Comparison of Shiraz Trauma Transfusion Score (STTS) Potency With Common Scoring Systems for Trauma in Predicting the Short and Long Term Mortality of Injured Patients

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Abstract

Background and Objective: Trauma is the leading cause of death in people under 40 years of age worldwide. Various studies have been conducted focused on reducing the annual mortality rate due to trauma. One of the most important measures is reducing the time between the incident and the treatment set up, therefore the estimation of the severity of trauma and progressing to mortality before further evaluation is justified. In this study, we aim to compare different trauma scoring systems (such as GAP, MGAP, RTS, TRISS) with a relatively new model – Shiraz Trauma Transfusion Score (STTS) – and to describe the best qualities of these scoring systems for trauma patients in short (less than 24 hours) and long (more than 24 hours) term.

Methods: In this cross-sectional study, data from hospitalized trauma patients in Rajaei hospital (center B) of Shiraz, Iran from May to November 2016 were collected and analyzed. Collected data consisted of age, sex, hospital admission duration, mechanism of trauma along with clinical data for calculating different trauma scoring systems, were recorded.

Results: while RTS and STTS were the best predictors of mortality in trauma patients in the first 24 hours (sensitivity of 100.00%), GAP and MGAP were the best predictors of the patients' survival (specificity of 93.83% and 92.59%). GAP and ISS were the best predictors of mortality in trauma patients for more than 24 hours (sensitivity of 82.02%). On the other hand, TRIS and RTS were the best predictors of patients' survival (specificity of 82.59% and 80.26%).

Conclusions: Our study findings suggest that the utility and applicability of Shiraz Trauma Transfusion Score(STTS) in predicting mortality is not only comparable with other commonly used scoring methods but it may be of more value in shortterm mortality prediction.

Background

Trauma is one of the most important causes of death which accounts for 1 out of 10 mortalities worldwide¹. This matter is definitely a time-sensitive state which means that the more rapidly the patients receive appropriate treatment, the outcome will improve significantly². Hence, assessment, management, and a definitive treatment could decrease short term and long term physical and psychological complications as well as mortality³. One of the best tools which help the trauma centers and health care providers to assess and treat trauma patients as fast as possible is trauma scoring systems, which were initially created for field triage in the late 1960s and early 1970s⁴. Since then, prognostic scores have been changed and modified to predict outcomes more accurately, but the complexity of these systems and the need for laboratory tests and imaging information have restricted their effectiveness in emergencies⁵.

Numerous systems have been suggested for the evaluation of trauma patients. One of the very first scoring systems which were introduced to determine the overall severity of trauma patients was the Abbreviated Injury Scale (AIS)⁶ which was modified to AIS-85 and AIS-90 over time⁷. Since then, many other scoring systems such as Injury Severity System (ISS), Trauma Injury Severity score (TISS), A Severity Characterization of Trauma (ASCOT), New Injury Severity Score (NISS), and the Harborview Assessment of Risk of Mortality (HARM) have been introduced. Recently, MGAP (Mechanism, Glasgow Coma Scale, Age, and Systolic Blood Pressure) and

Revised Trauma Score (RTS) which includes Glasgow Coma Scale (GCS), systolic blood pressure, and respiratory rate were introduced and shortly became the most commonly used methods in emergency departments ^{8,9}.

Various studies have demonstrated some of the limitations of these methods which would affect their accuracy in predicting the prognosis of traumatic patients ⁵. This study aimed to compare a newly introduced scoring system named STTS (Shiraz Trauma Transfusion Score) with the current trauma scoring systems including RTS, ISS, GAP, MGAP, and TRISS in short and long term prognosis of hospitalized traumatic patients in Shiraz Rajaei hospital.

Methods

In this retrospective observational study, 1254 hospitalized patients with trauma in Rajaei hospital (center B) of Shiraz (Iran) from May to November 2016 were enrolled. Sampling was performed using the census method. The inclusion criteria for this study included age more than 16 years, ISS score at least 8, and admission to the hospital for at least one day. Patients who died on the scene and those who had defective or incomplete information were excluded from the study.

The information including age, sex, hospital admission duration, discharge condition (live or dead). also, Systolic Blood Pressure (SBP), Respiratory rate (RR), Glasgow Coma Scale (GCS), mechanism of trauma, and ISS were recorded in order to calculate different trauma scoring systems. The trauma scoring systems which was included in this study ISS, GAP, MGAP, TRISS, RTS, along with our scoring system.

Some of these methods are used for physiological assessment (systolic blood pressure, GCS, respiratory rate or need for ventilator support) and some for anatomical considerations (penetrating injury to the head, neck, thorax, and extremities, chest wall instability or deformity, amputation proximal to the wrist or ankle, pelvic fracture, open or depressed skull fracture, and paralysis) of patients as demonstrated in Table 1.

[INSERT TABLE 1]

Injury Severity Score (ISS) can be considered as an anatomical scoring system derived from Abbreviated Injury Scale (AIS) which divides the body into 5 regions, including the head and neck, face, chest, abdomen, extremity, and external organs. The minimum and maximum ISS are 3 and 75, respectively

The New ISS score used in New TRISS takes the three most serious injuries (highest three scoring from any of the nine AIS regions(2005/2008 update)) in calculating the severity of trauma, irrespective of body region affected ^{10,11}.

The GAP and MGAP scores can accurately predict the mortality rate of trauma patients in the hospital. These were calculated as follows ¹²: $GCS + Patient\ age + Systolic\ BP + (Mechanism\ of\ trauma)$.

The revised trauma score (RTS) is a physiologic-based triage score that was derived from two earlier versions of triage scores, the Triage Index and the Trauma Score. RTS is the sum of respiratory rate, systolic blood pressure, and GCS ¹³. Trauma and injury severity score (TRISS), introduced in 1981, is a combination index based on RTS, ISS, and patient's age ¹⁴.

STTS (Shiraz Trauma Transfusion Score) includes the patients' health status before the trauma, blood pressure, heart rate, Hemoglobin level, and base excess. Using STTS is possible after hydrating the patients with 2 liters of crystalloids. According to this scoring system, patients are divided into three groups: Multiple traumas with and without brain injury and penetrating trauma which is demonstrated in Table 2.

[INSERT TABLE 2]

To evaluate c-statistic and therefore, the discrimination of the model, we used Receiving Operating Curves (ROC) evaluating the area under the curve (AUC) and its 95 % confidence interval (CI). The area under the ROC curve was calculated in a variety of trauma scoring systems for both short- and long-term death and then analyzed. Statistical analysis was performed using SPSS software version 20 and Logistic regression, t-test, and descriptive statistics, and ROC graphs.

Results

In this study, 1254 hospitalized trauma patients in Rajaei hospital (center B) of Shiraz (Iran) from May to November 2016 were enrolled. 826 patients were excluded from the study due to lack of the required criteria (Reasons for exclusion: 98 patients death, 90 patients less than 1 day of hospitalization, 648 patients with ISS less than 8). Patient characteristics are demonstrated in Table 3.

[INSERT TABLE 3]

The most important causes of trauma in patients are described in Table 4. Road accidents (cars and motorcycles) have been the main causes of trauma in this study.

[INSERT TABLE 4]

The area under the ROC curve in different trauma scoring systems for short and long term death was calculated and analyzed.

Comparison of different trauma scoring systems during the first 24 hours (short term):

The area under the curve of the GAP index in the shortterm death diagnosis was 0.938. GAP index less than 17 could perfectly identify 88.89% of the deaths and 93.83% of the survivors. The area under the curve of the MGAP index in the shortterm death prognosis was 0.926. GAP index less than 21 can perfectly identify 88.89% of deaths and 92.59% of the survival cases. The area under the curve of the RTS index in the short term death prognosis was 0.942. At the cutoff point of 6.9, the GAP index could perfectly diagnose all of the deaths and 80.25% of the survival cases. The area under the curve of the TRISS index in the short term death prognosis was 0.826. At the

cutoff point of 0.99, the TRISS index could perfectly detect 77.78% of the deaths and 84.48% of the survival cases. The area under the curve of the ISS index in the short term death prognosis was 0.847. ISS index at the injury severity of more than 13 could rightly detect 66.67% of the death and 87.65% of survival cases. The area under the curve of the STTS index in the short term death prognosis was 0.773. ISS index at the cutoff point of 4 could truly distinguish all of the death and 40.74% of survival cases. (Figure 1.)

[INSERT FIGURE 1]

Table 5 displays the area under the curve, sensitivity, specificity, and cut off point for each scoring system's short term prognosis. RTS and STTS were the best predictors of mortality in trauma patients in less than 24 hours. On the other hand, GAP and MGAP were the best predictors of the patients' survival with a specificity of 93.83% and 92.52%, respectively.

[INSERT TABLE 5]

Comparison of different trauma scoring systems after the first 24 hours (long term):

The area under the curve of the GAP index in the longterm death prognosis was 0.847. GAP index less than 21 could rightly detect the mortality and survival as 82.2% and 67.88%, respectively. The area under the curve of the MGAP index in the long term death prognosis was 0.765. MGAP index less than 23 could rightly detect mortality and survival as 61.80% and 79.61% respectively. The area under the curve of the RTS index in the long term death prognosis was 0.693. RTS index less than 7.11 could rightly detect mortality and survival as 53.93% and 80.26%, respectively. The area under the curve of the TRISS index in the long term death prognosis was 0.636. TRISS index less than 0.9957152 could rightly detect mortality and survival as 51.69% and 82.59%, respectively. The area under the curve of the ISS index in the long-term death prognosis was 0.77. ISS index more than 5 could rightly detect mortality and survival as 82.02% and 61.08%, respectively. The area under the curve of the STTS index in the long term death prognosis was 0.77. STTS index more than 6 could rightly detect mortality and survival as 48.31% and 82.12%, respectively. (Figure 2.)

[INSERT FIGURE 2]

Table 6 represents the area under the curve, sensitivity, specificity, and the cut-off point for each scoring system's long term prognosis. GAP and ISS were the best predictors of mortality in trauma patients in more than 24 hours. On the other hand, TRIS and RTS were the best predictors of the patients' survival with a specificity of 82.59% and 80.26%, respectively.

[INSERT TABLE 6]

Discussion

A scoring system should fulfill certain criteria including precision, credibility, and specificity, in order to serve as a useful tool in quality improvement and prevention programs as well as competency to predict the outcome from trauma and comparing therapeutic methods.

In 2016, Trauma Research Center, Shahid Rajaei (Emtiaz) Trauma Hospital developed A Scoring System for Blood Transfusion in Trauma Patients which was named Shiraz Trauma Transfusion Score (STTS)¹⁵. In this score, patients are categorized based on the mechanism of injury they endure. In recent years, this scoring method was observed to be a valid mortality predictor for major trauma patients. The goal of our study is to compare the STTS (Shiraz Trauma Transfusion Score) with the current trauma scoring systems in the short and long-term prognosis of hospitalized traumatic patients in Shiraz Rajaei hospital. Over the years, many scoring systems were presented including RTS, ISS, GAP, MGAP, and TRISS which aimed to predict short- and long-term prognosis of injured individuals.

The revised trauma score (RTS) was first introduced in the 1980s and is considered to be one of the most commonly used psychological scores¹⁶. The coded form of RTS ($RTS = 0.9368 \text{ GCS} + 0.7326 \text{ SBP} + 0.2908 \text{ RR}$) is more often used to evaluate patient outcome. This scoring method has certain disadvantages including the inability to access intubated patients and also since the calculation of the coded form of RTS is not practical, it could limit its usage in field triage. Mortality prediction may be considered the most fundamental use of injury scoring. The overall accuracy of RTS in predicting mortality was reported to be higher than other scores^{17,18} as we mentioned in our results. RTS performance in short term mortality prediction was acceptable but in long term, it fails to predict accordingly.

New Injury severity score (NISS) is an anatomical scoring system that delivers an overall score for trauma patients. Since this score is produced by the summation of scores from the 3 most injured body regions several limitations were reported regarding underestimating patients' condition¹⁹⁻²¹. Although ISS used an older version of AIS in which 5 body regions were evaluated. In comparison to STTS, ISS could determine mortality more accurately but in predicting the survival rate, ISS did not provide acceptable results.

GAP and MGAP scoring systems are considered as one of the more recent and reliable scoring systems available up to date. In our results, GAP performed well in predicting mortality, with areas under the ROC curve of approximately 84%, but MGAP did not perform well in predicting mortality. In terms of longterm and short-term mortality prediction, various studies were conducted. In this study GAP and MGAP performed equally with almost 88% sensitivity in short term prediction, however, in long term prediction GAP was more sensitive than MGAP.

Sartorius et al. investigated the MGAP mortality prediction value in prehospital patients and demonstrated that this scoring system is more accurate and specific in prehospital triage than triage Revised Trauma Score and Revised Trauma Score²². In a study conducted by Yutaka et al. regarding the prediction of in-hospital mortality in the emergency department, the GAP scoring system is considered to be more applicable in the clinical setting and MGAP is suggested to be a scoring system targeted for use in ED than prehospital setting but since its data comes from mobile ICUs their prediction model should deal with ED prediction as well²³. Regarding the long term prediction value of these two models, Yadollahi reported that both systems' performances were acceptable²⁴.

TRISS is a commonly used trauma scoring method in evaluating the trauma outcome; it defines the probability of survival and is used as a standard for evaluating the quality of trauma care in hospitals. TRISS was reported to

have good discrimination with inadequate calibration particularly in blunt trauma in the Spanish ICU Trauma Registry ²⁵ and in another study, this scoring method failed to meet the acceptable thresholds for both model calibration and discrimination ²⁶. in our study, this method seemed to be more sensitive in short term mortality prediction. Domingues, C. d. A. et al. presented three new variations of TRISS including New Trauma and Injury Severity Score (NTRISS)-like, TRISS SpO2, and NTRISS-like SpO2 which all of them had similar accuracy and discriminatory capacity however obtaining information from its components were reported to be more unchallenged which made them more functional and adaptable for local realities.

As was demonstrated in our results, at a cut-off point of more than four, STSS can identify 100% of mortality with a sensitivity of 100.00% and a specificity of 40.74% in short term prediction which seems to be a preferable system compared to GAP, MGAP, ISS, and TRISS. This analysis was register-based; therefore, the main limitation of this study was missing data.

This study was designed to compare STSS with the most commonly used scores in Iran which could be considered another limitation since some of these scores have been updated including ISS and TRISS.

Conclusion

Our study findings suggest that the utility and applicability of the Shiraz Trauma Transfusion Score (STTS) in predicting mortality is not only comparable with other commonly used scoring methods but it may be of more value in short term mortality prediction, in this regard, RTS was reported to be the next best scoring system available. GAP and ISS were observed to be the best predictors of longterm mortality.

Abbreviations

Abbreviated Injury Scale (AIS), Injury Severity System (ISS), Trauma Injury Severity score (TISS), A Severity Characterization of Trauma (ASCOT), New Injury Severity Score (NISS), and the Harborview Assessment of Risk of Mortality (HARM), Mechanism, Glasgow Coma Scale, Age (MGAP), Revised Trauma Score (RTS), Glasgow Coma Scale (GCS), Shiraz Trauma Transfusion Score (STTS), Receiving Operating Curves (ROC), evaluating the area under the curve (AUC), confidence interval (CI), Trauma and injury severity score (TRISS)

Declarations

Ethics approval and consent to participate

The ethics committee of Shiraz University of Medical Sciences approved this study. Patients' information was de-identified prior to data analysis and confidentiality of patient information was guaranteed and protected by recording only necessary information regarding this study.

Consent for publication

Not applicable.

Availability of data and materials

SPSS data of the participant can be requested from the authors. Please write to the corresponding author if you are interested in such data.

Competing interests

The authors declare that they have no competing interests.

Funding

None.

Authors' contributions

SV, HH, MK, and SP designed the study, HA collected the clinical data, HH and SK carried out the data gathering. AS, SP, MK carried out the statistical analysis. SP and SV drafted the manuscript while HH, SK and MK edited and prepared the final version of the article. All author proofread and approved the final version of the manuscript.

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Tables

Table 1. Anatomical vs. physiological scoring systems

Anatomical	Physiological
Injury Severity Score (ISS)	
New Injury Severity Score (NISS)	Revised Trauma Score (RTS)
Abbreviated Injury Score (AIS)	Triage-Revised Trauma Score (T-RTS)
Trauma-Related Injury Severity Score (TRISS)	Glasgow, Age, and Arterial Pressure Score (GAP)
	Mechanism, Glasgow, Age, and Arterial Pressure Score (MGAP)

Table 2. Shiraz Trauma Transfusion Score (STTS)

Mechanism	Score A	Pre-existing condition	Score B	B.P. ^c	Score C	P.R. ^d	Score D	Hb ^e	Score E	B.E ^f	Score F
mutiple trauma with brain injury	3	cardio vascular Dis ^a , Lung Dis	2	80<BP	4	PR>120	2	Hb<7	4	BE<-10	4
mutiple trauma without brain injury	2	D.M. ^b , old age	1	100>BP>80	2	120>PR>100	1	10>Hb>7	3	-10<BE<-6	2
penetrating trauma	1	Beta blocker / Anticoagulants	1	BP>100	0	PR<100	0	16>Hb>10	0	BE>-6	0

Dis^a :Disease; D.M.^b :Diabetes Mellitus; B.P.^c :Blood Pressure; P.R.^d :Pulse Rate; Hb^e :Hemoglobin level; B.E^f :Base Excess; Shiraz TraumaTransfusionScore (STTS)=A+B+C+D+E+F;No Transfusion if score is <5; TransfuseP.C. one by one if score is 5=<score<8; TransfuseP.C . two by two+1:1 FFP(or 2 gr Fibrinogen)+(1+1) TranexamicAcid if score=>8; If Hb>16 but TTS>5: continue resuscitation with crystalloids or colloids

Table 3. Basic patient characteristics

	Male	Female	Total
Number (%)	365 (87.3%)	53 (12.7%)	428 (100)
Age (SD)	35.19 (15.85)	39.34 (18.68)	35.72 (16.27)
Median of hospitalization days (min-max)	12 (1-431)	9 (1-69)	11 (1-431)
ISS (SD)	12.53 (5.09)	14.36 (6.32)	12.76 (5.28)

Table 4. The main causes of trauma

Cause of injury	Number (%)
Car accident	141 (33.7)
Motorcycle accident	102 (24.4)
Pedestrian accident	55 (13.2)
Fall	43 (10.3)
Quarrel	24 (5.7)
Corrosion knife	18 (4.3)
bullet Shot	6 (1.4)
Other	29 (6.9)

Table 5. The area under curve, sensitivity, specificity and the cut-off point for each scoring system in less than 24 hr (short term)

Score	Area under curve	Cutoff point	Sensitivity	Specificity	95% CI
RTS	0.942	≤ 6.9	100.00	80.25	0.871 to 0.980
GAP	0.938	≤ 17	88.89	93.83	0.866 to 0.978
MGAP	0.926	≤ 21	88.89	92.59	0.851 to 0.971
ISS	0.847	> 13	66.67	87.65	0.756 to 0.914
TRISS	0.826	≤ 0.9969745	77.78	81.48	0.732 to 0.898
STTS	0.733	> 4	100.00	40.74	0.629 to 0.820

Table 6. The area under curve, sensitivity, specificity and cut-off point for each scoring system in more than 24 hr (long term)

Score	Area under curve	Cut-off point	Sensitivity	Specificity	95% CI
GAP	0.807	≤ 21	82.02	67.88	0.784 to 0.830
ISS	0.771	> 5	82.02	61.08	0.746 to 0.795
MGAP	0.765	≤ 23	61.80	79.61	0.739 to 0.789
STTS	0.710	> 6	48.31	82.12	0.683 to 0.736
RTS	0.693	≤ 7.11	53.93	80.26	0.665 to 0.719
TRISS	0.636	≤ 0.9957152	51.69	82.59	0.607 to 0.664

Figures

Figure 1

Short-term Scoring systems charts. Most commonly used scoring systems charts demonstrating each system performance in less than 24 hours (short-term). (A) Short term RTS scoring system chart (B) Short term ISS scoring system chart (C) Short term MGAP scoring system chart (D) Short term GAP scoring system chart (E) Short term TRISS scoring system chart (F) Short term STTS scoring system chart

Figure 2

Long-term scoring systems charts. Most commonly used scoring systems charts demonstrating each system performance in more than 24 hours (long-term). (A) Long term RTS scoring system chart (B) Long term ISS scoring system chart (C) Long term MGAP scoring system chart (D) Long term GAP scoring system chart (E) Long term TRISS scoring system chart (F) Long term STTS scoring system chart