ORIGINAL RESEARCH

Acute Physiology and Chronic Health Evaluation (APACHE) III Score compared to Trauma-Injury Severity Score (TRISS) in Predicting Mortality of Trauma Patients

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Abstract

Introduction: More than 50 scoring systems have been published for classification of trauma patients in the field, emergency room, and intensive care settings, so far. The present study aimed to compare the ability of trauma injury severity score (TRISS) and acute physiology and chronic health evaluation (APACHE) III in predicting mortality of intensive care unit (ICU) admitted trauma patients. **Methods:** This prospective cross-sectional study included ICU admitted multiple trauma patients of Imam Hossein and Hafte-Tir Hospitals, Tehran, Iran, during 2011 and 2012. Demographic data, vital signs, mechanism of injury and required variables for calculating APACHE III score and TRISS were recorded. The accuracy of the two models in predicting mortality of trauma patients was compared using area under the ROC curve. **Results:** 152 multiple trauma patients with mean age of 37.09 ± 14.60 years were studied (78.94% male). 48 (31.57%) cases died. For both APACHE III and TRISS, predicted death rates significantly correlated with observed death rates ($p < 0.0001$). The mean age of dead patients was 37.21 ± 14.07 years compared to 37.03±14.96 years for those who survived ($p = 0.4$). The area under ROC curve was 0.806 (95% CI: 0.663-0.908) for TRISS and 0.797 (95% CI: 0.652-0.901) for APACHE III ($p = 0.2$). **Conclusion:** Based on the results of this study, both TRISS and APACHE models have the same accuracy in predicting mortality of ICU admitted trauma patients. Therefore, it seems that TRISS model would be more applicable in this regard because of its easier calculation, consideration of trauma characteristics, and independency of patient care quality.

Keywords: Trauma severity indices; APACHE; injury severity score; multiple trauma

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Introduction:

A trauma-scoring system converts the severity of injury into a number (1). Scoring systems have been continuously developed to predict outcomes in patients with severe illness, improve resource allocation, and assist in clinical decision-making (2-4). Moreover, the ability to predict the outcome of trauma (i.e., mortality) is perhaps the most fundamental use of injury severity scoring, which arises from the patients and their families' desires to know the prognosis (5). In recent years, several trauma scoring systems have been developed and validated for use in prediction of outcome, quality assurance and research (6). Characterization of injury severity emerged in the 1950s. More than 50 scoring systems have been published for the classification of trauma patients in the field, emergency room, and intensive care settings, so far (5). There are three main groups of scoring systems for risk prediction in trauma patients. Anatomical scores, which provide an overall score based on grades of multiple injuries; physiological scores are calculated by evaluating the physiological variables of the patient without considering the anatomical injuries; and comorbidity scores that assess both anatomical injury variables and physiological parameters to increase the predictive power (5, 7). Trauma Injury Severity Score (TRISS), the most widely used combined system,

provided improvements in the ability to predict outcome after trauma (1). TRISS method had its inception in 1981, followed by further consolidation of the concept with the Major Trauma Outcome Study. This method provided improvements in the ability to predict trauma outcome, especially mortality, and therefore acquired worldwide popularity despite its limitations being recognized later (1).

The need to collect information on patients in the intensive care units (ICU) and use that information to improve outcomes, led to the development of Acute Physiology, Age, and Chronic Health Evaluation system, known by its acronym APACHE (8). In 1991 APACHE III was introduced, which consisted of a set of equations for predicting hospital mortality, ICU mortality, hospital length of stay, ICU length of stay, risk of active treatment, duration of mechanical ventilation, and Therapeutic Intervention Scoring System (TISS) (8). Practitioners do not widely accept APACHE III, partly because it is proprietary and expensive. In addition, its accuracy needs to be validated in trauma patients (1). Therefore, the aim of this research was to assess the ability of TRISS and APACHE III in predicting mortality rate of multiple trauma patients.

Methods:

Study design and setting

This prospective cross-sectional study included 152 multiple trauma patients admitted to the ICU of Imam Hossein and Hafte-Tir Hospitals, Tehran, Iran, in 2011 and 2012. Patients younger than 14 years old and those who died within less than 4 hours of arrival in ICU were excluded. Each patient's demographic data, vital signs (systolic blood pressure (SBP), heart rate, respiratory rate (RR)), mechanism of injury, level of consciousness (based on Glasgow coma scale (GCS)), and other required variables for calculation of TRISS and APACHE III scores were recorded. TRISS combines physiologic (Revised Trauma Score: RTS) and anatomic (Injury Severity Score: ISS) components of injury with age (9). Data collected on admission to the emergency department, were used for calculation of RTS and ISS. The protocol of this study was approved by the Ethical Committee of Shahid Beheshti University of Medical Sciences. The authors adhered to confidentiality of patient information during the study period.

Definitions:

RTS: RTS is the sum of the coded value multiplied of GCS, SBP, and RR (6). It is calculated by the following formula (6):

RTS = 0.9368 GCS +0.7326 SBP +0.2908 RR

RTS values range from 0 to 7.84.

ISS: ISS is an index of severity and location of anatomy injury. It correlates reasonably well with mortality probability, and is calculated by adding the square of each of the coded values of the three most severely injured body regions and has a range from 0 to 75. RTS, ISS, and patient age, were placed in a logistic transformation to yield a survival probability (P_s) ranging from 0 to 1 and death probability (POD) is 1-P_s.

APACHE: APACHE III scores were calculated for each patient from data collected during the first 24 hours of ICU admission. The APACHE III score consists of several parts including the primary reason for ICU admission, age, sex, race, preexisting comorbidities, and location prior to ICU admission (10). The range of APACHE III score is from 0 to 299 points.

Statistical analysis

Data were analyzed using SPSS 21 software. Continuous variables were expressed as mean ± standard deviation and categorical ones were expressed in frequencies and percentages. The area under the ROC curve for each scale was used to compare the accuracy of the studied models (11). Chi square and Fisher exact test were used to compare categorical measures and student's *t*-test was used to compare means. $P > 0.05$ was considered as statistically non-significant.

Results:

152 multiple trauma patients were studied. 120 of them were male (78.94%) and 32 (21.05%) were female. Mean age was 37.09 ± 14.60 years (range: 16-70 years). The most common cause of trauma was traffic accidents involving: pedestrian-car accidents (23.36%), car-car accidents (17.76%), motorcycle-car accidents (14.47%), Car rollover (11.84%), pedestrian- motorcycle accidents (9.21%) and Motor rollover (2.06%). The others were falling down (16.44%), assault (3.64%) and hanging (1.31%). In the end, 48 (31.57%) died (75% male). For both APACHE III and TRISS predicted death rates significantly correlated with observed death rates ($p < 0.0001$). The mean age of dead patients was 37.21 ± 14.07 years compared to 37.03±14.96 years for those who survived ($p = 0.4$). Table 1 compares alive and dead patients' trauma severity based on ISS, RTS, TRISS, and APACHE III scores. The area under ROC curve was 0.806 (95% CI: 0.663-0.908) for TRISS and 0.797 (95% CI:

Table 1: Comparison of alive and dead patients' trauma severity based on ISS, RTS, TRISS and APACHE III scores

Scores*	Alive (n=104)	Dead (n=48)	p-value
Injury severity score (ISS)	37.88 ± 12.77	50.69 ± 11.61	<0.0001
Revised trauma score (RTS)	6.71 ± 1.18	5.52 ± 1.33	<0.0001
Trauma injury severity score (TRISS)	25.36 ± 24.80	56.01 ± 32.30	<0.0001
APACHE III	41.92 ± 22.67	70.04 ± 24.48	<0.0001

*Mean ± standard deviation; APACHE: acute physiology and chronic health evaluation.

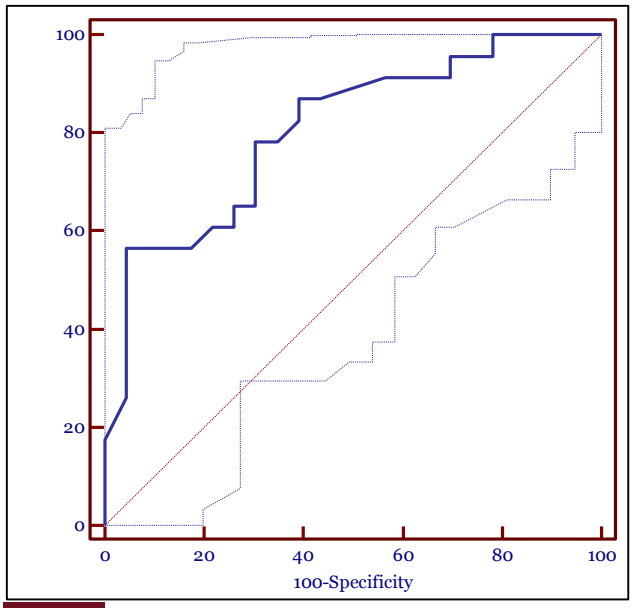

Figure 1: Receiver operating characteristic (ROC) curve for TRISS model.

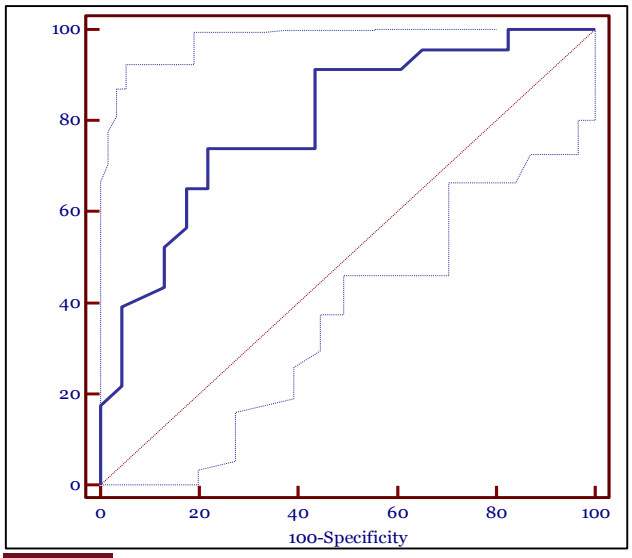

Figure 2: Receiver operating characteristic (ROC) curve for APACHE III model.

0.652-0.901) for APACHE III (Figure 1 and 2, p = 0.2). The best cut-off points for mortality prediction were 13.2 (sensitivity = 76.52%; specificity = 95.65%) and 51 (sensitivity = 73.91%; specificity = 78.26%) for TRISS and APACHE III, respectively.

Discussion:

According to results of our study, both TRISS and APACHE III scores accurately predict mortality of multiple trauma patients. The area under ROC curve for TRISS and APACHE III were not significantly different (p = 0.2), which means they are equally accurate in this regard.

There are several scoring systems and prognostic models in general use for outcome prediction in hospitalized patients. The rationale behind using these scales commonly, is to rate illness severity to yield comparison between patients (12, 13). Objective risk estimates are particularly important in the high-cost, emotional, and technologically demanding environments of ICU. Because of the high costs of ICU, precise quality assurance and utilization management strategies are essential (10). Outcome prediction systems have become key tools to evaluate the care quality and the ICU performance. TRISS and APACHE III are two systems currently in common use for measuring the condition of ICU patients (14). TRISS has been used in quality assurance programs for evaluating trauma care and identifying unexpected deaths (15, 16). It has been widely used in outcome prediction of trauma patients. The basis for the development of APACHE is the hypothesis that the severity of acute diseases can be measured by quantifying the degree of abnormality from multiple physiologic variables (17). The development of APACHE III was based on the association between acute changes in a patient's physiologic balance and short-term risk of death (10). APACHE III is widely used to assess illness severity of patients admitted to ICU and to compare risk-adjusted outcomes between ICUs. Age, level of consciousness, biochemical, physiological, and chronic health variables in the first 24 hours of ICU admission are incorporated into the score (18).

In line with the findings of the present study, Thanapaisal and Saksaen declared the ability of TRISS system in predicting mortality in intensive care unit (ICU) trauma patients (18). Safavi and Honarmand found that APACHE III provides more information than APACHE II regarding determining factors of trauma severity (19). Knaus et al. found that the overall explanatory power of APACHE III on the first day of ICU treatment (r^2 = 041 and ROC = 0.90) compares well to that of previous versions of APACHE (10). However, in contrast to our results, some showed that Trauma Score or ISS did not predict survival (20). Vassar et al. evaluated the ability of TRISS to predict mortality in 1,000 ICU admitted trauma patients and reported that TRISS overestimates mortality in patients whose predicted risk ranges were high (21). Likewise, Wong et al. (1996) found that TRISS was a poor predictor of hospital death risk among ICU admitted trauma patients (22).

It seems that, TRISS has several advantages over APACHE for application on trauma patients. First, TRISS has a detailed description of severity and location of anatomic injury, but APACHE does not include an assessment of trauma mechanism or the specific anatomical injury. Second, APACHE assesses the most abnormal physiologic data in the first 24 hours and is highly dependent on the quality of care given to the patient. Third, TRISS is easier to calculate than APACHE. The results of our study

give us the support to use both combined scores for mortality prediction in critically ill trauma patients. However, the simplicity of TRISS calculation makes it easier and more applicable than APACHE III (23, 24).

Conclusion:

Based on the results of this study, both TRISS and APACHE models have the same accuracy in predicting mortality of trauma patients. Therefore, it seems that TRISS model would be more applicable in this regard because of its easier calculation, consideration of trauma characteristics, and independency of patient care quality.

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