Canadian Major Trauma Cohort Research Program

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John S. Sampalis, PhD

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Key Implications for Decision Makers

- In Canada, regionalization of trauma care services results in significant reductions of trauma-related mortality.

- Regionalization of trauma care must involve designating tertiary (level I) trauma hospitals, implementing patient triage protocols, establishing efficient and effective pre-hospital care, and centralizing co-ordination of these services.

- When planning and organizing trauma care services in Canada and allocating resources, emphasis should be placed on centralizing control and concentrating specialized services in dedicated trauma centres, with an established network for the transfer of patients to these centres from less-specialized institutions.

- The implementation of triage protocols aimed at identifying severely injured patients and transporting them to the appropriate trauma centres is also necessary.

- Finally, resources should be allocated towards properly staffing and equipping trauma centres so that the demands of patient care can be addressed.
Executive Summary

Trauma is the fourth highest cause of death in North America and is the leading cause of death for individuals under the age of 45 years. Because of trauma’s prevalence and the large number of lives lost each year to this preventable and often treatable condition, many government and healthcare systems have looked for ways to prevent trauma and decrease trauma-related morbidity and mortality.

Regionalization of trauma care, or the shift in trauma care management from an individual, hospital-based approach to a systems approach, has been repeatedly shown to decrease mortality in many systems throughout the world. In addition to improving outcomes, trauma care regionalization also serves to pool resources, maximize efficiency, and minimize costs.

In Canada, trauma care services range from no organization at all to fully integrated and regionalized systems. This variation in the organization of trauma care services results in inequality and sub-optimal care for many Canadian trauma patients. Trauma system models that were developed in the United States may not be appropriate for Canada because of the specific trauma epidemiology, geographical distribution, and healthcare system. The current challenge is to identify the ideal composition and level of centralization of trauma care services that are required within distinct regions of Canada. The current study assessed the effect of different components of trauma care regionalization on trauma-related mortality in Canada to identify those components that should be considered as critical in the design and implementation of Canadian trauma care systems.

The research studies conducted as part of this program are retrospective observational cohort studies, which included all trauma patients that were treated at acute care hospitals in Canada between 1995 and 2001. The data used to conduct these studies were obtained from the National
and Provincial Trauma Registries and a survey of Canadian hospitals treating trauma patients. The program studies specifically evaluated the impact of variation in the type, organization, and components of trauma services between Canadian regions on trauma-related mortality. Specifically, trauma centre regionalization, hospital designation, patient triage and transport protocols, pre-hospital treatment, and the rural/urban differences were evaluated. The primary outcome measure was trauma-related mortality, which was defined as death prior to discharge.

The program was based on 1,509,203 patients treated for injuries in Canadian acute care hospitals between 1995 and 2001. The mean (SD) age of the patients was 46.2 (23.3) years; 42.5 percent were females. The following are the salient observations from the studies conducted:

i. Implementation of trauma system regionalization produces a significant 80-percent reduction in the risk for trauma-related mortality. This is after adjusting for patient age and injury severity.

ii. After adjusting for age and injury severity, patients treated in hospitals that are accredited as tertiary (level I) trauma centres and fulfill the American College of Surgeons’ requirements for this classification have significantly reduced adjusted risk of mortality by 81 percent, when compared to patients treated at other hospitals that do not have this level of specialization in trauma care.

iii. Trauma-related mortality, adjusted for patient’s age, injury severity, and type of hospital, is significantly reduced by 96 percent in regions where patient triage protocols have been implemented.
iv. With respect to pre-hospital on-site procedures, the results of the program study showed that endo-tracheal intubation (to assist breathing) is possibly beneficial in reducing trauma-related mortality by 25 percent. However, the use of on-site intravenous line access and fluid replacement was of no benefit. The use of on-site cardiopulmonary resuscitation was shown to increase the risk of trauma-related mortality by a factor of 15. This is an alarming observation that indicates inappropriate use of the procedure. This is consistent with concerns of inadequate training of pre-hospital personnel. The use of anti-shock trousers in cases of blood loss was shown to be beneficial. However, these devises have been shown to be harmful for severely injured patients in randomized clinical trials. This observation may be due to highly selective use of this intervention in very rare cases.

v. Patients that are treated in rural centres have a 20-percent increased adjusted mortality rate when compared to similar patients treated at urban centres.

The results of these studies show that regionalization of trauma care services with trauma centre designation and implementation of patient triage protocols is essential for the effective prevention of trauma-related mortality in Canada. Special consideration should be given to rural areas, with emphasis on the establishment of patient transfer policies by which severely injured patients are transferred from rural centres to highly specialized trauma hospitals within minimal delay. Allocation of resources towards this goal is critical. Finally, with respect to pre-hospital care, the study identified a potential lack of adequate training of emergency medical personnel. The observed benefit of endo-tracheal intubation is consistent with the current state of knowledge, and this intervention should be incorporated in all Canadian pre-hospital care systems.
BACKGROUND
Injuries are the fourth leading cause of mortality for all ages combined and the leading cause of death for individuals under the age of 45 years. Approximately 220,000 Canadians are admitted to hospital every year for the treatment of injuries. Every year 22,000 patients have major life-threatening injuries, of which 6,500 die in the hospital and another 6,500 die before they arrive at the hospital. Because injuries affect individuals in the younger age categories, they are the major cause of potential years of life lost, causing 334,800 potential lost years or 31 percent of the total. Approximately 11 percent of the total annual direct and indirect healthcare costs, or more than $14 billion in Canada, are due to injuries. This is higher than the costs for cancer ($13 million) and third after cardiovascular ($20 million) and musculoskeletal disease ($18 million). Approximately seven percent of the total direct healthcare costs, or $3.1 billion, are used for injuries.1-7

Preventive interventions against injuries employ legislative or technological measures and have had some success, as shown by the reduction in the incidence of severe trauma in Canada from 64/100,000 in 1991 to 56/100,000 in 1996. Despite the reduction in incidence, injuries continue to plague our society, making interventions that reduce the consequences of trauma essential.8-14

The interventions are applied after the injury has occurred and focus on providing definitive care to the patient with minimal delay. In the United States, the Emergency Medical Services Act forced the establishment of organized, centrally controlled regional trauma care systems. A regionalized trauma care system has the following requirements:15-31

1. classification of all hospitals according to the level of trauma care available;
2. designation of level I trauma centres where patients with severe injuries should be treated;
3. centralized control and communication;
4. establishment of a central alert system;
5. training of paramedics and emergency medical technicians to evaluate and provide on-site care of trauma victims;
6. implementation of protocols for the direct transport of patients with major injuries to level I trauma centres;
7. establishment of communication between the emergency personnel and the receiving hospital; and
8. evaluation, research, and education.
Several studies have shown that, in locations with regionalized integrated trauma care systems, trauma-related mortality was significantly lower due to the reduction of the time between injury and definitive care, and the high level of care at the level I trauma centers. These results have established the two undisputed axioms of trauma care:

1. patients with major life-threatening injuries should be treated at level I (tertiary) trauma centres; and
2. definitive care to severely injured patients should be provided within 60 minutes (golden hour).

There is significant variation in the type of trauma care that is available to Canadians in different regions. This geographical variation exists at the pre-hospital, in-hospital, and overall system levels.

The qualifications and training of emergency personnel who are dispatched to the scene and provide on-site care to major trauma victims vary significantly from physicians, paramedics, emergency medical technicians, and ambulance drivers. Similarly, the type of on-site care available to trauma patients varies from physician-provided advanced life support, paramedic-provided advanced life support, physician- or paramedic-provided basic life support, emergency medical technician-provided basic life support, and no on-site care. Trauma triage protocols in Canadian regions vary from none, to non-standardized assessment of vital signs, to more complex assessments based on physiological indices of injury. Rules for the hospital transport of major trauma patients vary from transport to the nearest hospital, transport to a trauma centre of any designation, and direct transport to a tertiary trauma centre.

Variations in the level of in-hospital care also contribute to inequalities of trauma care in Canada. There are 48 hospitals in Canada that are accredited as a trauma centre by the Trauma Association of Canada. Of these, only 19 are designated by their local ministry of health, although 35 operate as trauma centres. All of these trauma centres have a general surgery service available, 40 (83 percent) have orthopedic service, but only 31 (65 percent) have a neurosurgical service, and 32 (67 percent) have a plastic surgery service available. The number and proportion of these hospitals having 24-hour coverage by the following services is emergency physician - 31 (65 percent); trauma team leader - 18 (38 percent); general surgeon - 22 (46 percent); neurosurgeon - 15 (31 percent); orthopedic surgeon - 17 (35 percent); plastic surgeon - 18 (38 percent); anesthesiologist - 25 (52 percent); intensivist - 19 (40 percent); emergency department nurse - 40 (83 percent); respiratory technologist - 38 (79 percent); radiology technologist - 39 (81 percent); and lab/blood bank staff - 39 (81 percent). These data
show that patients receive different in-hospital care even if they are treated in hospitals that function or are designated as trauma centres.

At the level of the system and organization, there is again variation between different Canadian regions. Organization of trauma care ranges from complete regionalization or integration with designated trauma centres and patient triage protocols, to intermediate in which only certain components of a regionalized system are in place, to no organization at all. The epidemiology of rural trauma is significantly different from that of the urban setting with a higher mean age and a higher proportion of patients injured in motor vehicle collisions or farm machinery-related injuries. Major trauma patients in the rural setting are at an increased risk for mortality. The epidemiology, outcomes, and care provided to rural trauma patients in Canada have not been described or evaluated in any systematic manner. Rural trauma care in Canada is poorly organized, without defined protocols or a network for patient management. Of the 44 trauma hospitals in Canada, only eight are in rural areas. There is significant variation in the management of Canadian rural trauma patients with respect to the type of pre-hospital and in-hospital care and with respect to triage or transfer protocols.115-131

The composition and organization of trauma care services in each region are governed by local policies that are defined by local health boards or governments that are, in some cases, affected by national guidelines. The official designation of hospitals as trauma centres and the implementation of protocols that will ensure that patients with severe injuries are treated in trauma hospitals are functions of provincial governments and regional health boards. Similarly, the amount of resources allocated to trauma centres for the treatment of trauma victims are also governed by provincial governments. The nature and operation of pre-hospital trauma services are governed by local health boards. However, the definition of criteria for designation of trauma centres is a mandate of the Trauma Association of Canada, a national organization.

The previous discussion supports the fact that results of studies evaluating the effectiveness of trauma care services will be fundamental and of major importance to policy makers and healthcare managers. These individuals and organizations that they work in are the decision makers which define and implement the policies which govern local trauma care services.

The current research program evaluated the association between different levels and types of trauma care services and trauma-related mortality. These results are essential for policy makers and healthcare managers who make the decisions regarding the composition and organization of regional trauma care services.
PROGRAM STUDIES
The following studies comprised the current research program and converge into a conceptual framework that facilitated the definition of models for the optimization of trauma care services in specific Canadian regions:

1. Evaluation of the association between the degree of trauma care regionalization/integration and mortality in patients with major trauma
2. Evaluation of the impact of trauma hospital designation and characteristics on mortality of patients with major trauma
3. Evaluation of the association between trauma patient triage and transport policies and trauma-related mortality
4. Evaluation of the association between the type of pre-hospital care and mortality in trauma patients
5. Evaluation of rural trauma care in Canada and assessment of the need for integration or segregation with urban trauma care systems
6. Economic assessment and cost-benefit analysis of trauma care services in Canada

Studies 1-5 were successfully completed. Study 6 could not be completed as planned because of the lack of valid costing data.

METHODS
Overall Program
These were observational studies of cohorts comprised of all patients with trauma that were treated in the participating regions and hospitals. Patients were entered in the cohort at the time of the injury and were followed up to discharge from the acute care hospital. Patients were entered into the study from January 1, 1995 to December 31, 2000.

Inclusion and Exclusion Criteria
All patients treated at one of the acute care hospitals treating trauma patients from the participating provinces were eligible for inclusion. In assembling the study cohort, the following criteria were applied:

1) ICD-9 codes indicating external cause, and any one of the following:
   i. death due to injury at any time, including at the scene, en-route, the emergency room, or after admission in the hospital;
   ii. length of hospital stay was more than three days;
iii. treatment in an intensive care unit; or
iv. injury severity score of more than 12.

Patients surviving to discharge and admitted for isolated fractures, with the exception of head
injuries, or admitted only for poisoning, asphyxiation, or drowning were excluded.

Data Sources
National and Provincial Trauma Registries:
The National Trauma Registry collects data on trauma patients from 29 of 30 trauma centres and
approximately 600 acute care hospitals in Canada, excluding Quebec. The Quebec Trauma Registry
collects data on trauma patients from 32 trauma centres and 59 acute care hospitals in Quebec.

Study Variables
Outcome Measures:
The primary outcome measure was mortality. Mortality was defined as death prior to discharge
from the hospital for the treatment of the injury.

STUDY SAMPLE
There were 1,509,203 patients identified and entered into the study from 1995 to 2001. The
original plan was to include patients treated up to 2003; however the data for the last two years
were incomplete and have been excluded from the analyses.

Table 1 shows the distribution of patients by year of the study. Table 2 shows the distribution
by province. The mean (SD) age of the patients in the cohort was 46.2 (23.3) years; 42.5 percent
were female. The overall mortality rate for the study cohort was four percent.

Table 1: Sample Distribution by Year

<table>
<thead>
<tr>
<th>YEAR</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>192,928</td>
<td>12.8%</td>
</tr>
<tr>
<td>1996</td>
<td>208,329</td>
<td>13.8%</td>
</tr>
<tr>
<td>1997</td>
<td>208,494</td>
<td>13.8%</td>
</tr>
<tr>
<td>1998</td>
<td>244,544</td>
<td>16.2%</td>
</tr>
<tr>
<td>1999</td>
<td>260,286</td>
<td>17.2%</td>
</tr>
<tr>
<td>2000</td>
<td>290,304</td>
<td>19.2%</td>
</tr>
<tr>
<td>Total</td>
<td>1,509,203</td>
<td>100%</td>
</tr>
</tbody>
</table>
DETAILED DESCRIPTION OF EACH STUDY

The following sections describe the results of each study of the program. The results are presented in summary format highlighting the major findings of the studies. Details will be reported in peer-reviewed manuscripts describing the results of individual studies. Copies of these manuscripts will be submitted to the Canadian Health Services Research Foundation.

Study #1: Evaluation of the association between the degree of trauma care regionalization/integration and mortality in patients with major trauma

Methods

The exposure variable was the degree of regionalization/integration of local trauma care, classified as:

   i) Present: where the following requirements are in place:
      a. Classification of all hospitals according to the level of trauma care available
      b. Designation of level I trauma centres where patients with severe injuries should be treated
      c. Centralized control and communication
      d. Establishment of a central alert system

<table>
<thead>
<tr>
<th>Province</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>143,389</td>
<td>9.5%</td>
</tr>
<tr>
<td>BC</td>
<td>200,438</td>
<td>13.3%</td>
</tr>
<tr>
<td>MB</td>
<td>59,522</td>
<td>3.9%</td>
</tr>
<tr>
<td>NB</td>
<td>38,212</td>
<td>2.5%</td>
</tr>
<tr>
<td>NL</td>
<td>20,815</td>
<td>1.4%</td>
</tr>
<tr>
<td>NS</td>
<td>33,286</td>
<td>2.2%</td>
</tr>
<tr>
<td>NT</td>
<td>3,571</td>
<td>.2%</td>
</tr>
<tr>
<td>NU</td>
<td>194</td>
<td>.01%</td>
</tr>
<tr>
<td>ON</td>
<td>496,087</td>
<td>32.9%</td>
</tr>
<tr>
<td>PE</td>
<td>5,279</td>
<td>.3%</td>
</tr>
<tr>
<td>QC</td>
<td>443,129</td>
<td>29.4%</td>
</tr>
<tr>
<td>SK</td>
<td>63,667</td>
<td>4.2%</td>
</tr>
<tr>
<td>YK</td>
<td>1,614</td>
<td>.1%</td>
</tr>
<tr>
<td>Total:</td>
<td>1,509,203</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
e. Training of paramedics and emergency medical technicians to evaluate and provide on-site care to trauma victims
f. Implementation of protocols for the direct transport of patients with major injuries to level I trauma centres
g. Establishment of communication between the emergency personnel and the receiving hospital

ii) Not Present: in which the above criteria were not met.

Results:
There were 261,380 (17.3 percent) patients that were treated in a regionalized trauma care system. Table 3 describes the crude mortality rates for the patients treated in regionalized and non-regionalized trauma care systems. However, these results are most likely confounded by injury severity. The results of the multiple-logistic regression model assessing the mortality risk adjusted for age and injury severity score are shown in Table 4. These results show that regionalized trauma care systems are associated with a significant reduction in adjusted mortality among trauma patients.

Table 3: Mortality by Trauma Care System

<table>
<thead>
<tr>
<th>Status</th>
<th>Non-Regionalized</th>
<th>Regionalized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Alive</td>
<td>1,201,700</td>
<td>96.3%</td>
</tr>
<tr>
<td>Deceased</td>
<td>46,123</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

Table 4: Multiple-Logistic Regression Analysis for Mortality by Regionalized Trauma Care System

<table>
<thead>
<tr>
<th>Variable:</th>
<th>Parameter estimate</th>
<th>S.E. of parameter estimate</th>
<th>P Value</th>
<th>Odds Ratio (OR)</th>
<th>95.0% C.I. for OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regionalized Trauma Care System (Yes vs. No)</td>
<td>-1.578</td>
<td>0.010</td>
<td>&lt;0.001</td>
<td>0.206</td>
<td>0.202 – 0.211</td>
</tr>
<tr>
<td>Age (years)</td>
<td>0.054</td>
<td>0.001</td>
<td>&lt;0.001</td>
<td>1.013</td>
<td>1.012 – 1.014</td>
</tr>
<tr>
<td>Injury Severity Score</td>
<td>0.026</td>
<td>0.001</td>
<td>&lt;0.001</td>
<td>1.026</td>
<td>1.025 – 1.027</td>
</tr>
</tbody>
</table>
**Conclusion**
Trauma care system regionalization has been well-established worldwide to improve patient outcomes. In Canada, implementation of such services has likewise yielded significant improvements in trauma-related mortality rates. Even so, after many successful changes in the Canadian trauma system, there continues to be a concerning level of mortality. Continual criticism and re-evaluation is vital for the system to evolve and meet the specific needs of distinct Canadian regions.

**Study #2: Evaluation of the impact of trauma hospital designation and characteristics on mortality of patients with major trauma**

**Methods**
The exposure variable was the designation or American College of Surgeons classification of the treating hospital.

**Results**
The distribution of hospital designation and mortality for the study sample is described in Table 5. Table 6 summarizes the results of the multiple-logistic regression analysis evaluating the adjusted association between mortality and hospital trauma level designation. These results show that, after adjusting for age and injury severity, patients treated at level I-designated trauma hospitals have a reduced rate of mortality when compared to the patients treated at lower level or non-designated hospitals. It is important to note that the difference in lower mortality risk for level I hospitals is consistent across all non-level I hospital designations.

<table>
<thead>
<tr>
<th>Hospital Trauma Designation (ACS Level)</th>
<th>Status</th>
<th>Total (% of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alive</td>
<td>Deceased</td>
</tr>
<tr>
<td>Tertiary (I)</td>
<td>N 186,606</td>
<td>11862</td>
</tr>
<tr>
<td></td>
<td>% 94.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Secondary (II)</td>
<td>N 65,833</td>
<td>3102</td>
</tr>
<tr>
<td></td>
<td>% 95.5%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Primary (III)</td>
<td>N 2,657</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>% 96.1%</td>
<td>3.9%</td>
</tr>
<tr>
<td>No Designation</td>
<td>N 1,193,500</td>
<td>45535</td>
</tr>
<tr>
<td></td>
<td>% 96.3%</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

ACS = American College of Surgeons
Conclusion

Trauma patients of comparable injury severity experience improved survival outcomes when treated at accredited level I (tertiary) trauma centres compared to trauma centres of lower or no designation. This study re-affirms that trauma-related mortality decreases significantly when patients are transported directly to specialized trauma centres which are prepared to accept and are committed to the care of severely injured patients 24 hours a day.

Study #3: Evaluation of the association between trauma patient triage and transport policies and trauma-related mortality

Methods

For this study, the implementation of a triage protocol for the transport of severely injured patients to trauma hospitals was the exposure variable.

Results

Of the patients in the study sample, 19 percent were treated in a system that had regional patient triage protocols for transfer of severely injured patients to appropriate hospitals. The results in Table 7 show that the unadjusted mortality for patients triaged to a hospital was higher when compared to the patients not triaged. However, as the adjusted analysis summarized in Table 8 shows, establishing patient triage criteria has a significant and the highest effect in reducing trauma mortality, after adjusting for patient’s age, Injury Severity Score, and hospital designation.

Table 6: Logistic Regression Analysis for Mortality by Hospital Designation

<table>
<thead>
<tr>
<th>Variable:</th>
<th>Parameter estimate</th>
<th>S.E. of parameter estimate</th>
<th>P Value</th>
<th>Odds Ratio (OR)</th>
<th>95.0% C.I. for OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS Level I vs. II</td>
<td>-1.683</td>
<td>0.020</td>
<td>&lt;0.001</td>
<td>0.186</td>
<td>0.179</td>
</tr>
<tr>
<td>ACS Level I vs. III</td>
<td>-1.538</td>
<td>0.104</td>
<td>&lt;0.001</td>
<td>0.215</td>
<td>0.175</td>
</tr>
<tr>
<td>ACS Level I vs. No Designation</td>
<td>-1.695</td>
<td>0.010</td>
<td>&lt;0.001</td>
<td>0.184</td>
<td>0.180</td>
</tr>
<tr>
<td>Age (years)</td>
<td>0.049</td>
<td>0.001</td>
<td>&lt;0.001</td>
<td>1.009</td>
<td>1.007</td>
</tr>
<tr>
<td>Injury Severity Score</td>
<td>0.027</td>
<td>0.001</td>
<td>&lt;0.001</td>
<td>1.027</td>
<td>1.026</td>
</tr>
</tbody>
</table>

Conclusion

Trauma patients of comparable injury severity experience improved survival outcomes when treated at accredited level I (tertiary) trauma centres compared to trauma centres of lower or no designation. This study re-affirms that trauma-related mortality decreases significantly when patients are transported directly to specialized trauma centres which are prepared to accept and are committed to the care of severely injured patients 24 hours a day.
Conclusions

This study re-affirms the positive association between the establishment of patient triage and transport protocols on outcome. The direct transfer of patients to specialized trauma centres rather than simply the nearest emergency department ensures early definite care and significantly reduces mortality in the trauma care system.

Study #4: Evaluation of the association between the type of pre-hospital care and mortality in trauma patients

Methods

The exposure variable was the type of pre-hospital trauma care received by the patient.
Results

Study 4 evaluated the effect of the type of pre-hospital care used on mortality of trauma patients. In this study, pre-hospital care was defined according to the pre-hospital interventions used and not as a dichotomous variable as advanced life support and basic life support. This was decided because of the evolution of pre-hospital trauma care in recent years where the distinction is based on the interventions performed and not the type of care established for the region. In fact, this is compatible with the current state of pre-hospital care where paramedics, emergency medical technicians, or physicians may apply any of the conventional advanced life support procedures depending on regional policies.

The results in Table 9 show that, for the four procedures evaluated, the unadjusted mortality rate was higher when these procedures were used. However, there is significant confounding through bias by indication with respect to injury severity. The adjusted mortality analysis summarized in Table 10 shows that, for endo-tracheal intubation (to assist breathing) and Medical Anti-Shock Trousers (to prevent shock from blood loss), there is a significant adjusted reduced risk for mortality. However, while the use of an intravenous was not associated with benefit, the use of cardiopulmonary resuscitation was associated with a significant increase in the risk of mortality.
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<th>Pre-Hospital Procedure:</th>
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CPR = Cardiopulmonary Resuscitation; ETI = Endo-Tracheal Intubation; MAST = Medical Anti-Shock Trousers; IV = Initiation of Intravenous Line and Fluid Replacement
The rationale for the use of on-site advanced life support in trauma is that these interventions will reduce the rate of blood loss and physiologic deterioration, thus stabilizing the patient before arrival at the hospital. It is expected that this will result in increased chances of survival. The paradox is that on-site advanced life support increases the amount of time that is spent on the scene and hence increases the delay to definitive in-hospital care. Although advanced techniques are being used by many emergency response teams, to date, we do not know the clear benefits of these invasive and often time-consuming interventions.

This study examined the benefit/risk ratio of individual advanced life support-associated procedures. Certain interventions provided on-scene to trauma patients were determined to increase mean on-scene time and consequently resulted in poorer survival outcomes. Specifically, the pre-hospital administration of CPR to trauma patients was associated with increased odds of death. Conversely, intubation and use of anti-shock trousers were shown to have a positive impact on patient survival and intravenous fluid replacement was determined to neither benefit nor harm the outcomes of trauma patients.

**Conclusion**

Table 10: Logistic Regression Analysis for Mortality by Pre-Hospital Procedures

<table>
<thead>
<tr>
<th>Variable:</th>
<th>Parameter estimate</th>
<th>S.E. of parameter estimate</th>
<th>P Value</th>
<th>Odds Ratio (OR)</th>
<th>95.0% C.I. for OR</th>
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<tbody>
<tr>
<td>CPR (Yes vs. No)</td>
<td>2.715</td>
<td>0.027</td>
<td>&lt;0.001</td>
<td>15.112</td>
<td>14.328</td>
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<tr>
<td>ETI (Yes vs. No)</td>
<td>-0.284</td>
<td>0.123</td>
<td>0.021</td>
<td>0.753</td>
<td>0.592</td>
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<tr>
<td>MAST (Yes vs. No)</td>
<td>-2.104</td>
<td>0.047</td>
<td>&lt;0.001</td>
<td>0.122</td>
<td>0.111</td>
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<tr>
<td>IV (Yes vs. No)</td>
<td>-0.002</td>
<td>0.018</td>
<td>0.098</td>
<td>0.998</td>
<td>0.964</td>
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<td>Regionalized System</td>
<td>-1.584</td>
<td>0.011</td>
<td>&lt;0.001</td>
<td>0.205</td>
<td>0.201</td>
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<td>Triage Established (Yes/No)</td>
<td>-3.278</td>
<td>0.014</td>
<td>&lt;0.001</td>
<td>0.038</td>
<td>0.037</td>
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<tr>
<td>ACS Level I vs. II</td>
<td>-0.529</td>
<td>0.025</td>
<td>&lt;0.001</td>
<td>0.589</td>
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<td>ACS Level I vs. III</td>
<td>-0.028</td>
<td>0.119</td>
<td>&lt;0.001</td>
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<td>ACS Level I vs. No Designation</td>
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<td>Age (years)</td>
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<td>&lt;0.001</td>
<td>1.023</td>
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<td>Injury Severity Score</td>
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<td>0.001</td>
<td>&lt;0.001</td>
<td>1.108</td>
<td>1.107</td>
</tr>
</tbody>
</table>

CPR = Cardiopulmonary Resuscitation; ETI = Endo-Tracheal Intubation; MAST = Medical Anti-Shock Trousers; IV = Initiation of Intravenous Line and Fluid Replacement
As one of the principle axioms of pre-trauma care states that definitive care to severely injured patients should be provided within 60 minutes (the “golden hour”), the need for pre-hospital care and the need for prompt transport of the patient to the hospital must be balanced. Therefore, improvements in the outcomes of trauma patients can only be successful through evidence-based evaluation of pre-hospital interventions, algorithms, treatments, and systems of care.

**Study #5: Evaluation of rural trauma care in Canada and assessment of the need for integration or segregation with urban trauma care systems**

This study had the following objectives:
1. to describe the epidemiology and outcomes of rural trauma victims in Canada;
2. to compare the profile and outcomes of rural and urban trauma patients in Canada; and
3. to evaluate the association between different modes of management of Canadian rural trauma patients with mortality and morbidity.

**Method**

This study described the difference in injury profile and outcomes for patients treated in urban and rural centers. This study was primarily descriptive in nature.

**Results**

Of the patients included in the study, 80 percent were treated in urban and 20 percent in rural regions. Penetrating injuries were more common in urban areas (4.4 percent urban, 3.3 percent rural, p<0.001). Crude mortality for severely injured trauma patients in rural centres was 2.5 percent, compared to 4.6 percent in urban centres (p<0.001). Patients treated in rural hospitals were significantly older and had injuries of lower severity than patients treated in urban hospitals.

Logistic regression showed that there was no difference in adjusted odds of death in rural hospitals compared to urban centres (odds ratio for patients treated in rural centers = 1.207; 95% confidence interval = 0.966-1.508). Treatment in a rural centre compared to an urban centre also did not affect the mean adjusted hospital or intensive care unit length of stay. When the analysis was stratified by injury severity score category, patients with mild injuries (ISS = 0-12) had significantly poorer outcomes in rural compared to urban centres (odds ratio = 1.33, 95% confidence interval = 1.025-1.737). No differences were observed in either the ISS = 12-24 or 24-75 groups.
**Conclusion**

Patients injured in rural areas have different demographics and injury patterns than their urban counterparts. This study was undertaken with the goal of understanding the variation in outcomes based on location of injury: urban versus rural. We have used a survey linked with outcome and injury severity measures from a trauma registry to compare the outcomes between urban and rural areas. The results are encouraging and demonstrate that patients injured in rural areas have similar outcomes to their urban counterparts.

The evidence presented supports the need for the creation of trauma systems based on patient demographics and the importance of the differences between urban and rural areas. Areas requiring further investigation include the impact of specific components of trauma systems in rural areas with the aim of creating evidence-based and cost-effective trauma care systems as well as the evaluation of outcomes of patients transferred from rural to urban centres.

**OVERALL CONCLUSION**

The current program included a series of studies, each one individually evaluating the potential effect of specific components of trauma care systems. The results of these studies have confirmed the existence of variation with respect to the type and organization of trauma care across Canada. The studies produced evidence showing that regionalization of trauma services, designation of trauma hospitals, and implementation of patient triage protocols are essential components for efficient trauma care systems in Canada. With respect to pre-hospital care, emphasis should be placed on improved training and better use of pre-hospital on-site basic life support, with consideration of incorporating endo-tracheal intubation among the emergency pre-hospital interventions. Finally the results showed that rural areas in Canada are under-serviced with respect to trauma care and that policies for transferring injured patients from rural to urban tertiary centres should become a priority.
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