Introduction of Pediatric Physiological and Anatomical Triage Score in Mass-Casualty Incident

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Overview

• Disasters in Japan
• Disaster Management for Children
• Triage
• Newly Developed Secondary Triage Method
• Future Prospects
Disasters in Japan

- Disaster-prone Country

Overview of disaster in Japan since 1995

<table>
<thead>
<tr>
<th>Date</th>
<th>Disaster</th>
<th>No. of Deaths &amp; Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>Great Hanshin-Awaji Earthquake (M7.3)</td>
<td>6,437</td>
</tr>
<tr>
<td>1995</td>
<td>Sarin Attack on Tokyo’s Subways</td>
<td>12 died &amp; 5,000 injured</td>
</tr>
<tr>
<td>2011</td>
<td>Great East Japan Earthquakes (M9.0)</td>
<td>23,769</td>
</tr>
<tr>
<td>2011</td>
<td>Typhoon 12</td>
<td>133</td>
</tr>
<tr>
<td>2011-13</td>
<td>Heavy Snowfalls</td>
<td>237</td>
</tr>
<tr>
<td>2014</td>
<td>Eruption of Mount Ontake</td>
<td>68</td>
</tr>
<tr>
<td>2018</td>
<td>Torrential Rain in West Japan</td>
<td>236</td>
</tr>
</tbody>
</table>

Disasters in Japan

- Natural Disaster-prone Country

No. of Earthquakes $\geq$ M6

<table>
<thead>
<tr>
<th>World 1,629</th>
<th>Japan 303 (19%)</th>
<th>Earthquake &amp; Tsunami</th>
<th>Torrential Rains</th>
<th>Heavy Snowfalls</th>
</tr>
</thead>
</table>

2004-2013

Disasters in Japan

• Natural Disasters have caused a great loss of lives

Great East Japan Earthquake with Magnitude 9, in 2011

Disaster Management for Children

Plan for the needs of children is important in disaster

- 10-30% of casualties in major incident are children
- Children have higher mortality in disasters
- Children have various considerations and needs
  - Age-related differences:
    - Physiological variables
    - Anatomical variables
Triage

Medical Management and Support at disaster setting

- Imbalance between casualties and resources in disaster
- Triage is essential part of medical management
  
  Aim: the right patient to the right place at the right time to receive the optimum treatment
  
  Timing: casualties must be re-triaged repeatedly
  
  Priority: Immediate, Urgent, Delayed, Dead

Source: Major Incident Medical Management and Support
Triage

Primary triage - Sieve
- A large number of triage decisions must be made quickly

Secondary triage - Sort
- It has a great role in refining the results of primary triage

[Diagram showing the triage process with primary and secondary triage]
Several types of triage methods are used by each country

<table>
<thead>
<tr>
<th>Triage Methods</th>
<th>Used in Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Triage</td>
<td></td>
</tr>
<tr>
<td>START</td>
<td>Japan, U.S.A.</td>
</tr>
<tr>
<td>Jump START</td>
<td>Japan, U.S.A.</td>
</tr>
<tr>
<td>Care Flight</td>
<td>Australia</td>
</tr>
<tr>
<td>Pediatric triage Tape</td>
<td>England</td>
</tr>
<tr>
<td>Triage Sieve</td>
<td>England</td>
</tr>
<tr>
<td>SALT system</td>
<td>U.S.A.</td>
</tr>
<tr>
<td>Secondary Triage</td>
<td></td>
</tr>
<tr>
<td>PAT</td>
<td>Japan</td>
</tr>
<tr>
<td>TRTS</td>
<td>England, Japan</td>
</tr>
<tr>
<td>SAVE</td>
<td>U.S.A.</td>
</tr>
<tr>
<td>Triage Sort</td>
<td>England</td>
</tr>
</tbody>
</table>

ALSG. Major incident medical management and support. BMJ Books. 2002/ 
Primary Triage

- **START method** is most frequently used in Japan

**START:** the Simple Triage and Rapid Treatment method

- **Can Walk?**
  - YES: DELAYED
  - NO: Breathing?
    - YES: Resp Rate
      - 10-29/min: Radial pulse
        - Palpable: Follow Commands
          - YES: URGENT
          - NO: Absent
        - Absent: Respiration
          - <9/min or >30/min: NO Rest
            - RESPIRATIONS
              - IMMEDIATE
            - NO Rest: DEAD
Secondary Triage

- **PAT, TRTS method** are most frequently used in Japan

**PAT; Physiological and Anatomical Triage**

**TRTS; Triage Revised Trauma Score**

**STEP 1: Assess the physiologic variables**
- Consciousness
- Respiratory condition
- SpO2
- Heart rate
- Blood pressure
- Body temperature
- Other

**STEP 2: Assess the anatomical variables**
- Compound depressed skull fracture
- Adjacent venous distention
- Subcutaneous emphysema of neck or chest
- Flail chest
- Open pneumothorax
- Abdominal distension
- Pelvic fracture (fracture and/or tenderness and/or leg length discrepancy)
- Fracture of femur on both sides
- Quadruple amputation
- Quadriplegia
- Penetrating injury
- Severe burn, facial and/or inhalation burn

Patients with at least one physiological or anatomical variable were assigned the triage priority of "immediate".

**STEP 3: Assess the mechanism of injury**
- Crush syndrome
- Burn injury
- Fall from high height
- Abnormal temperature environment
- Generation of toxic gas
- Nuclear, biological and chemical disaster

Patients with at least one mechanism of injury were assigned the triage priority of "urgent".

**STEP 4: Assess the persons needing care**
- Children, elderly person, the pregnant person with an underlying disease, traveler, etc.

Patients needing care were assigned the triage priority of "urgent".

**STEP 1: calculate the physiologic variables**

**A. Respiratory rate, /min**
- 10-29: 4 points
- >29: 3 points
- 6-9: 2 points
- 1-5: 1 point
- 0: 0 point

**B. Systolic blood pressure, mmHg**
- ≥90: 4 points
- 76-89: 3 points
- 50-75: 2 points
- 1-49: 1 point
- 0: 0 point

**C. Glasgow coma score**
- 13-15: 4 points
- 9-12: 3 points
- 6-8: 2 points
- 4-5: 1 point
- 3: 0 point

**TRTS = A + B + C**

**STEP 2: Assign a triage priority**

<table>
<thead>
<tr>
<th>TRTS</th>
<th>Triage priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>Immediate</td>
</tr>
<tr>
<td>11</td>
<td>Urgent</td>
</tr>
<tr>
<td>12</td>
<td>Delayed</td>
</tr>
<tr>
<td>0</td>
<td>Dead</td>
</tr>
</tbody>
</table>
Primary Triage for children

- START has higher over-triage rate among younger children

the Results of triage drill for in-hospital children

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Total Cases</th>
<th>Over-Triage Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 y</td>
<td>122 case</td>
<td>92% (112 case/122)</td>
</tr>
<tr>
<td>2 – 4 y</td>
<td>16 case</td>
<td>56% (9 case/16)</td>
</tr>
<tr>
<td>5-14 y</td>
<td>11 case</td>
<td>0% (0 case/11)</td>
</tr>
</tbody>
</table>

Primary Triage for children

- High over-triage rate is caused by age-related differences

### the Results of triage drill for in-hospital children

<table>
<thead>
<tr>
<th></th>
<th>&lt; 2 y N=122</th>
<th>2 – 4 y N=16</th>
<th>5 – 14 y N=11</th>
<th>15+ y N=10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over-triage of “IMMEDIATE”</td>
<td>92 (112)</td>
<td>56 (9)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Cannot walk</td>
<td>100 (122)</td>
<td>100 (16)</td>
<td>100 (11)</td>
<td>100 (10)</td>
</tr>
<tr>
<td>Respiratory rate &gt;30 /min</td>
<td>69 (84)</td>
<td>6 (9)</td>
<td>45 (5)</td>
<td>10 (1)</td>
</tr>
<tr>
<td>Cannot follow commands</td>
<td>29 (35)</td>
<td>4 (7)</td>
<td>45 (5)</td>
<td>90 (9)</td>
</tr>
</tbody>
</table>

An Optimum Triage Method for Children?

- No triage method has been validated for children

### Accuracy of each triage methods for children

<table>
<thead>
<tr>
<th>Triage Method</th>
<th>Sensitivity(%)</th>
<th>Specificity(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary triage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>START</td>
<td>31.3</td>
<td>77.9</td>
</tr>
<tr>
<td>Jump START</td>
<td>3.2</td>
<td>97.8</td>
</tr>
<tr>
<td>Care Flight Triage</td>
<td>48.4</td>
<td>98.9</td>
</tr>
<tr>
<td>PTT*</td>
<td>37.8</td>
<td>98.6</td>
</tr>
<tr>
<td><strong>Secondary triage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAT</td>
<td>91.7</td>
<td>38.1</td>
</tr>
<tr>
<td>TRTS</td>
<td>62.5</td>
<td>94.7</td>
</tr>
</tbody>
</table>

*PTT; Pediatric Triage Tape

Objectives

• To develop a new, advanced secondary triage method for children in a disaster setting

• To compare the accuracy of triage methods for identifying patients who require immediate treatment

• To evaluate the correlations between the score calculated by the newly developed secondary triage method and the severity and outcome of the patients
Methods

Study Design

A single-center, retrospective chart review study

Subjects

137 Patients admitted to Emergency Center from 2014-2016

Inclusion criteria
- Patients < 16 years old
- Patients stayed ED stay for > 3 hours
- Patients transported directly from scene
- Patients without missing data

Exclusion criteria
- Patients experienced OHCA

ED; Emergency Department, OHCA; Out-of-Hospital Cardiac Arrest
Methods

- Development of PPATS

- Accuracy of PPATS
  - Accuracy of PPATS was compared with PAT and TRTS for predicting the triage priority as “Immediate”
  - ICU-patients were defined as the truly “immediate”

- Correlations between the PPATS and the Severity/Outcome
  - Assess the predictive mortality rate, ventilation time, ICU length of stay, hospital length of stay

PPATS; Pediatric Physiological and Anatomical Triage Score
PPATS; Pediatric Physiological and Anatomical Triage Score

- **PPATS’s criteria and scoring system**
  - PPATS was calculated based on 6 factors
  - Total score was the sum of 6 factors range from 0 to 22

<table>
<thead>
<tr>
<th>Variable</th>
<th>0</th>
<th>+1</th>
<th>+2</th>
<th>+3</th>
<th>+4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiological variable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory rate, percentile</td>
<td>25-75</td>
<td>10-24, 76-90</td>
<td>1-9, 91-99</td>
<td>&lt;1, &gt;99</td>
<td>-</td>
</tr>
<tr>
<td>Heart rate, percentile</td>
<td>25-75</td>
<td>10-24, 76-90</td>
<td>1-9, 91-99</td>
<td>&lt;1, &gt;99</td>
<td>-</td>
</tr>
<tr>
<td>Systolic BP, mmHg</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Hypotension</td>
</tr>
<tr>
<td>Glasgow coma scale</td>
<td>15</td>
<td>13, 14</td>
<td>9-12</td>
<td>-</td>
<td>3-8</td>
</tr>
<tr>
<td>Anatomical abnormality</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Need of life-saving intervention</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Glasgow coma scale: 15 = normal, 13-14 = mild, 9-12 = moderate, 3-8 = severe.
## Results

### Patients’ Characteristics

<table>
<thead>
<tr>
<th></th>
<th>ICU admission (n=24)</th>
<th>Non-ICU admission (n=113)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, n(%)</td>
<td>16 (67)</td>
<td>66 (58)</td>
<td>0.500</td>
</tr>
<tr>
<td>Age in month, (median, IQR)</td>
<td>135 (99-170)</td>
<td>32 (15-73)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Respiratory rate, /min, (median, IQR)</td>
<td>24 (20-30)</td>
<td>30 (20-35)</td>
<td>0.322</td>
</tr>
<tr>
<td>O₂ saturation, %, (median, IQR)</td>
<td>100 (99-100)</td>
<td>100 (98-100)</td>
<td>0.160</td>
</tr>
<tr>
<td>Heart rate, bpm, (median, IQR)</td>
<td>118 (97-133)</td>
<td>120 (98-140)</td>
<td>0.537</td>
</tr>
<tr>
<td>Systolic blood pressure, mmHg, (median, IQR)</td>
<td>128 (115-153)</td>
<td>110 (100-122)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Glasgow coma scale, (median, IQR)</td>
<td>9 (6-13)</td>
<td>15 (15-15)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of patients with anatomical abnormality, n(%)</td>
<td>4 (17)</td>
<td>1 (1)</td>
<td>0.003</td>
</tr>
<tr>
<td>Number of patients needing life-saving intervention, n(%)</td>
<td>22 (92)</td>
<td>14 (12)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PPATS score, (median, IQR)</td>
<td>11 (9-13)</td>
<td>3 (2-4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Length of mechanical ventilation, days, (median, IQR)</td>
<td>3 (0-10)</td>
<td>0 (0-0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Length of ICU stay, days, (median, IQR)</td>
<td>5 (3-13)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Length of hospital stay, days, (median, IQR)</td>
<td>15 (4-38)</td>
<td>0 (0-2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Predicted mortality, %, (median, IQR)</td>
<td>3.9 (1.5-5.0)</td>
<td>1.1 (1.1-1.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mortality rate, n(%)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>-</td>
</tr>
</tbody>
</table>
**Results**

- **Accuracy Values of PPATS, PAT, TRTS methods**

<table>
<thead>
<tr>
<th>Method</th>
<th>Sensitivity(%)</th>
<th>Specificity(%)</th>
<th>PPV(%)</th>
<th>NPV(%)</th>
<th>AUC</th>
<th>(95%CI)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPATS</td>
<td>95.8</td>
<td>86.7</td>
<td>60.5</td>
<td>99.0</td>
<td>0.95</td>
<td>(0.87-1.00)</td>
<td>-</td>
</tr>
<tr>
<td>PAT</td>
<td>91.7</td>
<td>38.1</td>
<td>23.9</td>
<td>95.6</td>
<td>0.65</td>
<td>(0.58-0.72)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TRTS</td>
<td>62.5</td>
<td>94.7</td>
<td>71.4</td>
<td>92.2</td>
<td>0.79</td>
<td>(0.69-0.89)</td>
<td>0.003</td>
</tr>
</tbody>
</table>

**ROC curve for PPATS, PAT, TRTS**

- Optimum cut-off value of PPATS
  - 6 points
Results

- Correlations between PPATS and the Severity/Outcome

\[ r^2 = 0.139; \ p < 0.001 \]

\[ r^2 = 0.320; \ p < 0.001 \]

\[ r^2 = 0.362; \ p < 0.001 \]

\[ r^2 = 0.308; \ p < 0.001 \]
Summary

- The accuracy of PPATS, a newly developed secondary triage method for children, was superior to the conventional triage methods (PAT, TRTS).

- PPATS is useful for not only classifying high-priority patients, but also determining the priority ranking based on the PPATS score.
Advantage of PPATS

PPATS was accurate compared with PAT, TRTS

- over- and under-triaging at a disaster are said to result in increase in number of preventable disaster deaths.

Frykberg ER. J Trauma 2002;53:201-212

- PPATS was made by combining advantage of each method

<table>
<thead>
<tr>
<th>Triage method</th>
<th>Criteria</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>Physiological variables</td>
<td>Quick and Simple Assessment</td>
</tr>
<tr>
<td>PTT</td>
<td>Physiological variables</td>
<td>Assessing based on age-related variation of children</td>
</tr>
<tr>
<td>PAT</td>
<td>Physiological and Anatomical variables</td>
<td>Assessing based on several variables</td>
</tr>
<tr>
<td></td>
<td>Mechanism of injury, necessity for special care</td>
<td></td>
</tr>
<tr>
<td>TRTS</td>
<td>Physiological variables</td>
<td>Assessing based on scoring system</td>
</tr>
</tbody>
</table>
Advantage of PPATS

PPATS has Scoring system available for assessing the severity

- High rate of over-triage
- Only classify the priority

- High accuracy for triage
- Determine the priority ranking
Advantage of PPATS

PPATS uses Physiological and Anatomical measures

- It is the same as those commonly measured when patients are monitored in hospital at no-disaster setting.

- PPATS may be useful in that it serves both as a triage tool and as a clinically useful tool, like a disaster medical record for monitoring a patient’s condition.
Limitation of PPATS

- Single center, retrospective study
- PPATS can classify only the “IMMEDIATE” priority.
Future Prospects

PPATS may be utilized as a criteria for wide area transportation.

- Large earthquake is predicted to occur in Japan
- When disaster with widespread damage occurs, people must evacuate to anywhere outside the damaged area.
- When we determine the priority of patients adapted for the wide-area transportation, unified objective criteria system in Japan is necessary.
Future Prospects

Developed App equips with a function to calculate PPATS score

• To eliminate complications in assessing physiological variables based on pediatric age-related factor
• To use as a medical record system by monitoring and reporting a patient’s condition repeatedly.
Conclusions

- A pediatric physiology-based medical management plan for children is an important component in disaster preparedness for major incidents.
- The new secondary disaster triage may be accurate and useful for pediatric triage, treatment, and transport.
- We would like to popularize the PPATS by improving the operation system.
Contact us:

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The University of Tokyo

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