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The Revised Trauma Score plus serum albumin level improves the prediction of mortality in trauma patients

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ABSTRACT

Introduction: The Revised Trauma Score (RTS) is used worldwide in prehospital practice and in the emergency department (ED) settings to triage trauma patients. The main purpose of this study was to evaluate the value of the RTS plus serum albumin (RTS-A) and to compare it with other existing trauma scores as well as to compare the predictive performance of the Trauma and Injury Severity Score with the RTS-A (TRISS-A) with the original TRISS.

Methods: This was a single center, trauma registry based observational cohort study. Data were collected from consecutive patients with blunt or penetrating injuries who presented to the emergency department of a tertiary referral hospital, between January 2012 and June 2016. 3145 and 2447 patients were assigned to the derivation group and validation group, respectively. Main outcome was in-hospital mortality.

Results: Among patients in the derivation group, the median [interquartile range] age was 59 [43–73] years, and 66.7% were male. The area under the receiver operating characteristic curves (AUC) of the RTS-A (0.948; 95% CI: 0.939–0.955) was higher than that of the RTS (0.919; 95% CI: 0.909–0.929). In patients with blunt trauma, the AUC of the TRISS-A (0.960; 95% CI: 0.952–0.967) was significantly higher than that of the original TRISS (0.949; 95% CI: 0.941–0.957).

Conclusion: The value of the RTS-A predicts the in-hospital mortality of trauma patients better than the RTS, and the TRISS-A is a better mortality predictor compared to the original TRISS in patients with blunt trauma.

1. Introduction

The Revised Trauma Score (RTS) is used worldwide in prehospital practice and in the emergency department (ED) settings to triage trauma patients. The RTS is composed of physiological patient parameters: systolic blood pressure (SBP), respiratory rate (RR), and the Glasgow Coma Scale (GCS) [1]. While those parameters are easily obtainable during the early phase of trauma, the RTS almost always yields definite scores that guarantee clear decisions in triage settings. Whereas the physiological scoring system is readily influenced by many external and internal factors, it can produce many false positives. Because there was a need for a more accurate prediction of survival of trauma patients, the Trauma and Injury Severity Score (TRISS) was developed from the Major Trauma Outcome Study (MTOS). The TRISS consisted of the RTS, Injury Severity Score (ISS), mechanisms of injury and age [2]. It showed a better predictive power of the survival of trauma patients than the RTS and remains the most prominent survival predictor in research for the quality control of trauma management and prevention.

The BIG score (Admission base deficit, International normalized ratio, and Glasgow Coma Scale) was developed to predict trauma mortality in children [3]. The BIG showed a good predictive performance in the adult trauma population [4]. The emergency trauma score (EMTRAS) is a validated trauma score using age, GCS, and the initial results of base excess and prothrombin time [5,6]. Both scoring systems were focused on quick triage in the early period of trauma management and included biochemical markers to improve the predictive ability.

Hypoalbuminemia has been shown to be closely related to adverse outcomes in various medical and surgical settings [7–10]. The most convincing explanation is that hypoalbuminemia is caused by a condition of protein-energy malnutrition (PEM); PEM contributes to impaired wound healing, increased susceptibility to infection, multiorgan dysfunction, prolonged hospitalization, and in-hospital mortality [11]. Practically, the patients with chronic underlying diseases, such as cancer, liver cirrhosis, or chronic renal failure, showed poorer clinical outcomes than previously healthy patients [12-15]. In other words, the serum

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albumin level represents the status of a patient's chronic illness, nutrition, and immunocompetence. We postulated that the serum albumin level may provide an important clinical insight on the prognosis of trauma victims, and the additive value of serum albumin levels combined with the RTS may improve the predictive power of the RTS. Furthermore, the predictive performance of the original TRISS may be improved when the singular value of the RTS was replaced with the value of the RTS and serum albumin.

1.1. Goals of This Investigation

The purposes of this study were to evaluate the predictive performance of a value of the RTS plus serum albumin (RTS-A) and the TRISS using the RTS-A (TRISS-A) as well as to compare these scores with the RTS, the BIG, the EMTRAS, and the TRISS.

2. Materials and methods

2.1. Study design and setting

This is a prospectively recorded registry-based observational study using data from the trauma registry of a tertiary hospital located in Jinju, Republic of Korea. Our hospital is the only tertiary referral hospital, not a specialized trauma facility, located in the southcentral region of the Republic of Korea covering a relatively small area of 70 km in radius. The annual ED census is approximately 33,000. The Gyeongsang National University Hospital Trauma Registry has been established as a part of the National Emergency Department-based Injury In-depth Surveillance funded by the Korea Centers for Disease Control and Prevention. The registry enrolls all injured patients who presented to our ED. The enrolled patients are categorized by mechanism of injury: blunt, penetrating, thermal, asphyxia, poisoning, and others. A total of 240 items were prospectively recorded from the prehospital period to the hospital discharge. Items included demographic characteristics, initial physiological parameters, initial laboratory findings, the results from ED management, and the results from hospital admission. Most of the data were abstracted from the electronic medical records in our hospital. Initial systolic and diastolic blood pressure, heart rate (HR), RR, body temperature, the GCS were collected from ED triage records after being entered by the triage nurses. Abbreviated Injury Scales (AIS) were recorded according to clinical presentation, imaging results, intervention findings and operative records. The RTSs and the ISSs were automatically calculated and were recorded in the registry. Injury descriptions were preliminarily prepared by professional heath information managers and were reviewed by emergency physicians before final confirmation.

2.2. Participants and data collection

We used consecutive data from January 2012 to June 2014. Inclusion criteria were an age of 15 years or older, blunt or penetrating mechanism, ISS ≥ 1, and the results from ED management were either admission or death during the ED stay. We did not include patients who were dead on arrival or those who were discharged or transferred from the ED. Demographic characteristics, physiological parameters, international normalized ratios of prothrombin time (PT_{INR}) and percent of the reference value of prothrombin time ($PT_{PERCENT}$), base excess (BE) levels, and serum albumin levels (gram/deciliter) were collected. The EMTRAS, the BIG, and the TRISS were calculated for each patient. In-hospital mortality was the outcome measure. For validation of the final predictive model, we used the data from the same registry from July 2014 to June 2016. This study was approved by the Gyeongsang National University hospital institutional review board.

2.3. Statistical analysis

Multivariate imputation with chained equations using predictive mean matching was used to control for the missing data [16]. The missing values included the PT_{INR} (4.6%), $PT_{PERCENT}$ (4.3%), BE (10.1%), albumin (4.3%), and the GCS (0.1%). All variables which were needed for the trauma scores as well as sex, age, SBP, HR, RR, ISS, and the outcome variable, which was death, were included in the imputation. Ten imputations were performed and the mean values of PT_{INR}, $PT_{PERCENT}$, BE, albumin, and the GCS replaced the missing values. Complete scores of the RTS, the EMTRAS, the BIG, the TRISS, and the RTS-A were calculated with the imputed data set. The same procedure was performed with the validation group.

To verify the adequacy of the RTS-A score in the prediction of in-hospital mortality, we compared the RTS-A with two multivariable logistic regression models. First, after confirmation of the statistical significance of all the variables (age, sex, mechanism, PT_{INR}, $PT_{PERCENT}$, BE, albumin, and the RTS) with the univariable analysis, a multivariable analysis was performed with all significant parameters (model 1). The ISS was not included in the analysis due to its lack of availability during the early phase of treatment. Second, a multivariable analysis was conducted using albumin and the RTS (model 2). Third, we added the RTS score and the serum albumin level (model 3), then compared the area under the receiver operating characteristic curves (AUC) of the three models using a nonparametric method [17]. While model 3 was far easier to calculate than either model 1 or model 2, because there were no statistical significances between the models, it was appropriate to choose model 3.

The predictive properties of the value of the RTS-A were evaluated with a receiver operating characteristics (ROC) for discrimination and

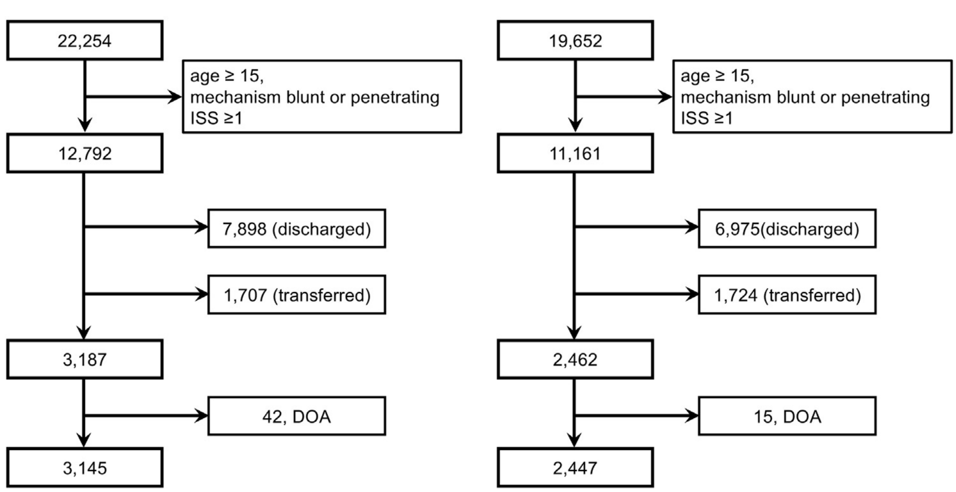

Fig. 1. Derivation and validation cohort.

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