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Original Article

Assessment of the Suitability of Trauma Triage According to Physiological Criteria in Korea

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ABSTRACT

Purpose: A trauma center project for treating patients with trauma has been established in Korea. A trauma team is activated based on the Centers for Disease Control and Prevention (CDC) field triage Step 1 for patient triage. Here, we determined if the currently applied criteria were appropriate for the triage of patients with trauma in Korea.

Methods: This retrospective study included patients who were taken to the regional trauma center from January 1, 2016 to December 31, 2019, and were registered in the Korean Trauma database. The rates for undertriage and overtriage were calculated from the in-field and in-hospital triage according to the CDC guidelines Step 1.

Results: Among the 9,383 patients transferred to the trauma center, 3,423 were directly transferred from the site and were investigated. The overall rates for undertriage and overtriage of these patients were 28.13% and 30.35%, respectively. For the patients who received in-field triage and were directly transferred to the trauma center, the rates for undertriage and overtriage were 27.92% and 32.39%, and 25.92% and 29.11% for in-hospital triage, respectively. The concordance rate of triage was 87.09%.

Conclusion: The current use of in-hospital triage physiological criteria as set out in the CDC guidelines Step 1, indicated an undertriage rate which was high and an overtriage rate within the acceptable range. Further studies on triaging patients with trauma are warranted. Improvements in the guidelines of the trauma center project are necessary and this needs to be supported by resources and training for field personnel.

Keywords: transportation, triage, wounds and injuries

Introduction

In Korea, a trauma center project was initiated 10 years ago, and the system for treating patients with trauma has been under development. Over the years, operating guidelines for regional trauma centers have been revised. One of the most important aspects of treating patients with trauma is ensuring access to an appropriate trauma center [1]. Triage constitutes the first step in treating patients with trauma and corresponds to classification of patient trauma according to the degree of urgency and priority of tasks. In Korea, triage tools have been developed and applied based on the guidelines established by the Centers for

Disease Control and Prevention (CDC). In addition, a trauma team is activated upon the arrival of patients with trauma at trauma centers to ensure immediate treatment. Triage tools are used to calculate the rates for undertriage and overtriage and evaluate the appropriateness of triage [2]. Generally in a trauma system, when defining an acceptable level of undertriage where a trauma patient is classified as not needing trauma center care when they subsequently require trauma care, and if determining the number of major trauma patients who were transported incorrectly to a non-trauma center with an injury severity score of ≥ 16, an undertriage rate of < 5% is acceptable [3]. An overtriage rate where a patient has been incorrectly classified as needing trauma center care (which was retrospectively determined as not needed) by using standard registry criteria to classify major trauma patients, an overtriage rate of < 35% is acceptable [3].

Presently, government assessments of the functioning of trauma centers involve the evaluation of whether trauma teams are activated based on in-hospital physiological criteria of patients according to the CDC guidelines Step 1. The original CDC guidelines recommended the application of field triage. Herein, the rates for undertriage and overtriage were calculated using in-field and in-hospital triage physiological criteria of patients. Furthermore, to determine whether triage was appropriately performed this was only evaluated when Step 1 guidelines had been applied.

Materials and Methods

This retrospective study included patients who visited the regional trauma center of Pusan National University Hospital from January 1, 2016 to December 31, 2019 and were registered in the Korean Trauma database (KTDB). Data regarding sex, age, vital signs in-field and in-hospital triage, Glasgow coma scale (GCS) scores, and injury severity score (ISS) were collated for all the patients.

The following Step 1 criteria of the application of triage according to the CDC guidelines were used to calculate the rates for undertriage and overtriage using the Cribari matrix: GCS ≤ 13, systolic blood pressure < 90mmHg, respiratory rate < 10 or > 29 breaths/minute, and requirement for ventilator support [4,5]. In-field triage, the mental status of patients with trauma was measured using the alert, verbal, pain, and unresponsive scale. Alert was included in the normal category and the remaining factors were included in the activation of the trauma team category. Severe trauma was defined as an ISS score of ≥ 16. All statistical analyses were performed using SPSS Version 22.0 (IBM Corp., Armonk, NY, USA).

The rates for undertriage and overtriage were calculated for all patients triaged in field or in hospital) who were taken to the trauma center from the values measured in hospital. The field values of patients who were transferred from other hospitals were difficult to determine. To investigate the necessity of a field triage and activation of a trauma team in advance, the rates for undertriage and overtriage were calculated separately for the patients who were transferred directly from the field. This study was approved by the institutional review board of Pusan National University Hospital (IRB no.: H-2008-006-093).

Results

In total, there were 9,383 patients in the KTDB of which 3,423 were transferred directly from the field to the trauma center and

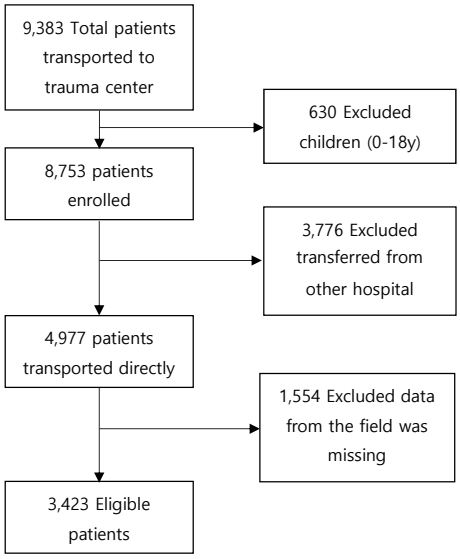

Figure 1. Flowchart of patient inclusion.

Table 1. Undertriage and overtriage rates of all patients transferred to the trauma center according to physiological criteria for triage.

	Overall	SBP	GCS	Respiration rate
Undertriage rate (%)	28.13	36.61	30.38	38.58
Overtriage rate (%)	30.35	37.22	23.95	36.14

GCS = Glasgow coma scale; SBP = systolic blood pressure.

Table 2. Comparison of in-field and in-hospital triage of patient transferred directly to the trauma center.

	Total	SBP	GCS	Respiration rate
In field				
Undertriage rate (%)	27.92	35.01	29.3	37.26
Overtriage rate (%)	32.39	43.13	26.21	60.63
In hospital				
Undertriage rate (%)	25.92	34.04	28.49	36.30
Overtriage rate (%)	29.11	35.58	25.23	45.30

GCS = Glasgow coma scale; SBP = systolic blood pressure.

Table 3. Concordance rate of the activation of the trauma team from the field or in hospital.

Trauma team	Activation in hospital	Activation not in hospital	Total	Concordance rate (%)*
Activation in the field (*n*)	618 (a)	194	812	
Activation not in the field (*n*)	248	2,363 (b)	2,611	
Total (*n*)	866	2,557	3,423 (c)	87

* Concordance rate: (a + b) / c.

were eligible for this study (Figure 1). The mean age of these patients was 59 years.

The triage rates of all the patients who were transferred to the trauma center irrespective of where the patients received triage are shown in Table 1. The undertriage rate was 28%, which was higher than the acceptable range of 5%. The overtriage rate was 30%, which was within the acceptable range of 25-35%, categorizing triage rates into in-field or in-hospital triage returned similar undertriage and overtriage rates (Table 2).

To determine whether activating the trauma team using in-hospital triage values or in-field triage values was different, comparisons were made and the concordance was determined. Upon evaluating whether the measured values met the activation criteria from in-field triage measurements and in-hospital triage measurements, a concordance rate of 87.09% (3,379/3,423) was obtained (Table 3).

Discussion

Several trauma centers worldwide, including those in Korea, are currently developing standards for activation of the trauma team and using the CDC field triage guidelines [6]. The CDC field triage guidelines are divided into four steps [1-4]. Step 1 comprise physiological criteria; Step 2, anatomical criteria; Step 3, injury mechanism; and Step 4, special considerations. The CDC field triage guidelines are applied by paramedics in the field to classify patients with trauma and determine the level of trauma center they need to be transferred to [4]. The present government-approved operational guidelines for trauma centers recommend activating the trauma team based on in-hospital physiological criteria of patients. Therefore, this study included the in-hospital triage vital signs of patients for determining whether the trauma team should be activated. Furthermore, to verify the CDC guidelines, the triage rates of the patients were investigated based on the field values.

In field and in-hospital measurements may exhibit differences depending on the treatment provided during transport. In patients with a low blood pressure in the field, the blood pressure may recover to some extent via fluid injection. Conversely, the blood pressure or mental status of patients may be within normal ranges in the field, but worsen during transport. In the former case, overtriage would be reported, and in the latter case, undertriage would be reported. Herein, for each item of systolic blood pressure, and respiration rate, in-hospital triage measurements seem to decreased overtriage rates compared with in-field triage measurements. This may be due to improvement in blood pressure or respiratory rate during transport or inaccurate in-field triage measurements.

In an undertriage case, the criteria for total activation of the trauma team, blood pressure, GCS, and respiratory rate were significantly higher than the acceptable value of ≤ 5%. The undertriage rate was around 28% for the total activation criteria. In Korea, the incidence of blunt trauma is relatively high [7]. If measurements, such as vital signs and GCS scores, are within normal ranges, injury is often not suspected in-field triage, thereby leading to undertriage [8,9]. Even in patients with high ISS scores, vital signs or GCS scores may be within the normal ranges. Moreover, undertriage is frequent among older patients [10]. Underestimating the possibility of severe trauma at initial evaluations of such patients does not allow for active resuscitation, thereby delaying diagnosis and increasing the incidence of morbidity and mortality.

Regarding the GCS scores, we expected low GCS scores owing to alcohol abuse in several patients, thereby increasing the overtriage rate. However, the overtriage rate was lower than the reference value even when evaluated using GCS scores alone. Therefore, in addition to considering the effects of alcohol abuse, evaluating changes in the mental status of these patients is necessary.

The measurement of respiratory rate is prone to numerous errors. We consider the respiratory rates to have been estimated in numerous cases rather than actually being measured. Even in trauma centers, the measured respiratory rate may not be accurate in many cases.

The purpose of triage is to allocate medical resources appropriately by excluding patients with minor trauma and not overlooking patients with severe trauma [11]. During undertriage, patients with severe trauma may be overlooked, delaying critical treatment, and increasing preventable mortality and complications. The main purpose of a trauma center is to ensure the proper management of patients to reduce such complications [12,13]. During overtriage, the use of medical resources for patients with minor trauma, can affect the

treatment of other severely injured patients who are more in need of specialized treatments [14]. Hence, undertriage should be minimized and overtriage can be allowed to some extent. In this respect, the results of the present study are not satisfactory.

Among the current trauma center evaluation guidelines established by the government, the criteria for activating the trauma team are based on in-hospital physiological criteria. Therefore, in this study, only Step 1 of the CDC field triage guidelines was applied. In Korea, as the implementation of the trauma treatment system is in its initial stage, some issues such as lack of human and other resources and a data management system, exist. Imparting knowledge regarding the trauma treatment system to paramedics is also necessary. From the perspective of the medical staff, most field measurements seem to be inaccurate, and data for Steps 2 and 3 are often insufficient. Field measurements and triage are included in the role of paramedics, and trauma centers should educate paramedics accordingly [15]. If the abovementioned issues are resolved in the future, the inclusion of Steps 2 and 3 of the CDC field triage guidelines, including anatomical criteria and mechanism of accidents, can be considered in the criteria for the activation of the trauma team, allowing the trauma team to be preactivated [16]. After adding Steps 2, 3, and 4 to the criteria, the overtriage rate is expected to increase and the undertriage rate is expected to decrease [6].

In this study, the rates for undertriage and overtriage were calculated using the in-field and in-hospital triage values. Additionally, the concordance rate of these values was calculated. However, there may be differences between the in-field and in-hospital data, and a high concordance rate does not signify that the data are good. To the best of our knowledge, no studies have calculated and compared concordance rates between in-field and in-hospital data. Therefore, it may not be possible to evaluate whether the concordance rate obtained in this study, i.e., 87%, is appropriate. Although the concordance rate cannot indicate the reliability of in-field measurements, a certain degree of concordance rate can provide evidence for preactivation based on field measurements.

A limitation of this study was that it was a retrospective, single-center study. Additionally, the possibility of measurement errors cannot be excluded. As this was a retrospective survey that used data registered in KTDB, confirming erroneous in-field measurements was not possible. There were many differences between the in-field and in-hospital values. Although alterations in patient conditions must be considered, errors in the measured values or database entries cannot be ignored. There were numerous omissions in the data obtained at the accident site due to their inapplicability, measurement impossibility, and measurement rejection by patients. To avoid errors in measurements, training of field personnel is necessary.

Conclusion

The results of the study revealed that the undertriage rate was high and the overtriage rate was acceptable when only the in-hospital physiological criteria corresponding to the CDC guidelines Step 1 were evaluated. Further studies on triaging patients with trauma are warranted. Furthermore, it is necessary to improve the guidelines for this trauma center project through additional human and other resources and training of field personnel.

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Author Contributions

Conceptualization: KGH, KJH and WIJ. Methodology: KHH and PCI. Formal investigation: KSH, LKH and WIJ. Data analysis: PSJ, LSB, RDY, KSH and LNH. Writing original draft: KGH. Writing - review and editing: KGH and KJH.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

Ethical Statement

This research did not involve any human or animal experiments.

Data Availability

All relevant data are included in this manuscript.

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