Seasonal Variations in Mortality of Trauma Transport Patients: Is there a difference?

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Background

• Time is critical in trauma
• North Dakota Climate
  – Winter can have blizzards or forty below zero temperatures for months at a time.
  – Summer brings thunderstorms, tornadoes, hail, and flash floods with high temperatures
  – These conditions cause road closures or hazardous traveling conditions
• World War One French records indicate casualties evacuated by air within six hours of injury, mortality rate fell from 60% to less than 10%.2
• Helicopter transport began during the Vietnam War with the Huey medevac units.8
• Mortality rate in Vietnam was less than 1 per 1008
  – Compared to 4.5 deaths per 100 in World War II
• Researchers found better rates of survival in wounded servicemen than motor vehicle accident victims on California expressways14
Variables for Transport

- Helicopters ideally reduce transit time by their capabilities.
  - Vertical takeoff
  - Maneuverability
  - Ability to carry large loads
  - Speed
- Disadvantages include
  - Maintenance
  - Start up cost
  - Trained personnel
  - Insurance

Our Study

- Analyze transport of trauma patients by mode controlling for distance, ISS, and transport time.
- Use seasonal variation to analyze ground versus helicopter medical transport.
- Also, the appropriateness of Helicopter Emergency Medical Service (HEMS) versus non-HEMS transport.
  - At times patients go by air when ground would be a cheaper and as good as an alternative.
  - Alternatively, there are times when time-sensitive patients are sent by ground when air would be faster.
Methods

- Study Type
  - Retrospective chart review
- Study Population
  - Men and women 15 years old and older
  - Transported by ground or helicopter for trauma purposes
  - From July 1\textsuperscript{st} 2008-June 30\textsuperscript{th} 2013

- Criteria
  - Men and Women 15 year old and older
  - Trauma patients transported to Sanford Health
- Exclusions
  - Patients whom had already been brought to and stabilized at another facility.
  - Younger than 15 years of age, patients whom had missing data, extreme outliers for field time and transport time, and patients whom were dead on arrival.
  - Inconsistent data
- Variables
  - Age, gender, date of transport (Admit Date), discharge date, Injury Severity Score (ISS), distance of transport, pick up location, transport time, and in-hospital mortality.
  - ISS was further divided to 15 and below and 16 and above
  - Distance of transport further divided to $\geq 30$ miles and $<30$ miles
Methods

• Analysis
  – SPSS 21.0 for Windows was used to analyze demographic and clinical characteristics of patients.
  – Means (standard deviation) were used for skewed distributions
  – Relative percentages were computed for each categorical variable.
  – Chi-square tests or Fisher’s exact tests were performed to determine which categories were significantly different from one another
  – T-test and/or ANOVA were used to compare continuous variables.
  – P-value ≤0.05 was considered significant.

Results

• 582 patients were eligible for our study
• 30 In-Hospital deaths
Table 1: Percentage of Deaths by Seasons

<table>
<thead>
<tr>
<th>Season</th>
<th>Ground</th>
<th>Helicopter</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>2.1</td>
<td>9.7</td>
<td>.057*</td>
</tr>
<tr>
<td>Spring</td>
<td>2.3</td>
<td>10.5</td>
<td>.050</td>
</tr>
<tr>
<td>Summer</td>
<td>2.1</td>
<td>9.9</td>
<td>.024</td>
</tr>
<tr>
<td>Fall</td>
<td>4.4</td>
<td>7.5</td>
<td>.426*</td>
</tr>
</tbody>
</table>

(*) indicates a low number of deaths

Table 2: Number of Transports by Season

<table>
<thead>
<tr>
<th>Season</th>
<th>Ground</th>
<th>Helicopter</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>97</td>
<td>31</td>
<td>128 (22.0)</td>
</tr>
<tr>
<td>Spring</td>
<td>86</td>
<td>38</td>
<td>124 (21.3)</td>
</tr>
<tr>
<td>Summer</td>
<td>95</td>
<td>91</td>
<td>186 (32.0)</td>
</tr>
<tr>
<td>Fall</td>
<td>91</td>
<td>53</td>
<td>144 (24.7)</td>
</tr>
</tbody>
</table>
Results

• Helicopter flights without seasonal variation have a higher percentage of deaths (9.4%) compared to ground (2.7%) (p value = .000).
• Transports ≥30 miles (p value 0.000)
  – Helicopter transports - 59.6%
  – Ground transports - 39.3%
• ISS score 16+ (p value 0.000)
  – Helicopter transports 37.1%
  – Ground transports 11.9%

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Ground</th>
<th>Helicopter</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>51.91 ± 25.12</td>
<td>40.29 ± 18.26</td>
<td>.000</td>
</tr>
<tr>
<td>Distance (miles)</td>
<td>27.72 ± 19.01</td>
<td>43.61 ± 28.29</td>
<td>.000</td>
</tr>
<tr>
<td>Field Time (mins)</td>
<td>126.27 ± 144.74</td>
<td>94.26 ± 39.81</td>
<td>.001</td>
</tr>
<tr>
<td>Transport Time (mins)</td>
<td>58.09 ± 25.78</td>
<td>37.85 ± 16.77</td>
<td>.000</td>
</tr>
<tr>
<td>In-Hospital Length of Stay (days)</td>
<td>4.72 ± 4.48</td>
<td>7.25 ± 8.44</td>
<td>.000</td>
</tr>
</tbody>
</table>

Described in mean ± standard deviation.
Discussion

• Our results indicate that HEMS has a significant higher rate of patient mortality in spring and summer.
• HEMS patients have a significant relationship of higher ISS score, which has been previously reported in the literature.³
• Our data concludes that patients have an increased mortality when transported by air; most likely due to the relationship of higher ISS and greater transport distances.
  – Rose et al. found that no survival benefit was seen in rural areas when utilizing air transport.¹⁴

Discussion

• Spring and summer have the higher mortality than fall and winter is surprising.
  – Our expectation was fall and winter to have higher mortality.
  – Compounding factors: increase in risky behavior.
• In summer, HEMS transport equaled ground transport in numbers.
  – Whereas in the other seasons there were significantly less helicopter transports.
  – We expected to find winter to have increased transport.
Discussion

• In ND, HEMS significantly transports 30 miles or greater than ground transport.
  – Rhinehart et al. found that patients with access to HEMS and living > 20 miles from a tertiary center had a reduced risk of death.\textsuperscript{13}
• Our data shows shorter transport time than ground, which is consistent with Phillips et al.\textsuperscript{9}

Discussion

• Stewart et al. and Chappell et al. found inadequate use of air transport.\textsuperscript{4,11}
  – Transported by air for low ISS, no head injuries, or stable vitals.
  – Suggesting better triage principles or algorithms.
• Our study supports the adequate use of helicopter transport in North Dakota.
  – Helicopters were significantly more likely to transport high ISS, greater distances (>30 miles), less transport time, and have an increased mortality rate.
  – This suggests that HEMS has a significant role in North Dakota.
  – North Dakota healthcare providers are adequately utilizing HEMS transport.
Limitations

• Small, homogenous population size
• Sparse warnings encountered on data analysis
• Exclusion of pediatric patients (<15yo)
  – Elderly patients were still included in the study
• Outliers for transport time and distance were excluded
• ISS, Injury Severity Score, might not be the best indicator of trauma severity.
  – Calculated hours to days after event
  – Not routinely taught or used by healthcare providers for care
  – Trauma research
• No control for specific types of trauma

Future areas of study

• Specific weather or road conditions
• Adequacy of helicopter type to handle specific weather conditions
• Increasing sample size
• Prospective study
• Other trauma scores
  – Future algorithms have been introduced, but none routinely used.
• Mechanism of injury
• Insurance
• Care provided during transport
Conclusions

- Seasonal variation is an important variable to take into account for trauma patient transport.
- Our study shows in spring and summer, helicopter transport trauma patients have a significant increase in mortality when compared to ground transport.
- Helicopter transport patients were more likely to be younger, transported farther, shorter transport time, and have a higher ISS.
- North Dakota is adequately utilizing HEMS.
- Helicopter transport is still earning its place in medevac, but the future looks promising.

References