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Original Research

The role of trauma team activation by emergency physicians on outcomes in severe trauma patients

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Abstract

Background: In our region, trauma team activation (TTA) is initiated by emergency physicians once an injured patient meets any of the criteria of TTA after the injured patient arrives at the emergency department (ED).
Purpose: To evaluate the role of TTA on outcomes in patients with severe trauma.
Methods: All trauma patients who had injury severity score (ISS) >15 and were admitted from ED between January 2010 to December 2010 were included in the study. Mann–Whitney *U* test (non-normal distribution) or Student's *t* test (normal distribution) for continuous variables and Fisher exact test or Chi-square test for categorical variables were used to compare the statistically significant differences between TTA and non-TTA groups. Logistic regression was applied to determine any significant differences found in the statistical analysis for 30-day mortality.
Results: A total of 231 patients were signed up in the study. The TTA group had shorter time from ED to operation room (170 minutes vs. 534 minutes, $p = 0.02$) and tended to have more emergent operations (42.7% vs. 23.2%, $p = 0.002$). Emergent operation [odds ratio (OR), 0.34; 95% confidence interval (CI), 0.12–0.92, $p = 0.035$) was associated with lower mortality while ISS > 25 (OR, 7.48; 95% CI, 2.48–22.57, $p < 0.0001$), Glasgow coma scale score <13 (OR, 32.1; 95% CI, 4.30–94.6, $p < 0.0001$), hypotension (OR, 3.0; 95% CI, 1.1–7.9, $p = 0.03$), and coagulopathy (OR, 9.3; 95% CI, 1.2–71.4, $p = 0.033$) were associated with higher mortality.
Conclusion: This study shows that TTA may shorten the time from ED to operation room in trauma patients with an ISS > 15.

Keywords: Injury severity score; Trauma; Trauma team activation

1. Introduction

Improved patient assessment and management systems can reduce morbidity and mortality from serious injury or trauma. The chains of life contain injury prevention, prehospital care, services provided by trauma centers and other acute-disease care facilities, and posthospital care. Outcome improvements in the patient population have been achieved through the regionalization of trauma care and the designation of level I trauma centers.[1–4] The cornerstone of trauma care has been the early involvement of surgeons in the management of injured patients.[5] In Taiwan, the emergency medical system (EMS) provides only basic and noninvasive prehospital care. The EMS in Taiwan does not perform field triage. Most trauma patients are transported to the nearest hospitals or to the hospitals based on a patient's or their family's request instead of the level of trauma care provided by the hospital. After arrival at the hospital, severely injured patients are first evaluated by emergency physicians, not trauma physicians. Trauma team activation (TTA) at our hospital is at the discretion of the initial emergency attending physician according to consensus triage guidelines. The emergency physicians lead the initial resuscitation, assessment, and invasive

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procedures before the trauma team arrives. Injured patients receive trauma service only if a trauma team is activated. In this situation, a proportion of moderately to severely injured trauma patients do not receive trauma service but individual service since the trauma team is not activated after their initial assessment and resuscitation.

To date, only a limited number of studies related to trauma patients in our region have been reported. The aim of this study was to evaluate the role of TTA on outcomes in trauma patients with an injury severity score (ISS) >15 at a level I trauma center.

2. Methods

2.1. Study design and population

All trauma patients with ISS > 15 admitted from the emergency department (ED) from January 2010 to December 2010 were included in our analysis. Four groups of patients were excluded: (1) patients pronounced dead at the scene or initial hospital but still transported to our hospital; (2) patients who stayed at the initial hospital for more than 6 hours; (3) patients who were admitted to a ward or intensive care unit (ICU) at the initial hospital; and (4) patient was transported to the initial hospital or to our hospital by any mode of transportation other than EMS. The reason for the exclusion of those patients pronounced dead at the scene or initial hospital was that they might have received resuscitation only, which would be a confounding factor in the TTA group with increase of mortality. In addition, patients not transported by EMS were excluded because they might not receive enough standard and qualified prehospital care, resulting in variable outcomes.

This study was conducted at a university-affiliated teaching hospital located in south-central Taiwan. The hospital has an annual ED volume of 60,000 patients, approximately 20% (12,000) of whom are trauma patients, and has approximately 1000 beds in the general ward and 120 beds in the ICU. This is also the only hospital in our region rated as a *severe-grade emergency care ability hospital*, a rating similar to a level I trauma center, and can receive patients transferred for definitive care. It provides a trauma team composed of in-house attending surgeons, has an operating room service on a 24-hour basis and admits referred patients with severe major trauma within the region. The ED is staffed 24 hours a day by board-certified and ATLS-certified attending emergency physicians. An emergency attending physician or resident evaluates all trauma patients presenting at the ED. The activation of a trauma team for the major trauma patients is initiated by attending emergency physicians once the injured patient meets any one of the following criteria: (1) Glasgow coma scale (GCS) score <13; (2) respiratory distress, systolic pressure <90 mmHg, or hemodynamic instability; (3) fall from a very high height (>6 m or 2 floors); (4) head, neck or torso penetration wound (gunshot wound or knife wound); (5) severe pelvic fractures; (6) multiple traumas; (7) severe burn; and (8) children aged <10 years or elderly aged >65 years with suspicious multiple traumas. The in-house attending trauma surgeon presents at ED within 10 minutes after the initiation of TTA. The trauma surgeons lead the treatment of injured patients with TTA, whereas the emergency physicians and specialized surgeons cooperated in the treatment of those injured patients without TTA.

This study was approved by our hospital's Institute Reviewing Board with serial number 98-2032B and is exempted from informed consents.

2.2. Survey content and administration

We evaluated all trauma patients presenting at ED and calculated the ISS scores of all the patients once the diagnoses were confirmed. We followed their clinical courses and recorded their demographic data, injury mechanisms, laboratory data, radiographic reports, trauma team activation or not, management, discharge diagnosis, and 30-day mortality or survival on discharge. Only patients with ISS > 15 and who did not meet any exclusion criteria were included in the analysis. Initial GCS scores were recorded as the first data assessed by physicians. The number of invasive procedures (including endotracheal intubation, cricothyrotomy, tracheostomy, needle thoracostomy, tube thoracostomy, central venous catheter insertion, large-bore catheter insertion, and venous cut-down) of each enrolled patient was documented. Prothrombin time test and hemoglobin and platelet count were assessed by first laboratory analyses. Hypotension was defined as the lowest systolic pressure checked during ED stay, that is, <90 mmHg. Bradycardia was defined as the lowest heart rate checked during ED stay, that is, <60 beats/minute. A body temperature of <36.0 °C was defined as hypothermia and a body temperature of >38.0 °C was defined as hyperthermia. The presence of coagulopathy was defined as international ratio (INR) of prothrombin time >1.5 checked at ED and acidosis was defined as pH < 7.35 in first arterial blood gas checked at ED. Hyperglycemia was defined as blood glucose >200 mg/dL. Emergent operation was defined as a case when a patient was sent to the operation room directly from ED. The decision of ICU admission was made by treatment providers.

2.3. Data analysis

The demographic characteristics, trauma mechanism, performance of emergent operation, and time elapsed from ED to operation room were analyzed. Statistical analysis was carried out using the software SPSS 17.0 (SPSS Inc, Chicago, IL, USA). Mann−Whitney *U* test (non-normal distribution) or Student's *t* test (normal distribution) for continuous variables and Fisher exact test or Chi-square test for categorical variables, were used to compare the statistically significant differences between the TTA and non-TTA groups. The difference was considered significant if the *p*-value was <0.05. A stepwise backward logistic regression model was developed. All variables with a $p < 0.05$ in the univariate analysis were selected for the stepwise backward elimination model. Continuous cycles of repeated operations were performed until all covariates with a multivariate $p > 0.1$ were eliminated from

the model. Hospital mortality was used as the dependent variable in the model, while $p < 0.05$ indicated a significant contribution of the variable in the model.

3. Results

In total, 231 patients were enrolled in this study and 33 (14.3%) of them died. The mean ± standard deviation age of the enrolled patients was 52.0 ± 21.1. Of 231 patients, 59 (25.5%) had hypotension episode during ED stay, 17 (7.4%) patients experienced bradycardia, 65 (28.1%) patients had hypothermia, and 10 (4.3%) patients suffered from hyperthermia. Also, 30 (13.0%) patients had acidosis, 10 (4.3%) patients had coagulopathy, and 183 patients (79.2%) had hyperglycemia at ED. In addition, 68 patients (29.4%) had fluid resuscitation with normal saline or lactated Ringer's saline at ED, 62 patients (26.8%) had blood transfusion, and pressor had been used in 15 patients (6.4%) at ED to maintain adequate blood pressure. Of the 231 patients, 72 (31.2%) received endotracheal intubation at ED, 13 (5.6%) received cardiopulmonary resuscitation, and 71 (30.7%) received emergent operation (i.e., patients were sent to the operation room directly from the emergency department). Finally, 52 patients (22.5%) received at least one invasive procedure, such as thoracostomy, diagnostic peritoneal lavage, central venous catheter or large-bore catheter insertion, and therapeutic angiogram.

The demographic data are shown in Table 1. We divided these patients into two groups according to need for TTA or not. There were no differences in the age, sex, and mechanism of trauma. The most frequent mechanisms of injury were accidents with motorcycle or scooter (62.3%), fall (10.4%), motor vehicle (8.2%), bicycle (6.1%), and pedestrian (5.2%). No gunshot wound cases were seen during the study period.

More patients received emergent operation (patients were sent to the operation room directly from emergency department) in the TTA group than in the non-TTA group (42.7% vs. 23.2%, $p = 0.002$). The time elapsed from ED to operation room was shorter in the TTA group than in the non-TTA group (170 minutes vs. 534 minutes, median, $p = 0.02$).

To examine the role of TTA on outcomes, patients were grouped into two categories based on their ISS (Table 2). Analysis of mortality, ICU admission and number of invasive procedures in subgroups (ISS 16–25 and ISS > 25) demonstrated no differences between TTA and non-TTA. After multivariate analysis, we found that ISS > 25, GCS < 13, emergent operation, hypotension and coagulopathy had significant difference between the mortality and nonmortality groups (Table 3).

4. Discussion

Successful trauma systems depend on triage to identify patients with severe injuries that will benefit from trauma team resuscitation.[6,7] Several studies have shown that there was a benefit in a tiered trauma response system for both adult and pediatric patients.[8–10] In a meta-analysis, Celso et al found that establishing a trauma system could save about 15% of major trauma patients.[11] The establishment of a trauma system is a reasonable way to improve outcomes in severely injured patients.

Although the value of the trauma surgeon's involvement in the early care of the critically injured patient is well established, the timing of this involvement and its relationship to improved outcome continue to be debated.[2] Most people agree that the trauma surgeon directs the evaluation and management of the seriously injured patient.[12] In our hospital, the emergency attending physicians did the initial assessment and resuscitation of all trauma patients and activated the trauma team as needed. Only those patients with TTA would secondarily be evaluated systemically and be managed by trauma surgeons who would lead the treatment. However, those without TTA would be evaluated secondarily by emergency physicians and other specialized surgeons, and emergency physicians and specialized surgeons would cooperate with the treatment.

The study of Petrie et al showed that the outcomes of trauma patients with an ISS > 12 were statistically significantly better if the trauma team were activated than if the patients were managed on an individual service-by-service basis.[1] Khetarpal et al demonstrated that the presence of a

Table 1
Demographic characteristics and mechanism.

	Without trauma team activation group ($n = 142$; %)	Trauma team activation group ($n = 89$; %)	p
Age (mean ± standard deviation)	53.9 ± 21.3	49 ± 20.5	0.13 (by Student's t test due to normal distribution)
Male	101 (71.1)	62 (69.5)	0.88
Fall	19 (13.5)	5 (5.8)	0.08
Traffic accident while driving a motorcycle or scooter	89 (63.1)	55 (64.0)	1
Traffic accident while driving a vehicle	11 (7.8)	8 (9.3)	0.8
Traffic accident while riding a bicycle	10 (7.1)	4 (4.3)	0.58
Traffic accident as a pedestrian	5 (3.5)	7 (8.1)	0.11 (by Fisher's exact test)
Blunt trauma	140 (98.6)	84 (94.4)	0.08
Emergent operation	33 (23.2%)	38 (42.7)	0.002
Median time from emergency department to operation room (min)	534	170	0.02 (by Mann–Whitney U test due to non-normal distribution)

Table 2
Mortality, intensive care unit (ICU) admission and number of invasive procedures based on the Injury Severity Score (ISS).

	ISS 16−25 ($n = 169$)			ISS > 25 ($n = 62$)		
	Without activation ($n = 132$)	Trauma team activation ($n = 37$)	p	Without activation ($n = 10$)	Trauma team activation ($n = 52$)	p
30-day mortality	6 (4.5%)	1 (2.7%)	0.52 (by Fisher's exact test)	3 (30.0%)	23 (44.2%)	0.32 (by Fisher's exact test)
ICU admission	116 (87.9%)	36 (97.3%)	0.08 (by Fisher's exact test)	8 (80%)	42 (80.8%)	0.63 (by Fisher's exact test)
Number of invasive procedures (median)	0	0	0.07 (by Mann−Whitney U test due to non-normal distribution)	1	1	0.23 (by Mann−Whitney U test due to non-normal distribution)

The decision of ICU admission was made by the treating provider. Invasive procedures included endotracheal intubation, cricothyrotomy, tracheostomy, needle thoracostomy, tube thoracostomy, central venous catheter insertion, large-bore catheter insertion, venous cut-down.

trauma surgeon on the trauma team reduced resuscitation time and reduced time to incision for emergent operations, particularly in penetrating trauma. However, their study had no measurable impact on mortality based on trauma and injury severity score probability of survival.[3] Dodek et al reported that after TTA, the median elapsed time from initial nursing assessment in the ED to arrival in the operating room for blunt trauma patients could be decreased, but there were no significant differences in crude mortality or adjusted mortality.[4]

Our data show that there were no obvious differences in mortality between TTA and non-TTA either in ISS 16−25 group or in ISS > 25 group, similar to the studies of Khetarpal et al[3] and Dodek et al.[4] However, patients in the TTA group did have shorter time from ED to operation room (170 minutes vs. 534 minutes, $p = 0.02$) and a higher proportion of emergent operation (42.7% vs. 23.2%, $p = 0.002$). Furthermore, emergent operation was associated with lower mortality in our multivariate analysis (odds ratio, 0.34; 95% confidence interval, 0.12−0.92, $p = 0.035$). Although our current data did not show the significant association between trauma team activation and mortality, we believe the role of trauma team on outcome improvement in severe trauma patients was affirmative. A higher proportion of patients in the TTA group had emergent operation, which was associated with lower mortality.

Several physiologic variables had been shown previously to be independent predictors of injury severity and the requirement for emergent intervention. The study of Norwood et al reported that GCS ≤ 14 in the blunt trauma patients was a strong predictor of severe injury and the need for urgent evaluation and hospitalization.[13] Tinkoff et al also demonstrated that SBP < 90 mmHg, endotracheal intubation, and worse GCS score (<8) were associated with increased mortality, need for emergent surgery, and intensive care unit admission.[14] Similarly, our data showed that GCS was an independent risk factor of mortality. Our study also found that trauma patients with worse ISS score, hypotension, and coagulopathy had a higher mortality rate.

Table 3
Multivariate analysis of risk factors of mortality.

Risk factor	p	95% CI	Odds ratio
ISS score >25	<0.0001	2.48−22.57	7.48
GCS score <13	<0.0001	4.30−94.6	32.1
Emergent operation	0.035	0.12−0.92	0.34
Hypotension	0.03	1.1−7.9	3.0
Coagulopathy	0.033	1.2−71.4	9.3

CI = confidence interval; GCS = Glasgow Coma Scale; ISS = Injury Severity Score.

4.1. Limitations

A limitation of our study was its relatively small sample size. We excluded the patients who were dead before arriving at our ED, those who were transferred from other hospitals with ward, ICU admission, or longer stay (>6 hours) and those were transported not by EMS because the factors in such patients could be too numerous for the scope of this study. Another limitation was our study design. We evaluated all trauma patients presenting at ED and calculated the ISS scores of all the patients once the diagnoses were confirmed. We followed their clinical courses and recorded their demographic data, injury mechanisms, laboratory data, radiographic reports, trauma team activation or not, management, discharge diagnosis, and 30-day mortality or survival on discharge. Only patients with ISS > 15 who did not meet any exclusion criteria were included in the analysis. However, we did not interfere with the clinical decision making of all the treatment providers. Selection bias was another limitation. Injured patients with less severity tended to be in the non-TTA group. To solve this concern, we made two subgroup analyses of TTA and non-TTA with ISS 16−25 and ISS > 25, in which ICU admission, the number of invasive procedures, and the 30-day mortality of the TTA and non-TTA group were found to be not significantly different. Furthermore, the adherence of ED attending physicians to the criteria of TTA guidelines was a confounding factor. The ED physicians' adherence to the criteria of trauma team activation (TTA) in our hospital was not good. Of our 231 patients with ISS > 15, 195 patients met at least one criterion of TTA whereas only 89 patients received TTA eventually. There were 106 patients who met the TTA criteria but did not receive TTA and three of died within 30 days. Due to the undetermined role of TTA in our country and the limitations of our study design, we were unsure if any outcome improvement would have been achieved if all the 106 patients had received TTA. Differences in outcomes in severely injured patients before and after improvement of adherence of TTA guidelines should be addressed in future studies.

5. Conclusion

In conclusion, this study demonstrated that TTA may shorten the time from ED to operation room in trauma patients with an ISS $>$ 15. The TTA group had a higher proportion of emergent operation, which was associated with a lower mortality rate in multivariate analysis. ISS $>$ 25, GCS score $<$13, hypotension and coagulopathy were associated with a higher mortality rate.

Conflicts of interest

The authors have no conflicts of interest related to this study.

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