JTI
JOURNAL OF
TRAUMA AND INJURY

ORIGINAL ARTICLE
J Trauma Inj 2019;32(1):1-7
https://doi.org/10.20408/jti.2018.054

Effectiveness after Designation of a Trauma Center: Experience with Operating a Trauma Team at a Private Hospital

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Received: November 26, 2018

Accepted: December 19, 2018

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Purpose: The present study aimed to evaluate the influence of how the trauma care system applied on the management of trauma patient within the region.

Methods: We divided the patients in a pre-trauma system group and a post-trauma system group according to the time when we began to apply the trauma care system in the Halla Hospital after designation of a trauma center. We compared annual general characteristics, injury severity score, the average numbers of the major trauma patients, clinical outcomes of the emergency department, and mortality rates between the two groups.

Results: No significant differences were found in the annual patients' average age (54.1±20.0 vs. 52.8±18.2, p=0.201), transportation pathways (p=0.462), injury mechanism (p=0.486), injury severity score (22.93 vs. 23.96, p=0.877), emergency room (ER) stay in minutes (199.17 vs. 194.29, p=0.935), time to operation or procedure in minutes (154.07 vs. 142.1, p=0.767), time interval to intensive care unit (ICU) in minutes (219.54 vs. 237.13, p=0.662). The W score and Z score indicated better outcomes in post-trauma system group than in pre-trauma system group (W scores, 2.186 vs. 2.027; Z scores, 2.189 vs. 1.928). However, when analyzing survival rates for each department, in the neurosurgery department, in comparison with W score and Z score, both W score were positive and Z core was higher than +1.96. (pre-trauma group: 3.426, 2.335 vs. post-trauma group: 4.17, 1.967). In other than the neurosurgery department, W score was positive after selection, but Z score was less than +1.96, which is not a meaningful outcome of treatment (pre-trauma group: -0.358, -0.271 vs. post-trauma group: 1.071, 0.958).

Conclusions: There were significant increases in patient numbers and improvement in survival rate after the introduction of the trauma system. However, there were no remarkable change in ER stay, time to ICU admission, time interval to emergent procedure or operation, and survival rates except neurosurgery. To achieve meaningful survival rates and the result of the rise of the trauma index, we will need to secure sufficient manpower, including specialists in various surgical area as well as rapid establishment of the trauma center.

Keywords: Trauma center; Injury severity score; Mortality

http://www.jtraumainj.org
eISSN 2287-1683
pISSN 1738-8767

INTRODUCTION

Korea ranks third among the total causes of death for trauma, especially among teens and 30s [1]. As a result, the social and economic losses of young age are huge, and medical developed countries are striving to balance the distribution of credit centers in each region to quickly and appropriately respond to cases of trauma [2]. As a result of these efforts, the preventable death rate, one of the major indicators of assessing the quality of care for trauma patients in clinical trials, has decreased from about 30-40% in recent years to about 2.5-10% [3]. According to a 2010 survey, Korea has a very high level of preventable death rate of 35.2%, and has come to realize the urgency of introducing a systematic trauma patient management system [4]. Accordingly, the government established the first five hospitals nationwide in 2012 with the aim of lowering the nation's preventable death rate to less than 20% in 2020 to support the trauma specialist, intensive care unit, operating room, and various resources [5]. In 2016, the Halla Hospital was designated as a regional trauma center in order to provide trauma care in the secluded Jeju Island, which ranks third as the cause of death for trauma, such as other areas [6]. After being selected as a regional trauma center in 2016, the main building was not completed, so the trauma center was not completed. But In order to establish a systemic traumatic care system despite the lack of facilities and manpower, such as intensive care unit for trauma patients, trauma ward, resuscitation room, etc. There has been a change in the trauma system and trauma surgeons were assigned on 24 hours standby with a quick appearance to the major trauma patient within 10 minutes after the initial emergency call. The study was initiated to confirm the change in the care process of patients with severe trauma and to improve and supplement the practice of establishing a trauma center.

METHODS

Patient data from January 2016 to December 2017 were retrospectively reviewed. We included major trauma patients who visited the emergency room (ER) with injury severity score (ISS) higher than 15; excluding dead-on-arrival patients, dead patients during receiving treatments in the ER, minor trauma, burned patients and patients hanged themselves. We divided the patients in a pre-trauma system group and a post-trauma system group according to the time when we began to apply the trauma care system in the Halla Hospital, such as securing a specialist in charge of trauma, resident registration of 24 hours, and starting patient care within 10 minutes after designation of a trauma center and compared those who came at 2016, before designation, with those at 2017, after designation (Fig. 1).

We investigated the number of patients, sex, age, mechanism, ISS, whether they were sent to the intensive care unit (ICU) or operation room, hospital stay, ER stay, time interval to operation and to the ICU, and survival rates.

In this study, we applied the trauma and injury severity scores (TRISS) because this method offers a standard approach for tracking and evaluating the outcome of trauma care, provides an excellent screening tool for case identification in a quality assurance review, and allows the comparison of outcomes among different populations or trauma patients [7]. The TRISS is calculated from anatomic, physiologic, and age characteristics and used to quantify the probability of survival in patients with major trauma. Three factors (ISS, revised trauma scale [RTS],

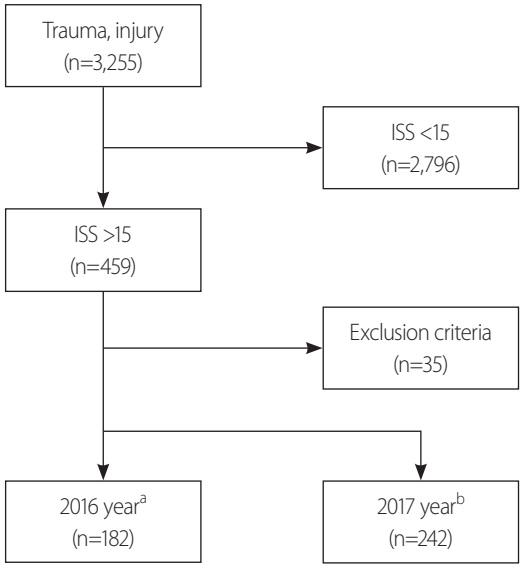

Fig. 1. Study flow diagram of annual adult major trauma patients. ISS: injury severity score. [a]Pre-trauma system group. [b]Post-trauma system group.

https://doi.org/10.20408/jti.2018.054

and age) are needed to calculate the TRISS. The RTS can be calculated from the initial vital signs of systolic blood pressure, respiratory rate, and Glasgow coma scale (GCS). The Z score and W score were also calculated. We compared the mortality rate of major trauma patients. Both the predicted and actual patient mortality were compared using Z score and W score. The Z score is to compare the actual number of survivors of the medical institutions under evaluation with the number of expected survival patients based on existing quality standards. Generally, when the number of patients to be surveyed is 150 or more, when the Z score exceeds +1.96 or -1.96, the mortality rate is statically higher or lower than the existing quality standard. Because the ability to detect statistically significant differences in survival rates by Z score is strongly influenced by the number of patients surveyed, the quality of emergency medical institutions cannot be assessed solely by the Z score. W score was developed to accurately estimate the magnitude of the difference in survival provability. The W score estimates the number of survivors expected using the major trauma outcome study norm per 100 patients analyzed and allows more accurate comparisons between different institutions or system [8]. IBM® SPSS version 22 (IBM corp., Armonk, NY, USA) was used for statistical analysis and a *p*-value less than 0.05 was considered significant.

RESULTS

General characteristic (Table 1)

Total number of patients with ISS higher than 15 from January 2016 to December 2017 was 424, male (296, 69.8%) more dominant than female (128, 30.2%), (p<0.001). The average age was 53.3 (standard deviation, 18.9) years. The main injury mechanism of trauma was motor vehicle accidents (189, 44.4%), while fall was the second (178, 41.9%). There was no significant difference of age, sex, and mechanism between the two groups (p=0.201, 0.514, and 0.486). The mean ISS of patients were 22.93 and 23.96, there was no significant difference (p=0.877). After designation, there was a significant in-

Table 1. General characteristics of the pre-trauma system group and the post-trauma system group

Characteristic	Pre-trauma system[a] (n=182)	Post-trauma system[b] (n=242)	*p*-value
Age (years)	54.1±20.0	52.8±18.2	0.201
Sex			0.514
Male	124 (68.1)	172 (71.1)	
Female	58 (31.9)	70 (28.9)	
Visiting route			0.462
Direct visit	111 (61.0)	139 (57.4)	
Transfer from other hospital	71 (39.0)	103 (42.6)	
Injury mechanism			0.486
Traffic accident	75 (41.2)	114 (47.1)	
Falls/slip	83 (45.6)	95 (39.2)	
Machine/stab	2 (1.0)	9 (3.7)	
Collision	11 (6.0)	6 (2.4)	
Unknown	21 (11.5)	18 (7.4)	
ISS	22.93	23.96	0.877
Monthly number	15.2±5.4	20.2±4.9	0.007

Values are presented as mean±standard deviation or number (%).
ISS: injury severity score.
[a]2016 year.
[b]2017 year.

crease in the average monthly number of patients of the post-trauma system group in serious trauma patients (15.2 vs. 20.2, p=0.007).

Clinical outcome of the emergency department treatment (Table 2)

ICU admission rate and operation rate increased in 2017 to 85.1% and 42.5%, respectively, but without statistical significance (p=0.207 and 0.11, respectively). There were no significant difference in average hospital stay in days (43.8 vs. 47.5, p=0.924), ER stay in minutes (199.17 vs. 194.29, p=0.935), time to operation or procedure in minutes (154.07 vs. 142.1, p=0.767), and time interval to ICU admission in minutes (219.54 vs. 237.13, p=0.662). The predicted and actual survival rate of patients by calculation of TRISS in the pre-trauma center group were 84.79% and 86.81%, respectively, yielding a 2.0% increase. In the post-trauma center group, the predicted and actual survival rate of were 82.94% and 85.12%, respectively, yielding a 2.2% increase. The W score and Z score indicated better outcomes in post-trauma system group than in pre-trauma system group (W scores, 2.1859 vs. 2.0274; Z scores, 2.1887 vs. 1.9276). W scores all have positive numbers, and Z score has shown better results than +1.96 since selection. The misclassification rate was 9.19% due to 39 cases totally, 7.14% due to 13 cases of 182 before trauma system, and 10.74% due to 26 case of 242 after trauma system

Table 2. Clinical outcome of the emergency department treatment

	Pre-trauma system[a] (n=182)	Post-trauma system[b] (n=242)	*p*-value
ICU admission	151 (82.9)	206 (85.1)	0.207
Emergent Op. and procedure	67 (36.8)	103 (42.5)	0.110
Mean hospital stay (days)	43.8	47.5	0.924
Emergent room stay (minutes)	199.17	194.29	0.935
Time interval to emergent Op. or procedure (minutes)	154.07	142.1	0.767
Time interval to ICU admission time (minutes)	219.54	237.13	0.662
Actual survival rate	158 (86.81)	206 (85.12)	
Predicted survival rate	154 (84.79)	200 (82.94)	
Z score	1.9276	2.1887	
W score	2.0274	2.1859	

Values are presented as mean±standard deviation or number (%).
ICU: intensive care unit, Op.: operation.
[a]2016 year.
[b]2017 year.

Table 3. Survival rates, W score, and Z score by admitted department

	NS		Others	
	Pre-trauma system[a] (n=115)	Post-trauma system[b] (n=130)	Pre-trauma system[a] (n=67)	Post-trauma system[b] (n=112)
Actual survival rate	99 (86.08)	107 (82.31)	59 (88.06)	99 (88.39)
Predicted survival rate	95.1 (82.66)	102.8 (79.10)	59.2 (88.42)	97.8 (87.33)
W score	3.426	4.170	-0.358	1.071
Z score	2.335	1.967	-0.271	0.958

Values are presented as mean±standard deviation or number (%).
NS: neurosurgery.
[a]2016 year.
[b]2017 year.

https://doi.org/10.20408/jti.2018.054

Survival rates for each department (Table 3)

When analyzing survival rates for each department, in the neurosurgery department, in comparison with W score and Z score, both W score were positive and Z score was higher than +1.96 (pre-trauma group: 3.426, 2.335 vs. post-trauma group: 4.170, 1.967). In other than the neurosurgery department, W score was positive after selection, but Z score was less than +1.96, which is not a meaningful outcome of treatment (pre-trauma group: -0.358, -0.271 vs. post-trauma group: 1.071, 0.958). For further trauma surgery department, after selecting the center, W score and Z score were all negative (pre-trauma group: -0.333, -1.40 vs. post-trauma group: -0.140, -0.885). The misclassification rate per department was 11.61% due to 28 cases of neurosurgery department, 8.82% due to nine cases of trauma surgery department, 2.7% due to one case of chest surgery department, and 2.5% due to one case of other department..

DISCUSSION

Trauma is one of the most common cause of death in Korea, as well as worldwide. Trauma deaths and disabilities of the working adults severely hinder the society and economy of the country [9]. Trauma life support is the key element for reducing this loss, thus advanced countries have developed various trauma systems for quick and effective trauma management [10,11]. The Korean government has established trauma system by designating regional trauma centers since 2012 and currently 17 centers are designated [12].

This trauma center was designated in 2016 and since then trauma surgeons have been on stand by for 24 hours a day, allowing trauma management within 10 minutes after arrival at ER. After designation, although major trauma patients with ISS higher than 15 have increased with statistical difference, there was no difference in time to emergency procedure or operation, and ER stay. Time interval to ICU has increased without statistical significance. Although trauma surgeons' decision making saved more time, the lack of trauma ICU, trauma ward, and trauma-designated personnel attributed to the delay. The department of neurosurgery (NS), and department of trauma surgery (TS) admitted 80% of all trauma patients. Time interval to ICU admission for NS, TS, and all, have increased (181.3 vs. 189.3 minutes, p=0.613; 180.5 vs. 183.3 minutes, 0.924; 219.5 vs. 237.1 minutes, p=0.662; respectively). ER stay of NS, and TS have also increased (180.2 vs. 189.7 minutes, p=0.601; 178.1 vs. 192.1 minutes, p=0.608; respectively). Cherry et al. [13] reported ER stay and length of stay have decreased after opening of trauma center. It is reported that the increase in ER stay has a negative effect on the prognosis of major trauma patients. This is more serious in intubated patients; thus, it is crucial to reduce the ER stay by installing trauma ICU and ward by proper establishment of trauma center [14].

Time interval to emergency procedure and operation is shorter than other Korean reports [15], which decreased after designation. This is different between departments. The time decreased in the department of TS (175.5 vs. 121.3 minutes, p=0.052) and chest surgery (175.6 vs. 164.4 minutes, p=0.849), while it increased in the department of NS (131.2 vs. 141.8 minutes, p=0.667). This may be due to the lack of trauma-designated surgeon in the department of NS, one of the key components of trauma center.

Before designation, expected survival rates by calculation of TRISS and actual survival rates were 84.8% to 86.8%, respectively, while the rates after designation were 82.9% and 85.1%, respectively. The W score and Z score before designation were 2.027 and 1.928, while the scores after designation were 2.186 and 2.189, respectively. The W scores were both positive and the Z score was better than 1.96. However, this was different when the analysis was done for each department. The data of NS department showed positive W scores, and Z score higher than 1.96 (pre-trauma group: 3.426, 2.335 vs. post-trauma group: 4.17, 1.967). The data of departments other NS showed positive W score after designation, but Z score lower than 1.96, demonstrating no significant treatment results (pre-trauma group: -0.358, -0.271 vs. post-trauma group: 1.071, 0.958) [16]. The data of TS department showed all negative W score and Z score (pre-trauma group: -0.333, -1.40 vs. post-trauma group: 0.140, -0.885). This analysis demonstrates no improvement of survival rates in other department than NS patients who've been good since the center selection. Lee et al. [17] reported early trauma team activation allowed early decision mak-

ing, but no improvement of survival rates in short term. Moreover, improvement of survival rates could not be expected with limited introduction of trauma system lacking manpower and facilities to already over-crowded ER. The lack of NS trauma surgeon, in which department the majority of major trauma patients are admitted, and the lack of trauma ICU, resulting in return of trauma patients to ER after procedure or operation, limited improvement of ER stays, time to ICU, and survival rates.

Regardless of trauma center opening, establishment of guideline and protocol by quality improvement is necessary. Mortality and morbidity are inevitable [18], improvement in patient management should be done, and change in survival rates should be checked few years later.

This study showed increased major trauma patients and overall survival rates, but no improvement time interval, or survival rates other than NS department. The reason is that the center has not been opened and the facilities for trauma or other specialists has not been increased. First, the facility for completion in 2019, which is scheduled for completion in 2019. Second, since the opening of the center cannot solve all problems, we need to revise protocols and guidelines for improving the trauma index through the activities of the quality improvement committee [19].

The limitations of this study are; first, the short duration of study and small number of patients; second, limited patient group who were admitted to a single hospital unrepresentative of the whole trauma population; and third, the limitation of RTS and TRISS scores for calculation of survival rates. GCS scoring has its inaccuracy done at ER and with intubated patients [20].

CONCLUSION

There were significant increases in patient numbers and improvement in survival rate after the introduction of the trauma system. However, there were no remarkable change in ER stay, time to ICU admission, time interval to emergent procedure or operation, and survival rates except neurosurgery. To achieve meaningful survival rates and the result of the rise of the trauma index, we will need to secure sufficient manpower, including specialists in various surgical area as well as rapid establishment of the trauma center. Furthermore, we should form process for effective trauma center management and continue to put our efforts in maximizing its capabilities.

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