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A Systematic Review of Hospital Trauma Team Activation Criteria for Children

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Abstract

Objectives: Hospital trauma activation criteria are intended to identify children who are likely to require aggressive resuscitation or specific surgical interventions that are time sensitive and require the resources of a trauma team at the bedside. Evidence to support criteria is limited, and no prior publication has provided historical or current perspectives on hospital practices toward informing best practice. This study aimed to describe the published variation in (1) highest level of hospital trauma team activation criteria for pediatric patients and (2) hospital trauma team membership and (3) compare these findings to the current ACS recommendations.

Methods: Using an Ovid MEDLINE In-Process & Other Non-Indexed Citations search, any published description of hospital trauma team activation criteria for children that used information captured in the prehospital setting was identified. Only studies of children were included. If the study included both adults and children, it was included if the number of children assessed with the criteria was included.

Results: Eighteen studies spanning 20 years and 13,184 children were included. Hospital trauma team activation and trauma team membership were variable. Nearly all (92%) of the trauma criteria used physiologic factors. Penetrating trauma (83%) was frequently included in the trauma team activation criteria. Mechanisms of injury (52%) were least likely to be included in the highest level of activation. No predictable pattern of criterion adoption was found. Only 2 of the published criteria and 1 of published trauma team membership are consistent with the current American College of Surgeons recommendations.

Conclusions: Published hospital trauma team activation criteria and trauma team membership for children were variable. Future prospective studies are needed to define the optimal hospital trauma team activation criteria and trauma team membership and assess its impact on improving outcomes for children.

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Keywords

trauma/emergency team; emergency medical services; wounds and injury

When children are transported to a trauma center, emergency medical services providers communicate the condition of the child to the emergency department (ED) staff before arrival. That information is used to determine whether the trauma team should be activated so that they are present in the ED when the patient arrives. Hospital trauma activation criteria are intended to identify children who are likely to require aggressive resuscitation or specific surgical interventions that are time sensitive and require the resources of a trauma team at the bedside. Presence of the trauma team has been shown to decrease mortality by 25% to 30% for the seriously injured child.¹ Overuse of the trauma team, however, can lead to excess costs and resource use as well as provider fatigue. Indeed activating the trauma team only when a critically injured patient is identified has been shown to reduce costs in adult and pediatric trauma patients.^{2,3}

The American College of Surgeons (ACS) Committee on Trauma described a tiered trauma team activation that is based on predetermined prehospital criteria.⁴ These criteria are distinct from the prehospital triage criteria that are used to identify patients that need the services of a trauma center. The ACS proposes 6 criteria that serve as the minimum criteria that should be used for the highest level trauma team activation, as follows:

- Age-specific hypotension: systolic blood pressure less than 70 mm Hg + (2 × age in years);
- Gunshot wound to the neck, chest, or abdomen or extremities proximal to the elbow/knee;
- Glasgow Coma Scale less than 9 or deteriorating by 2, 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 emergency airway *or* intubated patients who are transferred from another facility with ongoing respiratory compromise;
- Discretion of the emergency physician;

Trauma centers can expand on these criteria to include any of the prehospital information that is available. This typically includes physiologic, anatomic, and mechanism of injury criteria. There is no referenced evidence to support the ACS recommendations, although they parallel in content the minimum criteria for adults.

Trauma team members that usually respond to the activation are also outlined by the ACS.⁴

- General surgeon
- Emergency physician
- Surgical and emergency residents

- Emergency department nurses
- Laboratory technician
- Radiology technologist
- Critical care nurse
- Anesthesiologist or certified registered nurse anesthetist
- Operating room nurse
- Security officers
- Chaplain or social worker
- Scribe

The rationale for this systematic review is to evaluate the published evidence and compare it with the recommended criteria and team composition for the pediatric trauma patient. This synthesis of data is an incremental step toward understanding current practice, identifying variability, and optimizing hospital trauma activation criteria for children. The objective of this systematic review was to describe for pediatric patients (1) the variation in highest level of hospital trauma team activation criteria and (2) trauma team membership. Lastly, we sought to (3) compare these findings with the current ACS recommendations.

METHODS

Studies were identified with a search of Ovid MEDLINE In-Process & Other Non-Indexed Citations, Ovid MEDLINE Daily, and Ovid MEDLINE using search terms outlined in Figure 1, including only human trials without language restriction. *Trauma/emergency service* and *trauma/emergency team* were the terms chosen to search broadly for any publications on the topic, and then, the search was focused to include all children aged 0 to 18 years. A published protocol does not exist for this systematic review. All databases were searched from inception until January 3, 2015. To be included in this review, studies had to describe hospital trauma team activation criteria for pediatric patients that were assessed in the prehospital setting. Studies that included both children and adults were included if trauma activation criteria and number of children evaluated were included separately. Studies that included only prehospital triage criteria that are used to identify patients that need the services of a trauma center were not included. Studies that included only a specific population (*ie*, winter sports injuries) or mechanism of injury (*ie*, horse-related injuries) or simply interhospital transfers were excluded. Reference lists from studies included in the analyses were reviewed by hand to identify additional articles meeting criteria, and no additional articles were identified.

Data were abstracted by a single author (A.D.). Patient characteristics, trauma activation criteria, and trauma team membership were abstracted from each publication. These were reviewed and specific criteria and trauma team members that were shared between publications were used to populate the rows of the tables. The data were then abstracted a second time from each of the publications directly into the tables. Finally, the data in the table were then compared with the published manuscript on a third review to assure

accuracy. Patient characteristics included dates of inclusion, patient age, number of trauma patients overall during study enrollment, number transferred to the operating room (variable definitions of emergent operative cases), deaths (including ED deaths, when available), and number of trauma activations. Trauma activation criteria were divided into categories for ease of reporting: physiologic, penetrating, anatomic, mechanism of injury, and other criteria. Criteria were assigned to each of these 5 categories based on their most frequent assignment in the published literature. If the study specifically excluded a population (eg, penetrating injuries or drowning) this was designated as “*” in the table, and the proportion of criteria with that criterion was calculated using only the criteria that included the population. This review is focused on the highest level (most severely injured) of trauma team activation. When the publication included graded or tiered response activation, this was noted in Table 1, but only the highest-level criteria were reported in Table 2. If 2 different criteria were compared, then both criteria were included. The current ACS recommendations were also included for comparison. The membership for the trauma team activated for the highest level activation was also abstracted, and the current ACS recommendations included for comparison.

RESULTS

The search identified 246 articles. Two review authors (A.D. and M.G.) independently screened the titles and abstracts of all citations identified by the search (Fig. 2). Full articles were obtained when they seemed to meet the inclusion criteria or there were insufficient data in the title and abstract to make a clear decision for inclusion. The inclusion of the studies was made after reviewing the full-text articles. Agreement between reviewers was excellent for inclusion of articles, with a Kappa coefficient of 0.91 (0.81, 1.00). Disagreements were resolved between the 2 review authors about study inclusion by discussion and consensus.

Application of the inclusion and exclusion criteria resulted in 18 studies and 25 criteria that were included in our analysis (Fig. 1).^{2,5-21} Table 1 shows the included studies and criteria. All but 1 were retrospective cohort studies. The only prospective study empirically derived pediatric trauma activation criteria.¹³ Many (39%) described 2-tiered trauma team activation criteria.^{5,8-10,16,17,21} A number of studies evaluated the accuracy of criteria categories including mechanism^{6,8,18,19} and physiologic criteria² as well as simplified criteria including only respiratory compromise and intubation.¹² Two studies evaluated variations of the Pediatric Trauma Score,^{11,15} and 2 studies applied the current ACS criteria to the trauma population.^{14,20} The included articles spanned 20 years, and 13,184 children meeting the trauma activation criteria were included. Most studies reported the number of children that underwent surgery and number of deaths (Table 1), but this inconsistent reporting limits the ability to compare injury severity.

Physiologic factors reported for trauma team activation generally included assessments for airway integrity, respiratory distress or compromise, signs of shock or resuscitation requirements, and the Glasgow Coma Scale. Nearly all (92%) of the trauma criteria used physiologic factors (Table 2), and most included respiratory compromise (72%), although this was inconsistently defined between studies. Specifically, an intervention for airway compromise like intubation (52%) was reported more often than respiratory rate (32%), but

intervention for shock including fluid bolus (8%) and blood transfusion (12%) was less frequent than heart rate (44%) or blood pressure (72%). Cardiopulmonary arrest was the designated criterion for only 28% of trauma activation criteria. Most activation criteria included Glasgow Coma Scale (68%), but the threshold score was variably defined between 8 and 14.

Penetrating trauma (83%) was frequently included in the trauma team activation criteria (Table 2). For penetrating trauma, the site of injury was inconsistent between studies including head (77%), neck (77%), abdomen (66%), chest (50%), groin (38%), and extremity (27%). Anatomic factors (76%) were commonly included, but there was significant variability in the factors included, with the most common criteria being amputation or degloving (56%), burns or suspected airway injury from burns (41%), long bone fractures (32%), facial/tracheal injury (24%), and flail chest (24%). Some published criteria depended heavily on anatomic factors to identify trauma team activation criteria including 14 specific injuries,² but 6 criteria included no anatomic factors at all.^{6,7,12-14,18}

Mechanisms of injury (52%) were least likely to be included in the highest level of activation (Table 2). The most frequently included criteria were motor vehicle crash with ejection (36%), death in the same car (32%), and falls (28%). A number of unique trauma team activation criteria were included that did not meet the standard categories and are also included in Table 2. One of these, emergency physician's discretion, is now recommended by the ACS but was infrequently included (16%).

Of the studies included in this systematic review, 12 studies reported their trauma team composition (Table 3). The average number of trauma team members was 14 (range, 6–19). All activation criteria included a surgeon, although the level of training required was variable, and most included an ED physician (92%).

Current ACS guidelines recommend only physiologic factors. Only 2 of the published pediatric trauma activation criteria in this review included all elements.^{14,20} The currently recommended ACS trauma team member response for highest level activations for a severely injured patient include 12 people.⁴ None of the published team compositions included all of the ACS-recommended members.

DISCUSSION

The published literature about hospital trauma team activation for pediatric patients shows a significant amount of variability in the criteria used and the team that is commenced. This historical perspective provides the opportunity to evaluate the evolution of trauma team activation criteria during the last 20 years, but this evidence shows no predictable pattern of criterion adoption or any data to support the current criteria. Nor any evidence to support the value of these criteria in identifying children who require the activation of a trauma team. Prospective research is needed to evaluate the criteria used for trauma team activation for children.

The initial assessment and evaluation of severely injured trauma patients begins with the prehospital assessment and care. This information is used for both destination decision-

making as well as hospital trauma team activation. The cost of missing a severely injured child during destination decision-making can be significant because of hours of delay for the child to be evaluated at a lower level or nontrauma center and then for the child to be transported to a higher level trauma center. In fact, the typical goal is for the transfer to occur in 2 to 3 hours. In contrast, if the hospital trauma team is not activated for a severely injured child being transported to a trauma center, the delay will be much shorter. However, for some critically injured patients, even a short delay will affect morbidity and mortality. This suggests the tradeoff between sensitivity and specificity, for the 2 criteria can be different. For destination decision-making, a goal of 5% undertriage and 30% to 50% overtriage is often quoted, but for hospital trauma activation, it might be reasonable to increase the rate of undertriage to decrease the overtriage rate.²² This would lead to a better use of resources and likely a minimal change in morbidity and mortality.

Trauma centers have published their experiences evaluating potential criteria for trauma team activation because most centers have developed their criteria based on experiences at their center. Historically, most trauma centers included more anatomic and mechanistic factors. This review did not find a reduced number of criteria over time as one might expect with performance review. This systematic review found that pediatric hospital trauma team activation criteria used are consistently inconsistent, not based in empiric evidence, and not consistent with the most recent published guidelines.

The evidence to support each criterion is lacking based on the findings of this systematic review. Only 1 study evaluated each factor (as opposed to full criteria), and the same study was the only prospectively performed study.¹³ Future investigations should include a rigorous evaluation of each factor with the determination of the incremental improvement to the undertriage and overtriage rates for injured children. Most of the included studies did evaluate the undertriage and overtriage rates for the overall trauma activation criteria. However, there was no consistency in the outcome used to define the need for a trauma center, making comparisons impossible in this study. Multidisciplinary performance improvement to refine the undertriage and overtriage rates and the appropriateness of prehospital-based trauma team activations has been recommended. A recent publication of that consensus statement should lead to stronger evidence to support the selection of criteria.²³

This study has limitations. Synthesis of results by combining studies to assess the accuracy of the hospital trauma team activation criteria was not possible because of the inconsistent use of outcomes to assess the criteria. The published literature may not represent clinical practice and may not provide accurate insights into historical practices. However, many institutions rely on the published literature to inform system changes, and this review provides an excellent summary of that information.

In conclusion, published hospital trauma team activation criteria and trauma team membership for children were historically variable. No predictable pattern of criterion adoption was found. The published criteria are also dissimilar from the current ACS-recommended criteria. Future prospective studies are needed to define the optimal hospital

trauma team activation criteria and trauma team membership and assess its impact on improving outcomes for children.

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REFERENCES

1. Stafford PW, Blinman TA, Nance ML. Practical points in evaluation and resuscitation of the injured child. *Surg Clin North Am*. 2002;82: 273–301. [PubMed: 12113366]
2. Mukherjee K, Rimer M, McConnell MD, et al. Physiologically focused triage criteria improve utilization of pediatric surgeon-directed trauma teams and reduce costs. *J Pediatr Surg*. 2010;45:1315–1323. [PubMed: 20620338]
3. Ochsner MG, Schmidt JA, Rozycki GS, et al. The evaluation of a two-tier trauma response system at a major trauma center; is it cost effective and safe? *J Trauma*. 1995;39:971–977. [PubMed: 7474017]
4. American College of Surgeons Committee on Trauma. Resources for Optimal Care of the Injured Patient 2014. Chicago, IL: American College of Surgeons Committee on Trauma; 2014.
5. Sola JE, Scherer LR, Haller JA, et al. Criteria for safe cost-effective pediatric trauma triage: prehospital evaluation and distribution of injured children. *J Pediatr Surg*. 1994;29:738–741. [PubMed: 8078009]
6. Qazi K, Wright MS, Kippes C. Stable pediatric blunt trauma patients: is trauma team activation always necessary? *J Trauma*. 1998;45: 562–564. [PubMed: 9751551]
7. Vernon DD, Furnival RA, Hansen KW, et al. Effect of a pediatric trauma response team on emergency department treatment time and mortality of pediatric trauma victims. *Pediatrics*. 1999;103:20–24. [PubMed: 9917434]
8. Dowd MD, McAneney C, Lacher M, et al. Maximizing the sensitivity and specificity of pediatric trauma team activation criteria. *Acad Emerg Med*. 2000;7:1119–1125. [PubMed: 11015243]
9. Nuss KE, Dietrich AM, Smith GA. Effectiveness of a pediatric trauma team protocol. *Pediatr Emerg Care*. 2001;17:96–100. [PubMed: 11334102]
10. Chen LE, Snyder AK, Minkes RK, et al. Trauma stat and trauma minor: are we making the call appropriately? *Pediatr Emerg Care*. 2004;20: 421–425. [PubMed: 15232239]
11. Simon B, Gabor R, Letourneau P. Secondary triage of the injured pediatric patient within the trauma center: support for a selective resource-sparing two-stage system. *Pediatr Emerg Care*. 2004;20:5–11. [PubMed: 14716158]
12. Edil BH, Tuggle DW, Jones S, et al. Pediatric major resuscitation—respiratory compromise as a criterion for mandatory surgeon presence. *J Pediatr Surg*. 2005;40:926–928. [PubMed: 15991172]
13. Steele R, Green SM, Gill M, et al. Clinical decision rules for secondary trauma triage: predictors of emergency operative management. *Ann Emerg Med*. 2006;47:135. [PubMed: 16431223]
14. Steele R, Gill M, Green SM, et al. Do the American College of Surgeons' "major resuscitation" trauma triage criteria predict emergency operative management? *Ann Emerg Med*. 2007;50:1–6. [PubMed: 17083993]
15. Nasr A, Mikrogianakis A, McDowall D, et al. External validation and modification of a pediatric trauma triage tool. *J Trauma*. 2007;62:606–609. [PubMed: 17414335]
16. Bevan C, Officer C, Cramer J, et al. Reducing "Cry Wolf"—Changing trauma team activation at a pediatric trauma center. *J Trauma*. 2009;66:698–702. [PubMed: 19276740]
17. Williams D, Foglia R, Megison S, et al. Trauma activation: are we making the right call? A 3-year experience at a Level I pediatric trauma center. *J Pediatr Surg*. 2011;46:1985–1991. [PubMed: 22008339]

18. Bozeman AP, Dassinger MS, Recicar JF, et al. Restraint status improves the predictive value of motor vehicle crash criteria for pediatric trauma team activation. *Am J Surg.* 2012;204:933–937. [PubMed: 23231935]
19. Krieger AR, Wills HE, Green MC, et al. Efficacy of anatomic and physiologic indicators versus mechanism of injury criteria for trauma activation in pediatric emergencies. *J Trauma Acute Care Surg.* 2012;73: 1471–1477. [PubMed: 23188240]
20. Falcone RA Jr, Haas L, King E, et al. A multicenter prospective analysis of pediatric trauma activation criteria routinely used in addition to the six criteria of the American College of Surgeons. *J Trauma Acute Care Surg.* 2012;73:377–384. [PubMed: 22846943]
21. Nabaweesi R, Morlock L, Lule C, et al. Do prehospital criteria optimally assign injured children to the appropriate level of trauma team activation and emergency department disposition at a level I pediatric trauma center? *Pediatr Surg Int.* 2014;30:1097–1102. [PubMed: 25142797]
22. American College of Surgeons Committee on Trauma. *Resources for Optimal Care of the Injured Patient*: 2006. Chicago, IL: American College of Surgeons; 2006.
23. Lerner EB, Drendel AL, Falcone RA, et al. A consensus-based criterion standard definition for pediatric patients who needed the highest-level trauma team activation. *J Trauma Acute Care Surg.* 2015;78:634–638. PMID 25710438. [PubMed: 25710438]

Search Strategy

1. exp Trauma Centers/ or exp Emergency Service, Hospital/ or exp Emergency Medical Services
2. trauma service:.mp.
3. emergency service:.mp.
4. emergency team:.mp.
5. trauma team:.mp.
6. 1 or 2 or 3 or 4 or 5
7. (activate: or activation:).mp.
8. 6 and 7
- 9 limit 8 to english language
- 10 limit 9 to "all child (0 to 18 years)"
- 11 (child: or infant: or adolescen: or baby or babies or pediater: or paediatric: or newborn:).mp.
- 12 exp Pediatrics
- 13 11 or 12
- 14 9 and 13
- 15 10 or 14

FIGURE 1.
Search strategy.

Study Selection

FIGURE 2.
Study selection.

TABLE 1.

Studies Included in the Systematic Review

Author	Journal	Publication Year	Enrollment Years	Age	Total Trauma Patients	Operating Room	Deaths (ED deaths)	Trauma Activations	Name
Sola, JE	Journal of Pediatric Surgery	1994	1/19/91–2/6/92	0–14		26	15	216	Baltimore "Alpha"
DeKeyser	Annals of Emergency Medicine	1994	1991			5	0	736	Baltimore "Bravo"
DeKeyser	Annals of Emergency Medicine	1994	1991					214	Fairfax Blue
Quazi	Academic Emergency Medicine	1998	7/12/96–2/28/97	0–14	192			604	Fairfax Yellow
Quazi, K	Journal of Trauma	1998	7/1/93–7/31/94	0–14		0	0	12	Akron Paramedic
Vernon, DD	Pediatrics	1999			638	8	7	194	Akron Mechanism
Dowd, MD	Academic Emergency Medicine	2000	1/1/96–12/31/96	0–15	492	32	21	179	Salt Lake City "Trauma One"
Nuss, KE	Pediatric Emergency Care	2001	1/1/95–12/31/96		542	26	39 (6 ED)	253	Cincinnati Trauma Team Activation
Chen, LE	Pediatric Emergency Care	2004	1994–1999	0–19	5122	22	1 (0 ED)	289	Columbus Level 1
Simon, B	Pediatric Emergency Care	2004	1990–2001	0–13	1112	21	6	461	Columbus Level 2
Edil, BH	Journal of Pediatric Surgery	2005	1/2000–1/2004	0–13	118	4	18	40	St Louis Trauma Stat
Steele, R	Annals of Emergency Medicine	2006	1/1/97–6/30/04	0–14	2311	8/62/121		87/166/836	St Louis Trauma Minor
Steele, R	Annals of Emergency Medicine	2007	1/1/97–6/30/04	0–14	2311	8/62/121		534	mPTS
Nasr, A	Journal of Trauma	2007	1993–2003	0–15	3579			628	Oklahoma Level 1 Alert
Bevan, C	Journal of Trauma	2009	4/2004–4/2006	0–15	~4400		6	192	Loma Linda Peds
Kouzinova	Journal of Trauma	2009	1998–2007				7	82	ACS Criteria 2002
Kouzinova	Journal of Trauma	2009	1998–2007	*					Toronto mPTS
Mukherjee, K	Journal of Pediatric Surgery	2010	1 y	0–14	152	18	10	98	Melbourne #1
Davis	Injury, International J. Care Injured	2010	2008	*					Melbourne #2
Williams, D	Journal of Pediatric Surgery	2011	2006–2008	0–14	4502	2118	48	211	Santa Clara Major
									Santa Clara Minor
									Vanderbilt (physiologic focused)
									Vanderbilt (standard)
									South Wales
									UT Southwestern Stat
									UT Southwestern Alert

Author	Journal	Publication Year	Enrollment Years	Age	Total Trauma Patients	Operating Room	Deaths (ED deaths)	Trauma Activations	Name
Bozeman, AP	The American Journal of Surgery	2012	1/1/2009–2/10/2011	0–14	271			176	Arkansas Restraints
Krieger, AR	Journal of Trauma Acute Care Surgery	2012	1/2006–3/2009 4/2009–6/2010	0–18				2538	St. Louis Traum Stat MOI
Falcone, RA	Journal of Trauma Acute Care Surgery	2012	1 y	0–20	9722	144	72 (24 ED)	1088	St. Louis Trauma Major ABP Multicenter
Nabaweesi, R	Pediatric Surgery International	2014	1/1/2008–12/31/2011	0–14	2235	37	7	369	Arkansas FTTA
								1766	Arkansas PTTA

TABLE 2.

Published Hospital Trauma Activation Criteria for Children

Author and Pub Year	Sohn 1994	Quinn 1998		Vernon 1999	David 2000	Nass 2001	Chen 2004		Simon 2004			Fell 2005	Stode 2006	Stode 2007	Nasr 2007		Bevan 2009		Mukherjee 2010		Williams 2011	Bozeman 2012	Krieger 2012		Falcone 2012	Nahavandi 2014	% of Criteria	ACS Criteria	
Criteria type (if multiple)		Physio	Anat						PTS	mPTS	Criteria			ACS 2002		mPTS	1 of 3	single		Physio		penetrating trauma		mechanism	anat/ physio				
Physiologic criteria	Cardiopulmonary arrest																										28		
	Systolic Blood Pressure (SBP)	<80	age- specific		age- specific	<80	hypotension	<80		<90	age- specific		age- specific		age- specific	<80	hypotension		hypotension	hypotension				hypotension	age- specific	age- specific	age- specific	72	
	Heart rate	>130 <50	age- specific		age- specific		tachycardia	age- specific			age- specific		age- specific			<90				tachycardia	tachycardia			tachycardia		tachycardia	age- specific	44	
	Pulse quality							weak pulse		2														weak/absent				16	
	Perfusion quality				CRF>3 sec	"poor"		cool, climpy, CRF	>2		CRF >2 sec													cool, climpy, CRF	cyanosis		24		
	Clinical signs of shock																										32		
	Blood transfusion																										12		
	IV fluid bolus																										8		
	Ongoing blood loss																							or sig blood loss			8		
	Resp compromise/ distress																			unstable airway	unstable airway			grunt/retract			72		
	Intubation							with blood			airway integrity																	52	
	Airway foreign body / obstruction										airway integrity																	24	
	Stridor																											20	
	Respiratory rate	>30, <20	age- specific			>30						age- specific		age- specific		<10-50				tachypnea							age- specific	32	
	Glasgow Coma Scale	<9				<8	<9	<9				<14		<8	<8	<8				<8	<8	<8	<13	<13	<8	<9	68		
	Suspected spinal cord injury					w/ paralysis	cervical																					44	
Paralysis																											24		
Focal neuro deficit																											8		
Deteriorating level of consciousness																									GCS by 2	20			
Agitated or confused or altered																											24		
Loss of consciousness							>5 min	<5 min			>5 min								>5 min								24		
Penetrating criteria	Any physiologic Criteria																									GCS by 2	92		
	GSW		*	*					*	*						*						*				*	16		
	Penetrating injury to extremity		*	*					*	*						*						*				*	27		
	Penetrating injury to abdomen		*	*					*	*						*				or pelvis	or pelvis	or pelvis	*		*GSW, BB	*	66		

Author Manuscript

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Author and Pub Year	Sola 1994	Quazi 1998		Vernon 1999	Dowd 2000	Nass 2001	Chen 2004		Simon 2004			Feldt 2006	Storde 2006	Storde 2007	Nisar 2007		Bevan 2009		Mukherjee 2010		Williams 2011	Bosman 2012	Krieger 2012		Falcone 2012	Nahavandi 2014	% of Criteria	ACS Criteria			
Criteria type (if multiple)		Physio	Anat						PTS	mPTS	Criteria			ACS 2002	mPTS	1 of 3	single		Physio				mechaniism	anast/ physio							
Penetrating injury to neck		*	*						*	*												*			+GSW, BB	*	77				
	Penetrating injury to head		*						*	*													*			+GSW, BB	*	77			
	Penetrating injury to torso		*						*	*													*					27			
	Penetrating injury to trunk		*	*					*	*													*					22			
	Penetrating injury to the thorax		*	*					*	*													*					22			
	Penetrating injury to groin		*	*					*	*													*					38			
Penetrating injury to chest		*	*						*	*												*			+GSW, BB	*	50				
	Any penetrating criteria		*	*					*	*													*					83			
	Maxillofacial/Tracheal injury																											24			
	Open or depressed skull fx																											12			
	CFS leak																											12			
	Flail chest																											24			
Anatomic Criteria	Open chest wound																		open				or hemo	or hemo		or hemo	20				
	Pneumothorax																										8				
	Cardiac/great vessel injury																										4				
	Crush of torso																										12				
	Crush of chest or abdomen																			crush					crush	8					
	Peritonitis																										4				
	Burns: total			*	>30% BSA	>30% BSA	>20% BSA				>10% BSA			*	*				>20% BSA	>40% TBSA	>30% BSA	*			*	41					
	Burns: 2nd and 3rd degree			*	>15% BSA									*	*		burns >40%								>15% BSA	*	14				
	Suspected airway injury from burn			*										*	*									*	*	*	41				
	Long bone fractures		2+		2+	2+, 2+	2+	2+			2+							upper/ lower	multiple					2+			32				
	Pubic fracture/ injury																		Soft tissue, tachycardia and hypotension								20				
	Skeletal integrity																										12				
Axial skeleton fracture																										8					
Arterial bleeding																										8					
Vascular injury																										4					
Pulseless extremity																										16					

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Author and Pub Year	Sch 1994	Quazi 1998		Vernon 1999	Dowd 2000	Nass 2001	Chen 2004		Simon 2004			Felt 2005	Stade 2006	Stade 2007	Nisar 2007		Bevan 2009		Mukherjee 2010		Williams 2011	Bozeman 2012	Krieger 2012		Falcone 2012	Nahavest 2014	% of Criteria	ACS Criteria
		Physio	Anat						PTS	mPTS	Criteria						1 of 3	single	proximal	Physio			mechanism	anat/ physio				
Criteria type (if multiple)																												
Amputation or degloving																					or crush proximal						56	
2 systems injured																											16	
Blunt abdominal trauma						seatbelt sign												abd injury									8	
Injury above and below diaphragm																												
Severe head or neck injury																midline shift	scalp wound			intracranial injury GCS<14			intracranial bleed				4	
Severe chest or abdominal injury																				soft tachycardia and hypotension						20		
subq emphysema																												
Open wound																											12	
Any anatomic criteria																											76	
MVC unrestrained																											8	
MVC with ejection																											36	
MVC with prolonged extrication					> 20 min			>20 min							>20 min												12	
MVC with roll-over															>70 mph												20	
MVC with death in same car																											32	
MVC >20 mph					unrestrained																						8	
MVC >40 mph					restrained																						8	
Runover or dragged by car															or thrown												12	
Motorists deformity >50 cm																											4	
MVC intrusion					>20 in			>12 in							>30 cm						>18 inches						20	
MPC/MBC	thrown 15 ft		10 mph		>20 mph		>20 mph	>20 mph							10 km/hr/30 km/hr			including horse									28	
Drowning				*																		*	*				5	
Fall			>20 ft		>20 ft			>10 ft							3x height			>5m									28	
Lightening strike/ Electric shock																							>200 v	>200 v			20	
Trauma in a hostile environment																											8	
Hanging or strangulation																						*	*				4	
High velocity impact																	explosion									12		
Any mechanism criteria																											52	

	Author and Pub Year	Sola 1994	Quazi 1998		Vernon 1999	Dowd 2000	Nuss 2001	Chen 2004		Simon 2004			Edil 2005	Stede 2006	Stede 2007	Nisar 2007		Bevan 2009		Muharjee 2010		Williams 2011	Bozeman 2012	Krieger 2012		Falcone 2012	Nahavessal 2014	# of Criteria	ACS Criteria
			Physio	Anat						PTS	mPTS	Criteria					mPTS	1 of 3	single		Physio			mechanism	anat/ physio				
Other	Criteria type (if multiple)																												
	Multiple simultaneous victims																										4		
	Trauma score <12																										4		
	Child abuse with vital signs change																							*			4		
	Ambulance discretion																										4		
	Trauma transfer with criteria																									*	12		
	MD discretion																										16		

* Patients with these findings were explicitly excluded.

TABLE 3.

Trauma Team Composition

Author and Publication Year	Sola 1994	Quazi 1998	Vernon 1999	Dowd 2000	Nuss 2001	Chen 2004	Simon 2004	Nasr 2007	Bevan 2009	Mukhejee 2010	Williams 2011	Nabaweesi 2014	ACS 2014
Surgery attending													
Surgery fellow													
Surgery Sr resident													
Surgery Jr resident													
PICU attending													
PICU fellow													
PICU resident							senior						
ED attending					or				or				
PEM fellow													
EM resident					or		senior						
Pediatric resident													
Pediatrics													
Anesthesiologist													
Anesthesiologist resident													
Peds Neurosurgery													
Orthopedics													
RN supervisor													
OR Charge RN/RN													
OR personnel/team													
PICU RN													
PICU Charge RN													
ER RN		2		2		2	2			2			
Float RN													
Phlebotomist													
Respiratory therapist													
Radiology tech													

Author and Publication Year	Sola 1994	Quazi 1998	Vernon 1999	Dowd 2000	Nuss 2001	Chen 2004	Simon 2004	Nasr 2007	Bevan 2009	Mukheijee 2010	Williams 2011	Nabaweesi 2014	ACS 2014
Radiologist													
Pharmacist													
Distribution													
Chaplain / Pastoral Care													
Social Services													or
Security													
Orderly													
Blood products / Blood Bank													
Administrative supervisor													
Trauma nurse coordinator													
Patient service attendant													
Scribe													
Number of participants	9	12	12	18	13	19	7	8	9	18	18 *team members not identified	6	13