Triage of the Pediatric Trauma Patient

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No Disclosures

Outline
- What are the goals of triage?
- How are children different than adults?
- Pre-hospital triage
- Emergency Department triage
- Evaluation of shock index
What are the goals of triage?

Goals of Field Triage

- Injured child
- Suspected Severe injury
- Trauma center

- Suspected Mild injury
- Non-trauma center

Goals of ED Triage

- Injured child
- Suspected Severe injury
- Activate Trauma Team

- Suspected Mild injury
- ED manages

- Severe injury
- Mild injury
- Mild injury

- Severe injury
- Mild injury

How are children different than adults?

Variable Vital Signs

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Heart Rate</th>
<th>Respiration</th>
<th>Systolic BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preterm</td>
<td>120 - 180</td>
<td>80 - 70</td>
<td>40 - 80</td>
</tr>
<tr>
<td>Newborn (0 to 1 month)</td>
<td>110 - 130</td>
<td>35 - 55</td>
<td>50 - 70</td>
</tr>
<tr>
<td>Infant (1 to 12 months)</td>
<td>80 - 140</td>
<td>30 - 40</td>
<td>70 - 120</td>
</tr>
<tr>
<td>Toddler (1 to 3 years)</td>
<td>80 - 130</td>
<td>20 - 30</td>
<td>70 - 110</td>
</tr>
<tr>
<td>Preschool (4 to 8 years)</td>
<td>80 - 110</td>
<td>20 - 30</td>
<td>80 - 110</td>
</tr>
<tr>
<td>School Age (8 to 12 years)</td>
<td>70 - 100</td>
<td>18 - 24</td>
<td>80 - 120</td>
</tr>
<tr>
<td>Adolescents (12+ Years)</td>
<td>60 - 90</td>
<td>14 - 22</td>
<td>100 - 120</td>
</tr>
</tbody>
</table>

Size-specific Equipment
## Physiologic Differences

<table>
<thead>
<tr>
<th>Clinical Sign</th>
<th>% Blood loss</th>
<th>Heart rate</th>
<th>Blood pressure</th>
<th>Capillary refill</th>
<th>Respiratory rate</th>
<th>Urine output</th>
<th>Mental status</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 15%</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>15-25%</td>
<td>Slightly increased</td>
<td>Slightly increased</td>
<td>Slightly increased</td>
<td>Slightly increased</td>
<td>Slightly increased</td>
<td>Slightly increased</td>
<td>Slightly increased</td>
</tr>
<tr>
<td>&gt; 25%</td>
<td>Increased</td>
<td>Decreased</td>
<td>Prolonged</td>
<td>Tachypnea</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
</tbody>
</table>

### Goals of Field Triage

- **Undertriage** = 1 - sensitivity
- **Overtriage** = 1 - specificity

### Pre-hospital Triage

- **Suspected Severe injury**
  - Trauma center
- **Suspected Mild injury**
  - Non-trauma center

### Undertriage <5% ** or Overtriage <50%
Field Triage Schemes

Trauma Triage Rule

- Clinical Parameter
  - Systolic blood pressure <90 mmHg
  - Glasgow Coma Scale motor response <1 (localizes pain)
  - Potential penetrating injury to head, neck, or trunk

Presence of any of the 3 parameters triage positive for need for trauma care
Field Triage Schemes

How well are we doing?

Accuray of Pediatric Trauma Field Triage
A Systematic Review

Regine van de Sluys, MD, Eveline A. J. van Reijn, MD, Joep G. J. Wijnand, MD, Luuk F. H. Lemen, MD, PhD, Mark van Heijl, MD, PhD

How well are we doing?

<table>
<thead>
<tr>
<th>Undertriage</th>
<th>Overtriage</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-51%</td>
<td>15-58%</td>
</tr>
</tbody>
</table>

Table 1: Accuracy of Pediatric Trauma Field Triage Tools

<table>
<thead>
<tr>
<th>Index Test</th>
<th>Positive RC No. (N)</th>
<th>True PP</th>
<th>FP</th>
<th>TN</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatric Score Triage Decision (1)</td>
<td>50 (34; 7)</td>
<td>18</td>
<td>8</td>
<td>20</td>
<td>80.2 (78.4-81.6)</td>
<td>61.7 (59.0-64.3)</td>
</tr>
<tr>
<td>Trauma Score (2)</td>
<td>76 (31)</td>
<td>52</td>
<td>14</td>
<td>21</td>
<td>66.4 (65.4-69.4)</td>
<td>66.4 (64.4-69.4)</td>
</tr>
<tr>
<td>Multiple adaptation of TISS-2006 (3)</td>
<td>107 (41)</td>
<td>83</td>
<td>11</td>
<td>79</td>
<td>88.1 (87.1-88.9)</td>
<td>87.5 (86.6-88.1)</td>
</tr>
<tr>
<td>Pneumonia score of TISS-2006 (3)</td>
<td>158 (11)</td>
<td>137</td>
<td>14</td>
<td>20</td>
<td>88.1 (84.6-90.4)</td>
<td>82.8 (80.6-84.8)</td>
</tr>
</tbody>
</table>

Abbreviations: RC, Reference Category; PP, True positive; TP, True positive; FP, False positive; TN, True negative; TP, True positive.

Undertriage: 13-51%
Overtriage: 15-58%
How do we get better?

> Raise overtriage rates
> Pre-hospital responder experience
> Investigate other parameters
  - Shock index
  - Pulse pressure difference

Emergency Department Triage

Goals of ED Triage

Undertriage = 1 - sensitivity
Overtriage = 1 - specificity
Trauma team activation criteria

Trauma team activation criteria

Table 1: Minimum Criteria for Fall Trauma Team Activation

- Cardiac index: less than 2.5 L/min/m²
- Hemoglobin: less than 7 g/dL
- Severe neurologic deficits
- Chest wall or thoracic injury
- Abdominal injury
- Lower extremity injury
- Polytrauma
- Emergency obstetrical patient

HMC Trauma team activation criteria

1. Trauma patient with hemorrhage and instability in head or neck due to a falling fall injury, a fall of 5 feet, or below.

2. All patients with injuries or complications to the head, neck, spine, pelvis, or spine.

3. Patient with a high risk for surgery trauma as defined by our trauma criteria: PMTA Level 3 or with obvious polytrauma in the first 6 hours after admission.

4. Trauma patient with difficulty in maintaining airway, or airway obstruction or difficult breathing.

5. All pediatric trauma patients (age 1 to 17 years old) who require intubation or have significant injuries.

6. Trauma patient requiring intubation who has a vital sign or a trauma patient in the ICU who has a significant injury.

7. Trauma patient requiring intubation who is at risk for hemorrhage.

8. Mass casualty or mass trauma patients expected to be encountered.
HMC Trauma team activation criteria

Reference vital signs for Pediatric Patients ≤ 5 years of age:

<table>
<thead>
<tr>
<th>Color</th>
<th>Gray</th>
<th>Pink</th>
<th>Red</th>
<th>Purple</th>
<th>Yellow</th>
<th>White</th>
<th>Black</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx weight (kg)</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Approx Age</td>
<td>0-2 mo</td>
<td>2-5mo</td>
<td>6-10mo</td>
<td>1 yr</td>
<td>2-3 yr</td>
<td>4-6 yr</td>
<td>6-10 yr</td>
</tr>
<tr>
<td>Minimum SBP (average)</td>
<td>80</td>
<td>90</td>
<td>95</td>
<td>90</td>
<td>95</td>
<td>95</td>
<td>80</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>100-120</td>
<td>100-140</td>
<td>100-160</td>
<td>90-120</td>
<td>90-150</td>
<td>90-140</td>
<td>70-120</td>
</tr>
</tbody>
</table>

How well are we doing?

> Review of HMC data 2012-2018
  - Children age 0-17
  - Any trauma team activation
  - Outcome: Early critical resource use
    - Transfusion, advanced airway management, or angiography within 4h
    - Major operation, pericardiocentesis, ICP monitoring, or death within 24h

How well are we doing?

<table>
<thead>
<tr>
<th>Trauma Team Activation</th>
<th>Early Critical Resource Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>None</td>
<td>229</td>
</tr>
<tr>
<td>Modified</td>
<td>385</td>
</tr>
<tr>
<td>Full</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>923</td>
</tr>
</tbody>
</table>

Undertriage: 25%
Overtriage: 37%
How do we get better?

- Raise overtriage rates
- Pre-hospital responder and ED staff experience
- Investigate other parameters
  - Shock index
  - Pulse pressure difference

Evaluation of age-adjusted systolic blood pressure and shock index for pediatric trauma team activation

Elissa K. Butler, Jonathan I. Groner, Saman Arbabi, Monica S. Vavilala, Frederick P. Rivara

Background

- Pediatric trauma team activation criteria include age-adjusted hypotension (SBP-AA)
- Age-adjusted shock index (SIPA=HR/SBP) may be more accurate
- Standard cut points for SBP-AA and SIPA may not maximize sensitivity and specificity
**Methods**

- **Patient Selection:** Children age 1-15 years in TQIP database 2014-2016
- **Outcome:** Early critical resource use
  - Transfusion, advanced airway management, or angiography within 4h
  - Major operation, pericardiocentesis, ICP monitoring, or death within 24h
- **ROC curves to determine optimal cut point for SBP and SI**
- **Comparing diagnostic test characteristics of cut points**
  - ROC-generated SBP-AA to SIPA
  - ROC-generated SIPA to standard SIPA

**Results - ROC Curves**

**Systolic Blood Pressure**

- AUC: 0.544-0.587
- Cut Points:
  - Age 1-4: 100
  - Age 5-8: 112
  - Age 9-11: 114
  - Age 12-15: 119

**Shock Index**

- AUC: 0.554-0.626
- Cut Points:
  - Age 1-3: 1.33
  - Age 4-6: 1.02
  - Age 7-12: 0.96
  - Age 13-15: 0.78

**Results - Diagnostic Test Characteristics**

**ROC SBP-AA vs. ROC SIPA**

- Sensitivity: 49%
- Specificity: 61%
- Positive Predictive Value: 17%
- Negative Predictive Value: 93%

**ROC SIPA vs. standard SIPA**

- Sensitivity: 53%
- Specificity: 65%
- Positive Predictive Value: 13%
- Negative Predictive Value: 93%

**Undertriage:** 47%

**Overtriage:** 35%
Discussion

> Neither hypotension nor elevated shock index are good predictors of early critical resource use alone
> Must rely on other anatomic and injury criteria in addition to vital signs to appropriately triage pediatric patients

Next Steps

> Evaluate undertriage and overtriage of shock index in the context of all triage criteria
> Investigate pulse pressure difference as a possible predictor of severe injury
> Evaluate best ways to increase EMS provider confidence and accuracy in triaging injured children

Questions