Emergency Department Thoracotomy in Children

Western Pediatric Trauma Conference – July 13, 2023

Mubeen Jafri, MD

Disclosures

OHSU

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MUBEEN

When should I perform ar
thoracotomy in a child?

CHATGPT

Message

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MUBEEN

When should I perform an emergency department thoracotomy in a child?

CHATGPT

Performing an emergency department thoracotomy in a child is an extremely rare and high-stakes procedure that is typically reserved for life-threatening situations. It may be considered in cases of traumatic cardiac arrest, such as severe penetrating chest injuries or blunt trauma resulting in cardiac arrest. However, the decision to perform an emergency department thoracotomy should be made by a skilled medical professional in real-time, considering factors like the mechanism of injury, vital signs, and the overall clinical condition of the child. Immediate consultation with a pediatric surgeon or a pediatric trauma specialist is crucial in such situations.

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MUBEEN

But I need to tell a room of experts some specific indications and when not to do it. Can you be more specific?

CHATGPT

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CHATGPT

Certainly! Wher
department tho
indications may

1. Profound hy
experiencing
pressure) th
resuscitative
thoracotomy
2. Penetrating
penetrating
arrest or imp
emergency t
3. Blunt trauma
the child exp
into cardiac
emergency t
4. Severe ches
severe chest
hemothorax
clinical cond
resuscitatior
thoracotomy

Conversely, ther
emergency thor
including:

1. Prolonged d
experienced
arrest (typic
likelihood of
emergency t
significantly.
2. Unsurvivable

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the child experiences blunt trauma and g
into cardiac arrest with a witnessed even
emergency thoracotomy may be considered.
4. Severe chest injuries: When a child sustains severe chest injuries, such as massive hemothorax or cardiac tamponade, and their clinical condition rapidly deteriorates despite resuscitation efforts, an emergency thoracotomy may be indicated.

Conversely, there are situations where an emergency thoracotomy may not be appropriate, including:

1. Prolonged downtime: If the child has experienced a prolonged period of cardiac arrest (typically more than 10-15 minutes), the likelihood of a successful outcome from an emergency thoracotomy decreases significantly.
2. Unsurvivable injuries: If the child has sustained injuries that are deemed unsurvivable, such as severe brain injury or extensive multisystem trauma, an emergency thoracotomy may not be beneficial.
3. Lack of qualified personnel: If the healthcare facility lacks the necessary expertise or resources to perform an emergency thoracotomy in a pediatric patient, it may not be feasible or advisable.

Remember, these indications and contraindications are general guidelines, and individual cases may vary. It is essential to consult with experienced pediatric trauma experts in real-time to make informed decisions.

Message

OHSU

Pediatric Trauma Performance Improvement and Patient Safety

June 14th, 2023
Microsoft Teams 7-8:00 am

Case Reviews

RANDALL CHILDREN'S HOSPITAL
LEGACY EMANUEL

Mortality Case Review – J.C.

Age: 4 years old

Mechanism: Unknown/Non-Accidental Trauma

Level 1 Direct to OR – Scene Call

Final Injuries

Cardiac Arrest

Blunt Force Trauma: Head, Neck, Chest, Torso, Abdomen, Pelvis, Back, Arms, Legs

Liver laceration

Pancreas lacerations

Hemorrhage surrounding adrenals

RANDALL CHILDREN'S HOSPITAL
LEGACY EMANUEL

Mortality Case Review – Prehospital- J.C.

Timeline/Treatment:

1232 Dispatch
1232 Enroute
1235 Scene
1237 At Pt
1237 CPR
1240 IO
1241 Epi 0.22mg
1246 Epi 0.22mg
1250 Intubation
1252 Epi 0.22mg
1255 Reintubation – due to lack of lung sounds
1257 Transport
1258 Trauma activation
1258 Epi 0.22mg
1304 Arrival

Assessment:

Unresponsive, GCS 3 Blood in Airway, Asystole

V.S.

Pulseless and apneic
Est 21kg

RANDALL CHILDREN'S HOSPITAL
LEGACY EMANUEL

Mortality Case Review - LEMC– J.C.

Assessment

Pulseless and Apneic
GCS 3T
Pupils fixed
pH <6.8
pCO2 136
HCO3 15.5
BE -19.7
Na 144
K 7.7
iCa 1.32
Lactate >20
Hgb 6.4
Hct 19

Treatment

- 1306 code start
- 1310 L side thoracotomy, Cardiac massage
- 1311 PIV
- 1317 MTP started
  - Total 4 PRBC, 4 FFP, 2 PLT
- CaCl 7 doses
- Bicarb 8 doses
- Epi 9 doses than a drip of 0.1mcg/kg/min
- 3% 1 dose
- Insulin 3 doses
- 1429 code ended

RANDALL CHILDREN'S HOSPITAL
LEGACY EMANUEL

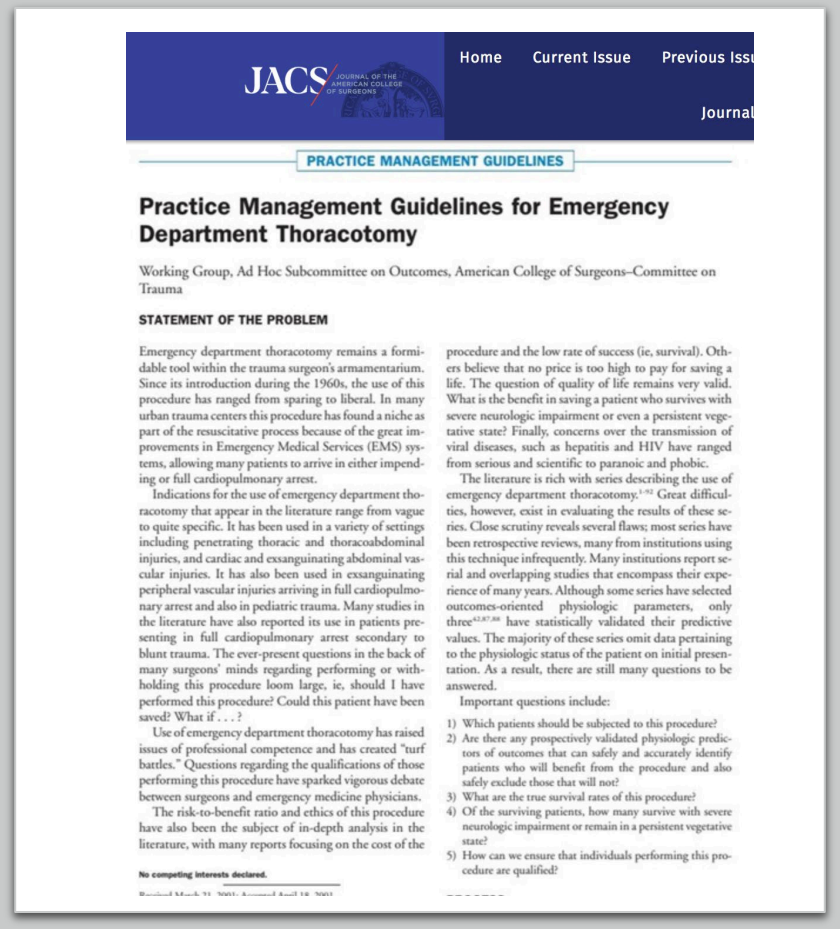
Discussion Points

- Nonsurvivable
- OFI

RANDALL CHILDREN'S HOSPITAL
LEGACY EMANUEL

Background

- EDT uncommonly performed in pediatric trauma patients.
- No specific evidence-based guidelines in the pediatric population.
- ?? Use Adult Guidelines??



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Journal

PRACTICE MANAGEMENT GUIDELINES

Practice Management Guidelines for Emergency Department Thoracotomy

Working Group, Ad Hoc Subcommittee on Outcomes, American College of Surgeons–Committee on Trauma

STATEMENT OF THE PROBLEM

Emergency department thoracotomy remains a formidable tool within the trauma surgeon's armamentarium. Since its introduction during the 1960s, the use of this procedure has ranged from sparing to liberal. In many urban trauma centers this procedure has found a niche as part of the resuscitative process because of the great improvements in Emergency Medical Services (EMS) systems, allowing many patients to arrive in either impending or full cardiopulmonary arrest.

Indications for the use of emergency department thoracotomy that appear in the literature range from vague to quite specific. It has been used in a variety of settings including penetrating thoracic and thoracoabdominal injuries, and cardiac and exsanguinating abdominal vascular injuries. It has also been used in exsanguinating peripheral vascular injuries arriving in full cardiopulmonary arrest and also in pediatric trauma. Many studies in the literature have also reported its use in patients presenting in full cardiopulmonary arrest secondary to blunt trauma. The ever-present questions in the back of many surgeons' minds regarding performing or withholding this procedure loom large, ie, should I have performed this procedure? Could this patient have been saved? What if . . . ?

Use of emergency department thoracotomy has raised issues of professional competence and has created "turf battles." Questions regarding the qualifications of those performing this procedure have sparked vigorous debate between surgeons and emergency medicine physicians.

The risk-to-benefit ratio and ethics of this procedure have also been the subject of in-depth analysis in the literature, with many reports focusing on the cost of the procedure and the low rate of success (ie, survival). Others believe that no price is too high to pay for saving a life. The question of quality of life remains very valid. What is the benefit in saving a patient who survives with severe neurologic impairment or even a persistent vegetative state? Finally, concerns over the transmission of viral diseases, such as hepatitis and HIV have ranged from serious and scientific to paranoic and phobic.

The literature is rich with series describing the use of emergency department thoracotomy.[1-92] Great difficulties, however, exist in evaluating the results of these series. Close scrutiny reveals several flaws; most series have been retrospective reviews, many from institutions using this technique infrequently. Many institutions report serial and overlapping studies that encompass their experience of many years. Although some series have selected outcomes-oriented physiologic parameters, only three[45,87,88] have statistically validated their predictive values. The majority of these series omit data pertaining to the physiologic status of the patient on initial presentation. As a result, there are still many questions to be answered.

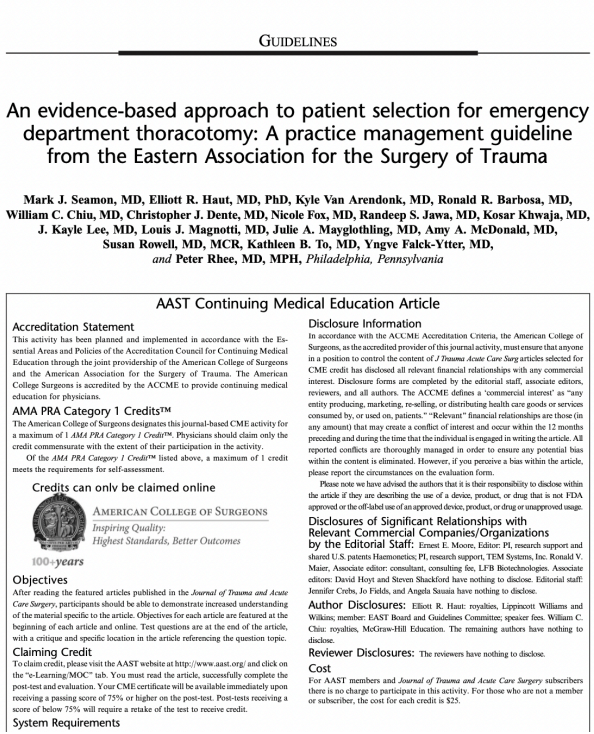
Important questions include:

1) Which patients should be subjected to this procedure?
2) Are there any prospectively validated physiologic predictors of outcomes that can safely and accurately identify patients who will benefit from the procedure and also safely exclude those that will not?
3) What are the true survival rates of this procedure?
4) Of the surviving patients, how many survive with severe neurologic impairment or remain in a persistent vegetative state?
5) How can we ensure that individuals performing this procedure are qualified?

No competing interests declared.

Background

- Emergency Department Thoracotomy (EDT) in adults is well-established
- EAST 2015



GUIDELINES

An evidence-based approach to patient selection for emergency department thoracotomy: A practice management guideline from the Eastern Association for the Surgery of Trauma

Mark J. Seamon, MD, Elliott R. Haut, MD, PhD, Kyle Van Arendonk, MD, Ronald R. Barbosa, MD, William C. Chiu, MD, Christopher J. Dente, MD, Nicole Fox, MD, Randeep S. Jawa, MD, Kosar Khwaja, MD, J. Kayle Lee, MD, Louis J. Magnotti, MD, Julie A. Mayglothling, MD, Amy A. McDonald, MD, Susan Rowell, MD, MCR, Kathleen B. To, MD, Yngve Falck-Ytter, MD, *and* **Peter Rhee, MD, MPH,** *Philadelphia, Pennsylvania*

AAST Continuing Medical Education Article

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This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education through the joint providership of the American College of Surgeons and the American Association for the Surgery of Trauma. The American College Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

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Objectives

After reading the featured articles published in the *Journal of Trauma and Acute Care Surgery*, participants should be able to demonstrate increased understanding of the material specific to the article. Objectives for each article are featured at the beginning of each article and online. Test questions are at the end of the article, with a critique and specific location in the article referencing the question topic.

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System Requirements

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Reviewer Disclosures: The reviewers have nothing to disclose.

Cost

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PICO	Adult	Pediatric
1. Penetrating thoracic + SOL	Support (strong)	?
2. Penetrating thoracic - SOL	Support (Conditional)	?
3. Penetrating abd/pelvic + SOL	Support (Conditional)	?
4. Penetrating abd/pelvic - SOL	Support (Conditional)	?
5. Blunt + SOL	Support (Conditional)	?
6. Blunt - SOL	Against (Conditional)	?

Background

- 40 year experience at single institution (1974-2013)
- 1,691 thoracotomies
- 179 pediatric patients
- Adolescents (15-18 yrs of age) had survival of 4.8%
- Pediatric (<15 yrs of age) had 0%
- Noted difference in mortality

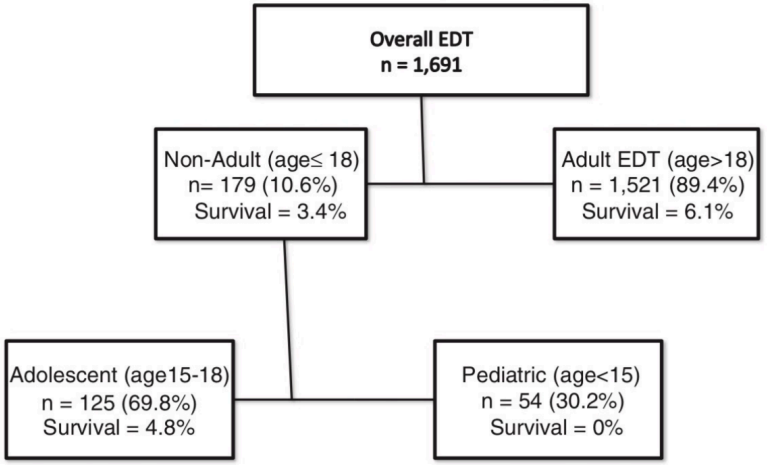

Fig. 1. Survival patterns in different age cohorts.

Moore HE, Moore EE, Bensard DD. Pediatric emergency department thoracotomy: a 40-year review

Background

Table 1
Systematic review of the published case series regarding pediatric EDT along with data from Ryder Trauma Center.

	Blunt	Penetrating	Survival
Powell et al. *The American Surgeon*, 1988	1/8	4/11	5/19
Beaver et al. *J Pediatric Surgery*, 1987	0/15	0/2	0/17
Rothenberg et al. *J Trauma*, 1989	1/47	2/36	3/83
Sheikh and Culbertson, *J Trauma*, 1993	0/15	1/8	1/23
Hofbauer et al. *Resuscitation*, 2011	0/10	1/1	1/11
Easter et al. *Resuscitation*, 2012	0/13	3/16	3/29
Boatright et al. *JACS*, 2013	0/9	0/0	0/9
Ryder Trauma Center, Miami, FL. 1991-2012	0/7	2/54	2/61
Survival	2/124	13/128	15/252

Blunt versus penetrating, survival.

- Allen CJ, Valle EJ, Thorson CM, Hogan AR, Perez EA, Namias N, Zakrison TL, Neville HL, Sola JE. Pediatric emergency department thoracotomy: a large case series and systematic review

Background

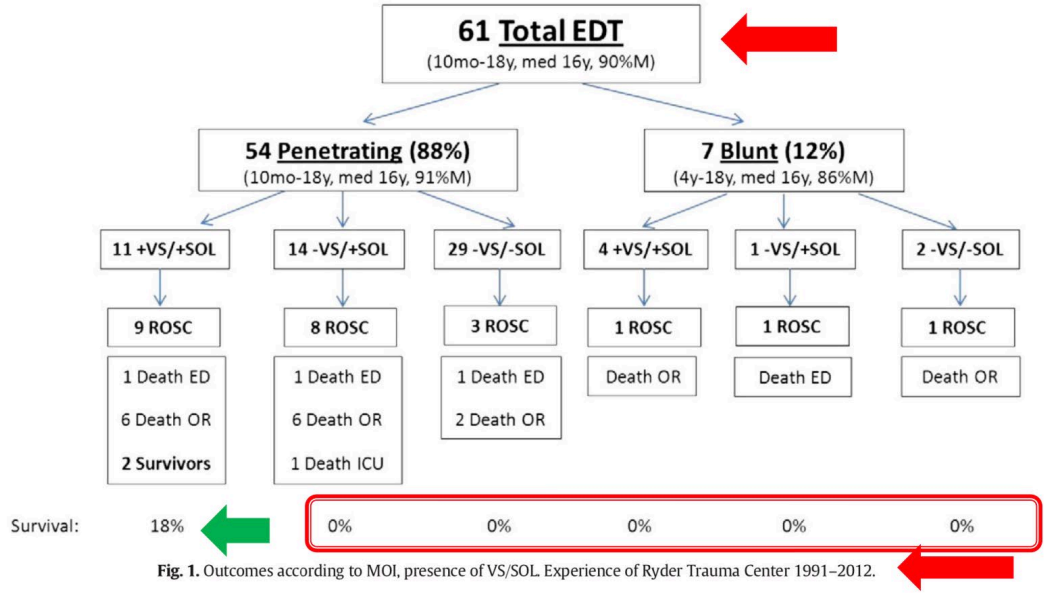

Fig. 1. Outcomes according to MOI, presence of VS/SOL. Experience of Ryder Trauma Center 1991–2012.

- Allen CJ, Valle EJ, Thorson CM, Hogan AR, Perez EA, Namias N, Zakrison TL, Neville HL, Sola JE. Pediatric emergency department thora-

Background

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Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Mortality after emergency department thoracotomy for pediatric blunt trauma: Analysis of the National Trauma Data Bank 2007–2012☆,☆☆,★

Katherine T. Flynn-O'Brien [a,b,*], Barclay T. Stewart [a], Mary E. Fallat [c], Ronald V. Maier [b,d], Saman Arbabi [b,d], Frederick P. Rivara [b,e], Lisa K. McIntyre [d]

[a] Department of Surgery, University of Washington, Seattle, WA
[b] Harborview Injury Prevention and Research Center, Seattle, WA
[c] Division of Pediatric Surgery, Department of Surgery, Kosair Children's Hospital and University of Louisville, Louisville, KY
[d] Department of Surgery, Harborview Medical Center and University of Washington, Seattle, WA
[e] Department of Pediatrics, Harborview Medical Center and University of Washington, Seattle, WA

100% died before hospital discharge

Table 4
Mortality and duration of survival in children who underwent emergency department thoracotomy after blunt trauma from the National Trauma Data Bank, 2007–2012.

Mortality	n	%	Cumulative %
Died in the ED	50	59.5	59.5
Died in the OR	21	25.0	84.5
Died ≤24 hours in the ICU	9	10.7	95.2
Died >24 hours in the ICU	4	4.8	100

Without SOL – 100% died in ED
With SOL:
- 60% died in ED
- 20% died in OR
- 20% died in ICU

Background

ORIGINAL ARTICLE

Nationwide analysis of resuscitative thoracotomy in pediatric trauma: Time to differentiate from adult guidelines?

James M. Prieto, MD, Jan Michael Van Gent, DO, Richard Y. Calvo, PhD, Alexandra S. Rooney, MPH, Matthew J. Martin, MD, Michael J. Sise, MD, C. Beth Sise, MSN, David A. Lazar, MD, Vishal Bansal, MD, *and* **Romeo C. Ignacio, MD**, *San Diego, California*

BACKGROUND: Emergency department thoracotomy (EDT) for pediatric patients is uncommon, and practice patterns have not been evaluated. We examined the indications and outcomes for EDT by trauma center designation using a nationwide database.

METHODS: Patients 16 years or younger who underwent EDT within 30 minutes of arrival from 2013 to 2016 were identified in the American College of Surgeons National Trauma Data Bank. Patient demographic information, indications for EDT, and outcomes were analyzed. Outcomes were compared between centers with and without pediatric trauma center designation.

RESULTS: A total of 114 patients were identified for analysis with a mean ± SD age of 10.3 ± 4.7 years. Patients were predominantly male (69%) with a median Injury Severity Score of 26 (interquartile range, 18–42). Penetrating trauma occurred in 56%. Overall, mortality was 90% and was similar in penetrating and blunt trauma (88% vs. 94%; $p = 0.34$). There were no survivors among the 53 patients (46%) who arrived with no signs of life. Among the 11 patients (10%) who survived, median length of stay was 26 days (interquartile range, 6–28 days). Overall, 8% of EDT was performed at free-standing pediatric trauma centers, 45% at adult centers, and 47% at combined trauma centers. Mortality rates and indications were similar among trauma centers regardless of designation status.

CONCLUSION: In a national population-based data set, the mortality after pediatric EDT is high, and many of these procedures are performed at nonpediatric trauma centers. Regardless of injury mechanism, EDT is not appropriate in children without signs of life on arrival. Pediatric guidelines are needed to increase awareness of the poor outcomes and limited indications for EDT. (*J Trauma Acute Care Surg.* 2020;89: 686–690.

LEVEL OF EVIDENCE: Therapeutic, level IV.
KEY WORDS: Emergency thoracotomy; pediatric; trauma center; mortality.

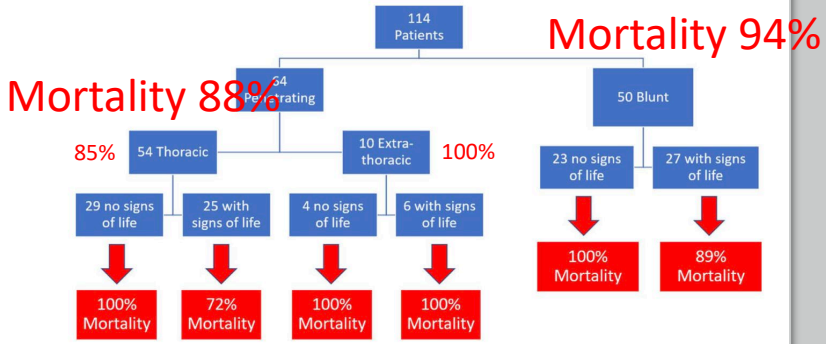

Figure 1. Survival by injury mechanism and signs of life on arrival.

PICO	Adult	Pediatric
1. Penetrating thoracic + SOL	Support (strong)	?
2. Penetrating thoracic - SOL	Support (Conditional)	?
3. Penetrating abd/pelvic + SOL	Support (Conditional)	?
4. Penetrating abd/pelvic - SOL	Support (Conditional)	?
5. Blunt + SOL	Support (Conditional)	?
6. Blunt - SOL	Against (Conditional)	?

east

Western Trauma Association

Emergency department thoracotomy in children: A Pediatric Trauma Society, Western Trauma Association, and Eastern Association for the Surgery of Trauma systematic review and practice management guideline

Leigh Selesner, MD, Brian Yorkgitis, DO, Matthew Martin, MD, Grace Ng, MD, Kaushik Mukherjee, MD, MSCI, FACS, Romeo Ignacio, MD, MSc, Jennifer Freeman, MD, Lye-Yeng Wong, MD, Samantha Durbin, MD, Marie Crandall, MD, MPH, Shannon W. Longshore, MD, Claire Gerall, MD, Katherine T. Flynn-O'Brien, MD, *and* **Mubeen Jafri, MD**, *Portland, Oregon*

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Objective

Determine if EDT vs. resuscitation without EDT improves *hospital survival* and *neurologically-intact hospital survival* in children (<19 years old) who present to hospital pulseless following a trauma.

Method

Perform systematic review and develop evidence-based guidelines using GRADE methodology.

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PICO Questions

PICO #	Population	Intervention	Comparator	Outcomes
PICO 1	Children who present pulseless to the ED following **PENETRATING THORACIC** trauma **with SOL**	EDT	Resuscitation without EDT	1. Hospital Survival 2. Neurologically intact survival
PICO 2	Children who present pulseless to the ED following **PENETRATING THORACIC** trauma **without SOL**	EDT	Resuscitation without EDT	1. Hospital Survival 2. Neurologically intact survival
PICO 3	Children who present pulseless to the ED following **PENETRATING EXTRATHORACIC** trauma **with SOL**	EDT	Resuscitation without EDT	1. Hospital Survival 2. Neurologically intact survival
PICO 4	Children who present pulseless to the ED following **PENETRATING EXTRATHORACIC** trauma **without SOL**	EDT	Resuscitation without EDT	1. Hospital Survival 2. Neurologically intact survival
PICO 5	Children who present pulseless to the ED following **BLUNT** trauma **with SOL**	EDT	Resuscitation without EDT	1. Hospital Survival 2. Neurologically intact survival
PICO 6	Children who present pulseless to the ED following **BLUNT** trauma **without SOL**	EDT	Resuscitation without EDT	1. Hospital Survival 2. Neurologically intact survival

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Signs of Life Definition:

Presence of one or several of the following: *cardiac electrical activity, respiratory effort, pupillary response, pulses, measurable or palpable blood pressure, extremity movement, and Glasgow coma score (GCS)*

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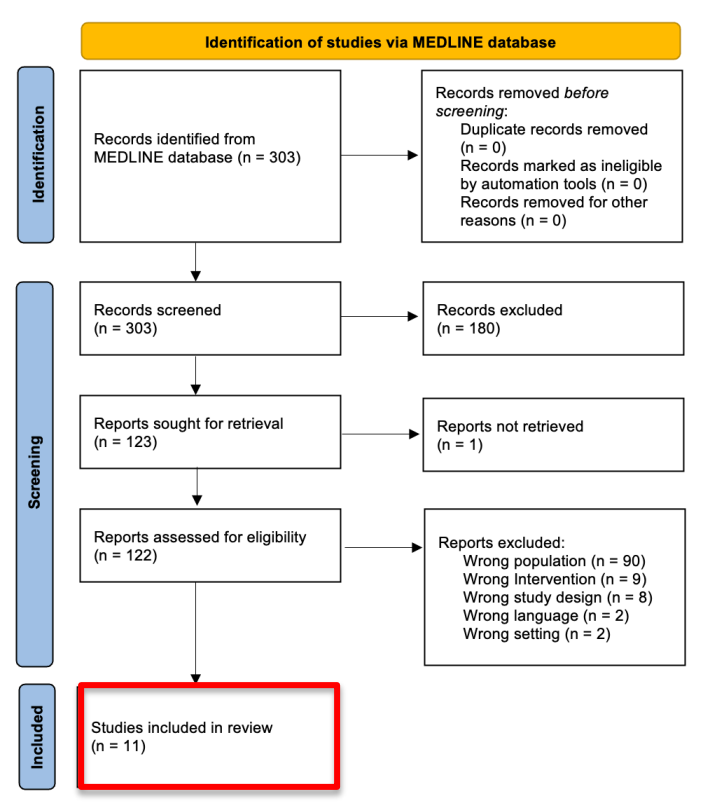
Methods

Preferred Reporting Items for Systematic Reviews and Meta-analyses Diagram of Included Studies (PRISMA)



Author (Year)	Title	# Patients	Years of Data Extraction
Beaver et al. (1987)	Efficacy of Emergency Room Thoracotomy in Pediatric Trauma	17	1980 – 1985
Powell et al. (1988)	Resuscitative Thoracotomy in Children and Adolescents	15	1981 – 1986
Rothenberg et al. (1989)	Emergency Department Thoracotomy in Children – A Critical Analysis	77	1977 – 1988
Sheikh et al. (1993)	Emergency Department Thoracotomy in Children: Rationale for Selective Application	15	1986 – 1991
Nance et al. (1996)	Thoracic Gunshot Wounds in Children Under 17 Years of Age	6	1987 – 1995
Hofbauer et al. (2011)	Retrospective Analysis of Emergency Room Thoracotomy in Pediatric Severe Trauma Patients	11	1992 – 2008
Easter et al. (2012)	Emergent Pediatric Thoracotomy Following Traumatic Arrest	25	1995 – 2009
Boatright et al. (2013)	Validation of Rules to Predict Emergent Surgical Intervention in Pediatric Trauma Patients	9	1993 – 2010
Allen et al. (2015)	Pediatric Emergency Department Thoracotomy: A large Case Series and Systematic Review	7	1991 – 2012
Nicolson et al. (2015)	Resuscitative Thoracotomy for Pediatric Trauma in Illinois, 1999 to 2009	23	1999 – 2009
Prieto et al. (2020)	Nationwide Analysis of Resuscitative Thoracotomy in Pediatric Trauma: Time to Differentiate from Adult Guidelines?	114	2013 – 2016

NTDB data

Methods

- Data extraction in Covidence
- Measurements of effect
  - No comparator group in the literature
  - Relative risks and confidence intervals calculated
- Quality of evidence
  - Strong recommendation = “strongly recommend”
  - Weak recommendation = “conditionally recommend”

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Results

Total # of children	319
# penetrating injury (%)	142 (44.5%)
# blunt injury (%)	177 (55%)
% survival penetrating group	13.4% (19/142)
% survival blunt group	2.3% (4/177)
% total survival	7.2% (23/319)

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Results:

PICO #1: In pediatric patients presenting pulseless to the ED with SOL after penetrating thoracic injury, does EDT, versus resuscitation without EDT improve HS and NIS?

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	EDT	no EDT	Relative (95% CI)	Absolute (95% CI)		
Hospital survival												
7 7	observational studies	serious	not serious	not serious	serious	none	13/42 (31.0%) 31%	28/1000 (2.8%) 2.8%	**RR 11.0544** (6.1840 to 19.7606) RR = 11 CI = 6.2 – 19.7	**282 more per 1,000** (from 145 more to 525 more)	⨁◯◯◯ Very low Very low	CRITICAL
Neurologically intact hospital survival												
5 5	observational studies	serious	not serious	not serious	serious	none	4/16 (25.0%) 25%	25/1000 (2.5%) 2.5%	**RR 10.0000** (3.9345 to 25.4162) RR = 10 CI = 3.9 – 25.4	**225 more per 1,000** (from 73 more to 610 more)	⨁◯◯◯ Very low Very low	CRITICAL

CI: confidence interval; **RR:** risk ratio

Conditional recommendation FOR EDT

7 (58.3%) votes – "conditional" recommendation FOR

5 (41.7%) votes – " strong" recommendation FOR

OHSU

Results:

PICO #2: In pediatric patients presenting pulseless to the ED without SOL after penetrating thoracic injury, does EDT, versus resuscitation without EDT improve HS and NIS?

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	EDT	no EDT	Relative (95% CI)	Absolute (95% CI)		
Hospital Survival												
7	observational studies	serious	not serious	not serious	serious	none	4/77 (5.2%)	2/1000 (0.2%)	**RR 25.9740** (4.8336 to 139.5753)	**50 more per 1,000** (from 8 more to 277 more)	⨁◯◯◯ Very low	CRITICAL
Neurologically Intact Hospital Survival												
7	observational studies	serious	not serious	not serious	serious	none	3/77 (3.9%)	1.8/1000 (0.2%)	**RR 21.6450** (6.5094 to 71.9742)	**37 more per 1,000** (from 10 more to 128 more)	⨁◯◯◯ Very low	CRITICAL

CI: confidence interval; **RR:** risk ratio

7
5.2%
0.2%
RR = 26
CI = 4.8 – 139.6
Very low

7
3.9%
0.018%
RR = 21.6
CI = 6.5 – 72
Very low

Conditional recommendation AGAINST EDT

8 (66.7%) votes – "conditional" recommendation AGAINST

4 (33.3%) votes – "conditional" recommendation FOR

OHSU

Results:

PICO #3: In pediatric patients presenting pulseless to the ED with SOL after penetrating extrathoracic injury, does EDT, versus resuscitation without EDT improve HS and NIS?

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	EDT	no EDT	Relative (95% CI)	Absolute (95% CI)		
Hospital Survival												
2	observational studies	serious	not serious	not serious	very serious	none	1/10 (10.0%)	17/1000 (1.7%)	**RR 5.8824** (0.8639 to 40.0520)	**83 more per 1,000** (from 2 fewer to 664 more)	⨁◯◯◯ Very low	CRITICAL
2							10%	1.7%	RR = 5.9		Very low	
									CI = 0.86 – 40.1			
Neurologically Intact Hospital Survival												
2	observational studies	serious	not serious	not serious	very serious	none	1/10 (10.0%)	15/1000 (1.5%)	**RR 6.6667** (0.9715 to 45.7494)	**85 more per 1,000** (from 0 fewer to 671 more)	⨁◯◯◯ Very low	CRITICAL
2							10%	1.5%	RR = 6.7		Very low	
									CI = 0.97 – 45.8			

CI: confidence interval; **RR:** risk ratio

Conditional recommendation FOR EDT

7 (58.3%) votes – "conditional" recommendation FOR

2 (16.7%) votes – "strong" recommendation FOR

2 (16.7%) – "conditional" recommendation AGAINST

1 (8.3%) – no recommendation can be made

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Results:

PICO #4: In pediatric patients presenting pulseless to the ED without SOL after penetrating extrathoracic injury, does EDT, versus resuscitation without EDT improve HS and NIS?

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	EDT	no EDT	Relative (95% CI)	Absolute (95% CI)		
Hospital Survival												
5	observational studies	serious	not serious	not serious	serious	none	1/19 (5.3%)	1/1000 (0.1%)	**RR 52.6316** (3.4174 to 810.5861)	**52 more per 1,000** (from 2 more to 810 more)	⨁◯◯◯ Very low	CRITICAL
5							5.3%	0.1%	RR = 52.6 CI = 3.4 – 810		Very low	
Neurologically Intact Hospital Survival												
5	observational studies	serious	not serious	not serious	serious	none	1/19 (5.3%)	9/10000 (0.1%)	**RR 58.4795** (7.7856 to 439.2538)	**52 more per 1,000** (from 6 more to 394 more)	⨁◯◯◯ Very low	CRITICAL
5							5.3%	0.09%	RR = 58.4 CI = 7.7 – 439		Very low	

CI: confidence interval; **RR:** risk ratio

Conditional recommendation AGAINST EDT

9 (75%) votes – "conditional" recommendation AGAINST

2 (16.7%) votes – "strong" recommendation AGAINST

1 (8.3%) – "conditional" recommendation FOR

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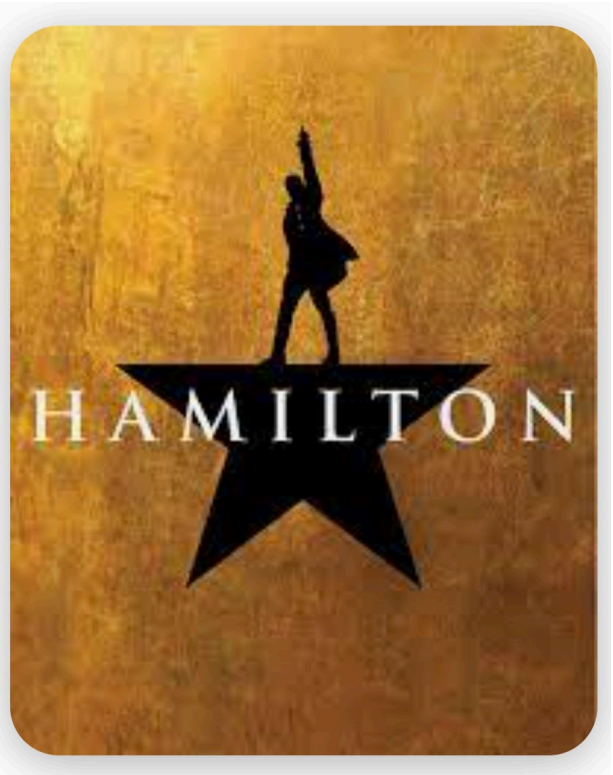

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Results:

PICO #5: In pediatric patients presenting pulseless to the ED with SOL after blunt injury, does EDT, versus resuscitation without EDT improve HS and NIS?

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	EDT	no EDT	Relative (95% CI)	Absolute (95% CI)		
Hospital Survival												
8	observational studies	serious	not serious	not serious	serious	none	4/72 (5.6%)	5/1000 (0.5%)	**RR 11.1111** (3.0498 to 40.4805)	**51 more per 1,000** (from 10 more to 197 more)	⨁◯◯◯ Very low	CRITICAL
8							5.6%	0.5%	RR = 11.1		Very low	
Neurologically Intact Hospital Survival												
7	observational studies	serious	not serious	not serious	serious	none	1/45 (2.2%)	3/1000 (0.3%)	**RR 7.4074** (0.7859 to 69.8184)	**19 more per 1,000** (from 1 fewer to 206 more)	⨁◯◯◯ Very low	CRITICAL
7							2.2%	0.3%	RR = 7.4		Very low	

CI: confidence interval; **RR:** risk ratio

CI = 3.1 – 40.5

CI = 0.78 – 69.8

Conditional recommendation FOR EDT

6 (50%) votes – "conditional" recommendation FOR

1 (8.3%) votes – "strong" recommendation FOR

4 (33.3%) – "conditional" recommendation AGAINST

1 (8.3%) – cannot make a recommendation

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Results:

PICO #6: In pediatric patients presenting pulseless to the ED without SOL after blunt injury, does EDT, versus resuscitation without EDT improve HS and NIS?

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	EDT	no EDT	Relative (95% CI)	Absolute (95% CI)		
Hospital Survival												
10	observational studies	serious	not serious	not serious	serious	none	0/105 (0.0%)	1/100000 (0.0%)	not estimable		⨁◯◯◯ Very low	CRITICAL
Neurologically Intact Hospital Survival												
10	observational studies	serious	not serious	not serious	serious	none	0/105 (0.0%)	6/1000000 (0.0%)	not estimable		⨁◯◯◯ Very low	CRITICAL

CI: confidence interval; **RR:** risk ratio

10 0% 0.001% Very low

10 0% 0.0003% Very low

Strong recommendation AGAINST EDT

12 (100%) votes – “strong” recommendation AGAINST

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Limitations

- Low-quality evidence
- Reliance on NTDB
- Estimation of survival in comparator group

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Future directions

- More studies needed to evaluate pediatric specific outcomes
- Study pediatric patients only < 15 years old
- REBOA

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PICO	Adult	Pediatric
1. Penetrating thoracic + SOL	Support (Strong)	Support (Conditional)
2. Penetrating thoracic - SOL	Support (Conditional)	Against (Conditional)
3. Penetrating abd/pelvic + SOL	Support (Conditional)	Support (Conditional)
4. Penetrating abd/pelvic - SOL	Support (Conditional)	Against (Conditional)
5. Blunt + SOL	Support (Conditional)	Support (Conditional)*
6. Blunt - SOL	Against (Conditional)	Against (Strong)

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Pediatric Emergency Resuscitative Thoracotomy: A Western Trauma Association, Pediatric Trauma Society, and Eastern Association for the Surgery of Trauma Collaborative Critical Decisions Algorithm

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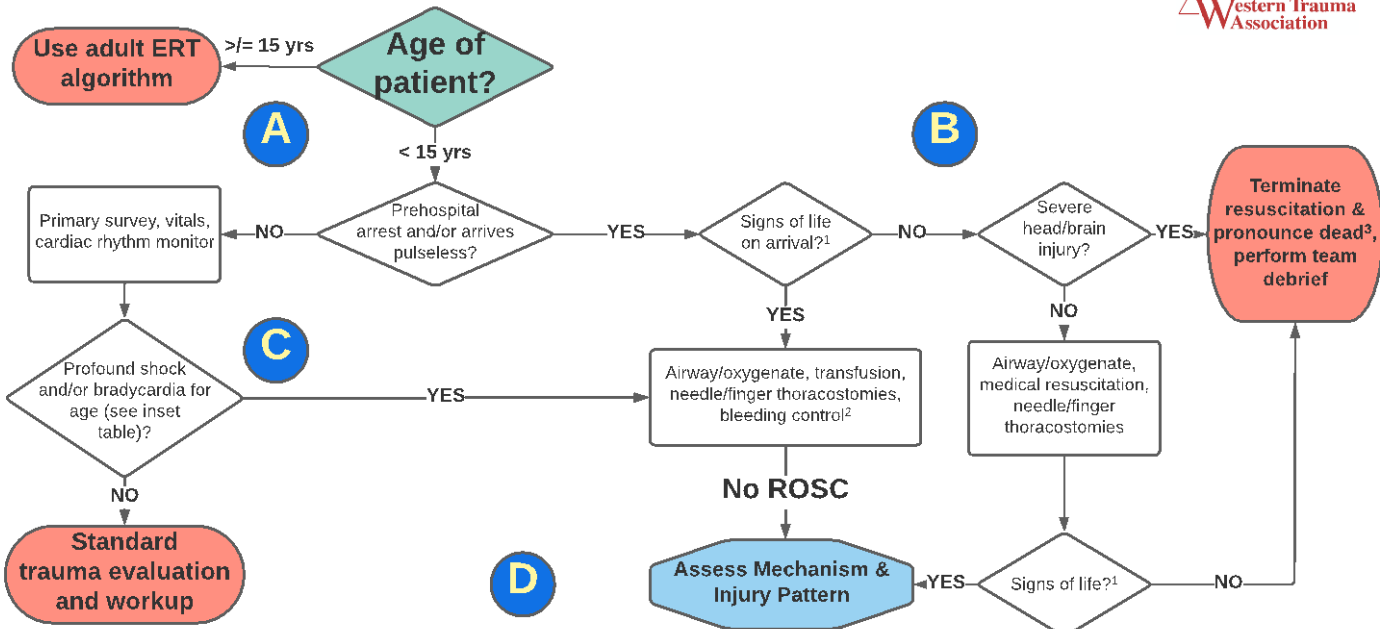
Pediatric Emergency Resuscitative Thoracotomy (ERT) Algorithm



Profound Shock Signs by Age

Age Category	Hypotension (SBP)	Bradycardia (beats/min)	Tachycardia (beats/min)
Neonate (0-1 months)	<60 mmHg	<110	>180
Infant (1-12 months)	<70 mmHg	<100	>170
Child (1-10 years)	<70 mmHg + (age x 2)	<60	>140
Child (>10 years)	<90 mmHg	<60	>110
Additional signs of hemorrhagic shock and malperfusion	delayed capillary refill, pulse pressure <20mmHg, skin mottling, cool extremities, decreased level of consciousness, dulled pain response		

One vital sign abnormality is concerning for shock, and two or more should be considered diagnostic in the absence of an alternate cause. Persistent or worsening severe hypotension with tachy or bradycardia despite initial resuscitation should prompt consideration of immediate emergency resuscitative thoracotomy, particularly with signs of malperfusion

Footnotes:

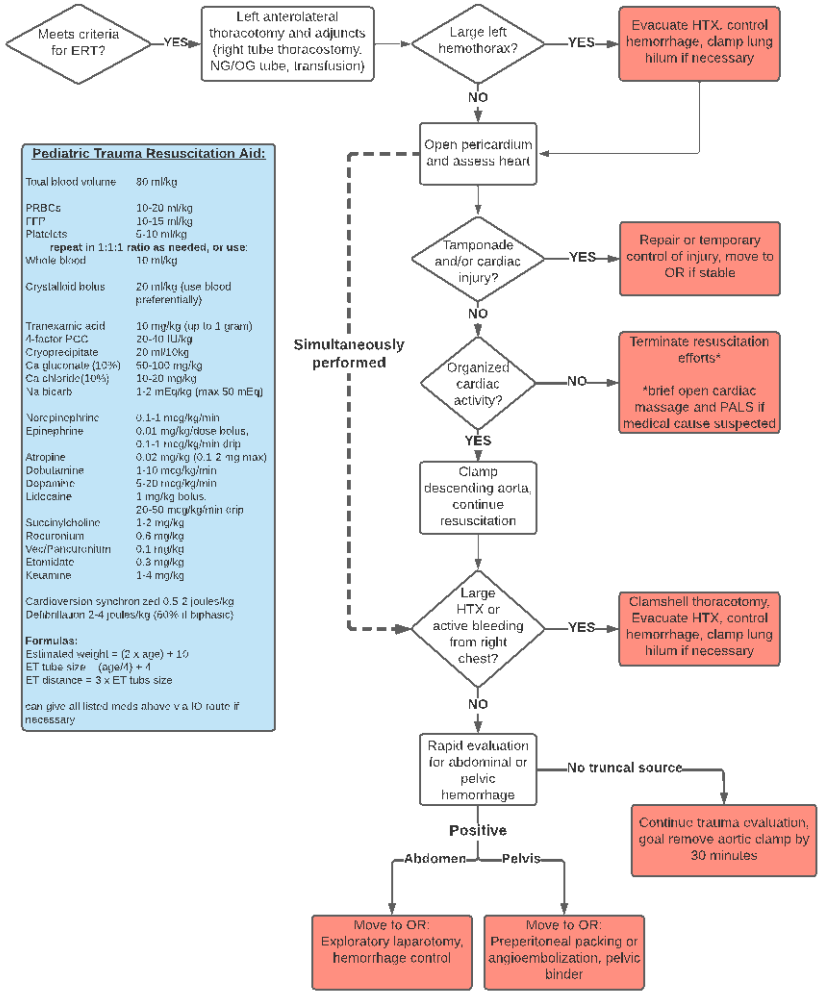
[1]spontaneous motor or respirations, reactive pupils, narrow complex EKG rhythm, organized cardiac motion

[2]pelvic binder, tourniquets, hemostatic dressings/wound packing, laceration management

[3]Resuscitative thoracotomy may be utilized in highly select cases of potentially salvageable brain injury or for stabilization for possible future organ donation

Pediatric Emergency Resuscitative Thoracotomy (ERT) Procedure Guide

Western Trauma Association



Pediatric Trauma Resuscitation Aid:

Total blood volume	80 ml/kg
PRBCs	10-20 ml/kg
FFP	10-15 ml/kg
Platelets	5-10 ml/kg
repeat in 1:1:1 ratio as needed, or use:	
Whole blood	10 ml/kg
Crystalloid bolus	20 ml/kg (use blood preferentially)
Tranexamic acid	10 mg/kg (up to 1 gram)
4-factor PCC	20-40 IU/kg
Cryoprecipitate	20 ml/10kg
Ca gluconate (10%)	50-100 mg/kg
Ca chloride(10%)	10-20 mg/kg
Na bicarb	1-2 mEq/kg (max 50 mEq)
Norepinephrine	0.1-1 mcg/kg/min
Epinephrine	0.01 mg/kg/dose bolus, 0.1-1 mcg/kg/min drip
Atropine	0.02 mg/kg (0.1 2 mg max)
Dobutamine	1-10 mcg/kg/min
Dopamine	5-20 mcg/kg/min
Lidocaine	1 mg/kg bolus, 20-50 mcg/kg/min drip
Succinylcholine	1-2 mg/kg
Rocuronium	0.6 mg/kg
Vec/Pancuronium	0.1 mg/kg
Etomidate	0.3 mg/kg
Ketamine	1-4 mg/kg

Cardioversion synchron zed 0.5 2 joules/kg
Defibrillaun 2-4 joules/kg (50% if biphasic)

Formulas:
Estimated weight = (2 x age) + 10
ET tube size = (age/4) + 4
ET distance = 3 x ET tube size

can give all listed meds above via IO route if necessary

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Thank You