





Triage of the Pediatric Trauma Patient

Elissa Butler, MD
ekbutler@uw.edu



 

No Disclosures

Outline

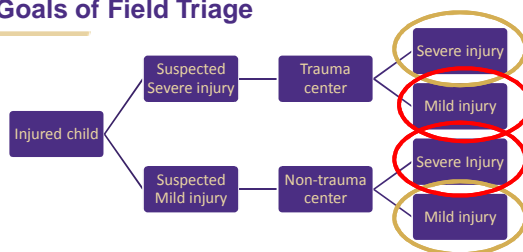
- > What are the goals of triage?
- > How are children different than adults?
- > Pre-hospital triage
- > Emergency Department triage
- > Evaluation of shock index

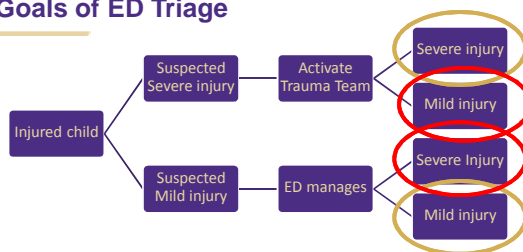
What are the goals of triage?



Goals of Field Triage



Goals of ED Triage



How are children different than adults?



Variable Vital Signs

Age Group	Heart Rate	Respirations	Systolic BP
Preterm	120 - 180	50 - 70	40 - 60
Newborn (0 to 1 Month)	100 - 160	35 - 55	50 - 70
Infant (1 to 12 Months)	80 - 140	30 - 40	70 - 100
Toddler (1 to 3 Years)	80 - 130	20 - 30	70 - 110
Preschool (3 to 6 Years)	80 - 110	20 - 30	80 - 110
School Age (6 to 12 Years)	70 - 100	18 - 24	80 - 120
Adolescents (12+ Years)	60 - 90	14 - 22	100 - 120



Size-specific Equipment

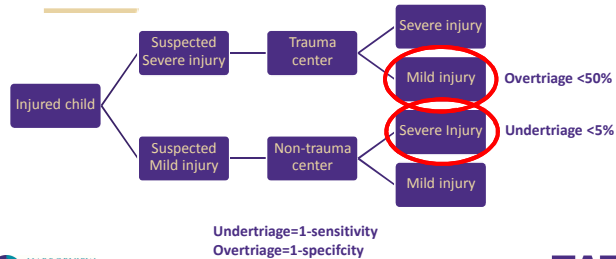


Physiologic Differences

Clinical Signs		Blood Pressure	Capillary refill	Respiratory rate	Urine output	Mental status
% blood loss	Heart rate					
< 15	Normal to slightly increased	Normal or increased	Normal	Normal	Normal	Anxious
15-25	Slightly increased	Might be decreased	Prolonged	Mildly tachypneic	Decreased	Anxious, might be agitated
25-40	Increased	Decreased	Prolonged	Moderately tachypneic	Decreased (<0.5 ml/kg/hour)	Anxious, confused
> 40	Increased	Decreased	Prolonged	Severely tachypneic	Absent	Confused, lethargic, unresponsive

Pre-hospital Triage

Goals of Field Triage



Field Triage Schemes

Trauma Triage Rule

Clinical Parameter

Systolic blood pressure <85 mmHg
Glasgow Coma Scale motor response <5 (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

Trauma scorecard criteria

Physiologic criteria
Blood pressure <90
Respiration rate <10 or >29
GCS <12
Anatomy and mechanism of injury criteria
Second/third degree burns $>15\%$ body surface area
Paralysis
Ejection from vehicle
Amputation proximate to wrist or ankle
Penetrating injury to head, neck, chest, abdomen, or groin

Presence of any of the parameters triage positive for need for trauma care



Field Triage Schemes

Pediatric Trauma Triage Checklist
This BMT or paramedic will assess the condition of these injured persons with anatomical and physiological characteristics of a person by years of age or weight based on each of the six physiologic components listed below (left column). The most appropriate criterion for each component is selected (along the row to the right). Refer to the color-coding of each criterion and legend below to determine the transport destination.

Component	Change or green	Yellow, white, or blue	Red or purple
Size	>20 kg (45 lbs) G	$10-20$ kg (22-45 lbs) B	<10 kg (22 lbs) R
Airway	Normal G	Supplemental O ₂ B	Assisted or intubated R
Consciousness	Awake G	Awareness or only verbal history of lost consciousness B	Altered mental status or presence or suspected spinal cord injury R
Circulation	Good peripheral pulses G	Careful or femoral pulse dependent B	Weak or no palpable pulses R

Fracture	None seen or suspected	Any single closed long bone fracture	Any open long bone fracture or multiple fracture sites
Cutaneous	No visible injury G	Contusion or abrasion B	Major tissue disruption ¹ or amputation ² or $>2"$ or $>2"$ laceration ³ or $>10\%$ TBSA or any penetrating injury to head, neck, or torso ⁴ R

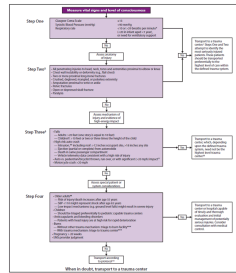
Red = any one (R) - transport as a "trauma alert"
Blue = any two (B) - transport as a "trauma alert"
Green = follow local protocols

¹Signaling injuries, major flexion/extension, or major soft tissue disruption
²Transverse the wrist or ankle
³Excluding superficial wounds in which the depth of the wound can be determined easily

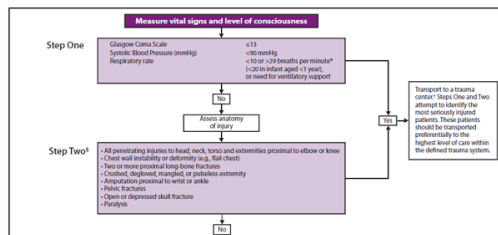
Any one red criterion or any two blue criteria are triage positive for need for trauma care



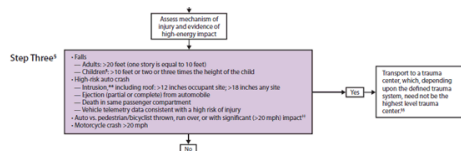
Field Triage Schemes

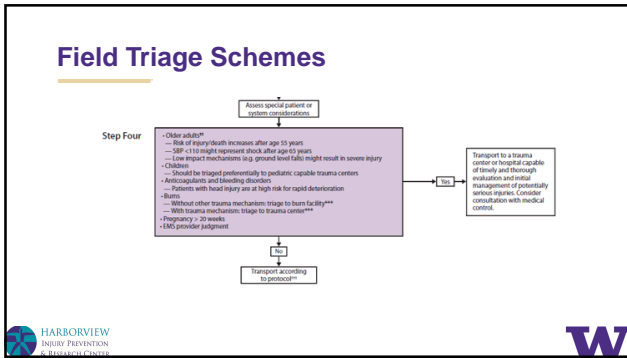


Field Triage Schemes



Field Triage Schemes





How well are we doing?

JAMA Surgery | Review

Accuracy of Pediatric Trauma Field Triage

A Systematic Review

Rogier van der Sluis, MD; Eveline A. J. van Rein, MD; Joep G. J. Wijnand, MD; Luke P. H. Leenen, MD, PhD; Mark van Heijl, MD, PhD

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How well are we doing?

Table 3. Accuracy of Pediatric Trauma Field Triage Tools

Index Test	Positive RS, No. (%)	Outcome, No.				Performance Measure, % (95% CI)	
		TP	FN	FP	TN	Sensitivity	Specificity
Pediatric Trauma Triage Checklist	58 (54.7)	50	8	28	20	86.2 (74.8-93.1)	41.7 (28.8-55.7)
Trauma Scorecard	78 (5.2)	52	26	217	1210	66.7 (55.6-76.2)	84.8 (82.8-86.6)
Multiple adaptations of FTDS 2006	697 (4.7)	586	111	4763	9414	84.1 (81.1-86.6)	66.4 (65.6-67.2)
Physiologic criteria of FTDS 2011	279 (5.0)	137	142	935	4380	49.1 (43.3-54.9)	82.4 (81.4-83.4)
Multiple adaptations of FTDS 2006	110 (2.6)	96	14	844	3243	87.3 (79.6-92.4)	79.3 (78.1-80.6)

Abbreviations: CI, Agresti-Coull confidence interval; FN, false negative; FP, false positive; FTDS, Field Triage Decision Scheme; RS, reference standard; TN, true negative; TP, true positive.

Undertriage: 13-51%

Overtriage: 15-58%

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How do we get better?

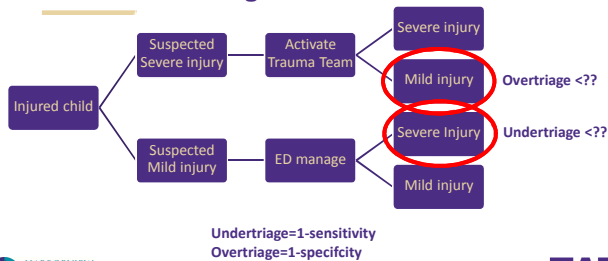
- > Raise overtriage rates
- > Pre-hospital responder experience
- > Investigate other parameters
 - Shock index
 - Pulse pressure difference



Emergency Department Triage



Goals of ED Triage





Trauma team activation criteria

RESOURCES

FOR OPTIMAL CARE
OF THE INJURED PATIENT



COMMITTEE ON TRAUMA
AMERICAN COLLEGE OF SURGEONS



Trauma team activation criteria

Table 2 Minimum Criteria for Full Trauma Team Activation



- Confirmed blood pressure less than 90 mm Hg at any time in adults and age-specific hypotension in children;
- Gunshot wounds to the neck, chest, or abdomen or extremities proximal to the elbow/knee;
- Glasgow Coma Scale score less than 9 with mechanism attributed to trauma;
- Transfer patients from other hospitals receiving blood to maintain vital signs;
- Intubated patients transferred from the scene, -OR-
- Patients who have respiratory compromise or are in need of an emergent airway
- Includes intubated patients who are transferred from another facility with ongoing respiratory compromise (does not include patients intubated at another facility who are now stable from a respiratory standpoint)
- Emergency physician's discretion



HMC Trauma team activation criteria

FULL TEAM TRAUMA ACTIVATION (FTTA)*

1. Trauma patient with hemodynamic instability in Field or HMC ED (SBP \leq 90mmHg for age \geq 5 years or below minimum SBP for age \leq 5 years; see table).
2. All Gunshot wounds or impalements to the neck, chest, abdomen, pelvis or groin.
3. Patient with a high mechanism trauma event (as defined by our current criteria, MTTA #10) or with obvious polytrauma at the time of initial report/presentation who are intubated in the field and transported directly to HMC.
4. Trauma patient with difficult or unsecured airway in Field or ED (Includes failed attempts at field intubation, all patients transported with airway rescue devices (King/LMA), all patients with Field or outside hospital cricothyrotomy).
5. Trauma patient with obvious major vascular injury (active arterial hemorrhage, expanding hematoma).
6. All pediatric trauma patients age 5 years or younger requiring intubation in the field or ED.
7. Transfer patient requiring transfusion to maintain vital signs or any trauma patient in ED for whom transfusion of PRBCs is being initiated.
8. Mass casualty: 3 or more major trauma patients expected simultaneously.



HMC Trauma team activation criteria

Reference Vital Signs for Pediatric Patients ≤ 5 years of age:

Color	Gray	Pink	Red	Purple	Yellow	White	Blue
Approx weight (kg)	5	6	8	10	13	16	20
Approx Age	0-2 mo	4 mo	8 mo	1 yr	2 yr	4 yr	5-6yr
Minimum SBP (mmHg)	50	70	70	70	70	75	80
Heart rate (beats/min)	100-160	100-160	100-160	90-150	90-150	80-140	70-120



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?

	Early Critical Resource Use		
	Yes	No	
Trauma Team Activation			
None	229	1643	1872
Modified	385	810	1195
Full	309	145	454
	923	2598	3521

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

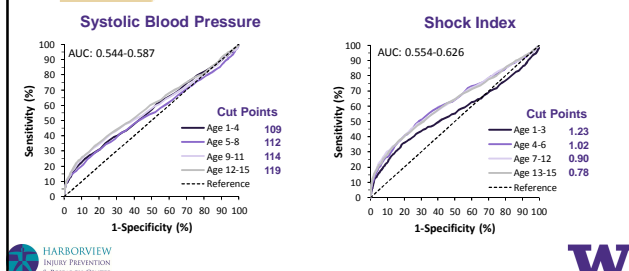
- > **Patient Selection:** Children age 1-15 years in TQIP database 2014-2016
- > **Outcome:** Early critical resource use¹
 - Transfusion, advanced airway management, or angiography within 4h
 - Major operation, pericardiocentesis, ICP monitoring, or death within 24h
- > ROC curves to determine optimal cut point for SBP and SI
- > Compared diagnostic test characteristics of cut points
 - ROC-generated SBP-AA to SIPA
 - ROC-generated SIPA to standard SIPA²



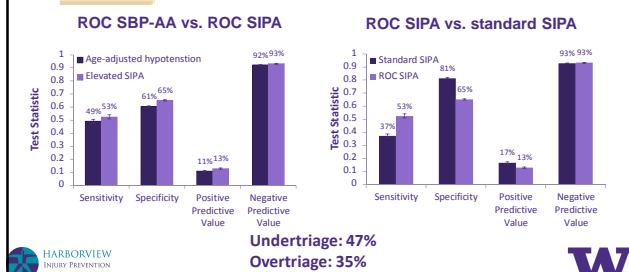
¹Lerner et al. *J Trauma Acute Care Surg* 2014; 76: 1157–1163.
²Jacker et al. *J Pediatr Surg* 2015; 50: 331–334.



Results- ROC Curves



Results- Diagnostic Test Characteristics



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

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