationship with length of stay. We selected a number of clinically reasonable covariates (age, sex, ISS, mode of transportation, and transport distance), and included only those that attained significance in univariable analysis in the subsequent multivariable models.

Statistical analysis was performed using paired t-tests to assess whether differences existed among the analyzed continuous variables. Categorical variables were compared using a contingency table, with Fisher exact tests. Significance was determined at a p-value of <0.05. Statistics were calculated using SAS (SAS 9.2, Cary, NC).

Results

Of 768 patients returned in our database query, 646 met our inclusion criteria. 510 (79%) patients were male, with a mean age of 40.5 years. There was a strong predominance of blunt injuries (610 patients, 94%), with the majority due to motor vehicle collisions (MVC). Median ISS was 22 (IQR 16–29). 272 (42%) patients were transported from the peripheral hospital by ground ambulance, with the remainder transferred by fixed wing air ambulance (307, 48%) or rotary air ambulance (67, 10%). The size of our catchment area is reflected in the wide range of transport distances (68–1992 km), with a median distance of 253 km between transferring hospitals (Table 1).

Among all patients, we found deficiencies in 8 of the 11 ATLS recommended interventions. Specifically, 5 of 6 resuscitation endpoints: supplemental oxygen (75% adherence) C-spine stabilization (71%), IV access (53%), foley catheter insertion (68%) and rewarming (8%). 1 of 3 neurological exam criteria: motor/sensory exam (72%), and both procedures: chest tube insertion (53%) and fracture immobilization (66%) (Fig. 1). Of these, documentation of rewarming, chest tube insertion and adequate IV access qualified as “serious deficiencies”, having adherence rates of <60%. 121 patients (19%) were hypothermic on admission, with an initial temperature <36 °C recorded in the ED.

Compared to patients with ISS <30, those with an ISS ≥30 had increased odds of receiving five ATLS interventions: supplemental oxygen (OR 4.42, p < 0.001), C-spine stabilization (OR 2.58, p < 0.001), IV access (OR 3.20, p < 0.001), foley catheter insertion (OR 4.85, p < 0.001) and rewarming (OR 4.32, p < 0.001). Patients with ISS ≥30 were less likely to have a documented motor/sensory exam than the ISS <30 group (OR 0.64, p = 0.04) (Table 2).

Despite the aforementioned improvements in guideline adherence in the ISS ≥30 group, there remained deficiencies in 5 of 11 interventions: IV access (74%), rewarming (19%), motor/sensory exam (64%), chest tube insertion (65%) and fracture immobilization (70%). Notably, rewarming remained a serious deficiency, with less than 60% adherence (Fig. 1).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Patient demographics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>N = 646</td>
</tr>
<tr>
<td>Sex (%)</td>
<td>Male 510 (78.9) Female 136 (21.1)</td>
</tr>
<tr>
<td>Age (years) Mean (sd)</td>
<td>40.5 (18.3)</td>
</tr>
<tr>
<td>Range</td>
<td>18–96</td>
</tr>
<tr>
<td>Mechanism (%)</td>
<td>Blunt 610 (94.4) Penetrating 36 (5.6)</td>
</tr>
<tr>
<td>Injury Severity Score Median (IQ range)</td>
<td>22 (16–29)</td>
</tr>
<tr>
<td>Mode of transport (%)</td>
<td>Ground 272 (42.1) Fixed wing 307 (47.5) Rotary 67 (10.4)</td>
</tr>
<tr>
<td>Distance transported (km) Median (IQ range)</td>
<td>253 (155–451)</td>
</tr>
</tbody>
</table>
We then compared patients transferred by air (fixed wing or rotary) to those transported by ground and found the air transport group to be more likely to receive 5 of the 11 ATLS guideline interventions: supplemental oxygen (OR 2.15, p < 0.001), C-spine stabilization (OR 1.72, p = 0.002), IV access (OR 4.06, p < 0.001), Foley catheter insertion (OR 4.34, p < 0.001) and rewarming (OR 2.45, p = 0.007) (Table 3). In multivariable regression, ISS, mode of transport and distance transported were all statistically significant predictors of guideline adherence.

Of the 646 patients in our study population, 14 (2.2%) died after arrival to the level I ED. We found no association between survival and number of ATLS guidelines completed after adjusting for severity of injury by ISS score. Adherence with ATLS guidelines was positively associated with increased length of stay at the level I trauma centre in univariable analysis (p < 0.001), however, this relationship was not significant once adjusted for ISS and mode of transportation (p = 0.06). Likewise, in the severely injured patients (ISS ≥ 30), the number of ATLS guidelines completed showed no association with survival or length of stay in multivariable analysis.

**Discussion**

ATLS protocol adherence has been used as a reliable process measure by which to evaluate quality of trauma care, due to its widespread use and clearly defined guidelines. Unfortunately, protocol adherence has been shown to be poor, with rates as low as 43% reported at urban trauma centres. Our study supports and extends these findings to the rural setting, where comprehensive patient evaluation and stabilization is of utmost importance due to the prolonged transport required to reach definitive treatment.

The primary finding of our study is the overall low rate of adherence to ATLS guidelines in all injured patients transferred to our level I centre, with less than 80% adherence documented for 8 of the 11 guidelines evaluated. Protocol adherence was significantly improved in severely injured patients (ISS ≥ 30) for 5 guidelines; a finding that is reassuring, as it suggests that severely injured patients are recognized in the rural setting and comprehensive resuscitation measures taken. Nevertheless, a number of key interventions are frequently missed.

**Table 2**

<table>
<thead>
<tr>
<th>ATLS Guideline</th>
<th>Guideline adherence (%)</th>
<th>Odds ratio for adherencea (95% CI)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ISS &lt; 30 (N=517)</td>
<td>ISS ≥ 30 (N=129)</td>
<td></td>
</tr>
<tr>
<td>Resuscitation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airway adequate</td>
<td>512 (99.0)</td>
<td>126 (97.7)</td>
<td>0.41 (0.10–1.76)</td>
</tr>
<tr>
<td>Supplemental oxygen</td>
<td>366 (70.8)</td>
<td>118 (91.5)</td>
<td>4.42 (2.32–8.45)</td>
</tr>
<tr>
<td>C-spine stabilization</td>
<td>351 (67.9)</td>
<td>109 (84.5)</td>
<td>2.58 (1.55–4.30)</td>
</tr>
<tr>
<td>IV access</td>
<td>246 (47.6)</td>
<td>96 (74.4)</td>
<td>3.20 (2.08–4.93)</td>
</tr>
<tr>
<td>Foley catheter insertion</td>
<td>325 (62.9)</td>
<td>115 (89.2)</td>
<td>4.85 (2.71–8.69)</td>
</tr>
<tr>
<td>Rewarming</td>
<td>26 (5.0)</td>
<td>24 (18.6)</td>
<td>4.32 (2.38–7.81)</td>
</tr>
<tr>
<td>Neurological exam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCS</td>
<td>492 (95.2)</td>
<td>127 (98.5)</td>
<td>3.23 (0.75–13.80)</td>
</tr>
<tr>
<td>Pupils</td>
<td>460 (89.0)</td>
<td>117 (90.7)</td>
<td>1.21 (0.63–2.33)</td>
</tr>
<tr>
<td>Motor/sensory exam</td>
<td>381 (73.7)</td>
<td>83 (64.3)</td>
<td>0.64 (0.43–0.97)</td>
</tr>
<tr>
<td>Procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct chest tube insertion</td>
<td>N=97</td>
<td>N=48</td>
<td>2.02 (0.99–4.13)</td>
</tr>
<tr>
<td>Fracture immobilization</td>
<td>N=134</td>
<td>N=54</td>
<td>1.28 (0.65–2.54)</td>
</tr>
</tbody>
</table>

a Odds ratio compares ISS ≥ 30 to ISS < 30. OR > 1 signifies increased odds of adherence in the ISS ≥ 30 group.

**Table 3**

<table>
<thead>
<tr>
<th>ATLS guidelinea</th>
<th>Mode of transport</th>
<th>Air (N=374)</th>
<th>Odds ratio for adherenceb (95% CI)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ground (N=272)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplemental oxygen</td>
<td>181 (66.5)</td>
<td>303 (81.0)</td>
<td>2.15 (1.50–3.08)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>C-spine stabilized</td>
<td>176 (64.7)</td>
<td>284 (75.9)</td>
<td>1.72 (1.22–2.43)</td>
<td>0.002</td>
</tr>
<tr>
<td>IV access</td>
<td>91 (33.5)</td>
<td>251 (67.1)</td>
<td>4.06 (2.91–5.66)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Foley catheter insertion</td>
<td>136 (50.0)</td>
<td>304 (81.3)</td>
<td>4.34 (3.05–6.18)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Rewarming documented</td>
<td>12 (4.4)</td>
<td>38 (10.2)</td>
<td>2.45 (1.26–4.78)</td>
<td>0.007</td>
</tr>
</tbody>
</table>

a All ATLS guidelines were evaluated. Variables not shown had no statistically significant finding.
b Odds ratio compares air transport to ground transport. OR > 1 signifies increased adherence in air transport group.
Understanding current patterns of ATLS guideline adherence is essential to the development of quality improvement programmes targeted to the unique needs of rural health care providers. Based on our results, three specific areas of resuscitation that should be targeted for improvement are patient rewarming, neurological assessment and procedural skills. Only 8% of patients had any type of rewarming effort documented before or during transport, and 19% of patients were hypothermic upon arrival to the level I ED. Given the well-documented association of hypothermia with increased odds of death in major trauma, this is one aspect of resuscitation deserving of more attention. Only 66% of all patients received a complete neurological exam, with the motor/sensory exam the most frequently overlooked component. Likewise, the low completion rates of procedure-based guidelines, particularly adequate IV access (53%) and chest tube insertion (53%), suggest that rural physicians and pre-hospital care teams would likely benefit from targeted education and additional support in this area.

Subgroup analysis showed that transfer by air (fixed wing or rotary) was an independent predictor of protocol adherence for 5 of 11 guidelines evaluated. It was significant even after adjusting for severity of injury and transport distance, and likely reflects the value of advanced trauma training: air transport crews often have a flight physician on board and are required to have advanced life support (ALS) training – which in itself has been associated with improved rural trauma outcomes – and consequently, have more experience managing acutely ill patients than ground transport teams, who often have only basic life support (BLS) training. Our finding that transport distance was also a significant predictor of increased compliance further suggests that rural providers and transport teams recognize the risks inherent in prolonged transport, and are more comprehensive in their resuscitation and stabilization efforts with these patients.

Increasing access to ATLS courses for rural health care providers remains an important priority. However, previous research has shown high attrition of knowledge and skills over time. Given that most rural physicians treat severely injured patients relatively infrequently, increasing the number of ATLS courses alone may be insufficient to provide these health care workers with the support they need.

Technology has an important role to play in improving trauma care in rural environments. Telemedicine has been shown to improve the quality and efficiency of care delivered to trauma patients both in rural hospitals and during transport. Video monitoring allows for continuous, real-time assessment of resuscitation beyond what may be communicated in a limited phone conversation. In addition, telemedicine has also shown promise for procedural coaching, allowing consulting surgeons to guide physicians through procedures such as laryngoscopy and chest tube insertion. In centres without telemedicine capabilities, computerized decision support has also shown potential to increase trauma protocol adherence, and reduce morbidity.

In addition to knowledge and procedural skills, teamwork plays a key role in successful trauma management. Deviation from protocols may be a reflection of suboptimal team performance, disinorganization and poor communication. Trauma team training focusing on communication, leadership and cooperation can lead to sustainable improvements in team performance and patient care.

Improving communication between the sending and receiving physicians through standardized communication protocols presents another opportunity to improve care and ensure guideline adherence prior to patient transfer.

The effect of ATLS guideline adherence on trauma outcomes has been difficult to evaluate. We were unable to show a significant relationship between ATLS guideline adherence and improved mortality rates, however, our analysis was limited by our database which excluded patients who died prior to arrival at the level I ED. In rural Canada, over 80% of trauma deaths are estimated to occur prior to arrival at hospital, which suggests there is a significant degree of selection bias in our study population, as we examined only patients who survived long enough to reach the tertiary centre.

Our study is further limited by its retrospective approach, which included patients from a variety of rural hospitals, and a heterogeneous mix of health care providers. We were unable to adjust for the level of physician training, or verify the ATLS status of individual ED physicians. It is likely that there was a combination of ATLS and non-ATLS trained ED physicians, and it is therefore difficult to decipher whether poor guideline adherence is due to lack of knowledge of ATLS principles, or failure to apply this knowledge in the clinical setting. As in any study reliant on medical records, there was an unavoidable degree of misclassification error in ascertaining if a particular intervention was performed, or in what setting it was completed (i.e. rural ED vs during transport). If an action was not documented, we assumed it was not fulfilled, and therefore counted it as incomplete – a practice which could underestimate adherence rates.

Conclusions

Our study provides strong evidence that adherence to ATLS guidelines is suboptimal in rural trauma patients transferred to a level I trauma centre. Protocol adherence is slightly higher in more severely injured patients; however there remains significant room for improvement.

Based on our results and the existing literature surrounding rural trauma care, we recommend a comprehensive approach to quality improvement programmes with an increased focus on strengthening the partnership between rural providers and receiving trauma teams. Specifically, consideration should be given to: (1) targeted education programmes with opportunities for procedural skill development; (2) use of telemedicine systems to allow receiving consultants to assist in the initial resuscitation in “real-time” and provide procedural coaching when needed; (3) team training programmes to further develop leadership and communication amongst rural trauma team members; and (4) standardized transfer protocols to maximize adherence to guidelines and increase communication between sending and receiving facilities.

Conflict of interest

The authors have no conflicts of interest – financial or otherwise – to disclose.

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References


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