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

Chiaki Toida, MD, PhD

Vice-Chair of Department of Disaster Medical Management
The University of Tokyo

# 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

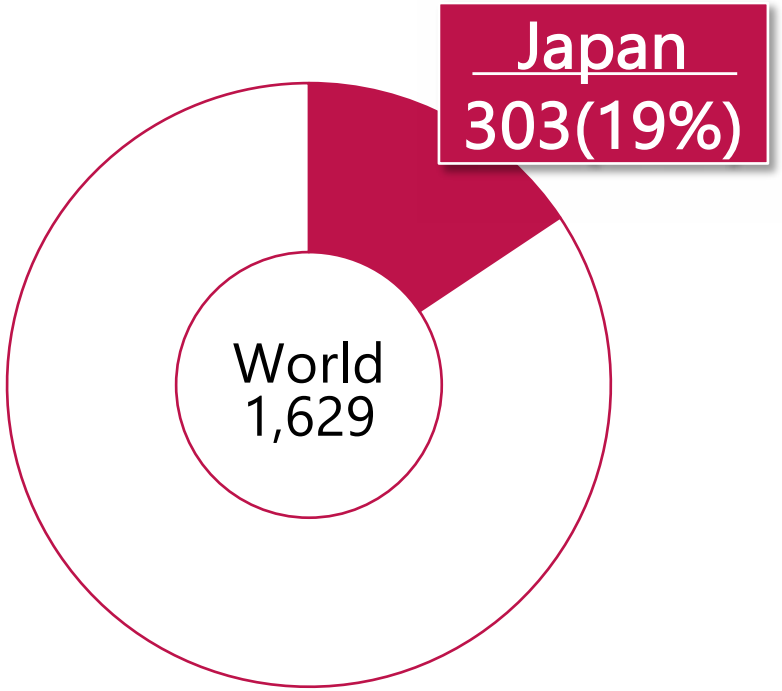
| Date | Disaster | No. of Deaths & Missing |
|---|---|---|
| 1995 | Great Hanshin-Awaji Earthquake (M7.3) | 6,437 |
| 1995 | Sarin Attack on Tokyo's Subways | 12 died & 5,000 injured |
| 2011 | Great East Japan Earthquakes (M9.0) | 23,769 |
| 2011 | Typhoon 12 | 133 |
| 2011-13 | Heavy Snowfalls | 237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

*Source: The Japanese Government. White Paper on Disaster Management 2011*

# Disasters in Japan

- Natural Disaster-prone Country

No. of Earthquakes ≧ M6




2004-2013

Earthquake & Tsunami

Torrential Rains

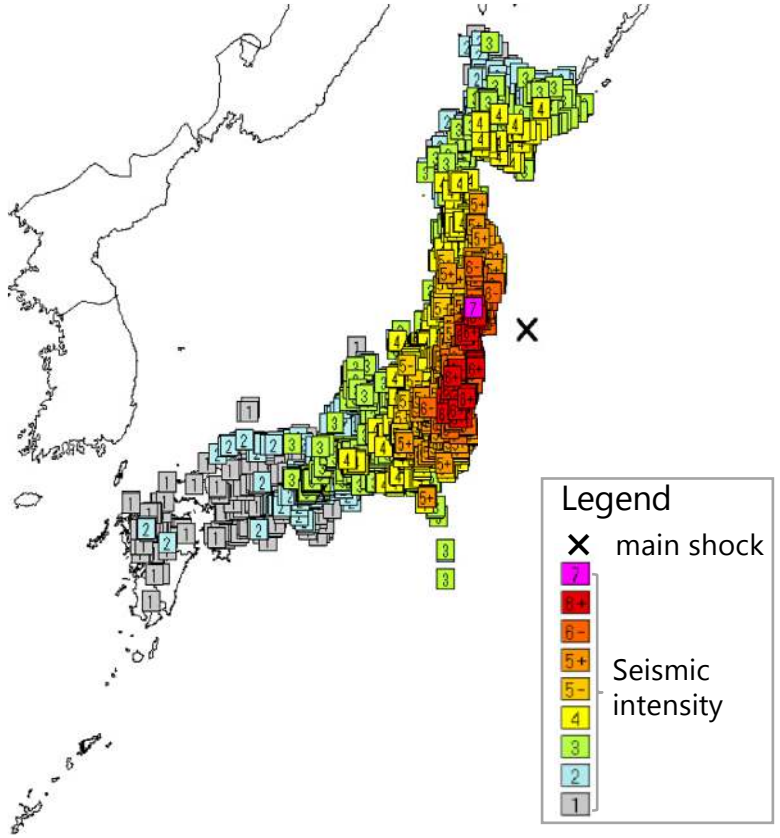
Heavy Snowfalls

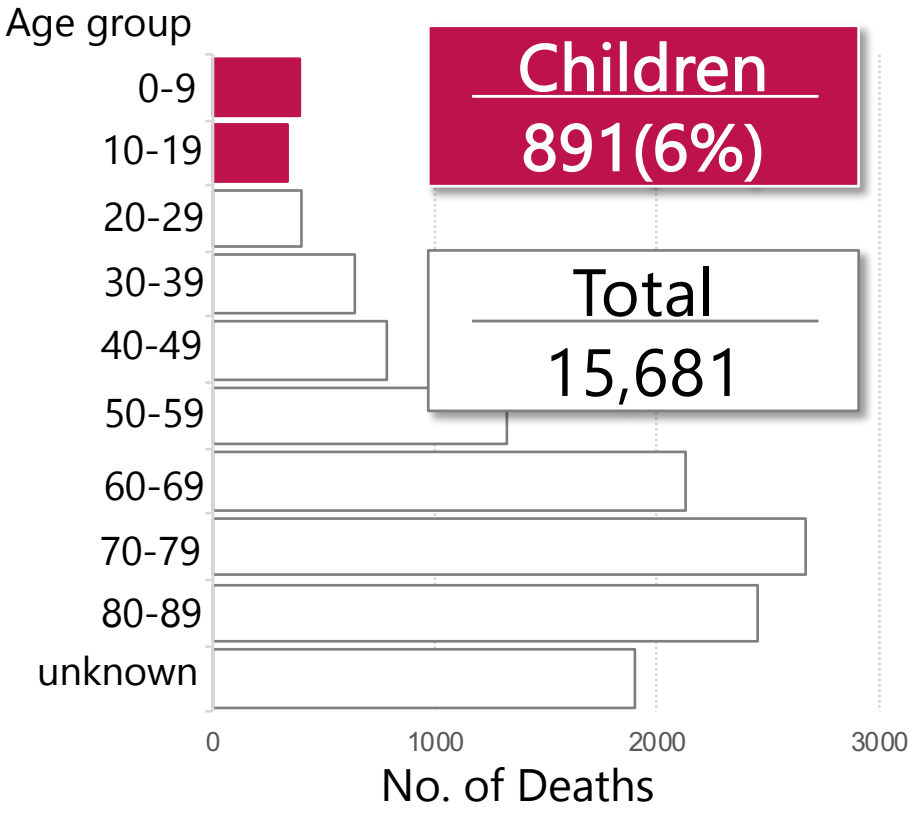
*Source: The Japanese Government. White Paper on Disaster Management 2011*

# Disasters in Japan

- Natural Disasters have caused a great loss of lives

## Great East Japan Earthquake with Magnitude 9, in 2011




*Source: The Japanese Government. White Paper on Disaster Management 2011*

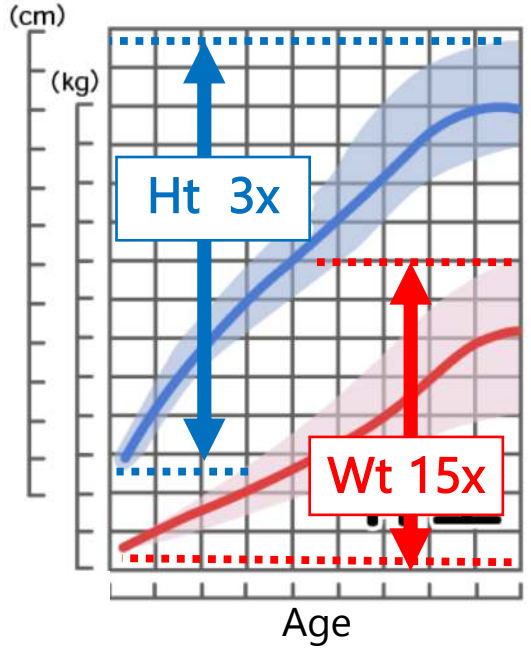
# Disaster Management for Children

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*

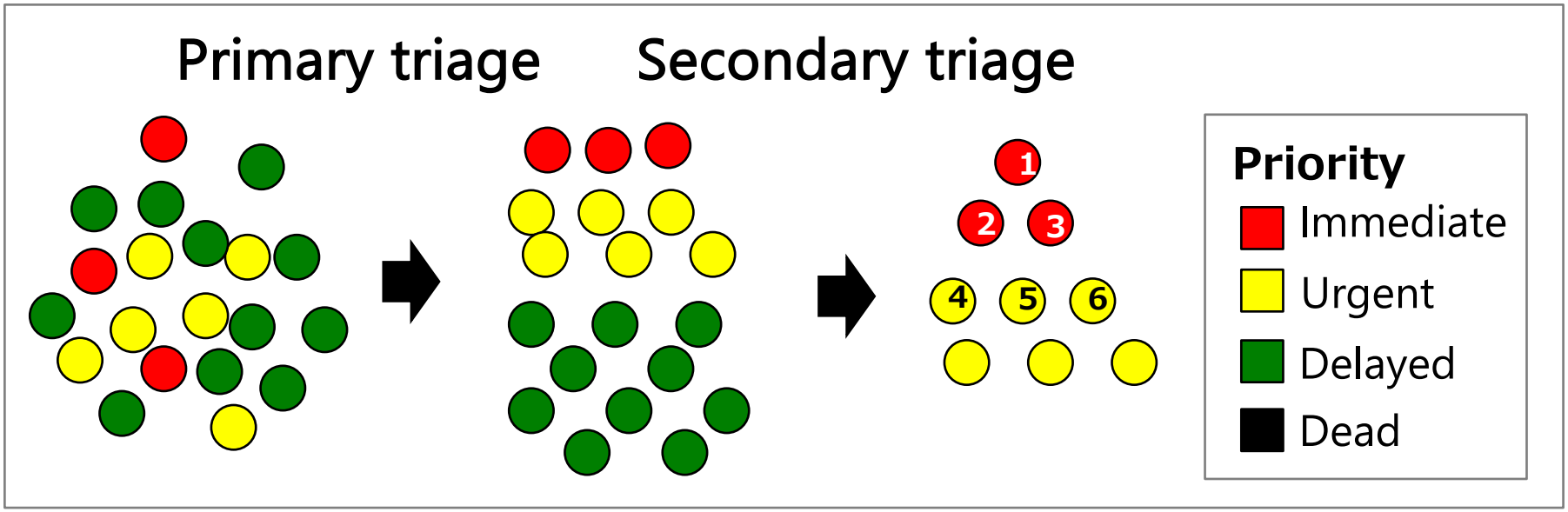
# Triage

## Primary triage - Sieve

- A large number of triage decision must be made quickly

## Secondary triage - Sort

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



# Triage

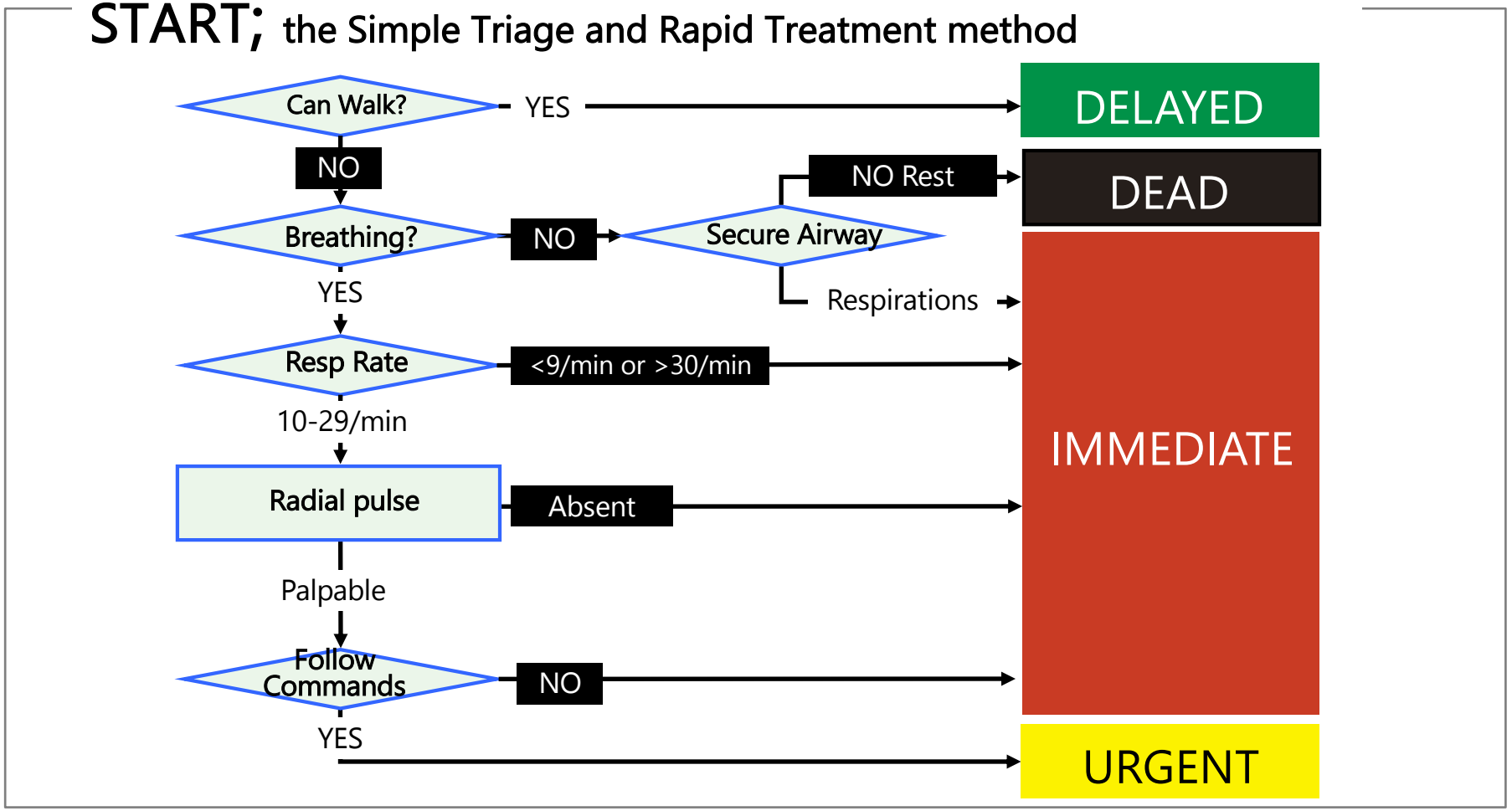
## Several types of triage methods are used by each country

| | Triage Methods | Used in Country |
|---|---|---|
| Primary Triage | START | Japan, U.S.A. |
| | Jump START | Japan, U.S.A. |
| | Care Flight | Australia |
| | Pediatric triage Tape | England |
| | Triage Sieve | England |
| | SALT system | U.S.A. |
| Secondary Triage | PAT | Japan |
| | TRTS | England, Japan |
| | SAVE | U.S.A. |
| | Triage Sort | England |

*Garner A, at al. Ann Emerg Med 2001;38:541-8.*
*ALSG. Major incident medical management and support. BMJ Books. 2002/*
*Benson M, et al. Prehospital Disaster Med 1996;11:117-24.*

# Primary Triage

- START method is most frequently used in Japan



# Secondary Triage

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

## PAT; Physiological and Anatomical Triage

**STEP 1: Assess the physiologic variables**

| | |
|---|---|
| Consciousness | Japan coma score 100-300 |
| Respiratory condition | Respiratory rate<10/min or ≥30/min<br>Laterality od respiratory sound<br>Abnormal breathing<br>$SpO_2$ < 90% |
| Heart rate | ≥120/min or <50/min |
| Systolic blood pressure | <90mmHg or ≥200mmHg |
| Body temperature | ≤35 °C |
| Other | shock state |

**STEP 2: Assess the anatomical variables**

Compound depressed skull fracture
Jugular venous distention
Subcutaneous emphysema of neck or chest
Flail chest
Open pneumothorax
Abdominal distension
Pelvic fracture (flail and/or tenderness and/or leg length discrepancy)
Fracture of femur on both sides
Quadruple amputation
Quadriplegia
Penetrating injury
Degloving 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
Burst 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, et al.

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

## TRTS; Triage Revised Trauma Score

**STEP 1: calculate the physiologic variables**

**A. Respiratory rate, /min**

| | points |
|---|---|
| 10-29 | 4 |
| >29 | 3 |
| 6-9 | 2 |
| 1-5 | 1 |
| 0 | 0 |

**B. Systolic blood pressure, mmHg**

| | points |
|---|---|
| ≥90 | 4 |
| 76-89 | 3 |
| 50-75 | 2 |
| 1-49 | 1 |
| 0 | 0 |

**C. Glasgow coma score**

| | points |
|---|---|
| 13-15 | 4 |
| 9-12 | 3 |
| 6-8 | 2 |
| 4-5 | 1 |
| 3 | 0 |

**TRTS = A + B + C**

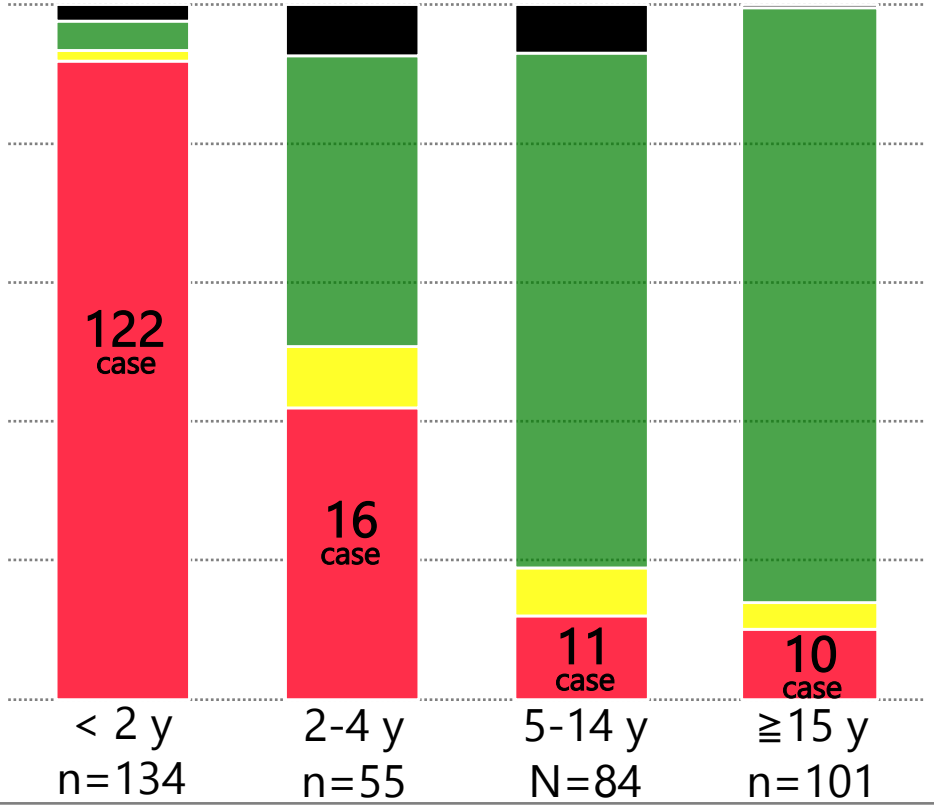
**STEP 2: Assign a triage priority**

| TRTS | triage priority |
|---|---|
| 1-10 | Immediate |
| 11 | Urgent |
| 12 | Delayed |
| 0 | Dead |

# Primary Triage for children

- START has higher over-triage rate among younger child

the Results of triage drill for in-hospital children




**Over-triage rate**

| | |
|---|---|
| < 2 y | 92% (112 case/122) |
| 2 – 4 y | 56% ( 9 case/16) |
| 5-14 y | 0% ( 0 case/11) |

*Source: C.Toida, et al. Disaster Med Public Health Prep. 2018 (in press)*

# Primary Triage for children

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

the Results of triage drill for in-hospital children

% (cases)

| | < 2 y N=122 | 2 – 4 y N=16 | 5 – 14 y N=11 | 15+ y N=10 |
|---|---|---|---|---|
| Over-triage of "IMMEDIATE" | 92 (112) | 56 (9) | 0 (0) | 0 (0) |
| Cannot walk | 100 (122) | 100 (16) | 100 (11) | 100 (10) |
| Respiratory rate >30 /min | 69 (84) | 6 (9) | 45 (5) | 10 (1) |
| Cannot follow commands | 29 (35) | 4 (7) | 45 (5) | 90 (9) |

*C.Toida, et al. Disaster Med Public Health Prep. 2018 (in press)*

# An Optimum Triage Method for Children?

- No triage method has been validated for children

Accuracy of each triage methods for children

| | | Sensitivity(%) | Specificity(%) |
|---|---|---|---|
| Primary triage | **START** | 31.3 | 77.9 |
| | Jump START | 3.2 | 97.8 |
| | Care Flight Triage | 48.4 | 98.9 |
| | PTT* | 37.8 | 98.6 |
| Secondary triage | **PAT** | 91.7 | 38.1 |
| | **TRTS** | 62.5 | 94.7 |

*PTT; Pediatric Triage Tape

*Garner A, at al. Ann Emerg Med 2001;38:541-8.*
*Wallis LA, et al. Emerg Med J 2006;23:475-8.*

# 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)

| Variable | 0 | +1 | +2 | +3 | +4 |
|---|---|---|---|---|---|
| Physiological variable | | | | | |
| Respiratory rate, percentile | 25-75 | 10-24, 76-90 | 1-9, 91-99 | <1, >99 | - |
| Heart rate, percentile | 25-75 | 10-24, 76-90 | 1-9, 91-99 | <1, >99 | - |
| Systolic BP, mmHg | - | - | - | - | Hypotension |
| Glasgow coma scale | 15 | 13, 14 | 9-12 | - | 3-8 |
| Anatomical abnormality | No | - | - | - | Yes |
| Need of life-saving intervention | No | - | - | - | Yes |

# Results

## Patients' Characteristics

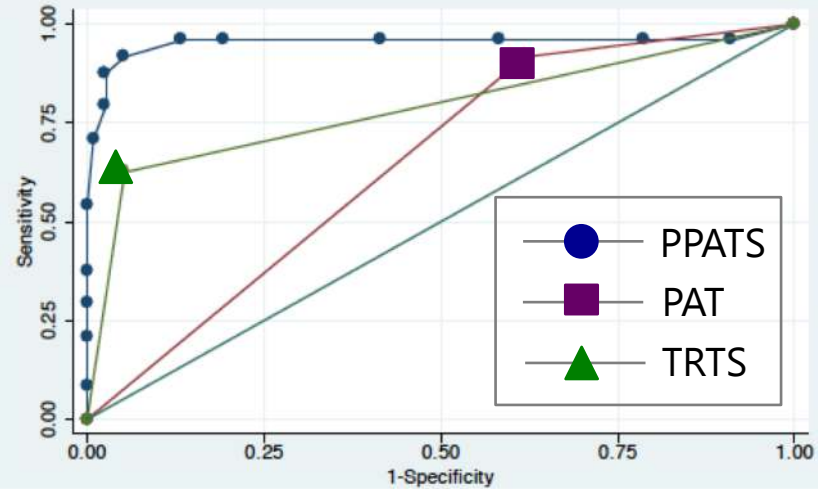
| | ICU admission (n=24) | Non-ICU admission (n=113) | P value |
|---|---|---|---|
| Male, n(%) | 16 (67) | 66 (58) | 0.500 |
| Age in month, (median, IQR) | 135 (99-170) | 32 (15-73) | <0.001 |
| Respiratory rate, /min, (median, IQR) | 24 (20-30) | 30 (20-35) | 0.322 |
| $O_2$ saturation, %, (median, IQR) | 100 (99-100) | 100 (98-100) | 0.160 |
| Heart rate, bpm, (median, IQR) | 118 (97-133) | 120 (98-140) | 0.537 |
| Systolic blood pressure, mmHg, (median, IQR) | 128 (115-153) | 110 (100-122) | <0.001 |
| Glasgow coma scale, (median, IQR) | 9 (6-13) | 15 (15-15) | <0.001 |
| Number of patients with anatomical abnormality, n(%) | 4 (17) | 1 (1) | 0.003 |
| Number of patients needing life-saving intervention, n(%) | 22 (92) | 14 (12) | <0.001 |
| PPATS score, (median, IQR) | 11 (9-13) | 3 (2-4) | <0.001 |
| Length of mechanical ventilation, days, (median, IQR) | 3 (0-10) | 0 (0-0) | <0.001 |
| Length of ICU stay, days, (median, IQR) | 5 (3-13) | - | - |
| Length of hospital stay, days, (median, IQR) | 15 (4-38) | 0 (0-2) | <0.001 |
| Predicted mortality, %, (median, IQR) | 3.9 (1.5-5.0) | 1.1 (1.1-1.1) | <0.001 |
| Mortality rate, n(%) | 0 (0) | 0 (0) | - |

# Results

- Accuracy Values of PPATS, PAT, TRTS methods

| | Sensitivity(%) | Specificity(%) | PPV(%) | NPV(%) | AUC | (95%CI) | P-value* |
|---|---|---|---|---|---|---|---|
| **PPATS** | **95.8** | **86.7** | **60.5** | **99.0** | **0.95** | **(0.87-1.00)** | **-** |
| PAT | 91.7 | 38.1 | 23.9 | 95.6 | 0.65 | (0.58-0.72) | <0.001 |
| TRTS | 62.5 | 94.7 | 71.4 | 92.2 | 0.79 | (0.69-0.89) | 0.003 |

## ROC curve for PPATS, PAT, TRTS

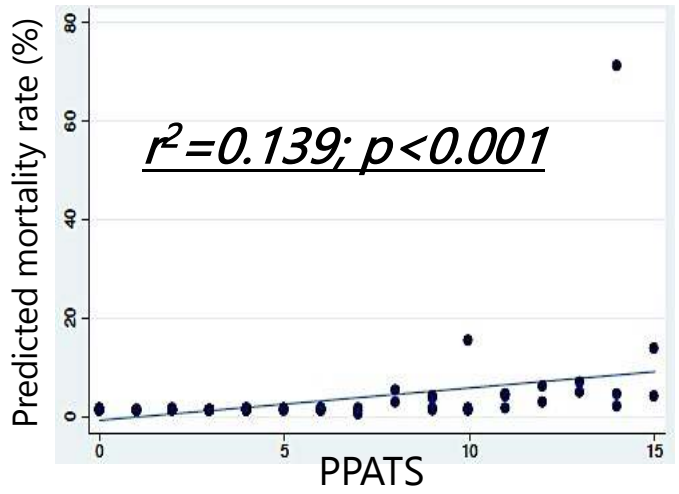


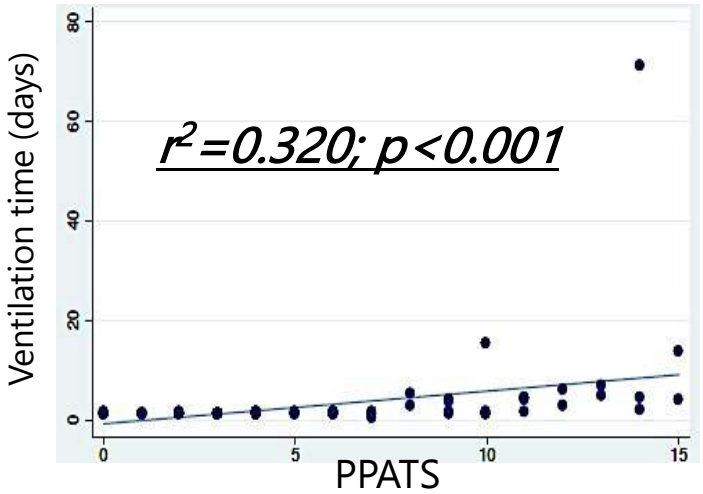

Optimum cut-off value of PPATS

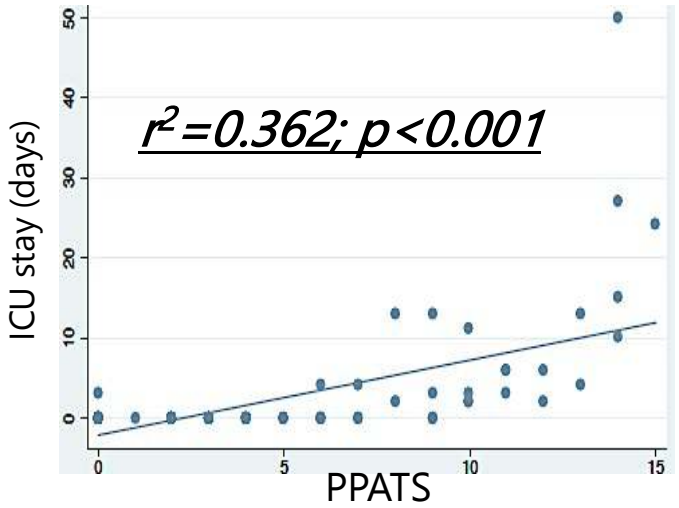
6 points

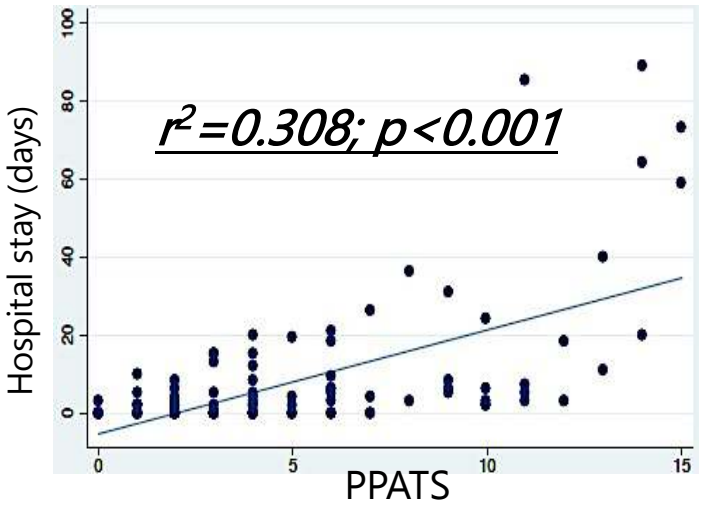
# Results

- Correlations between PPATS and the Severity/Outcome



# 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 priory 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.

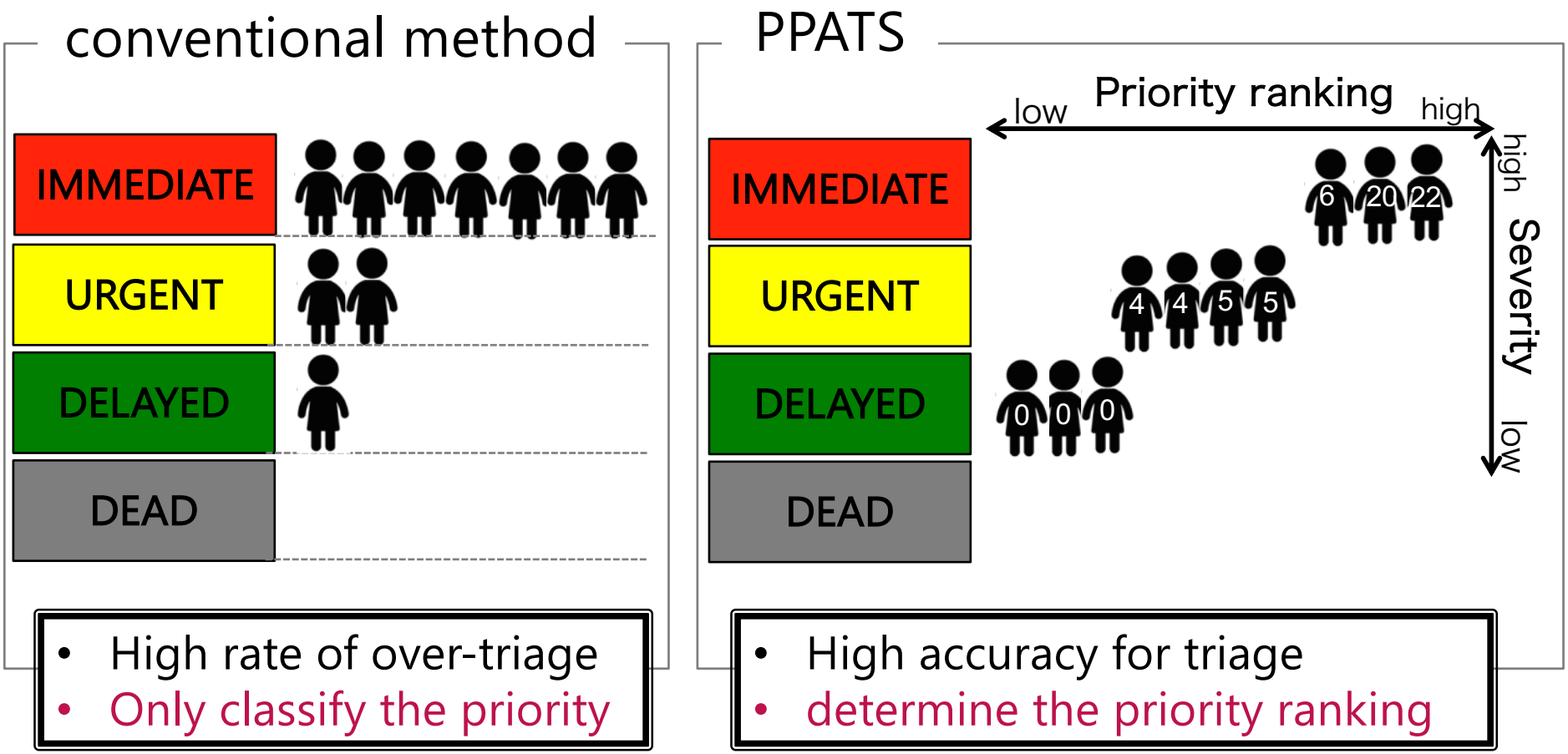
*Frykberg ER. J Trauma 2002;53:201-212*

- PPATS was made by combining advantage of each method

| Triage method | Criteria | Advantage |
|---|---|---|
| START | Physiological variables | Quick and Simple Assessment |
| PTT | Physiological variables | Assessing based on age-related variation of children |
| PAT | Physiological and Anatomical variables<br>Mechanism of injury, necessity for special care | Assessing based on several variables |
| TRTS | Physiological variables | Assessing based on scoring system |

# Advantage of PPATS

PPATS has Scoring system available for assessing the severity



# 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 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:

Chiaki Toida, MD, PhD

Vice-Chair of Department of Disaster Medical Management
The University of Tokyo

toidac-eme@h.u-tokyo.ac.jp