

Sustainable Effectiveness of Applying Trauma Team Activation in Managing Trauma Patients in the Emergency Department

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Objective: To determine long term effectiveness of trauma team activation criteria by measuring emergency department length of stay (EDLOS) and 28-day mortality.

Material and Method: A 3-year retrospective cohort study conducted in adult trauma patients who met one of the trauma team activation criteria (shock, penetrating torso injury, post traumatic arrest, respiratory rate of less than 12 or more than 30, and pulse rate of more than 120). Specific demographic data, physiologic parameters, EDLOS, injury severity score (ISS), and 28-day mortality were prospectively recorded into the Trauma Registry database. Multiple logistic regression analysis was used to determine factors affecting mortality. The Institutional Review Board approval was obtained prior to undertaking the project.

Results: Two hundred eighty two patients with a mean age of 35.1 years old were eligible. The median ISS was 25 (range, 13-30). The median EDLOS was 85 minutes (range, 50-135) and the 28-day mortality rate was 46.5%. The mean age was 31.7 years in the survival group and 38.7 years in the fatal group ($p = 0.001$). The median ISS was 17 in the survival group and 26 in the fatal group ($p = 0.000$) and the median EDLOS was 110 minutes in the survival group and 82 minutes in the fatal group ($p = 0.034$). When compared to data prior to the TTA application, the median time of EDLOS improved sustainably from 184 to 85 minutes ($p = 0.000$) and the mortality rate decreased from 66.7% to 46.5% ($p = 0.057$). The parameters affecting patient mortality were older age, high ISS, and shorter EDLOS.

Conclusion: Trauma team activation criteria significantly improved acute trauma care in the emergency department and decreased mortality.

Keywords: Trauma team activation criteria, Emergency room, Trauma

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Trauma is one of the conditions seen most often in an emergency department and is the most common cause of death in the younger population. The distribution of trauma deaths is divided into three phases, 1) immediately after the accident due to the severity and injury to major organ systems (e.g., severe airway injury, high spinal cord injury, severe head injury with major brain damage, severe major vascular injury with massive bleeding, undiagnosed tension pneumothorax, and massive hemothorax), 2) 30 to 90 minutes after the insult (the golden hour) from delayed

but life-threatening injuries to major organs (e.g., airway compromise from airway trauma and respiratory distress from C-spine injury, pneumothorax and hemothorax, massive bleeding, hemoperitoneum, and massive retroperitoneum bleeding), and 3) from other consequences (e.g., infections and sepsis, or acute renal failure) several days after the accident during the post-resuscitative phase⁽¹⁾. The strategies used to prevent first phase mortality are the implementation of policies and guidelines (e.g., seat belt, helmet, and blood alcohol detection systems for drivers). Mortality and morbidity in the second phase of trauma death can be decreased by well-organized pre-hospital and in-hospital emergency trauma care. Finally, well-organized and efficient post-resuscitative care included in the intensive care unit allows for a decrease in morbidity and mortality in the third phase.

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Songklanagarind Hospital is a level I trauma center, university based hospital located in the southern part of Thailand that takes care of approximately 10,000 trauma patients annually. The outcomes of trauma patients depend on both pre-hospital and in-hospital care. Although a pre-hospital system was established by the government of Thailand a decade ago, it is still under-developed. Therefore, a well-organized nationwide pre-hospital system for acute trauma care does not yet exist in Thailand. The recent implementation of early acute trauma care in the in-hospital setting at the Emergency Department has been easier to achieve and has shown favorable patient outcomes as recommended by the Trauma Committee of the American College of Surgeons⁽¹⁾. A rapid and prioritized approach to identify injuries requiring urgent intervention is the cornerstone for trauma patient management⁽¹⁾. Severely traumatized patients need rapid management and precise decision-making by experienced physicians to achieve favorable clinical outcomes⁽¹⁾.

The American College of Surgeons Committee on Trauma (ACS-COT)^(2,3) recommends that each trauma center have criteria for immediate trauma team consultation. Trauma team activation criteria (TTA) have proven to decrease trauma mortality and improve the acute trauma care system in emergency departments both in well-developed pre-hospital systems and in institutions where good pre-hospital care does not exist. A variety of criteria are selected based on capabilities of the hospital and available facilities e.g., Glasgow Coma Scale score <14, altered respiratory effort (absent or labored), penetrating truncal injury, stab and gunshot wounds^(1,4-6), systolic blood pressure (SBP) <90 mmHg, airway compromise managed by endotracheal intubation or surgical airway^(6,7), and respiratory rate (RR) more than 29 or less than 10 per minute⁽⁷⁾. Some trauma team activation criteria are correlated with longer in-hospital stay and ICU admissions, as well as the need to perform emergency laparotomy⁽⁷⁾. Rapid response trauma team (RRTT) was proved to decrease patient mortality in severe thoracic injury in the northern trauma center in Thailand⁽⁸⁾.

TTA with specific criteria was implemented in Songklanagarind Hospital in 2009 for the treatment of severe trauma patients corresponding with the standard trauma protocol. Acute trauma care procedures performed in the emergency department and patient demographic data were prospectively recorded into the trauma registry database. The patients were

followed-up and outcomes were determined by the emergency department length of stay (EDLOS) and the 28-day mortality rate. One-year pilot data demonstrated an improvement with a decreased EDLOS and decreased mortality. The authors aim to observe the sustainable improvement of the patient outcomes over a period of time.

Material and Method

The retrospective cohort study was conducted in the Emergency Department at Songklanagarind Hospital, level I trauma center. The prospective recorded data in the trauma registry database between January 1, 2010 and December 31, 2012 were reviewed. The Institutional Ethics Committee Board approved the study.

Patient eligibility

All patients aged ≥ 18 who presented with at least one of following parameters were included in the study, shock state (SBP <90 mmHg or <100 mmHg in hypertensive patient), penetrating torso injury, status post traumatic arrest, RR less than 12 or more than 30 per minute, and pulse rate (PR) of more than 120 beats per minute. Patients referred from other hospitals were excluded.

Outcome assessment

Demographic data, mechanism of injury, time sequences of acute trauma care processes, EDLOS, injury severity score (ISS), and 28-day mortality were extracted.

Data analysis

The results were reported as number, mean, standard deviation (SD), median, percentage (%), and interquartile range. The data were then compared to the data prior to the TTA criteria were implemented in the Emergency Department. Mann-Whitney U test and Chi-square test or Fisher's exact test were used to analyze the difference of EDLOS and 28-day mortality between the two groups. Statistical significance was set at $p < 0.05$.

Definitions

Shock state: SBP <90 mmHg or <100 mmHg in hypertensive patient

Penetrating torso injury: penetrating injury at chest and/or abdomen

EDLOS: time from patient arrival at the Emergency Department to the time when patients were

either admitted or discharged out of the Emergency Department

Results

Two hundred eighty two patients (244 males, 38 females) with a mean age of 35.1 years old were eligible and enrolled into the present study. The median ISS was 25 (range, 13-30). The median time of EDLOS was 85 minutes (range, 50-135) and the 28-day mortality rate was 46.5%.

The data were compared with pilot data prior to the implementation of TTA in 2009. There was no statistical significance in patient demographic data; only the ISS in the study group was found to be significantly higher than in the pilot data. The median time of EDLOS had significantly decreased (184 vs. 85 minutes, $p = 0.000$) in the study group, but the 28-day mortality had decreased without any statistical significance (66.7% vs. 46.5%, $p = 0.057$) (Table 1).

The mean age, median ISS, and EDLOS in the survival group were 31.7 years, 17, and 110 minutes, respectively. In the group that died, the mean age was

38.7 years, the median ISS was 26, and the median EDLOS was 82 minutes. Multiple logistic regressions identified the parameters affecting patient mortality were old age (31.7 vs. 38.7, $p = 0.001$), high ISS (17 vs. 26, $p = 0.000$), and shorter EDLOS (110 vs. 82, $p = 0.034$) (Table 2).

Discussion

The present study assessed the effectiveness of applying the TTA criteria in the Emergency Department to improve acute trauma care as represented by the EDLOS significantly decreased over three consecutive years (Table 3). The TTA criteria decreased resuscitative time and processes as well as time to the operating theater⁽⁹⁾ due to the arrival of a trauma surgeon at the Emergency Department who made decisions within a couple of minutes after the trauma team was activated. The similar results reported by Lillebo et al that proactive trauma team activation improved the initial management of trauma patients⁽¹⁰⁾.

Unfortunately, the decreased EDLOS had no impact on patient outcomes, similar to studies by

Table 1. Characteristics of the study group and the pilot study data

Characteristics	Pilot data (n = 24)	Study group (n = 282)	p-value
Male	24 (100)	244 (91.0)	0.097
Female	0	38 (9.0)	
Age in years, mean (SD)	33.8 (15.2)	35.1 (13.8)	0.526
ISS, median (IQR)	17 (10-24)	25 (13-30)	0.025
EDLOS, median (IQR)	184 (138-209)	85 (48-160)	0.000
28-day mortality, n (%)	16 (66.7)	131 (46.5)	0.057

ISS = injury severity score; EDLOS = emergency department length of stay

Table 2. Parameters effecting mortality in the study group

Parameters	Survived (n = 151)	Death (n = 131)	p-value
Age in years, mean (SD)	31.7 (10.8)	38.7 (16.0)	0.001
ISS, median (IQR)	17 (10-27)	26 (17-31)	0.000
EDLOS, median (IQR)	110 (64-160)	82 (48-138)	0.034

Table 3. Demographics and quality measurements of trauma patients from 2010 to 2012

Characteristics	2010 (n = 62)	2011 (n = 118)	2012 (n = 102)
Male, n (%)	51 (82.3)	103 (87.3)	90 (88.2)
Female, n (%)	11 (17.7)	15 (12.7)	12 (11.8)
Age in years, mean (SD)	36.8 (16.9)	35.8 (13.5)	33.4 (12.2)
ISS, median (IQR)	25 (13-30)	25 (14-33)	22 (10-29)
EDLOS, median (IQR)	75 (42-115)	85 (60-135)	85 (50-140)
28-day mortality, n (%)	37 (59.7)	47 (39.8)	47 (46.1)

Tinkoff et al⁽⁵⁾ and Khetarpal et al⁽⁹⁾. The shorter the EDLOS, the higher the patient's mortality. This was possibly a result of the higher ISS in the group that died compared to the survival group. Old age and high ISS were parameters found to affect the patient's mortality. These findings were consistent with the study performed by Cherry et al that reported a SBP <90 mmHg and a GCS score <8 were the predictive factors for mortality⁽¹¹⁾. Both hypotensive state and a low GCS score also correlated with a high ISS. The TTA decreased patient mortality in severe trauma patient, the result similar to the study by Chittawatanarat et al which reported RRTT could decrease the severity-adjusted mortality in severe thoracic injury⁽⁸⁾.

Since a well-organized pre-hospital system does not exist in Thailand, the TTA criteria and presenting of trauma team at the ED for treating severe trauma patients can account for the improved acute trauma care in the Emergency Department and the improvement in patient mortality. Appropriated TTA criteria improved resource allocation by decreasing overtriage and undertriage for trauma team activation. A similar study in the future should be reviewed on longer period of time. "Overtriage" and "Undertriage" should also be assessed to improve TTA effectiveness.

Conclusion

Efficient trauma team activation criteria can lead to sustainable improvement in providing acute trauma care in an emergency department that leads to improve mortality.

What is already known on this topic?

Study in Thailand only has the positive result of applying RRTT in severe thoracic injury, but not in all trauma conditions.

What this study adds?

The study presents the long-term result in applying trauma team activation criteria in managing all trauma condition in emergency department both in management and in clinical outcomes.

Compliance with ethical requirements

The Institutional Ethics Committee Board approved the present study.

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Author contributions

Prasit Wuthisuthimethawee performed the literature search, study design, data collection, data analysis, data interpretation, and writing. Michael S Molloy did the study design and critical revision. Gregory R Ciottono contributed to the study design and critical revision.

Potential conflicts of interest

None.

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ประสิทธิภาพการประยุกต์ใช้เกณฑ์การปรึกษาศัลยแพทย์อุบัติเหตุในการดูแลผู้ป่วยอุบัติเหตุที่ห้องฉุกเฉิน

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วัตถุประสงค์: เพื่อค้นหาประสิทธิภาพในระยะยาวของการประยุกต์ใช้เกณฑ์การปรึกษาศัลยแพทย์อุบัติเหตุโดยการวิเคราะห์ข้อมูลระยะเวลาที่ผู้ป่วยได้รับการดูแลที่ห้องฉุกเฉิน และอัตราการตายที่ 28 วัน

วัสดุและวิธีการ: การวิเคราะห์ข้อมูลย้อนหลังผู้ป่วยอุบัติเหตุผู้ใหญ่ที่มีการเข้าเกณฑ์การปรึกษาศัลยแพทย์อุบัติเหตุ (ช็อก บาดแผลทางทรวงอกและทรวงอก กว้างต้องได้รับการนวดหัวใจกู้ชีพ อัตราการหายใจน้อยกว่า 12 หรือมากกว่า 30 ครั้งต่อนาที ซีฟมากกว่า 120 ครั้งต่อนาที) จากฐานข้อมูลอุบัติเหตุที่มีการจัดเก็บข้อมูลแบบไปข้างหน้า ซึ่งประกอบด้วยข้อมูลพื้นฐาน ข้อมูลสัญญาณชีพ ระยะเวลาที่ผู้ป่วยได้รับการดูแลที่ห้องฉุกเฉิน ระดับความรุนแรงของการบาดเจ็บ และอัตราการตายที่ 28 วัน การวิเคราะห์ข้อมูลแบบ *multiple logistic regression* นำมาวิเคราะห์เพื่อค้นหาปัจจัยที่ส่งผลต่ออัตราการตาย การศึกษานี้ได้รับการรับรองจากคณะกรรมการจริยธรรมก่อนเริ่มดำเนินการศึกษา

ผลการศึกษา: ผู้ป่วยที่เข้าเกณฑ์การศึกษาทั้งหมด 282 ราย อายุเฉลี่ย 35.1 ปี ค่าเฉลี่ยระดับความรุนแรงของการบาดเจ็บเท่ากับ 25 (13-30) ค่ากลางระยะเวลาที่ผู้ป่วยได้รับการดูแลที่ห้องฉุกเฉินเท่ากับ 85 นาที (50-135) และอัตราการตายที่ 28 วัน เท่ากับร้อยละ 46.5 ผู้ป่วยที่รอดชีวิตมีอายุเฉลี่ย 31.7 ปี ส่วนผู้ป่วยที่เสียชีวิตมีอายุเฉลี่ย 38.7 ปี ($p = 0.001$) ค่ากลางระดับความรุนแรงของการบาดเจ็บเท่ากับ 17 ในกลุ่มที่รอดชีวิต และ 26 ในกลุ่มที่เสียชีวิต ($p = 0.000$) ค่ากลางระยะเวลาที่ผู้ป่วยได้รับการดูแลที่ห้องฉุกเฉินเท่ากับ 110 นาที ในกลุ่มที่รอดชีวิต และ 82 นาที ในกลุ่มที่เสียชีวิต ($p = 0.034$) เมื่อเปรียบเทียบข้อมูลปัจจุบันกับข้อมูลก่อนการประยุกต์ใช้เกณฑ์การปรึกษาศัลยแพทย์อุบัติเหตุพบว่า ค่ากลางระยะเวลาที่ผู้ป่วยได้รับการดูแลที่ห้องฉุกเฉินมีค่าลดลงจาก 184 นาที เป็น 85 นาที ($p = 0.000$) และอัตราการตายที่ 28 วัน ลดลงจากร้อยละ 66.7 เป็นร้อยละ 46.5 ($p = 0.057$) ปัจจัยที่มีผลต่ออัตราการตายอย่างมีนัยสำคัญ คือ อายุ ระดับความรุนแรงของการบาดเจ็บ และระยะเวลาที่ผู้ป่วยได้รับการดูแลในห้องฉุกเฉิน

สรุป: การประยุกต์ใช้เกณฑ์การปรึกษาศัลยแพทย์อุบัติเหตุสามารถพัฒนาการดูแลผู้ป่วยในห้องฉุกเฉินให้ดีขึ้นอย่างมีนัยสำคัญและสามารถลดอัตราการตายในผู้ป่วยอุบัติเหตุ