Differences in Injury Outcomes in Children versus Adults

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Project Goal

Identify specific injuries that result in varying levels of morbidity and mortality (both greater and lesser) in children when compared to adults
Background

• Abbreviated Injury Scale (AIS)
  – Anatomically based, consensus derived, severity scoring system
  – Global system of choice for injury data collection
  – Measures threat to life, tissue damage, complexity of treatment, and injury impairment on an ordinal scale
  – May be age-specific differences in injury outcomes

Background

Mortality Risk
• Associated mortality with an injury
  • Data Source: NTDB
  • Quantified for:
    – Pediatrics
    – Adults

Disability Risk
• Associated disability with an injury
  • Data Source: NTDB
  • Quantified for:
    – Pediatrics
    – Adults

Time Sensitivity
• Associated the urgency with which an injury should be treated
  • Data Source: Expert Survey Data
  • Quantified for:
    – Pediatrics
    – Adults
**Background**

Disability Risk Ratio vs Mortality Risk Ratio for 240 Common AIS 2+ Motor Vehicle Crash Injuries in Pediatrics

- Low Mortality Risk Ratios (MRRs) can have high Disability Risk Ratios
- These injuries still present opportunity to dramatically affect lives – especially pediatric, who have lower MRR than adults

**Disability Risk**

- Largest aggregation of trauma registry data
- Data from participating trauma centers

**Sample Sizes**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Ages</th>
<th># Occupants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatric</td>
<td>7-18</td>
<td>63,307</td>
</tr>
<tr>
<td>Adult</td>
<td>19-45</td>
<td>214,883</td>
</tr>
<tr>
<td>Middle Age</td>
<td>46-65</td>
<td>77,728</td>
</tr>
<tr>
<td>Older Adult</td>
<td>66+</td>
<td>41,753</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>397,671</strong></td>
</tr>
</tbody>
</table>

- Inclusion Details
  - Age ≥ 7 years old
  - Alive at discharge
  - Only injuries found on Top 95% Injury Lists for Children and Adults (NASS-CDS 2000-2011)
FIM Scores

- Functional Independence Measures (FIM) to evaluate disability after trauma
- NTDB contains truncated form with 3 items
  - FIM-FEED: ability to self-feed at discharge
  - FIM-LOCOMOT: ability to ambulate at discharge
  - FIM-EXPRESS: ability to express one’s self at discharge

Numeric score (1-4)
- (4) – Complete Independence
- (3) – Independence with Device
- (2) – Modified Dependence
- (1) – Complete Dependence

Disabled: If any of the FIM metrics = 1 or 2
Not Disabled: If all FIM metrics = 3 or 4

NTDB FIM Scores

NTDB FIM Score Availability

<table>
<thead>
<tr>
<th>Group</th>
<th>No FIM</th>
<th>No FIM %</th>
<th>FIM</th>
<th>FIM %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Pediatric)</td>
<td>35,796</td>
<td>57%</td>
<td>27,511</td>
<td>43%</td>
<td>63,307</td>
</tr>
<tr>
<td>2 (Adult)</td>
<td>117,931</td>
<td>55%</td>
<td>96,952</td>
<td>45%</td>
<td>214,883</td>
</tr>
<tr>
<td>3 (Middle Age)</td>
<td>42,659</td>
<td>55%</td>
<td>35,069</td>
<td>45%</td>
<td>77,728</td>
</tr>
<tr>
<td>4 (Older Adult)</td>
<td>22,515</td>
<td>54%</td>
<td>19,238</td>
<td>46%</td>
<td>41,753</td>
</tr>
</tbody>
</table>
### NTDB Disability Status

#### Pediatric Occupants
- Disabled: 13%
- Not Disabled: 87%

#### Adult Occupants
- Disabled: 17%
- Not Disabled: 83%

<table>
<thead>
<tr>
<th>Group</th>
<th>Not Disabled</th>
<th>Not Disabled %</th>
<th>Disabled</th>
<th>Disabled %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Pediatric)</td>
<td>28,748</td>
<td>87%</td>
<td>4,473</td>
<td>13%</td>
<td>33,221</td>
</tr>
<tr>
<td>2 (Adult)</td>
<td>100,532</td>
<td>86%</td>
<td>16,265</td>
<td>14%</td>
<td>116,797</td>
</tr>
<tr>
<td>3 (Middle Age)</td>
<td>34,695</td>
<td>81%</td>
<td>8,041</td>
<td>19%</td>
<td>42,736</td>
</tr>
<tr>
<td>4 (Older Adult)</td>
<td>16,080</td>
<td>70%</td>
<td>6,930</td>
<td>30%</td>
<td>23,010</td>
</tr>
</tbody>
</table>

### NTDB Disabled Pediatrics

#### Disabled Pediatric Occupants (n=4,473)
- Only Self-Feeding: 4%
- Only Locomotion: 23%
- Only Expression: 3%
- Self-Feeding and Locomotion: 10%
- Self-Feeding and Expression: 1%
- Locomotion and Expression: 2%
- Self-Feeding, Locomotion, Expression: 57%
NTDB Disabled Adults

Disabled Adult Occupants (n= 31,236)

- 20,277, 65%
- 8,811, 3%
- 3,361, 12%
- 3,614, 12%
- 491, 16%
- 1,011, 3%
- 159, 0%
- 379, 1%

- AIS 2: 58%
- AIS 3: 33%
- AIS 4: 7%
- AIS 5: 2%

Body Region:
- Thorax: 14%
- Lower Extremity: 35%
- Upper Extremity: 13%
- Spine: 11%
- Abdomen: 7%
- Head: 10%
- Face: 10%
- Neck: 0%

AIS Severity:
- AIS 2: 58%
- AIS 3: 33%
- AIS 4: 7%
- AIS 5: 2%

Locomotion:
- Only Locomotion
NTDB Disabled Adults

AIS Severity
- AIS 2: 43%
- AIS 3: 35%
- AIS 4: 16%
- AIS 5: 6%

Body Region
- Head: 26%
- Face: 14%
- Neck: 0%
- Thorax: 16%
- Abdomen: 7%
- Spine: 12%
- Upper Extremity: 15%
- Lower Extremity: 10%

Disability Risk Ratios

\[
\text{DRR} = \frac{\#\ \text{Disabled} \text{after injury}}{\text{Total} \#\ \text{with injury}}
\]

Example: AIS 160699.2
Lethargic, stuporous, obtunded post-resuscitation, Admission/at scene GCS 9-14
Ages 7-18yo

Disability Risk Ratio
- Disabled: 14%
- Not Disabled: 86%
Disability Risk Ratios

\[ \text{MAIS Adjusted DRR (DRR}_{\text{MAIS}}) = \frac{\text{# Disabled after injury w/ MAIS = Injury’s AIS}}{\text{Total # Injured w/ MAIS = Injury’s AIS}} \]

Example: AIS 160699.2

Exclude patients with AIS 3+ injury, then calculate disability risk

Disability Risk Ratios

<table>
<thead>
<tr>
<th>Age Group</th>
<th>1 (Pediatric)</th>
<th>2 (Adult)</th>
<th>3 (Middle Age)</th>
<th>4 (Older Adult)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median DRR</td>
<td>0.32</td>
<td>0.32</td>
<td>0.38</td>
<td>0.50</td>
</tr>
<tr>
<td>Median DRR_{\text{MAIS}}</td>
<td>0.22</td>
<td>0.25</td>
<td>0.31</td>
<td>0.47</td>
</tr>
</tbody>
</table>
DRR$_{MAIS}$ and Body Region

DRR$_{MAIS}$: FIM Component for Head Injuries

Pediatric
- Only Self-Feeding: 26%
- Only Locomotion: 12%
- Only Expression: 3%
- Self-Feeding and Locomotion: 3%
- Self-Feeding and Expression: 4%
- Only Expression: 3%

Adult
- Only Self-Feeding: 45%
- Only Locomotion: 11%
- Only Expression: 3%
- Self-Feeding and Locomotion: 36%
- Self-Feeding and Expression: 30%
- Only Expression: 5%

Middle Age
- Only Self-Feeding: 39%
- Only Locomotion: 13%
- Only Expression: 3%
- Self-Feeding and Locomotion: 36%
- Self-Feeding and Expression: 39%
- Only Expression: 1%

Older
- Only Self-Feeding: 41%
- Only Locomotion: 18%
- Only Expression: 1%
- Self-Feeding and Locomotion: 34%
- Self-Feeding and Expression: 39%
- Only Expression: 1%
**DRR\textsubscript{MAIS}: FIM Component for Thoracic Injuries**

- **Pediatric**
  - Only Self-Feeding: 4%
  - Self-Feeding and Locomotion: 3%
  - Only Locomotion: 18%
  - Self-Feeding and Expression: 3%
  - Only Expression: 1%
  - Locomotion and Expression: 1%
  - Self-Feeding, Locomotion, Expression: 61%

- **Adult**
  - Only Self-Feeding: 3%
  - Self-Feeding and Locomotion: 18%
  - Only Locomotion: 3%
  - Self-Feeding and Expression: 15%
  - Only Expression: 13%
  - Locomotion and Expression: 1%
  - Self-Feeding, Locomotion, Expression: 64%

- **Middle Age**
  - Only Self-Feeding: 2%
  - Self-Feeding and Locomotion: 15%
  - Only Locomotion: 3%
  - Self-Feeding and Expression: 2%
  - Only Expression: 6%
  - Locomotion and Expression: 13%
  - Self-Feeding, Locomotion, Expression: 66%

- **Older**
  - Only Self-Feeding: 3%
  - Self-Feeding and Locomotion: 23%
  - Only Locomotion: 3%
  - Self-Feeding and Expression: 18%
  - Only Expression: 18%
  - Locomotion and Expression: 0%
  - Self-Feeding, Locomotion, Expression: 54%

**DRR\textsubscript{MAIS} Body Region Analysis**

- Analysis of specific head and thoracic injuries
  - Larger variations of DRR\textsubscript{MAIS} within these body regions
- **Head**
  - 54 unique AIS codes present
    - 8 injury groups based on structure of the injury and injury type
- **Thorax**
  - 27 unique AIS codes present
    - 7 injury groups based on structure of the injury and injury type
### DRR_{MAIS} Head Injury Analysis

#### Head Injuries

- **Brain Stem Injury**: Pediatric
- **Contusion/Hemorrhage**: Older Adult
- **Diffuse Axonal Injury**: Adult
- **Epidural Hemorrhage**: Older Adult
- **Intracerebral Hemorrhage**: Older Adult
- **Loss of Consciousness**: Pediatric
- **Skull Fracture**: Older Adult
- **Subdural/ Subarachnoid Hemorrhage**: Older Adult

#### Injury Group Analysis

<table>
<thead>
<tr>
<th>Injury Group</th>
<th>Age Group with 1st Highest DRR</th>
<th>Age Group with 2nd Highest DRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain Stem Injury</td>
<td>Pediatric</td>
<td>Adult</td>
</tr>
<tr>
<td>Contusion/Hemorrhage</td>
<td>Older Adult</td>
<td>Pediatric</td>
</tr>
<tr>
<td>Diffuse Axonal Injury</td>
<td>Adult</td>
<td>Middle Age</td>
</tr>
<tr>
<td>Epidural Hemorrhage</td>
<td>Older Adult</td>
<td>Middle Age</td>
</tr>
<tr>
<td>Intracerebral Hemorrhage</td>
<td>Older Adult</td>
<td>Middle Age</td>
</tr>
<tr>
<td>Loss of Consciousness</td>
<td>Pediatric</td>
<td>Adult</td>
</tr>
<tr>
<td>Skull Fracture</td>
<td>Older Adult</td>
<td>Middle Age</td>
</tr>
<tr>
<td>Subdural/ Subarachnoid Hemorrhage</td>
<td>Older Adult</td>
<td>Middle Age</td>
</tr>
</tbody>
</table>
### DRR<sub>MAIS</sub> Thoracic Injury Analysis

#### Thoracic Injuries

<table>
<thead>
<tr>
<th>Injury Group</th>
<th>Age Group with 1&lt;sup&gt;st&lt;/sup&gt; Highest DRR</th>
<th>Age Group with 2&lt;sup&gt;nd&lt;/sup&gt; Highest DRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diaphragm Laceration/Rupture</td>
<td>Older Adult</td>
<td>Adult</td>
</tr>
<tr>
<td>Flail Chest</td>
<td>Pediatric</td>
<td>Older Adult</td>
</tr>
<tr>
<td>Heart/Aorta Laceration</td>
<td>Older Adult</td>
<td>Middle Age</td>
</tr>
<tr>
<td>Hemo/Pneumothorax</td>
<td>Older Adult</td>
<td>Middle Age</td>
</tr>
<tr>
<td>Lung Contusion/Laceration</td>
<td>Older Adult</td>
<td>Middle Age</td>
</tr>
<tr>
<td>Pneumomediastinum</td>
<td>Middle Age</td>
<td>Older Adult</td>
</tr>
<tr>
<td>Rib Fracture</td>
<td>Older Adult</td>
<td>Middle Age</td>
</tr>
</tbody>
</table>

*Older Adult tended to have highest DRR*
Next Steps

• ISS-adjusted DRRs
  – Use frequency distribution of ISS of the sample to determine logical cutoff values
  – Group patients by cutoff values

• Combine with MRR & Time Sensitivity analyses
  – Identify specific injuries that have dramatically different outcomes in children versus adults

Thank you!

Questions?