

REVIEW ARTICLE

Trauma Team Activation in the Emergency Department: A Literature Review of Criteria, Processes and Outcomes

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ABSTRACT

Multiple traumas require a fast and comprehensive treatment to overcome challenges that emerge from the patient's condition. The right time for trauma team activation is necessary to treat these multiple trauma patients to improve patient outcomes. This integrative review identifies the criteria used to activate the trauma team, the activation process and the outcome of the activation. The search was conducted from January to March 2023 with two databases, namely MEDLINE and PubMed, and grey literature via Google Scholar. The search was limited to articles written in English, with abstracts and available in full text. There was no year limitation. The review found four criteria that were used for trauma team activation: physiological, anatomical, mechanism of injury and others. The process of trauma team activation begins in the pre-hospital setting. Outcomes used to evaluate the impact of trauma team activation included the level of satisfaction of patients and families, the level of complaints, response time, discharge status, and mortality. The findings of this review recommend that the criteria, process, and outcomes of trauma team activation are tailored, based on the needs and available resources of the institutions. Moreover, standardized trauma team activation may be necessary for future development.

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INTRODUCTION

Polytrauma is an emergency that needs immediate treatment. Research has shown that most of the incidents occur in men aged 21-40. They usually receive immediate treatment at hospital within less than four hours. Moreover, 76.5% of incidents have been caused by traffic accidents (1). Polytrauma can cause disability and even death. Disabilities caused by polytrauma include motoric and sensory disorders, paresis, and impaired sublime functions (2). Meanwhile, deaths due to polytrauma were reported in a study conducted in Spain in 2014 which involved 1,200 patients who came to the hospital between 2006 and 2014. The study showed that 94% of polytrauma was caused by blunt trauma. Moreover, death due to polytrauma was 9.8%, which was caused by: neurological emergencies (45.3%), hypovolemic shock (14.7%), multi-organ

failure (10.3%), respiratory failure (9.4%) and cardiac arrest (6%) (3). To reduce the serious consequences of polytrauma, the treatment needs to be fast and accurate from the first time the patient is found until arrival at hospital (4).

Early activation of a trauma team is believed to be important for treating polytrauma patients, as this allows the team to prepare the necessary resources needed to treat the patient (5). The outcomes of severe trauma patients have been reported as the impact of trauma team activation, which includes shorter waiting time from the emergency department (ED) to the operation room and lower mortality (6).

The results of studies from high-income countries such as Dutch (7), Norwegian (8), and Australian ED (9) have highlighted that the criteria used for trauma team activation are varied. Moreover, these criteria are still debatable for their over- and under-use of emergency department resources (10) and may not be relevant in low- and middle-income countries (11).

This review aims to identify the criteria used to activate a trauma team in the emergency department and its process. Therefore, the review questions are: (a) what indicators are used to activate a trauma team? (b) what is the process of trauma team activation? and (c) what are the outcomes measured that are related to the quality of trauma team activation?

METHODOLOGY

This review used an integrative approach recommended by Whittemore and Knafl (12). The approach allows the synthesis of articles for different purposes, such as identifying concepts and processes. It also facilitates reviewing different methodologies (12). Thus, the approach is suitable for addressing our review questions. The approach consists of five steps: problem identification, literature search, evaluation, analysis and presentation (12). We designed our review by determining the review aim and questions, constructing a search strategy, and data analysis.

Eligibility criteria

In this review, the researchers only considered potentially relevant articles written in English. Moreover, the articles must meet the following inclusion criteria: (a) related to trauma patients, (b) emergency setting, and (c) trauma team activation. Although an integrative review allows the inclusion of different methodologies, such as quantitative, qualitative, and literature reviews, we excluded opinion pieces, editorial notes, letters and communications.

Search strategy

Two search strategies were used to identify the literature: (1) searching two electronic databases accessible from the authors’ university account: MEDLINE and PUBMED, and (2) grey literature using Google Scholar. Table I shows our search strategy, including keywords and filters used.

The search was also limited to articles with abstracts that can be retrieved in full text from the authors’ university account. There was no year limitation.

Study selection

The first author (SN) identified the articles from databases and uploaded them to rayyan.ai, which is software to organise and manage literature reviews. Two authors (SN and DI) screened the titles, abstracts and full texts. The criteria used for the screening were the availability of specific keywords: (a) trauma team activation, (b)

algorithm or pathway for trauma team activation, (c) outcome of trauma team activation, or (d) emergency setting. Full-text articles of potential studies were retrieved for further assessment. All authors discussed and resolved any disagreement regarding the included full-text articles.

Data extraction and analysis

Data extraction of the included studies used Microsoft Excel to record the key elements: (a) authors’ names, (b) title, (c) publication year and country, (d) setting, (e) design, (f) trauma team activation criteria, and (g) outcome.

According to Whittemore and Knalf (12), descriptive qualitative analysis can be used to analyse data from an integrative approach. Therefore, the analysis of the included articles followed a qualitative descriptive approach suggested by Doyle (13): (a) data sorting and transcribing, (b) coding, (c) reflecting, (d) identifying similarities and differences, and (e) developing subcategories and categories. We conducted the analysis as follows. We highlighted words and phrases that contained meanings from the article directly on the PDF version of the articles. Next, we extracted and put them into Microsoft Excel. Then, we continued working with Microsoft Excel to code and label these phrases or words. Lastly, we constructed subcategories and categories by comparing the labels’ similarities, differences, and connections.

RESULTS

Search Outcome

From a total of 26 articles, nine articles were excluded. Full-text screening of 17 articles was performed using the same inclusion criteria. Six articles were excluded after the full-text screening. This search found four eligible articles. A total of 11 articles were included in the review. Fig. 1 illustrates the diagram flow of study selection using the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) suggested by Moher (14).

Overview of included papers

Table II summarises the result of the review. The studies originated from the United States, Denmark, Italy, Canada, Norway, and Thailand. Different research designs were used, including review, cross-sectional, cohort, retrospective, and observational.

Criteria of Trauma Team Activation

Table III presents the categories and subcategories of the findings. Overall, the criteria for trauma team activation can be grouped into four categories, as follows: (a) physiological, (b) anatomical, (c) injury mechanism, and (d) others.

Category 1: Physiological criteria

Physiological criteria include parameters from the (a) airway, (b) breathing, (c) circulation, and (d) disability.

Table I: Search strategy

Components	Applied Terms and Limiters
Keywords	(trauma) AND (emergency department OR emergency room OR accident and emergency OR accident & emergency OR a & e) AND (team) AND (activation)
Filters	Abstract and full-text available; English language

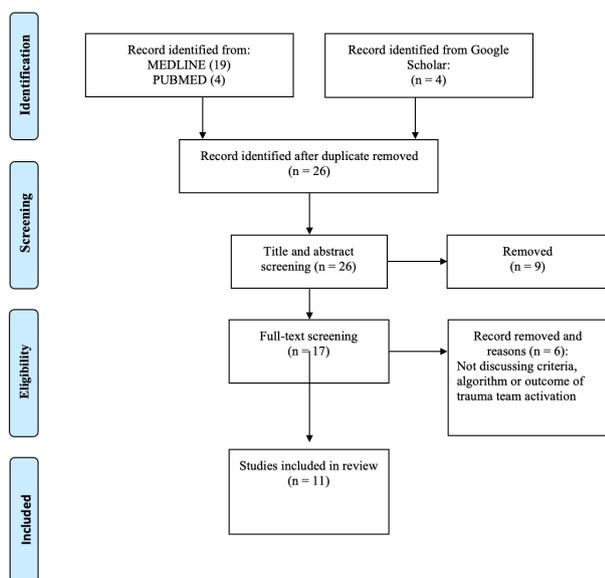


Figure 1: PRISMA Flow Diagram of Study Selection

Airway

Airway criteria for trauma team activation are as follows: patients need intubation or other airway emergency intervention, experience facial or inhalation trauma, and airway obstruction (such as stridor) (7, 8, 15–18).

Breathing

Most studies used respiratory rates (RR) for criteria of trauma team activation in breathing, with different rate ranges based on the patient’s age (17, 19–23). For instance, RR > 60 or < 20 breaths per minute for patients aged < 1 year old or >40 or <10 breaths per minute for patients aged > 1 year old. However, it is worth noting that there is no consensus regarding the range of respiratory rates across the included articles. Moreover, Larsen used more general criteria, such as dyspnoea (8), while Egberink did not specify the rate (7) (Table II).

Circulation

In circulation, most articles highlight the use of pulse

Table II: A chronological summary of included studies

Title (Design)	Author’s Name/ Publication Year/ Country	Trauma Team Activation Criteria							Activation Process	Outcome
		Physiological				Anatomical	Mechanistic	Others		
		Airway	Breathing	Circulation	Disability					
Trauma Team Activation can be Tailored by Prehospital Criteria (Observational)	(Claridge et al., 2010) United States of America	Require intubation	N/A	N/A	GCS < 8	Thorax and abdominal trauma	High speed vehicle accident, gun wound, ejection from vehicle	N/A	N/A	Satisfaction, complain, and response time
Trauma Team Activation varies across Dutch Emergency Department: A National Survey (Cross-sectional)	(Egberink et al., 2015) Netherlands	Mentioned airway but not specified	Mentioned Respiratory rate	Mentioned Pulse rate, blood pressure and oxygen saturation but not specified;	GCS not specified	N/A	N/A	Temperature	Notification of a trauma patient starts from pre-hospital → the notification was sent and received by different healthcare professionals	N/A
A Review of “Prehospital Hypotension as a Valid Indicator of Trauma Team Activation” (2000) (Review)	(Franklin, 2021) United States of America	Require intubation	N/A	SBP <90 mmHg (adult)	GCS <9	Neck, chest, abdominal, proximal extremities to knee or elbow	Gun wound	Pre-hospital transfusion	N/A	N/A
Geriatric Patients on Antithrombotic Agents who Fall: Does Trauma Team Activation Improve Outcomes? (Retrospective)	(Hwang et al., 2019) United States of America	Face trauma that cause airway obstruction; require intubation, inhalation trauma	RR < 10 or >29; hypoxia	SBP < 90 mmHg (adult); Children ≤ 10 years old SBP < 70 + (2x age in years); Life threatening active bleeding	GCC < 13 Paralysis	Flail chest; Pelvic fracture; Fracture >2 long bone	Penetration trauma to head, neck, chest and abdomen Ejection from vehicle; Fall from height > 6 metre Burn wound (>10% partial thickness or full thickness) Amputation foot and hand ankle	Pre-hospital transfusion	N/A	Mortality

Table II: A chronological summary of included studies (continued)

Title (Design)	Author's Name/ Publication Year/ Country	Trauma Team Activation Criteria							Activation Process	Outcome
		Physiological				Anatomical	Mechanistic	Others		
		Airway	Breathing	Circulation	Disability					
Evaluation of pre-hospital trauma triage criteria: a prospective study at a Danish level I trauma centre (Prospective cohort)	(Kann et al., 2007) Denmark	N/A	RR <10x/m or >29x/m	SBP <90 mmHg	GCS < 13	Flail chest; Pelvic fracture; Fracture >2 long bone	Penetration trauma to head, neck, chest and abdomen Ejection from vehicle; Fall from height > 5 metre Roll over vehicle, extrication time > 20 minutes, speed >65km/hour Inhalation trauma, burn wound Amputation foot and hand ankle	N/A	N/A	N/A
Trauma team activation criteria as predictors of patient disposition from the emergency department (Prospective cohort)	(Kohn et al., 2004) United States of America	N/A	RR <10x/m or >29x/m	Trauma arrest; pulse rate <50x/m or >120x/m; SBP <90x/m; pale skin, cold and sweat	GCS<10	N/A	Ejection from vehicle; Fall from height > 6 metre Roll over vehicle Gun wound to torso, head, neck, burn wound >20%	N/A	N/A	Disposition: discharge, ICU admission, operating room, general ward, death
Differences in trauma team activation criteria among Norwegian hospitals (Cross-sectional)	(Larsen et al., 2010) Norway	Stridor, airway obstruction	Dyspnea	Hypotension SBP < 90mmHg; radial pulse rate undetected; pulse rate >120 or >130x/m or <60x/m, extended CRT, low oxygen saturation	Level of consciousness, seizure, pupil abnormality	Flail chest, Pelvic fracture; Fracture >2 long bone,	Ejection from vehicle; Extended extrication, roll over vehicle, explosive, drowning Inhalation trauma, penetration wound	N/A	N/A	N/A
Sensitivity and specificity of trauma team activation protocol criteria in an Italian trauma center: A retrospective observational study (Retrospective)	(Maliziola et al., 2019) Italy	N/A	RR <10 or >29x/m	SBP <90mmHg	GCS<14	Flail chest, Pelvic fracture; Fracture >2 long bone,	Ejection from vehicle; Extended extrication, roll over vehicle, explosive, drowning High speed vehicle collision, extended extrication >20 minutes Fall from height > 6 metre, burn wound >20%, inhalation trauma	N/A	N/A	N/A
Do pre-hospital criteria optimally assign injured children to the appropriate level of trauma team activation and emergency department disposition at a level I pediatric trauma center? (Cross-sectional)	(Nabaweesi et al., 2014) The United States of America	N/A	RR >60 or <20 (if < 1 year old); or >40 or <10 (if ≥ 1 year old)	SBP < 80mmHg (< 5 years old); SBP <90mmHg (≥5 years old); pulse rate >160x/m or <60x/m if <5 years old; or > 140x/m or <50x/m if ≥5 years old	GCS<9	Abdominal and spinal trauma	Amputation foot and hand ankle; Extremities paralysis; Drowning; Hanging; Strangulation trauma	N/A	N/A	Disposition: ICU admission, death, operating room
A quality-improvement approach to effective trauma team activation (Plan-do-action-study and root cause analysis)	(Verhoeff et al., 2019) Canada	Require emergency intervention	Require emergency intervention	SBP <90 mmHg (adult) or pulse rate 130x/m	N/A		Penetration trauma to head, neck, chest or abdomen	Pre-hospital transfusion	Notification of a trauma patient starts from pre-hospital → the notification was sent and received by different healthcare professionals	Response time from arrival at ED to CT-Scan; Time period in resuscitation room; Time period in ED

Table II: A chronological summary of included studies (continued)

Title (Design)	Author's Name/ Publication Year/ Country	Trauma Team Activation Criteria							Activation Process	Outcome
		Physiological				Anatomical	Mechanistic	Others		
		Airway	Breathing	Circulation	Disability					
Trauma team activation criteria in managing trauma patients at an emergency room in Thailand (Prospective cohort)	(Wuthisuthimethawee, 2017) Thailand	N/A	RR <12x/m or >30x/m	SBP <90mmHg, cardiac arrest, pulse rate 120x/m	N/A	N/A	Gun wound or penetration in chest, abdomen, and back	N/A	N/A	Mortality

Table III: Categories and Subcategories

Review Questions	Categories	Subcategories
Criteria of Trauma Team Activation	Psychological criteria	Airway
		Breathing
		Circulation
		Disability
	Anatomical criteria	Not available
	Injury mechanism	Not available
Activation Process	Others	Pre-hospital transfusion
		Temperature
	Pre-hospital notification	Not available
Outcome measurement	Emergency department notification	Not available
	Satisfaction level	Patient/family
		Number of complaints
	Response time	Not available
	Mortality	Not available
	Disposition	Admitted: ICU/general ward
		Operating room

rate, oxygen saturation, and systolic blood pressure for the activation criteria (16, 17, 19, 20). The criteria for systolic blood pressure were varied across the included articles, either < 90 mmHg or < 80 mmHg. For children, systolic blood pressure measurement is more specific (17). Larsen also used capillary refill time and oxygen saturation (8) as the criteria for trauma team activation. Pale skin, cold, and sweating were also used for the criteria (20). Moreover, Hwang added active bleeding as the criteria for trauma team activation (Table II).

Disability

Three criteria are used in disability for trauma team activation: Glasgow Coma Scale (GCS) (15, 16, 19–22), paralysis (17), and pupil abnormality (8). It should be highlighted that the trauma team activation uses GCS ranges from < 8, <9, <10, <13, and <14 (Table II). There is as yet no agreement on this value.

Category 2: Anatomical criteria

Anatomical criteria for trauma team activation are trauma involving the neck, spine, chest, abdomen, and pelvis (8, 15–17, 19, 21, 22). However, there is no further explanation in the included studies regarding the minimum number of organs that should be involved in

activating the trauma team. Injury involving more than two long bones is also an anatomical criterion to activate the trauma team (8, 17, 19, 21) (Table II).

Category 3: Injury mechanism

Mechanisms of injury used as the criteria of trauma team activation include penetration trauma to the head, neck, chest and abdomen, ejection from the vehicle, fall from height > 5 to 6 metres, burn wound (>10% partial thickness or full thickness), amputation foot and ankle, high-speed vehicle accident, rollover of vehicle, prolonged extrication > 20 minutes, inhalation trauma, trauma because of explosion, drowning, strangulation or hanging (8,15,17–23) (Table II).

Category 4: Other criteria

Some authors highlighted that other criteria, such as temperature (7) and history of pre-hospital transfusion (16–18), were used as criteria for trauma team activation.

Activation Process

Category 1: Pre-hospital notification

The notification process regarding the condition of trauma patients usually starts pre-hospital if the patient is treated by the emergency medical system (7, 18). In pre-hospital, the notifications will be sent by different professionals, such as Emergency Medical Dispatchers (EMD) or Helicopter Emergency Medical Services (HEMS), to emergency departments (EDs) (7).

Category 2: Emergency department notification

The notifications from pre-hospital are also received by different healthcare professionals in the EDs, such as the first ED nurse present, the triage nurse, the coordinator or senior nurse, and the physician (7). Moreover, Verhoeff suggested that a charge nurse may also receive the notification (18). These professionals are also responsible for deciding on trauma team activation in the EDs (7).

The data related to the trauma patient condition, including physiological, anatomical, injury mechanism, and others, are delivered during notification and updated as necessary (7,18). These data are used to decide whether to activate the trauma team or not.

It is worth highlighting that within the included studies,

there is no cut-off point to determine how many criteria in each category should exist in a trauma patient to activate the trauma team or a discussion around using a single criterion.

Outcome measurement

Indicators used or discussed as an outcome of trauma team activation consist of four categories: (a) satisfaction level: patient, family, and number of complaints (15), (b) response time (15,18), (d) mortality (17,23), (e) disposition: discharge, ICU, general ward, operating room (20,22) (Table II).

DISCUSSION

The findings of this integrative review have highlighted that the criteria used to activate a trauma team can be grouped into four categories: (a) physiological, (b) anatomical, (c) injury mechanism, and (d) others. However, the range of values for each category is varied. There are more likely to be institutional-based criteria. These variations are influenced by several institutional-based factors, such as available resources, healthcare professionals responsible for activating the trauma team, experiences, and knowledge (9). In 2021, Waydhas conducted a worldwide survey regarding trauma team activation criteria to have consensus criteria for activation requirements (24). A total of 37 countries participated in the survey, consisting of low-, middle-, and high-income countries. The results revealed that the top 10 criteria with agreement score > 80% for trauma team activation are: (1) GCS < 9, (2) RR <0 or >29/min, (3) pericardiocentesis, (4) advanced airway management, (5) pulse oximetry (SpO₂)<90%, (6) vascular, neurosurgical, abdominal, thoracic, pelvic, spinal or extremity-saving surgery, (7) systolic blood pressure < 90 mmHg, shock index >0.9, (8) CPR, and (10) deterioration of GCS > 2 points before admission (24). However, these criteria were mostly based on physiological criteria. The other two important criteria that emerged from our integrative review, that is anatomical and injury mechanisms, have less than 80% agreement.

Ideally, the assessment and decision on whether or not to activate the emergency department (ED) trauma team begin from the pre-hospital phase. However, this can only be done if the Emergency Medical System is activated on the scene. It is difficult to initiate the activation process if it is a layperson who finds the trauma victims, and they bring them directly to the ED due to traffic jams, etc. Verhoeff et al. suggested a systemic change to make trauma team activation more effective, including structure, process, and system changes (18).

The indicators used to assess the effectiveness of trauma team activation may be debatable. For instance, the study designs for satisfaction level and mortality have no control for confounding factors. Thus, there is no

guarantee that a higher level of satisfaction, fewer complaints, and lower mortality were solely influenced by appropriate trauma team activation. There may be other factors affecting satisfaction levels. Therefore, other authors have suggested time-sensitive quality indicators for assessing the effectiveness of trauma team activation, which include (but are not limited to): (a) time from ED presentation to CT scanner, (b) time spent in the ED acute care area, and total time spent in the emergency department (18). These indicators may also have shortcomings, such as accuracy in recording the time. Nevertheless, alternative solutions can be provided to overcome the shortcomings.

Limitations

Despite the effort to identify all published articles related to trauma team activation, some articles may have been missed for inclusion due to language and access limitations. However, Google Scholar searching was also conducted to make sure that all accessible articles relevant to the review questions were identified.

CONCLUSION

Criteria, processes, and outcomes of trauma team activation are varied not only across countries but also across emergency departments within the same country. Several factors, such as the availability of resources and the level of emergency departments, may influence the differences. Therefore, it is highly recommended that the criteria, process, and outcomes of trauma team activation are tailor-based on the needs and available resources of the institutions. Moreover, standardized trauma team activation may need further development.

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