Geography and Trauma Systems in Canada

Implications for Emergency Physicians

D Boone MD FRCSC FACS
Discipline of Surgery
Memorial University
Disclosures

None
32 yr old male, ATV incident
Goals

• Understand Trauma Systems
• Appreciate challenges in Canadian Environment
• Evaluate methods of system performance measures
• Identify opportunities for improvement
PUBLIC HEALTH PROBLEM

- Trauma costs Canadian economy $4 billion/year
- Children, youth, specific occupations, Aboriginal Canadians, and elderly at risk
RATIONALE FOR TRAUMA SYSTEMS AND PUBLIC HEALTH PARADIGM

• Trauma major public health problem and societal burden
• Magnitude not widely appreciated/disproportionately modest resources brought to bear to curb epidemic
Public Health System Conceptual Framework

- Assessment
- Policy Development
- Assurance
  - Trauma Association of Canada
    • Adapted from Model Trauma System Planning and Evaluation, US Department of Human and Social Services, 2006
Trauma System Concept

• Publicly admin., funded and accountable
• Comprehensive injury surveillance/prevent
• Delivers full spectrum of care
  – Immediate access to EMS
  – Rapid trans. to appropriate level of care
  – Acute services...resus., surgery, ICU
  – Rehab/reintegration to community
• Engages in research, training and performance Improvement
• Links with Emerg. Preparedness program
Trauma System Components
• Administrative Components
  – Lead Agency
  – Facilitating Legislation
  – Funding
  – Development
  – Evaluation

• Clinical Components
  – Prehospital services
  – Acute care facilities
  – Rehabilitation and long term care

• Injury Surveillance and Prevention

• Research, Education and Training

• Emergency Preparedness
Clinical Components

• Prehospital services
  – Access
  – Communications
  – Triage
  – Transport
  – Stabilization and intervention

• Acute care Facilities
  – Trauma centre
  – Other facilities

• Rehabilitation and long term care
What is Rural?

• “Rural trauma occurs in areas where geography, population density, weather, distance, or availability of professional or institutional resources combine to isolate the patient in an environment where access to definitive care is limited”

• “Trauma is deemed as rural when optimal care of the patient is delayed or limited by geography, weather, distance, resources, or lack of experience”
What is rural?

• “A rural trauma region would be an area in which the population served is fewer than 2500, has a population density of fewer than 50 persons per square mile, has only basic life support prehospital care, has prehospital times that exceed 30 minutes on average, and is lacking in subspeciality coverage for specific injuries”
Rural Trauma Care Challenges

- Discovery and access to system
- Human resources
- Communications
- Transport
- Facilities
- Education and maintenance of skills
Weather
Access to Trauma Systems in Canada

Hameed SM, Shuurman N, Razek T, Boone D, et.al. for the Research Committee of the Trauma Association of Canada

J Trauma. 2010;69: 1350-1361
• National survey identified locations and capabilities of trauma systems in Canada
• Geographic Information Science methods mapped Level 1 and 2 Trauma Centres and defined 1 hour road travel times around centres
• 2006 Canadian census data estimated populations within and outside 1 hour access to definitive care
<table>
<thead>
<tr>
<th>Level of Care</th>
<th>Description</th>
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<td>Central role in the provincial trauma system, and majority of tertiary/quaternary major trauma care in the system. Academic leadership, teaching, research program</td>
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<td>2</td>
<td>Provides care for major trauma. Some trauma training and outreach programs. Similar to Level I without academic and research programs</td>
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<tr>
<td>3</td>
<td>Provides initial care for major trauma patients and transfers patients in need of complex care to Levels I and II trauma centers</td>
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<td>Major urban hospital with a nearby major trauma centre (Levels I–III). Does large volume of secondary trauma care. Bypass and triage protocols are in place diverting major trauma patients to level I and II centers</td>
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<td>5</td>
<td>Small rural community hospitals or treatment facilities with little to no immediate access to Level I, II, or III Trauma Centers. Most trauma patients are stabilized, if possible and rapidly transferred to higher level trauma care</td>
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Canadians in several provinces including BC, Alberta, Ontario, Québec and Nova Scotia enjoy excellent access to trauma care. In Ontario, for instance, 85%, 95% and 99% of the population have access by road to definitive trauma care within 1, 2 and 4 hours. But there is a pronounced urban/rural divide across the country. Manitoba, by contrast, has only 69% of its population with 1 hour of trauma services. And 9.3% remain outside 4 hours. Manitoba serves as the point of access for trauma services for the Territory of Nunavut where 100% of the population is outside of a 4-hour access catchment. In Newfoundland and Labrador, problems of access are intensified with 60% of the population outside of a 1-hour catchment and 42% outside 4 hours. Residents of Labrador are all outside 4 hours to trauma services. In New Brunswick, a compact province with a well-developed road network, 53% of the population remains outside a 1 hour catchment while 5% are outside 4 hours. Access to trauma services exemplifies the long-standing urban rural divide in Canada – and calls to our attention the need to address rural and remote access.
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Access to Canadian trauma centers by road and air. The presence of regular prehospital helicopter access would improve access in rural areas where available.
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Conclusion

• Access to high quality acute trauma care is well established
• BUT clear urban /rural divide exists
• Regional efforts to improve outcomes should focus on optimizing access to pre-hospital and acute trauma care in rural communities using locally relevant strategies or novel care delivery options
The Epidemiology of Trauma Death in Newfoundland & Labrador

V. Cranford, D. Boone, S. Avis
Department of Surgery & the Office of the Chief Medical Examiner, Department of Justice
COT Residents Trauma Paper Competition 2009
Purpose of the Study

• To evaluate all trauma deaths that occurred in Newfoundland & Labrador

• Hypothesis:
  – There will be a large proportion of on scene deaths
  – There will be a significant proportion of late deaths
  – ETOH will contribute to a significant number of trauma deaths
Results

• 251 charts identified through OCME
  – 4 charts excluded from study due to type of injury
• 44 deaths identified through Trauma registry
  – Identifying an additional 7 patients not identified through OCME
  – This equates to 15.9% unreported in-hospital trauma deaths
• Thus, leaving a total of 254 trauma deaths over four years
Results cont…

• N= 254

• Sex
  – Male 176 (69.3%)
  – Female 78 (30.7%)

• Age (mean)
  – Total= 46.0yrs
  – Male= 45.1yrs
  – Female= 48.1yrs
Occurrence of Death

- On Scene
  - 166 (65.3%)
- In Ambulance
  - 5 (2.0%)
- In Hospital
  - 83 (32.7%)

- For In Hospital Deaths:
  - Acute <48hrs
    - 50.6%
  - Early 48hrs-7days
    - 21.7%
  - Late >7days
    - 25.3%
  - Unknown
    - 2.4%
Occurrence of Death cont…

• Cause of In-Hospital Acute Death:
  – CNS 59.5%
  – Shock 26.2%
  – CNS + Shock 7.1%
  – Other 2.4%
  – Unknown 4.8%

• Location of In-Hospital Acute Death:
  – St. John’s 69.8%
  – Eastern 7%
  – Central 7%
  – Western 14%
  – Labrador 2.2%
# Mechanism of Injury

- **Blunt**: 227 (89.4%)
- **Penetrating**: 12 (4.7%)
- **Other**: 14 (5.5%)
- **Combo**: 1 (5.5%)
Injury Mechanism for In Hospital Trauma Death

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>FALL</td>
<td>30.00%</td>
</tr>
<tr>
<td>ATV</td>
<td>15.00%</td>
</tr>
<tr>
<td>FIRE</td>
<td>10.00%</td>
</tr>
<tr>
<td>MVA</td>
<td>25.00%</td>
</tr>
<tr>
<td>MVPA</td>
<td>20.00%</td>
</tr>
<tr>
<td>STAB</td>
<td>5.00%</td>
</tr>
<tr>
<td>ASSAULT</td>
<td>0.00%</td>
</tr>
</tbody>
</table>
Population Adjusted Rates of Death

Deaths per 10,000 people

Eastern  Central  Western  Labrador

Health Region
ETOH Involvement

- Yes 77 (30.3%)
- No 125 (49.2%)
- Unknown 52 (20.5%)
Subsets & ETOH

- ATV Accidents
  - 23 deaths in total
  - 16 positive for ETOH or 69.7%
- Fire
  - 13 deaths in total
  - 8 positive for ETOH or 61.5%
- Falls
  - 46 deaths in total
  - 17 positive for ETOH or 37.0%
Conclusions cont…

• What does this mean???
  – Prevention is the key
  – Incorporating this data into the development of a regional trauma system, with specific attention to Labrador-Grenfell
  – Address the treatment of TBI as the leading cause of early in hospital death
  – More attention given to alcohol abuse

• More to Come
  – Ambulance reports for on scene response & transfer times
  – Addition of suicides to study
A Population-based analysis of injury-related deaths and access to trauma care on rural-remote Northwest British Columbia

Simons R, Brasher p, Taulu T, Laka N, et. al

J Trauma. 2010 Jul;69(1): 11-9
### TABLE 3. Time at Which 25%, 50%, and 75% of Deaths After Injury Have Occurred in Different BC Jurisdictions

<table>
<thead>
<tr>
<th>Health Authority</th>
<th>Time (h)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P25</td>
<td>P50</td>
<td>P75</td>
<td></td>
</tr>
<tr>
<td>NW</td>
<td>0.2</td>
<td>1</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>FHA</td>
<td>0.9</td>
<td>4.4</td>
<td>66.8</td>
<td></td>
</tr>
<tr>
<td>VCH</td>
<td>0.9</td>
<td>6</td>
<td>41.7</td>
<td></td>
</tr>
<tr>
<td>VIHA</td>
<td>1.1</td>
<td>7.7</td>
<td>78.6</td>
<td></td>
</tr>
</tbody>
</table>

NW, Northwest British Columbia; BC, data for entire province; FHA, Fraser Health Authority (urban); VIHA, Vancouver Island Health Authority (urban and rural).

Times to death after injury measured as the time at which 25%, 50%, and 75% of deaths have occurred in the NW and other jurisdictions in BC.
<table>
<thead>
<tr>
<th>Phase</th>
<th>Component</th>
<th>Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prehospital</td>
<td>Discovery</td>
<td>Limited 911 coverage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited cell phone coverage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remote highways (light traffic)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EHS-delayed response (distance, volunteer)</td>
</tr>
<tr>
<td>Primary transport</td>
<td></td>
<td>Ground option only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long distances</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Road conditions (road type and weather)</td>
</tr>
<tr>
<td>Stabilization</td>
<td></td>
<td>BLS capability only</td>
</tr>
<tr>
<td>Hospital</td>
<td>Access</td>
<td>No hospital bypass protocols</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disparate, inconsistent services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No designated trauma centre</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No systems approach to trauma</td>
</tr>
<tr>
<td>Intraregional referral</td>
<td></td>
<td>Ineffective no-refusal policies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No ALS transfer capability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited BLS helicopter transfer capability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inconsistent and disparate surgical services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No “go to” centre (trauma centre)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No “go to” trauma service or care coordination</td>
</tr>
<tr>
<td>Tertiary referral</td>
<td></td>
<td>Long aeromedical response times (fixed wing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited local airport capabilities (night/weather)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long transport distances/times</td>
</tr>
<tr>
<td>Trauma education</td>
<td></td>
<td>In-community trauma CPD lacking</td>
</tr>
</tbody>
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CPD, continued professional development.

Barriers to effective trauma care as cited by front-line health care providers in NW BC.
EVOLUTION OF RURAL TRAUMA CARE IN A CANADIAN PROVINCE

S. Galgay; S Roche, RN; D. Boone, MD FRCSC FACS
Discipline of Surgery, Faculty of Medicine, Memorial University of Newfoundland and Eastern Healthcare
St. John’s, Newfoundland, Canada
System limitations

- No formal Trauma System
- HSC TAC accredited Tertiary Care Centre
- Poor EMS integration and control
- No ALS prehospital providers
- Limited 911 coverage
- Air transport cumbersome
Research Question – Improved Primary Trauma care provision over time?

• 700 – 1000 admissions yearly to TTC
• 70 – 100 with ISS >= 12
• 60% of this population is referred
• Trauma registry data used for 1996-97 audit
• Has there been improvement in the process of care over time?
Methodology

• Standards for “ideal” rural trauma care set for prehospital, primary hospital and inter-hospital transfer

• Data from the provincial trauma registry characterizing a TTC referred trauma patient population from 1996-97 (Group A) were compared to a 2003-04 population (Group B) using a chi squared analysis
“Ideal Rural Care System”

• Prehospital
  – Response time < 10 minutes
  – Scene time < 20 minutes
  – C-spine immobilization

• Primary Hospital
  – Intubation for GCS < 9
  – Chest tube placement for hemo or pneumothorax
  – Total time at primary hospital < 6 hours

• Transfer
  – Appropriate accompanying personnel for pt with GCS < 9
Results – Prehospital response time < 10 minutes

- Yes
- No
- Unknown

Group A vs Group B
Prehospital – Scene time < 20 minutes \( p < 0.001 \)
Prehospital – Total prehospital time
< 60 minutes  p < 0.001
Prehospital – C-Spine immobilization

The bar chart shows the distribution of C-Spine immobilization across different categories: Yes, No, and Unknown. Two groups, Group A and Group B, are compared.

- **Yes**: Group A significantly outnumbers Group B.
- **No**: Group B has a higher percentage than Group A.
- **Unknown**: Group B has a lower percentage than Group A.

The chart indicates a notable difference between the two groups in terms of C-Spine immobilization practices.
Primary Hospital – Intubation for GCS < 9

![Bar chart showing the comparison between Group A and Group B for intubation status. Group A shows significantly higher intubation rates compared to Group B.](chart.png)
Primary Hospital – Chest tube placement for hemo/pneumo

![Bar chart showing chest tube placement for hemo/pneumo in Group A and Group B.](chart.png)

- **Group A**
  - Yes: 80
  - No: 30
  - Unknown: 10

- **Group B**
  - Yes: 90
  - No: 20
  - Unknown: 10

Legend:
- Red: Group A
- Blue: Group B
Primary Hospital – Total time at primary hospital < 6 hours \( p<0.10 \)
Transfer – Appropriate personnel for GCS < 9
Conclusion

• There have been limited improvements, most clinically significant at the primary hospital level, over time in achieving “ideal” standards for rural trauma care in this large sparsely populated Canadian province.
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Evolution of a Trauma Flight program in a Rural Canadian Province

Smith C, Boone D
C J Surg vol 54, No. 3 June 2011
Newfoundland and Labrador

• Sparsely populated region

• Trauma – leading cause of death ages 15-24

• Golden hour
Flight Program

• Team of Nurses and Paramedics with advanced training deployed from St. John’s

• Fixed Wing Aircraft

• Active since July 2007
Research Question

• Does the implementation of a flight program improve outcomes for trauma patients?

• Hypothesis: the current flight program employed in Newfoundland and Labrador improves outcomes for trauma patients
Methods

• Data obtained from provincial trauma registry and flight program database

• Study population
  – July ‘06 – July ‘07 – pre flight team group
  – July ‘07 – Aug ‘08 – post flight team group

• Severely injured trauma patients with anatomic profile score of A, B or C.
Methods

• Transported from referring facility

• Excluded patients transported from areas not covered by flight team
  – 150Km

• Excluded patients <14 years of age
Methods

• Primary endpoint
  – time from activation of flight team to arrival back at HSC (total time)

• Secondary endpoints
  – Time from dispatch to arrival at referring facility (dispatch time)
  – Actual transport time (transport time)
Methods

• Secondary endpoints – process of care measures
  – GCS < 9 – intubation
  – Pneumothorax – tube thoracostomy
  – Adequate IV access

• Two sided t test; chi square

• alpha 0.05, beta 0.20, estimated difference 30%, n = 65

• All analysis using SPSS v. 18
Results

- total of 66 patients
- 55 male, 11 female
- 25 in pre flight team group
- 41 in post flight team group
- mean ISS 13.6
  - Before – 13.1
  - After – 14.5
### July/06 – Aug/08

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<th>Total time</th>
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<tr>
<td>Before FT</td>
<td>100</td>
<td>187</td>
<td>285</td>
</tr>
<tr>
<td>After FT</td>
<td>253</td>
<td>147</td>
<td>400</td>
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<tr>
<th></th>
<th>Intubation</th>
<th>Chest tube</th>
<th>IV access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before FT</td>
<td>100%</td>
<td>67%</td>
<td>73%</td>
</tr>
<tr>
<td>After FT</td>
<td>100%</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td><strong>p value</strong></td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

*Time measured in minutes*
Aug. 1/09 – Present

<table>
<thead>
<tr>
<th></th>
<th>Dispatch time</th>
<th>Transport time</th>
<th>Total time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before FT</td>
<td>100</td>
<td>187</td>
<td>285</td>
</tr>
<tr>
<td>After FT</td>
<td>207</td>
<td>139</td>
<td>345</td>
</tr>
<tr>
<td></td>
<td>(253)</td>
<td>(147)</td>
<td>(400)</td>
</tr>
</tbody>
</table>

p value: <0.001, 0.046, ns

n before = 25
n after = 31
Conclusion

• Flight team mobilization has unexpectedly led to prolonged transport times due to an increase in dispatch time.

• Improvements have been made with respect to flight team mobilization and the transport of severely injured trauma patients.
Conclusion

• Dispatch time for trauma team personnel remains a limiting factor
• There has been a trend toward improvement in the process of care of trauma patients
• Further studies will need to be done to examine the clinical impact of the trauma flight team
Future direction

- Establishment of separate flight team to be deployed out of Goose Bay
- Utilization of further aircraft
- Possibility of rotor wing aircraft
But how should we evaluate effectiveness?
Analysis of Preventable Trauma Deaths and Opportunities for Trauma Care improvement in Utah

Sanddal T, Esposito T et. al.

J Trauma. 2011;70: 970-977
• Retrospective review
• Cases assessed by multidisciplinary panel of physicians and nonphysicians
• Overall PD rate 7%
• PD rate for those surviving to hospital care 11%
• OFIs identified in 76% of cases
<table>
<thead>
<tr>
<th>NP</th>
<th>PP</th>
<th>FP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomic injuries considered nonsurvivable under optimum care (recognized peer review standards used)</td>
<td>Anatomic injuries very severe but survivable under optimum care</td>
<td>Anatomic injuries considered survivable</td>
</tr>
<tr>
<td>Physiologic state of patient at the time of arrival of first responder may be considered but noncritical to judgment</td>
<td>Patient generally considered unstable and responds minimally to treatment</td>
<td>Patient generally stable; if unstable, patient becomes stable with treatment</td>
</tr>
<tr>
<td>Appropriate management using ATLS/PHTLS guidelines (suspect care considered as error)</td>
<td>Generally appropriate ATLS/PHTLS care, suspect care directly or indirectly implicated in patient demise</td>
<td>Evaluation and management suspect in any way</td>
</tr>
<tr>
<td>Patient had comorbid factors, which were major contributors causing death</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ATLS, advanced trauma life support.
<table>
<thead>
<tr>
<th>Phases</th>
<th>Total Cases Treated</th>
<th>Adjusted percent of OFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prehospital</td>
<td>254</td>
<td>45</td>
</tr>
<tr>
<td>ED</td>
<td>248</td>
<td>63</td>
</tr>
<tr>
<td>Post-ED</td>
<td>141</td>
<td>34</td>
</tr>
<tr>
<td>Phase of Care (Patient Contacts)</td>
<td>Inappropriate Care Related to</td>
<td>Number of Occurrences*</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Prehospital (n = 254)</td>
<td>Airway management</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>C-spine</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Documentation</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Fluid resuscitation</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Medication</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total prehospital</strong></td>
<td></td>
<td><strong>130</strong></td>
</tr>
<tr>
<td>ED (n = 248)</td>
<td>Airway management</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Documentation</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Fluid resuscitation</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Evaluation of abdomen or chest</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Inappropriate imaging/diagnostics</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Management of chest injury</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Recognition of injury severity</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total ED</strong></td>
<td></td>
<td><strong>165</strong></td>
</tr>
<tr>
<td>Post-ED (n = 141)</td>
<td>Documentation</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Fluid resuscitation</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Inappropriate operation</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Management or monitoring of head injury</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Treatment of rebleeding</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Ventilator care</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total post-ED</strong></td>
<td></td>
<td><strong>56</strong></td>
</tr>
<tr>
<td><strong>Total all phases</strong></td>
<td></td>
<td><strong>351</strong></td>
</tr>
</tbody>
</table>

*Some patients were noted to have multiple errors in a single phase of care.*
Conclusion

• Resource organization and primary care provider education may be the most cost-effective method of reducing preventable deaths in this mixed urban and rural setting.
Opportunities
Hameed et. Al. Conclusion

• Access to high quality acute trauma care is well established
• BUT clear urban /rural divide exists
• Regional efforts to improve outcomes should focus on optimizing access to pre-hospital and acute trauma care in rural communities using locally relevant strategies or novel care delivery options
Prevention
Rural Trauma Team Development
Course in Newfoundland

Darrell Boone MD FRCSC FACS
St. John’s, NL, Canada
Novel Ideas

CAEP Position Statement

Recommendations for the management of rural, remote and isolated emergency health care facilities in Canada

• “regionalization. Five levels of ...health care facilities recommended”
• “Physician Procedure skills”
• “equipment”
• “protocols”
• “physician training”
Thank You