Does EMS Perceived Anatomic Injury Predict Trauma Center Need for Pediatric Patients?

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- Arthur Cooper, Columbia University
Conflicts of Interest and Support

- Conflicts of Interest: None
- Support:
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  - Contents are solely the responsibility of the authors and do not necessarily represent the official views of the CDC
EMS and Children

- Millions of injured children transported annually
- Severely injured:
  - minimize time to definitive care to maximize outcome
- EMS must identify severely injured
  - Direct transport to trauma center
  - Use the Field Triage Guidelines
- Step 1: Physiologic
- Step 2: Anatomic
- Step 3: Mechanism of Injury
- Step 4: Special Circumstances
When Triage Goes Wrong

- **Under-triage**
  - Failure to transport severely injured to trauma center
    - Patient effect
      - Increase in morbidity and mortality
When Triage Goes Wrong

- Over-triage
  - Transporting minimally injured to trauma center
    - Patient/provider effect
      - Safety
    - System effects
      - By-passing hospitals increases transport and hospital turnaround times
      - Negative economic consequences for by-passee hospitals
      - Can contribute to overcrowding at trauma center
## Effect of Guidelines on Pediatric Destination Decisions

<table>
<thead>
<tr>
<th></th>
<th>ACS Goal</th>
<th>2011 Field Triage Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over-Triage</td>
<td>25-50%</td>
<td>28%</td>
</tr>
<tr>
<td>Under-Triage</td>
<td>&lt;5%</td>
<td>35%</td>
</tr>
</tbody>
</table>
Physiologic Criteria

- Using the 2011 Guidelines
  - Under-triage 51%
  - Over-triage 18%
- +LR 2.8 (95%CI: 2.4 - 3.2)
### Vital Signs Not Obtained

<table>
<thead>
<tr>
<th>Age</th>
<th>N</th>
<th>GCS</th>
<th>SBP</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 years</td>
<td>329</td>
<td>14%</td>
<td>79%</td>
<td>11%</td>
</tr>
<tr>
<td>1-4 years</td>
<td>1569</td>
<td>7%</td>
<td>46%</td>
<td>8%</td>
</tr>
<tr>
<td>5-9 years</td>
<td>1431</td>
<td>3%</td>
<td>7%</td>
<td>3%</td>
</tr>
<tr>
<td>10-15 years</td>
<td>2265</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5594</td>
<td>4%</td>
<td>20%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Percent with missing vital who needed TC

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7%</td>
<td>4%</td>
<td>9%</td>
<td></td>
</tr>
</tbody>
</table>
Objective

To determine the predictive value of the anatomic step for identifying trauma center need for children.
Methods

- 2 year prospective observational study
- 3 pediatric regional trauma centers
  - Milwaukee, WI
  - Rochester, NY
  - Dallas, TX
Injured patient ≤15 years transported to the ED by EMS

- Yes:
  - Interview EMS provider in charge of patient care
  - Follow patient to determine trauma center need

- No:
  - Exclude

Refused:

Exclude
Interview Data

- Anatomic conditions – Pt appears to have
  - Burns
  - Flail chest
  - Two or more proximal long-bone fracture
  - Pelvic fracture
  - New onset paralysis
  - Crushed, degloved, or mangled extremity
  - Amputation proximal to wrist or ankle
  - Penetrating injury proximal to elbow or knee
Outcome – Trauma Center Need

- Composite measure
  - Non-orthopedic surgery within 24 hours
  - ICU admission
  - Died
# ICD-9 Used to Determine Accuracy

<table>
<thead>
<tr>
<th>Anatomic Criteria</th>
<th>ICD-9/E-codes</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetrating injuries</td>
<td>E955, E956, E965, E922, E966, E920, E970, E974, E985, E986</td>
<td>No specific injury so used E-codes</td>
</tr>
<tr>
<td>Flail chest</td>
<td>807.4</td>
<td></td>
</tr>
<tr>
<td>Two or more long-bone fx</td>
<td>812, 819, 820, 821</td>
<td>There is no way to identify two fractures so used any one</td>
</tr>
<tr>
<td>Amputation</td>
<td>887, 897</td>
<td>Cannot verify proximal to wrist or ankle – but did not use finger codes (885 thumb and 886 other fingers)</td>
</tr>
<tr>
<td>Pelvic fractures</td>
<td>808</td>
<td></td>
</tr>
<tr>
<td>Open or depressed skull fracture</td>
<td>Open: 800.5-800.9, 801.5-801.9, 803.5-803.9, 804.5-804.9 Closed:800-800.4, 801-801.4, 803-803.4</td>
<td>Used all major open and closed head injuries (may or may not be depressed)</td>
</tr>
<tr>
<td>Paralysis</td>
<td>951-957</td>
<td>Used any injury to the spinal nerves (paralysis unknown)</td>
</tr>
</tbody>
</table>
Data Analysis

- Descriptive statistics
  - Over- and under-triage rates
  - Positive Likelihood Ratios (+LR)
Results

- 5,610 provider interviews
- 16 missing outcome
- Average age 7.5 years
- 5% identified as needing trauma center
Anatomic Criteria

- Excluded 1,072 cases that met Physiologic Criteria

- 238 cases met anatomic criteria
  - 9.7% needed resources of a trauma center
Utility of Anatomic Criteria for Identifying Trauma Center Need

- **EMS Identified**
  - Under-triage 83.8%
  - Over-triage 4.9%
  - +LR 3.3 (95%CI: 2.2 – 4.9)

- **ICD-9 Identified**
  - Under-triage 57.7%
  - Over-triage 9.7%
  - +LR 4.4 (95%CI: 3.5 – 5.4)
# Individual Criteria - +LR>5

<table>
<thead>
<tr>
<th></th>
<th>Skull FX</th>
<th>Penetrating Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under- triage</td>
<td>98%</td>
<td>90%</td>
</tr>
<tr>
<td>Over- triage</td>
<td>0.2%</td>
<td>1.5%</td>
</tr>
<tr>
<td>+ LR</td>
<td>9.3</td>
<td>6.6</td>
</tr>
<tr>
<td>ICD-9 confirmed +</td>
<td>15% (2/13)</td>
<td>42% (33/79)</td>
</tr>
<tr>
<td>Not EMS identified</td>
<td>97% (69/71)</td>
<td>84% (175/208)</td>
</tr>
</tbody>
</table>
**Individual Criteria + LR<2.5**

<table>
<thead>
<tr>
<th></th>
<th>Long Bone Fracture</th>
<th>Pelvic Fracture</th>
<th>Extremity Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Under-triage</strong></td>
<td>97%</td>
<td>99%</td>
<td>9%</td>
</tr>
<tr>
<td><strong>Over-triage</strong></td>
<td>1.4%</td>
<td>.5%</td>
<td>1.2%</td>
</tr>
<tr>
<td><strong>+ LR</strong></td>
<td>2.1</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>ICD-9 Agreement +</strong></td>
<td>23% (15/64)</td>
<td>19% (4/21)</td>
<td>9% (5/53)</td>
</tr>
<tr>
<td><strong>Not EMS identified</strong></td>
<td>92% (162/177)</td>
<td>83% (19/23)</td>
<td>38% (3/8)</td>
</tr>
</tbody>
</table>

Insufficient cases to analyze: flail chest (n=1), paralysis (n=11), amputation (n=3)
Discussion

- Anatomic criteria moderate predictor of trauma center need
  - EMS suspected anatomic injuries rarely confirmed by discharge diagnosis
  - Minimal over-triage
Future Directions

- Improve identification
- Current Anatomic and Physiologic criteria are not sufficient for identifying children who need a trauma center
  - Mechanism is not sufficient
  - Need to consider new criteria
  - Balance complexity with accuracy
Conclusions

- EMS perception of injury is a moderate predictor of trauma center need in children.
Questions?

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