

Trauma Team Activation at an Emergency Department

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Abstract

Aim: Multidisciplinary trauma teams are routinely activated for patients with serious injuries in the emergency department (ED). We aim to describe the characteristics of patients requiring trauma team activation (TTA) at a level two trauma centre.

Materials and Methods: A retrospective review of a single centre's trauma registry data was performed. Information on demographics, circumstances of trauma, details of injury, and clinical progress was collected and analysed.

Results: Among 77,132 trauma cases, 496 (0.6%) required TTA. On average, one TTA occurred every three days. The median age was 38 years [interquartile range (IQR), 28-54 years], and 367 (74.0%) were male. The primary reason for TTA was the mechanism of injury (n=418, 84.3%). Blunt injuries occurred in 453 (91.3%) patients and vehicular accidents were the most common mechanism (n=342, 69.0%). The median injury severity score was 1 (IQR: 0-9). Twenty patients (4.0%) required emergency surgery. The overall mortality was 60 (12.1%), with 49 patients (9.9%) dying in the ED. Four hundred and one patients (80.8%) were admitted to the hospital; the median length of stay was 2 days (IQR 1-5 days).

Conclusion: TTA was an uncommon event; when it occurred, patients generally had low injury severity and low utilisation of healthcare resources. Revision of the activation criteria and a tiered trauma-team or expedited-care approach may help achieve a balance between timely, coordinated care and the justified, optimal deployment of personnel.

Keywords: Emergency department, multi-disciplinary, trauma

Introduction

A trauma team is a multidisciplinary group of healthcare professionals that can be activated using predefined criteria to attend to patients with serious injuries in the emergency department (ED). The primary aims of the team are to resuscitate and stabilise the patient, to determine the extent and severity of the injuries, and to prioritise the management for timely definitive care (1). By working as a team with a leader and members who have specific roles and responsibilities, the trauma team can reduce the time to diagnosis and treatment, optimise resource utilisation, and improve patient outcomes (2).

The activation criteria should be tailored to the local setting of the trauma centre to avoid undertriage and overtriage. According

to the American College of Surgeons' Committee on Trauma, acceptable rates of under-triage range from 1-5%, and those for over-triage range from 25-35% (3). Under-triage is defined as patients who were not trauma-activated but required high-level resources, whereas over-triage is defined as patients who were trauma-activated but did not require high-level resources. Inappropriate use of trauma team activation (TTA) can lead to overutilisation of valuable personnel when trauma team members are called to the ED, disrupting their duties to provide care in other areas of the hospital (4,5). Therefore, our study aimed to describe the characteristics of patients requiring TTA at the ED, so that the information gained from this work may be used to review the activation criteria and optimise manpower deployment without compromising the care of patients with serious injuries.



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Cite this article as: Lam SJ, Attal H, Tan WJD, Venugopal K, Lim SHC, Lee CM et al. Trauma team activation at an emergency department. Eurasian J Emerg Med. 2026;25: 194-8.

Received: 05.12.2025

Accepted: 11.02.2026

Published: 23.02.2026



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Materials and Methods

Study Setting

Our study was conducted at the ED of a level-two trauma centre in Singapore, with an annual census of about 122,000; trauma patients accounted for approximately 15% of visits. This level-two trauma centre is part of a regional trauma system comprising two other level-one trauma centres.

Pre-hospital emergency medical services (EMS) are provided by the Singapore Civil Defence Force, and patients are routinely conveyed from the incident site to the nearest ED. However, trauma patients meeting diversion criteria (Table 1) will be transferred only to level-one trauma centres, unless they are in extremis due to cardiorespiratory arrest. Our hospital has a single-tier trauma team that consists primarily of emergency doctors and nurses, general surgeons, and orthopaedic surgeons. The team is activated based on the criteria in Table 2 and will be led by the general surgeon. When required, additional personnel from relevant departments, such as neurosurgery, will be called upon to assist with patient care. Transfer to a level-one trauma centre in the regional trauma system will be undertaken if further trauma expertise available only at that centre is required. Otherwise, patients may be admitted to the hospital under the appropriate specialty for further management.

Study Design

Our study was a retrospective review of the trauma registry data that included all trauma patients presenting to the ED at a single level-two trauma centre from 1 August 2018 to 31 December 2022. We collected and analysed information, including demographics, types and mechanisms of injury, injuries sustained and their severities, investigations, treatments, and outcomes.

The evaluation of under- and over-triage according to TTA criteria was based on the utilisation of high-level resources by trauma patients. This definition of high-level resources included the following ED interventions: intubation, chest tube insertion, intraosseous insertion, central line insertion, blood administration, cardiopulmonary resuscitation, pericardiocentesis, open thoracotomy, and time to operation within 90 minutes of hospital arrival (6). The proportion of under-triage was determined as the number of trauma patients who utilised high-level resources but did not have TTA, divided by the total number of trauma patients in the study, while the proportion of over-triage was determined as the number of trauma patients who did not utilise high-level resources but had TTA, divided by the total number of trauma patients in the study.

This study was approved by Institutional Review Board of SingHealth, Singapore (CRIB reference: 2021/2417, date: 03.07.2021).

Statistical Analysis

Statistical analysis was performed using SPSS version 25 (SPSS, Chicago, IL). Continuous data were presented as median with interquartile range (IQR). Categorical data were presented as frequencies and percentages.

Results

A total of 77,132 trauma patients were seen in the ED during the study period. Of these, 496 patients (0.6%) were managed by the trauma team, corresponding to an average of one TTA every three days.

Characteristics of Trauma Patients with TTA at the ED

The median patient age was 38 years (IQR 28-54), and 367 (74.0%) of them were male. Seven (1.4%) patients were younger than 16 years, and 73 (14.7%) patients were 65 years or older. TTA was due to mechanism-of-injury, physiologic, and anatomic criteria in 418, 91, and 93 patients, respectively. Eighty five patients met more than one criterion for TTA. Blunt injuries occurred in 453 (91.3%) patients, and vehicular accidents were the most common mechanism of injury (n=342, 69.0%) (Table 3).

Outcomes of Trauma Patients with TTA at the ED

Among 414 (83.5%) patients admitted to the hospital, 333 were admitted to the general ward, 62 to the high-dependency unit, and 19 to the intensive care unit. Twenty (4.0%) patients underwent emergency surgery following direct operating theatre transfer from the ED. The overall median length of stay for admitted patients was 2 days (IQR 1-5). Sixty patients (12.1%) died: 49 arrived in cardiorespiratory arrest and died in the ED, and 11 died subsequently during the hospital stay. Excluding these patients who died because their cause of death and extent of injuries were not available in the coroner's report, the median injury severity score (ISS) of the remaining patients was 1 (IQR 0 to 9). Of these remaining patients, 202 had an ISS of 0; 196 had an ISS of 1 to 15, which is suggestive of minor trauma; and 38 had an ISS of 16 or more, which is suggestive of major trauma.

Twenty patients (4.0%) required transfer to another hospital: 14 were transferred to a level-one trauma centre, four to a hospital with a paediatric unit, and two to a hospital with a burn unit. Fourteen patients (2.8%) were discharged from the ED.

Performance of the Criteria for TTA

408 patients who were trauma-activated did not require high-level resources, whereas 63 patients who were trauma-

Table 1. Criteria for pre-hospital EMS diversion of a trauma patient to a level one trauma centre

<p>Physiology Systolic blood pressure less than 90 mmHg Glasgow Coma scale score 13 or less</p>
<p>Anatomy Penetrating injury to head, neck, torso and extremities proximal to elbow or knee Chest wall instability or deformity Two or more proximal long bone fractures Crushed, degloved, mangled or pulseless extremity (includes near amputation) Amputation proximal to wrist or ankle Pelvic fracture Open or depressed skull fracture Spinal cord injury</p>
<p>Mechanism Fall from height more than 3 meters High risk vehicle crash-ejection from vehicle, death from same vehicle, vehicle intrusion more than 30 cm in occupant site Motorcycle crash more than 50 km/h Vehicle crash with pedestrian/cyclist-more than 30 km/h or thrown or run over Trapped body or limb between a structure, machinery or vehicle more than 20 minutes High voltage injury Explosion</p>

Table 2. Criteria for trauma team activation at the emergency department

<p>Physiology Airway obstruction Respiratory rate less than 10 or more than 30 per minute Systolic blood pressure less than 90 mmHg or pulse rate more than 120 per minute Glasgow Coma scale score less than 13 Pregnant</p>
<p>Anatomy Penetrating injury to head, neck, torso Flail chest Two or more body region injury Two or more proximal long bone fractures Proximal limb amputation Pelvic fracture Open or depressed skull fracture Spinal cord injury</p>
<p>Mechanism Fall from height more than two meters Road traffic accident more than 50 km/h Ejection from vehicle or flung by vehicle Death from same vehicle Prolonged entrapment more than 20 minutes Crush injury High voltage injury Explosion</p>

activated required high-level resources. These corresponded to under-triage and over-triage proportions of 0.08% and 82.3%, respectively. Among patients who were under-triaged, the high-level resources utilised were endotracheal intubation, tube thoracostomy, and blood administration.

Discussion

Unlike a level one trauma centre, TTA was uncommon in the ED of a level-two trauma centre. Here, TTA was commonly based

on mechanism-of-injury criteria and, correspondingly, the ISS of patients, the utilisation of healthcare resources, and the proportion of patients who died during the inpatient hospital stay were low. Therefore, to reduce the imbalance between under- and over-triage proportions in the criteria for TTA, revision of the activation criteria and implementation of a tiered trauma team or expedited-care approach may help achieve a balance between timely, coordinated care and the justified, optimal deployment of manpower in a level-two trauma centre.

Variable	n (%)
Type of injury	
Blunt	453 (91.3)
Penetrating	43 (8.7)
Mechanism of Injury	
Vehicular accident	342 (69.0)
Fall	101 (20.4)
Tool/object	25 (5.0)
Interpersonal violence	11 (2.2)
Sports	4 (0.8)
Others	4 (0.8)
Unknown	9 (1.8)

The mechanism of injury as a criterion for TTA has been associated with high rates of over-triage (7,8). The circumstances of injury raise clinical concern for an underlying injury, which mandates prompt and thorough evaluation. However, there may be no injuries that are serious enough to warrant healthcare resource utilisation. This is unlike anatomic and physiologic criteria, which are direct clinical manifestations of sustained injuries and, when present, would more likely require the attention of the trauma team and subsequent healthcare resource utilisation. Boyle et al. (9) proposed that mechanism-of-injury criteria, in the absence of anatomic and physiologic criteria, were not clinically significant for major trauma. A Scandinavian study proposed revised criteria for TTA that place emphasis on anatomic and physiologic criteria while modifying mechanism of injury criteria by removing motorcycle accidents, considerable deformation of the vehicle passenger compartment, and traffic accidents at speeds greater than 60 kilometres per hour (10).

Specific to level-two trauma centres, a hospital in India identified the modified shock index, defined as heart rate divided by mean arterial pressure, as a potential marker for predicting mortality in adult trauma patients; it was significantly better than heart rate, systolic or diastolic blood pressure, and shock index (heart rate divided by systolic blood pressure), making it an ideal physiologic criterion for TTA (11). The under-triage and over-triage proportions, based on need for immediate emergency interventions or operative procedures, at another level-two trauma centre in the United States of America changed from 1% (under-triage) and 79% (over-triage), figures similar to our study, to 4% and 12%, respectively, after adopting a simplified criterion comprising only four variables-hypotension, mental status, altered respirations, and penetrating truncal wound (12).

Instead of a single-tier trauma team that activates all members of the multidisciplinary team, a tiered trauma team may be more prudent for deployment of personnel. A centre in the Netherlands changed the trauma system from a single-tier to a two-tier system, and this reduced the proportion of over-triage

(13). A two-tier system was similarly implemented as Code Red in the United Kingdom (14) and as Code Crimson in Australia (15), in which the first tier comprised the ED team attending to patients who met the mechanism-of-injury criteria, and the second tier comprised the trauma team attending to patients who met additional anatomic or physiologic criteria. Given the widespread adoption of Advanced Trauma Life Support, the initial assessment and management of patients, including those at high risk for severe injuries, can be competently and confidently performed by the ED team (16), with the trauma team ready to augment care as needed. Applying this two-tier approach to our study would reduce 418 TTA in a single-tier system that were activated based on mechanism criteria to 81 if the trauma team attended only to patients who fulfilled additional anatomic or physiologic criteria after assessment by the ED team, corresponding to an 80.6% reduction in multidisciplinary team activations.

TTA not only provides manpower in terms of quantity and expertise. From a process perspective, TTA also provides a system to expedite care from the ED to investigations (e.g., computed tomography), to interventions (e.g., interventional radiology procedures or operating-theatre interventions), and to admission to areas with higher acuity of care, such as intensive care or high-dependency units. Therefore, instead of focusing on staff deployment, another possible solution for a single-tier trauma team is to implement system-level protocols to expedite care for patients with serious injuries. For instance, at another hospital in Singapore, the Critical Haemorrhage to Operating Room Patient protocol, consisting of clearly defined roles, responsibilities, and tasks for healthcare professionals, was implemented to facilitate the escalation and mobilisation of resources upon recognition of a severely injured patient; all ten patients in this case series met the target of access to definitive intervention within 90 minutes, with an average time of 73 minutes from arrival at the ED to transfer to interventional radiology or the operating theatre (17).

Study Limitations

As this study was conducted at a single ED in a level-two trauma centre in Singapore, our recommendations are more relevant to EDs with settings similar to ours. For instance, trauma care is a continuum from prehospital to in-hospital care; Singapore's compact size and the high density of hospitals with trauma capabilities would result in shorter response and transport times by an EMS that uses predefined protocols and has access to online medical control when attending to trauma patients. The retrospective nature of this study meant that documentation could not be standardised, resulting in incomplete or missing information relevant to this study, such as the trauma team's perception of the appropriateness of TTA. We were also unable to determine the impact of TTA on

other patients in the ED or the hospital. Furthermore, the low frequency of TTA, coupled with a small number of patients with severe injuries requiring high-level resource utilisation, precluded further analysis and efforts to modify our current activation criteria.

Conclusion

TTA was an uncommon event at the ED of a level two trauma centre. To reduce the proportion of over-triage, we proposed revising the activation criteria and implementing a tiered trauma team or expedited care approach, since the overall injury severity of patients and their utilisation of healthcare resources were low. Future work should focus on the prevalence and spectrum of severe injuries, because these patients are the priority of the local trauma system, and any improvement efforts should be based on this.

Ethics

Ethics Committee Approval: This study was approved by Institutional Review Board of SingHealth, Singapore (CRIB reference: 2021/2417, date: 03.07.2021).

Informed Consent: Waiver of informed consent as it was a retrospective review of trauma registry data.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S. J. L., H. A., W. J. D. T., K. V., S. H. C. L., C. M. L., J. H. P., Y. L. C. L., Concept: C. M. L., J. H. P., Design: C. M. L., J. H. P., Data Collection or Processing: S. J. L., H. A., S. H. C. L., Analysis or Interpretation: S. J. L., H. A., W. J. D. T., K. V., J. H. P., Y. L. C. L., Literature Search: S. J. L., H. A., W. J. D. T., K. V., J. H. P., Y. L. C. L., Writing: S. J. L., H. A., W. J. D. T., K. V., J. H. P., Y. L. C. L.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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