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Utilizing injury severity score, Glasgow coma scale, and revised trauma score for trauma-related in-hospital mortality and ICU admission prediction; originated from 7-year results of a nationwide multicenter registry

Armin Khavandegar[1], Vali Baigi[1,2], Mohammadreza Zafarghandi[1], Vafa Rahimi-Movaghar[1], Esmaeil Fakharian[3], Seyed Houssein Saeed-Banadaky[4], Vahid Hoseinpour[5], Homayoun Sadeghi-Bazargani[6], Akram Zolfaghari Sadrabad[7], Salman Daliri[8], Mehdi Nasr Isfahani[9,10], Vahid Rahmanian[11], Morteza Hemmat [12], Rahim Aali [13], Mohamad Kogani[14], Sobhan Pourmasjedi[1], Seyed Mohammad Piri[1], Sara Mirzamohamadi[1], Mahgol Sadat Hassan Zadeh Tabatabaei[1], Khatereh Naghdi [1], Payman Salamati[1]*

1. Sina Trauma and Surgery Research Center, Tehran University of Medical Science, Tehran, Iran.
2. Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Science, Tehran, Iran.
3. Trauma Research Center, Kashan University of Medical Sciences, Kashan, Iran.
4. Trauma Research Center, Rahnemoon Hospital, School of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.
5. Department of Emergency Medicine, school of Medicine, Urmia University of Medical Sciences, Urmia, Iran.
6. Road Traffic Injury Research Center, Tabriz University of Medical Sciences, Tabriz, Iran.
7. Clinical Research Development Center, Imam Reza Hospital, Kermanshah University of Medical Sciences, Kermanshah, Iran.
8. Clinical Research Development Unit, Imam Hossein Hospital, Shahroud University of Medical Sciences, Shahroud, Iran.
9. Department of Emergency Medicine, Faculty of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran.
10. Trauma Data Registration Center, Isfahan University of Medical Sciences, Isfahan, Iran.
11. Research Center for Social Determinants of Health, Jahrom University of Medical Sciences, Jahrom, Iran.
12. Saveh University of Medical Sciences, Saveh, Iran.
13. Department of Environmental Health, School of Health Research Center for Environmental Pollutants, Qom University of Medical Sciences, Qom, Iran.
14. Abadan University of Medical Sciences, Abadan, Iran.

***Corresponding author:** Payman Salamati; **Email:** psalamati@tums.ac.ir

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Abstract: **Objective:** During the past few decades, many scoring systems have been developed to evaluate the severity of injury and predict the outcome in trauma patients. This study aimed to assess the capacity of three common trauma scoring systems: injury severity score (ISS), Glasgow coma scale (GCS), and revised trauma score (RTS) in predicting in-hospital mortality and ICU admission in patients with traumatic injury.

Methods: This is a multicenter study of the hospital-based national trauma registry of Iran (NTRI), an ongoing registry-based trauma database. This study included trauma cases from 12 major trauma centers throughout the country admitted between July 2016 and November 2023. The inclusion criteria were all patients admitted to the emergency department due to trauma, hospitalized for at least 24 hours, deceased within the first 24 hours of admission, and patients transferred from the intensive care unit (ICU)s of other hospitals.

Results: A total of 50,458 traumatic patients, with 38,740 (76.9%) being male, were included in this study. After adjustment for confounders, head, face, and neck injuries were associated with the highest odds of death (OR: 7.51, P-value<0.001), whereas abdominal injuries were associated with the highest odds of ICU admission (OR: 4.58, P-value<0.001). Each Unit increase in RTS score was accompanied by a 61% decrease in odds of death (OR: 0.39, P-value<0.001). The area under the ROC curve for predicting in-hospital mortality was 0.81 (0.79 to 0.82) in ISS, 0.78 (0.77 to 0.80) in GCS, and 0.75 (0.73 to 0.76) in RTS. There was a significant difference between RTS and GCS, as well as RTS and ISS for in-hospital mortality prediction (P-values< 0.001). The area under the ROC curve for the prediction of ICU admission was 0.75 (0.74 to 0.75) in ISS, 0.63 (0.62 to 0.63) in GCS, and 0.62 (0.61 to 0.63) in RTS. There was a statistically significant difference between ISS and GCS, as well as ISS and RTS, for ICU admission prediction (P-value<0.001).

Conclusion: ISS is the best predictor of in-hospital mortality and ICU admission, compared to GCS and RTS.

Keywords: Glasgow Coma Scale; Multiple Trauma; Patient Outcome Assessment; Prediction Model; Severity Scores; Trauma Registry; Wound and Injuries

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1. Introduction

Trauma is a serious public health issue. Although preventable, it ranks among the first major causes of mortality and morbidity, greatly impacting people, health systems, and the economy. Trauma causes four million deaths annually, accounting for nearly 10% of total disease burden globally. The incidence of various types of injuries in trauma patients and the prevalence of each injury type is not highly prioritized despite trauma's high mortality and morbidity. Hence, epidemiological studies of traumatic cases are of great importance (1-6).

An inseparable part of trauma management is developing scoring systems to better predict mortality and morbidity (7,8). Over the past 30 years, trauma scoring systems were established to anticipate trauma-associated mortality and morbidity based on numerical values attributed to physiological and anatomical alterations, including vital signs, caused due to trauma (9,10). As an anatomical scoring system, the injury severity score (ISS) ranges from 0 to 75. ISS values originate from the abbreviated injury scale (AIS) of three most commonly injured sites of trauma patients (11). It is well known that it linearly correlates with mortality, morbidity, and other severity indices. Based on Bolorunduro et al., it is classified as mild (1 to 8), moderate (9 to 15), and severe (≥16). A major trauma is defined as an ISS of >15 (12,13). As a physiological trauma scoring system, the revised trauma score (RTS) was developed by Champion et al. in 1989 to predict mortality and morbidity. It consists of three main components: systolic blood pressure (SBP), respiratory rate (RR), and Glascow coma scale (GCS). RTS is heavily weighted in favour of the latest, with an almost threefold value of GCS over RR. A cut-off of RTS<4 was deemed for trauma patients who should be treated in a trauma centre (14). As a physiological trauma scoring system, the Glasgow Coma Scale (GCS) is a generally accepted predictor of in-hospital mortality (15). With a history of almost 50 years, it plays a pivotal role in today's clinical practice (16). It consists of three main domains based on patients' responsiveness: eye-opening, motor, and verbal responses. The total score ranges from 3 to 15 (17).

Here, we delineated a comprehensive, nationally remarkable, registry-based study of inpatient traumatic cases in Iran between July 2016 and November 2023. In this study, we applied three main trauma scoring systems, i.e., ISS, GCS, and RTS, to predict trauma-related in-hospital mortality and intensive care unit (ICU) admission.

2. Methods

2.1. Administration and registry process

NTRI is a hospital-based multicentre registry across the country. It was developed in 2016 at the Sina Trauma and Surgery Research Centre (STSRC). Details on NTRI development and its associated questionnaire have been discussed elsewhere (18,19). The accuracy of input injury severity data was appraised by a surgeon using AIS, AIS pre-dot code, and ISS, based on instructions defined by the Association for Advancement of Automotive Medicine (AAAM) (20).

2.2. Study design and participants

This is a multicenter study of the hospital-based NTRI, an ongoing registry-based trauma database. The inclusion criteria were all patients admitted to the emergency department due to trauma and hospitalized for at least 24 hours, deceased within the first 24 hours of admission, or transferred from the ICUs of other hospitals (21). Every patient meeting the criteria, admitted to 12 major referral trauma centers throughout the country between July 2016 and November 2023, were included in this study. However, verbal consent was obtained from the patient or a next of kin relative in case they couldn't be directly interviewed. This study was approved by the ethics committee of Sina Hospital, Tehran University of Medical Sciences (approval ID: IR.TUMS.SINAHOSPITAL.REC.1399.090).

2.3. Variables

Three demographic data: age, gender, and educational level; four injury-related variables: transport mode to hospital, injury mechanism, injury severity, and injured body regions; and six clinical characteristics on admission including heart rate, O2 saturation, temperature, GCS, RTS, and ISS were considered and measured. Ultimately, two main outcomes were studied: death and ICU admission.

Patients' educational level was stratified as "no formal education" for those with no primary school education, "primary education" if they had completed six years of elementary school, "secondary education" if they had a high school degree, and "tertiary education" for college degree holders. The mechanism of injury was defined as traffic injuries, penetrating injuries due to stab and/or cut, falling, and others. Falling was defined by the world health organization (WHO) as an unintentional drop to the ground or lower level (22). Drowning, animal attacks, burns, heat injuries, and unknown reasons were included in the "others" category. We utilized the AIS for grading injury severity. Subsequently, ISS was calculated based on AIS scores and ranged from 1 to 75 (12,23). Multiple trauma was defined as traumatic injury of at least two different body regions with AIS>2 (24,25). GCS was categorized as mild (13-15), 9-12 as moderate, and 3-8 as severe injury (26). Systolic blood pressure (SBP) ≤90 mmHg was defined as low blood pressure, heart rate ≥100 beats per minute as tachycardia, RR ≥20 breaths per minute as tachypnea; SpO2 <90% as hypoxemia, and temperature <36 °C as hypothermia.

The RTS is a physiological scoring system comprising GCS, SBP, and RR. The coded value for each variable ranged from 0 to 4. The final score is calculated through the below formula (14):

$$RTS = 0.9368\ GCS + 0.7326\ SBP + 0.2908\ RR$$

The RTS values range from 0 to 7.8408. We used a cut-off of

7 for a better classification of trauma severity based on RTS (27).

2.4. Statistical analysis

Number and percent were used to describe nominal and categorical variables. Univariate and multiple logistic regression models were applied to assess the predictors of death and ICU admission. Finally, the area under the receiver operating characteristic curve (AUROC) was used to determine the predictive utility of ISS, GCS, and RTS. For testing the equality of AUROCs, Stata's roccomp command was used. Data analysis was performed using Stata software version 14.0 (Stata Corp, College Station, TX, USA).

2.5. Ethical considerations

The study protocol was based on the tenets of the Declaration of Helsinki. This study was approved by the ethics committee of Tehran University of Medical Sciences (Approval ID: IR.TUMS.SINAHOSPITAL.REC.1399.090).

3. Results

3.1. Demographic and clinical findings of trauma patients

As shown in table 1, a total of 50,458 cases were enrolled in this study, 38,740 (76.9%) of them being male. The mean (±SD) age was 37.2 (±21.4) years. The injury sustained was localized in extremities (n=24865, 49.3%), head, face, and neck (n=4032, 8.1%), spine/back (n=1154, 2.3%), abdomen (n=941, 1.9%), and thorax (n=889, 1.8%). In 18107 (35.9%) cases, multiple trauma was documented. ICU admission was reported in 5502 (10.9%) cases. Deceased patients comprised 843 (1.7%) of cases. The mean (±SD) RTS for deceased and alive cases were 6.20 (±1.73) and 7.78 (±0.46), respectively (P-value<0.001). The mean (±SD) RTS was 7.31 (±1.00) for ICU admitted patients and 7.7 (±0.42) for patients without need for ICU admission (P-value<0.001).

3.2. Uni-variable logistic regression for ICU admission and in-hospital mortality

Given the association between factors impacting patients' mortality, as demonstrated in table 2, patients experiencing road traffic incidents (RTI) had statistically significant increased odds of death compared to blunt and penetrating trauma (OR: 1,0.24,0.16, respectively). Overall, injuries in the head, face and neck region and hence, multiple trauma, were the regions associated with the highest mortality (OR: 12.28, [95% CI: 9.7,15.54]; OR: 5.89, [95% CI: 4.77,7.28], respectively; P-value<0.001). There was significantly increased mortality odds in patients with tachycardia, hypoxemia, and low body temperature on admission (OR: 4.74,22.06,11.11, respectively; P-value<0.001). 3≤GCS≤8 and 9≤GCS≤12 were significantly associated with increased mortality rate, compared to patients with 13≤GCS≤15. Moreover, patients with ISS≥16 and 9≤ISS≤15 had increased odds of death compared to 1≤ISS≤8. Each unit increase in RTS was significantly associated with a 67% decrease in odds of death (OR: 0.33, [95%

Table 1 Demographic and clinical findings of trauma patients (n=50,458)

Variables	N (%)
Age	
<18	10210 (20.2)
18-65	33678 (66.8)
>65	6555 (13.0)
Sex	
Male	38740 (76.9)
Female	11664 (23.1)
Educational level	
No formal education	10092 (20.3)
Primary school	10651 (21.4)
Secondary school	24644 (48.8)
College/ university	4427 (8.8)
Mode of transport	
Ambulance	26961 (53.4)
Private vehicle	22826 (45.2)
Others	671 (1.3)
Mechanism of injury	
Traffic accidents	22767 (45.1)
Fall	14738 (29.2)
Blunt force trauma	4001 (7.9)
Stab/cut injuries	6520 (12.9)
Others	2432 (4.8)
Injury intent	
Unintentional	47177 (93.5)
Intentional	3281 (6.5)
Body regions	
Extremities	24865 (49.3)
Head, face, and neck	4032 (8.1)
Thorax	889 (1.8)
Abdomen	941 (1.9)
Spine and back	1154 (2.3)
Multiple trauma	18107 (35.9)
Others	405 (0.8)
Heart rate (ED), beats/min	
<100	46314 (92.8)
≥100	3602 (7.2)
Respiratory rate (ED), breaths/min	
>20	3434 (6.8)
≤20	47024 (93.2)
O2 Saturation (ED), %	
≥90	36169 (97.6)
<90	885 (2.4)
Temperature (ED),°C	
<36	103 (0.2)
≥36	46655 (99.8)
GCS	
13-15	47977 (95.7)
9-12	1158 (2.3)
3-8	985 (2)
ISS	
Mild (1-8)	36893 (75.3)
Moderate (9-15)	10647 (21.7)
Severe (≥16)	1486 (3.0)

ED: Emergency department; GCS: Glascow come scale; ISS: Injury severity score.

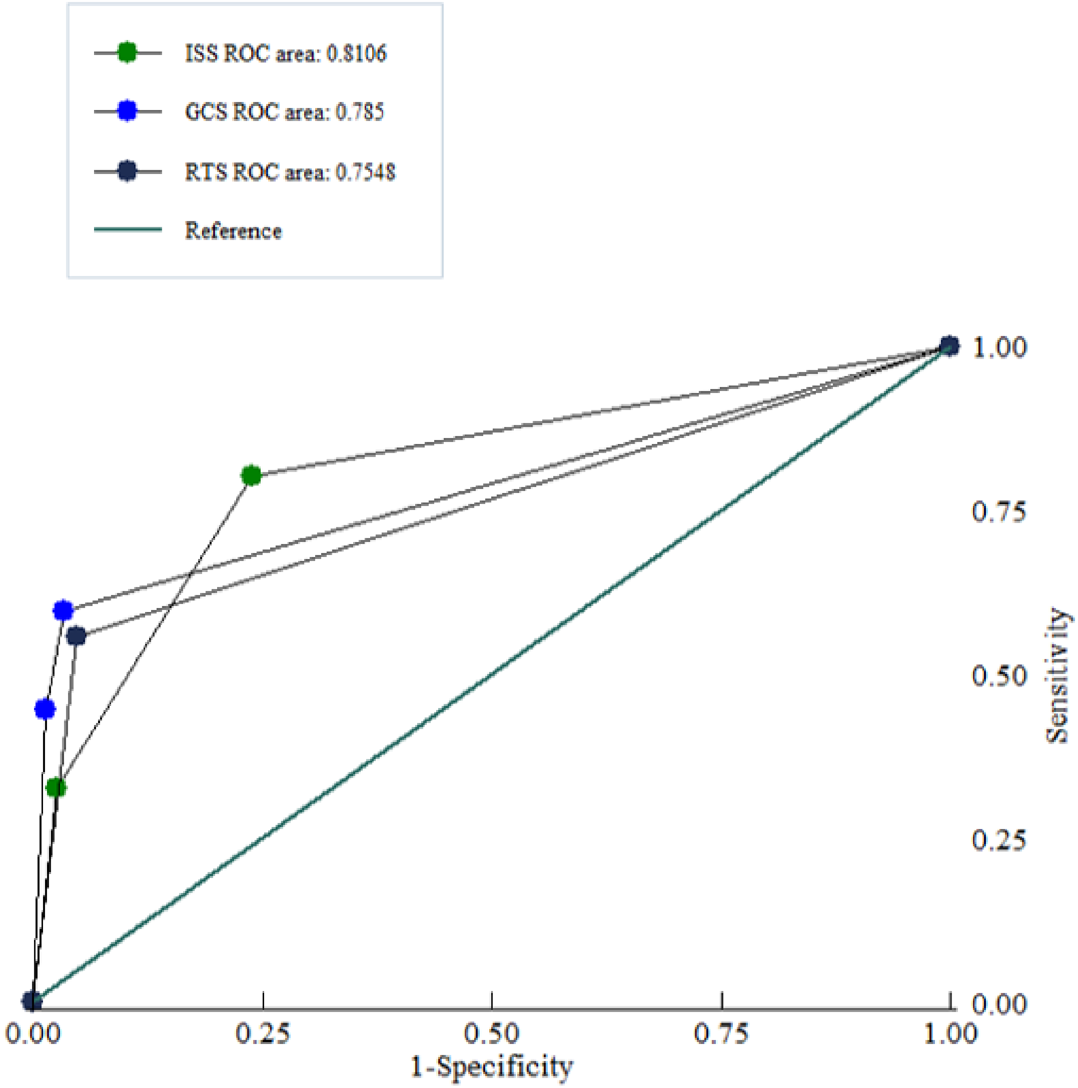

Figure 1 comparison of the area under reciever operating characteristics (AUROC) curve of RTS, GCS, and ISS in the prediction of in-hospital mortality

CI: 0.32,0.35]; P-value<0.001).

Given the association between factors impacting ICU admission, as demonstrated in illustrated in table 2, patients who sustained road traffic incidents had a significantly increased ICU admission rate compared to all other groups (P-value<0.001). Head, face, and neck injuries, as well as abdominal trauma, were the regions associated with the highest ICU admission rates (OR: 3.95, [95% CI: 3.58,4.35]; and OR: 3.87, [95% CI: 3.21,4.62], respectively; P-value<0.00). The odds of ICU admission were 30.90 and 6.54 times more in cases with GCS 3-8 and 9-12, compared to GCS 13-15 (OR: 30.90 and 6.54; P-value<0.001). Trauma patients with ISS≥16 and ISS 9-15 were admitted to ICU 30.90 and 6.54 times more respectively (OR: 30.90 and 6.54; P-value<0.001) than patients with ISS<9. Each unit increase in RTS was significantly associated with a 58% decrease in the odds of ICU admission (OR: 0.42, 95% CI: 0.32,0.35]; P-value<0.001).

3.3. Multiple logistic regression for ICU admission and in-hospital mortality

As shown in table 3, when adjusted for confounding factors, patients older than 65 years and 18-65 years had significantly increased odds of death compared to <18 years (P-value<0.001 for both). Furthermore, the odds of death were 82% higher in patients transported to the hospital via private vehicles (P-value<0.001). The odds of death were almost fivefold in RTI than in stab/cut injuries (aOR:0.19; P-value=0.002). Head, face, and neck injuries, along with abdominal trauma, were the regions associated with the highest death rates (aOR: 7.51,6.74, respectively; P-value<0.001 for both). As predicted, significantly increased mortality rates were observed in cases with lower oxygen saturation (SpO2), lower GCS, and higher ISS (P-value<0.001 for all). Finally, each unit increase in RTS was significantly associated with a

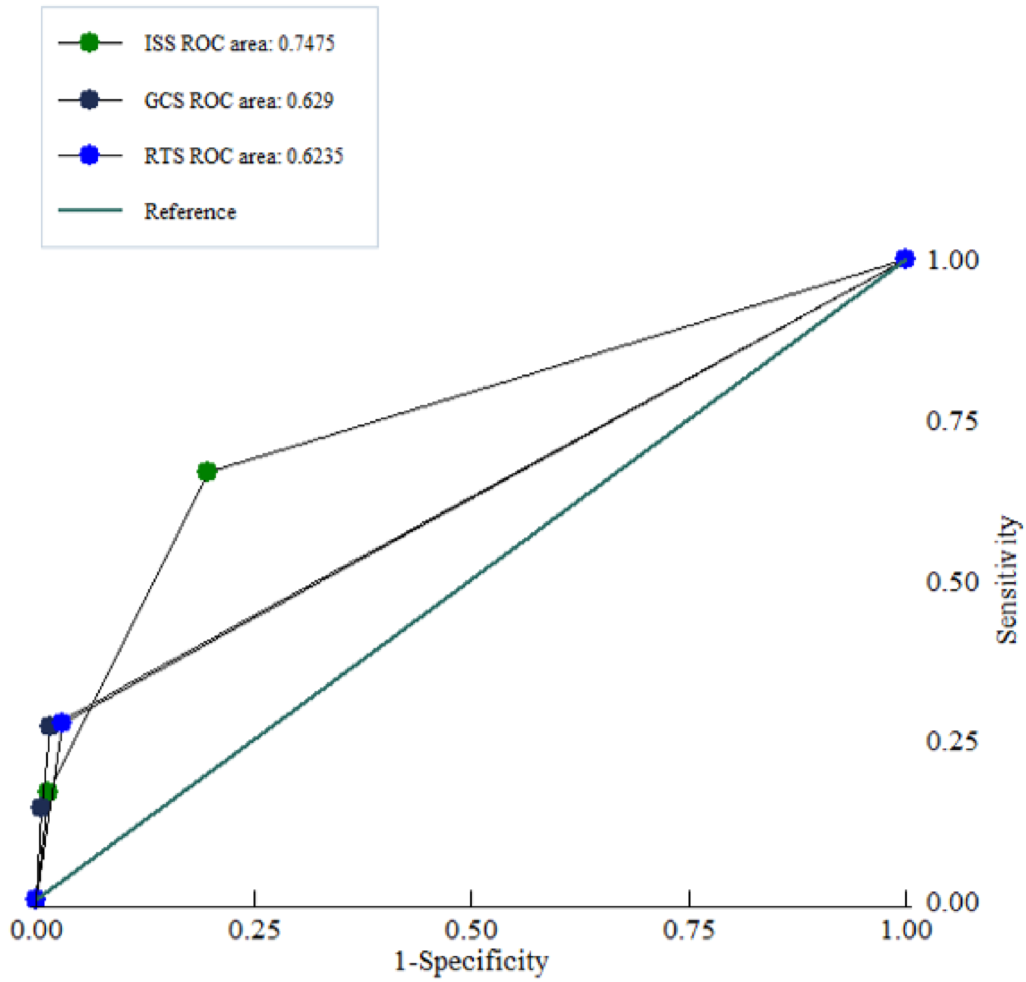

Figure 2 comparison of the area under reciever operating characteristics (AUROC) curve of RTS, GCS, and ISS in prediction of ICU admission

61% decrease in odds of death (OR: 0.39, [95% CI: 0.33,0.46]; P-value<0.001).

As depicted in table 3, when adjusted for confounding factors, younger age had a significant effect in the reduction of ICU admission rates (P-value<0.001). The odds of ICU admission were 14% more in falling cases and 37%, 34%, and 64% less in blunt, stab/cut, and other injuries compared to RTI (P-value<0.001). Abdominal and spine/back trauma were the body regions associated with the highest odds of ICU admission compared to other body regions (OR: 4.58 and 3.63, respectively; P-value<0.001). Patients with hypoxemia, lower GCS, and higher ISS on admission had a significantly higher rate of ICU admission (P-value<0.05). Cases with RTS≤7 had a 35% increased rate of ICU admission compared to RTS>7. Paradoxically, each unit increase in RTS was significantly associated with a 35% increase in odds of ICU admission (OR: 1.35, [95% CI: 1.15,1.59]; P-value<0.001).

3.4. Performance of scoring systems in prediction of in-hospital mortality

As demonstrated in table 4, the area under the ROC curve (AUROC) of GCS in predicting in-hospital mortality is 0.78 (95% CI: 0.77,0.80).

Besides, the area under the ROC curve for ISS and RTS in predicting in-hospital mortality is 0.81 (95% CI: 0.79,0.82) and 0.75 (95% CI: 0.73,0.76). There was no significant difference between ISS and GCS in predicting in-hospital mortality (P-value>0.05); however, both were significantly different from RTS (P-value<0.001). ISS and GCS are significantly better predictors of in-hospital mortality. Figure 1 demonstrates the ROC curve of ISS, GCS, and RTS in the prediction of in-hospital mortality.

3.5. Performance of scoring systems in prediction of ICU admission

As illustrated in table 5, the area under the ROC curve (AUROC) of GCS in predicting ICU admission is 0.63 (95% CI:

Table 2 Univariable logistic regression of the association between patient demographic and clinical characteristics and outcomes

	Death			ICU admission		
	OR	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**
Age						
<18	1	—	—	1	—	—
18-65	1.77	1.38,2.27	<0.001	1.32	1.21,1.43	<0.001
>65	7.44	5.77,9.59	<0.001	3.51	3.19,3.85	<0.001
Sex						
Male	1	—	—	1	—	—
Female	1.13	0.96,1.32	0.119	1.20	1.27,1.28	<0.001
Educational level						
No formal education	1	—	—	1	—	—
Primary school	0.56	0.46,0.68	<0.001	0.70	0.65,0.77	<0.001
Secondary school	0.33	0.27,0.39	<0.001	0.60	0.56,0.64	<0.001
College/ university	0.17	0.10,0.26	<0.001	0.56	0.50,0.63	<0.001
Mode of transport						
Ambulance	1	—	—	1	—	—
Private vehicle	0.49	0.42,0.57	<0.001	0.30	0.28,0.32	<0.001
Others	0.40	0.18,0.90	0.03	0.39	0.29,0.53	<0.001
Mechanism of injury						
Traffic accidents	1	—	—	1	—	—
Fall	0.93	0.80,1.08	0.352	0.80	0.75,0.85	<0.001
Blunt force trauma	0.24	0.15,0.38	<0.001	0.24	0.20,0.29	<0.001
Stab/cut injuries	0.16	0.10,0.24	<0.001	0.22	0.19,0.25	<0.001
Others	1.35	1.04,1.76	0.02	0.72	0.63,0.82	<0.001
Injury intent						
Unintentional	1	—	—	1	—	—
Intentional	1.18	0.92,1.53	0.19	1.02	0.91,1.14	0.714
Body regions						
Extremities	1	—	—	1	—	—
Head, face, and neck	12.28	9.70,15.54	<0.001	3.95	3.58,4.35	<0.001
Thorax	5.54	1.45,8.89	<0.001	2.28	1.84,2.83	<0.001
Abdomen	4.98	3.07,8.06	<0.001	3.87	3.21,4.62	<0.001
Spine and back	3.22	4.78,7.28	<0.001	3.30	2.78,3.91	<0.001
Multiple trauma	5.89	4.77,7.28	<0.001	3.67	3.42,3.92	<0.001
Heart rate (ED), beats/min						
<100	1	—	—	1	—	—
≥100	4.74	4.05,5.57	<0.001	3.28	3.03,3.56	<0.001
O2 saturation (ED), %						
≥90	1	—	—	1	—	—
<90	22.06	18.51,26.29	<0.001	7.21	6.29,8.26	<0.001
Temperature (ED),°C						
<36	1	—	—	1	—	—
≥36	0.09	0.05,0.16	<0.001	0.48	0.29, 0.77	0.003
GCS						
13-15	1	—	—	1	—	—
9-12	17.52	14.14,21.70	<0.001	16.21	14.35,18.31	<0.001
3-8	83.75	70.76,99.13	<0.001	43.36	37.01,50.80	<0.001
ISS						
Mild (1-8)	1	—	—	1	—	—
Moderate (9-15)	8.52	1.08,10.25	<0.001	6.54	6.13,6.97	<0.001
Severe (≥16)	49.13	40.10,60.20	<0.001	30.90	27.56,34.66	<0.001
RTS	0.33	0.32,0.35	<0.001	0.42	0.41,0.44	<0.001

OR: Odds ratio; CI: Confidence interval; ICU: Intensive care unit; ED: Emergency department;
ISS: Injury severity score; RTS: Revised trauma score; GCS: Glascow coma scale

0.62,0.63). The area under the ROC curve for ISS and RTS in predicting in-hospital mortality is 0.75 (95% CI: 0.74,0.75) and 0.62 (95% CI: 0.61,0.63) respectively. There was no statistically significant difference between RTS and GCS for the prediction of ICU admission (P-value>0.05); however, both were significantly different from ISS (P-value<0.001). In general, ISS is the best predictor of ICU admission, compared to GCS and RTS. Figure 2 illustrates the ROC curve of the predictive value of GCS, ISS, and RTS for ICU admission.

Table 3 Multiple logistic regression of the association between patient demographic and clinical characteristics and outcomes

	Death			ICU admission		
	aOR	**95% CI**	**P-value**	**aOR**	**95% CI**	**P-value**
Age						
<18	1	—	—	1	—	—
18-65	2.72	1.92,3.84	<0.001	1.34	1.19,1.51	<0.001
>65	11.19	7.68,16.31	<0.001	2.75	2.38,3.16	<0.001
Educational level						
No formal education	1	—	—	1	—	—
Primary school	0.72	0.55,0.95	0.019	0.76	0.68,0.86	<0.001
Secondary school	0.46	0.35,0.62	<0.001	0.65	0.58,0.73	<0.001
College/ university	0.18	0.09,0.34	<0.001	0.66	0.56,0.78	<0.001
Mode of transport						
Ambulance	1	—	—	1	—	—
Private vehicle	1.82	1.42,2.32	<0.001	0.54	0.49,0.60	<0.001
Others	1.39	0.40,4.83	0.600	1.04	0.70,1.56	0.836
Mechanism of injury						
Traffic accidents	1	—	—	1	—	—
Fall	1.15	0.88,1.51	0.303 1.14	1.03,1.27	<0.001	
Blunt force trauma	0.65	0.34,1.21	0.175	0.63	0.49,0.76	<0.001
Stab/cut injuries	0.19	0.07,0.54	0.002	0.66	0.55,0.80	<0.001
Others	0.47	0.29, 0.77	0.003	0.46	0.37,0.58	<0.001
Body regions						
Extremities	1	—	—	1	—	—
Head, face, and neck	7.51	5.13,10.98	<0.001	3.02	2.58,3.52	<0.001
Thorax	5.34	2.44,11.68	<0.001	2.79	2.11,3.69	<0.001
Abdomen	6.74	3.08,14.75	<0.001	4.58	3.44,6.08	<0.001
Spine and back	6.39	3.14,13.02	<0.001	3.63	2.86,4.60	<0.001
Multiple trauma	4.39	3.17,6.08	<0.001	2.92	2.64,3.23	<0.001
O2 saturation (ED),%						
≥90	1	—	—	1	—	—
<90	2.76	2.09,3.66	<0.001	1.29	1.05,1.59	0.016
GCS						
13-15	1	—	—	1	—	—
9-12	2.14	1.51,3.02	<0.001	10.91	8.71,13.66	<0.001
3-8	2.07	1.19,3.59	0.010	40.23	24.14,67.04	<0.001
ISS						
Mild (1-8)	1	—	—	1	—	—
Moderate (9-15)	3.62	2.79, 4.67	<0.001	4.08	3.75,4.44	<0.001
Severe (≥16)	7.11	5.18,9.75	<0.001	9.01	7.74,10.49	<0.001
RTS	0.39	0.33, 0.46	<0.001	1.35	1.15,1.59	<0.001

aOR: Associated odds ratio; CI: Confidence interval; ICU: Intensive care unit; GCS: Glascow coma scale; ISS: Injury severity score; RTS: Revised trauma score

Table 4 Performance of ISS, GCS, and RTS in prediction of in-hospital mortality

Scoring systems	Sensitivity (%)	Specificity (%)	AUROC	95% CI
ISS				
1 to 8	100	0	0.809	0.79,0.82
9 to 15	80	76		
≥16	32	97		
GCS				
13 to 15	100	0	0.785	0.77,0.80
9 to 12	59	97		
3 to 8	44	99		
RTS				
>7	100	0	0.748	0.73,0.76
≤7	54	95		

ISS: Injury severity score; GCS: Glasgow coma scale; RTS: Revised trauma score, CI: Confidence interval; AUROC: Area under receiver operating characteristic curve

Table 5 Performance of ISS, GCS, and RTS in the prediction of ICU admission

Scoring systems	Sensitivity (%)	Specificity (%)	AUROC	95% CI
ISS				
1 to 8	100	0	0.75	0.74,0.75
9 to 15	67	80		
≥16	17	97		
GCS				
13 to 15	100	0	0.63	0.62,0.63
9 to 12	27	98		
3 to 8	14	99		
RTS				
>7	100	0	0.62	0.62,0.63
≤7	27	97		

ISS: Injury severity score; GCS: Glasgow coma scale; RTS: Revised trauma score, CI: Confidence interval; AUROC: Area under receiver operating characteristic curve; ICU: Intensive care unit

4. Discussion

Trauma is still among the first leading causes of mortality and morbidity, especially in developing countries (28). Statistically, trauma ranks as the third cause of total mortality in Iran and the first cause in the young population (29). Based on a report by the world health organization (WHO), about 50% of discharged trauma patients suffer from some sort of disability (30). Older individuals tend to suffer more severe injuries and have a higher mortality rate when compared to their younger counterparts with the same injury mechanism (31-34). With an aging population and improved healthcare, an increasing proportion of trauma in elders is inevitable (1,35). Although healthcare systems have been developing rapidly, worse outcomes occur in the elderly population compared to the younger population (36). Findings from the current study suggest that older the age, greater is the possibility of encountering negative consequences.

In 2019, the first cause of death in patients 15-49-year-old was RTI (37). According to a WHO report in 2018, 15,932 fatalities and in other words, 20.5 deaths per 100,000 (38) were documented. Four fatalities were recorded for every 100 road accidents (39). Moreover, following natural disasters, road traffic injuries are known as the first cause of disability adjusted life years (DALY) in Iranian males (40). RTIs are reported to be the leading cause of trauma in many other nations, including Malaysia (77%), Sweden (49%), Australia (47%), Germany (47%), and the USA (33%) (41,42). In the current study, RTI comprised 45.1% of all trauma cases and contributed to an increase in in-hospital mortality.

Confirming the result of previous studies for extremities being the most frequent sites of injuries in trauma (43,44), our results showed that trauma localized in extremities encompass almost half of the injuries (49.2%). The results of the current study suggested that although head, face, and neck injuries do not contribute to a large proportion of injuries (8.1%), they are associated with the highest in-hospital mortalities compared to others. Similar to our findings, in a study of 550 trauma cases over 16 years, upper and lower extremities injury was the leading injury site, followed by head and neck injuries (45). The results of another study also confirmed our findings (7).

The current nationwide study consisted of 50458 trauma patients admitted to 12 major trauma centers throughout the country between July 2016 and November 2023, retrospectively. They were evaluated via an active database called NTRI. The primary goal of the current study was to evaluate the predictive value of ISS, GCS, and RTS for in-hospital mortality and ICU admission. It is now well-established that imminent diagnosis of trauma injury and severity is associated with significantly reduced mortality rate and disability (46). To address this, diagnostic imaging, including MRI, CT scan, and ultrasonography, have been utilized. However, due to their unavailability, that may hamper their widespread usage, researchers, as well as physicians have been seeking to discover criteria that would only use clinical signs and symptoms to categorize these patients. These criteria, known as scoring systems, have been used for years (47). There is still much debate on applying these scoring systems in various clinical settings. Many scoring systems have been developed over the years to predict mortality and morbidity based on anatomical, physiological, and combined scores (48). ISS as an anatomical scoring system, alongside RTS and GCS as physiological systems, have been applied in this study.

In a study by Yousefifard et al. (27) on 1702 cases of trauma, the AUROC curve of GCS in predicting in-hospital mortality was 0.89 (95% CI: 0.85,0.93), which was higher than ours (AUROC GCS for death: 0.78, 95% CI: 0.77,0.80). This difference can be explained by a relatively higher number of deceased cases in their study (n=111, 6.8%) compared to our study (n=843, 1.7%).

By considering vegetative state, disability, and mortality as poor outcomes in the aforementioned study, the AUROC curve of GCS in predicting poor outcomes was 0.89 (95% CI: 0.85,0.91). However, in our study, the AUROC curve of GCS in the prediction of ICU admission was 0.628 (95% CI: 0.62,0.63). In another study of 200 ICU-admitted trauma cases in predicting worse outcomes, the GCS performed better than other scoring systems (49). Another study for evaluation of the power of scoring systems, consisting of GCS, acute physiology and chronic health evaluation (APACHE-II), rapid acute physiology score (RAPS), and rapid emergency medicine score (REMS), was conducted in 2017 and suggested that there was no significant difference among them (50). For the prediction of in-hospital mortality, a prospective study in 2020 was conducted on trauma cases and concluded that the area under curve (AUC) of on-admission GCS for predicting in-hospital mortality was 0.91 and significantly superior to RTS (51). In another study performed in 2020 for predicting in-hospital mortality, the AUC of GCS was 0.88, which was lower than the GAP and MPAG scoring systems (52).

In Yousefifard et al.'s study (27), the AUROC curves for RTS in predicting in-hospital mortality and developing poor outcomes were 0.85 (95% CI: 0.80,0.89) and 0.81 (95% CI: 0.78,0.86). However, in the current study, the AUROC curves for RTS in the prediction of in-hospital death and ICU admission were 0.75 (95% CI: 0.73,0.76) and 0.63 (95% CI: 0.62,0.63). The AUC of ISS and RTS for the prediction of in-hospital mortality was 0.963 and 0.947 in a study of 200 trauma cases aged more than 60 years (7). Contrary to our findings, in a study of 385 pediatric trauma cases with a history of falls, RTS was a better predictor of in-hospital mortality (53). In a study of 426 trauma cases published in 2021 evaluating the predictive value of ISS, new injury severity score (NISS), RTS, trauma score and injury severity score (TRISS), and pediatric trauma BIG score (base deficit, INR, GCS) (BIG) for in-hospital mortality and ICU admission, TRISS had the best predictive value for in-hospital mortality, whereas ISS and RTS were the weakest scoring systems for predicting in-hospital mortality. Besides, NISS was the best predictor of ICU admission (54).

A study on various scoring systems performed in 2020 on 1861 trauma cases revealed that the AUC of ISS for prediction of in-hospital mortality was 0.80, which was significantly lower than the others, including GCS, GAP, and MGAP (52). A retrospective study on 326 ICU-admitted trauma patients published in 2021, utilizing various trauma scoring systems, including RTS, ISS, and GCS, among others, revealed that the AUC for in-hospital mortality in severe trauma cases was 0.69 in GCS, 0.74 in RTS, and 0.82 in ISS. Although other scoring systems' AUC acquired higher scores (AUC for NISS: 0.90), the comparison between GCS, RTS, and ISS pointed out that ISS has the highest predictive value for in-hospital mortality, in parallel to our findings (55). In another study, 754 trauma cases were used for predicting in-hospital mortality in the Iranian population; the AUC for GCS and ISS was 0.851 and 0.866, respectively.

In a comprehensive study involving 1410 trauma patients aged 13 years and older, various scoring systems including GCS, RTS, ISS, and TRISS were evaluated for their ability to predict mortality. The results revealed that RTS had the highest predictive value with an AUC of 0.93, followed by TRISS with an AUC of 0.85, ISS with an AUC of 0.80, and GCS with an AUC of 0.75. Upon further analysis, it was determined that age over 60 years, GCS<8, RTS<7.6, and TRISS<0.9 were the most significant predictor variables for in-hospital mortality. Specifically, individuals over the age of 60 had 7.38 times higher odds of mortality, while those with a GCS score below 8 had 6.5 times higher odds. Similarly, patients with an RTS score below 7.6 had a 6.04 times higher odds, and those with a TRISS score below 0.9 had a 3.09 times higher odds of in-hospital mortality (56). In another study conducted at a single center involving 938 trauma patients under the age of 6, the ISS demonstrated the highest AUC value for predicting mortality (ISS: 0.975; GCS: 0.864; RTS: 0.899). The cutoff values for predicting mortality were determined to be 15 for ISS, 11 for GCS, and 7 for RTS (57).

Altogether, the difference in the AUC of GCS, RTS, and ISS with previous studies in the literature might be a result of different cut-off points.

The results of the current findings indicated that anatomical-based scoring systems like ISS are better predictors of both ICU admission and in-hospital mortality than physiological-based scoring systems, like RTS and GCS, in overall trauma patients regardless of age classification.

5. Limitations

Evaluating a large population of traumatic patients retrieved from an active national registry is the main strength of this survey, which makes the results of the current study generalizable. When comparing our results to others, it should be considered that we only included traumatic cases, admitted and hospitalized for more than 24 hours. The study only examines three trauma scoring systems and does not consider other factors associated with mortality and ICU admission. Currently, a limited number of studies have evaluated and compared these scoring systems for predicting ICU admission. Further studies need to be conducted to assess the predictive value of these scoring systems for ICU admission in trauma cases. Besides, the generalizability of our study results can be assessed by conducting similar studies in other countries.

6. Conclusion

In this registry-based study, we confirmed the pivotal role of GCS, ISS, and RTS scores in the prediction of in-hospital mortality and ICU admission. ISS is the strongest predictor of in-hospital mortality and ICU admission compared to GCS and RTS. ISS as an anatomical-based scoring system possessing a higher power for predicting poor outcomes rather than RTS and GCS.

7. Declarations

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7.2. Authors' contribution

P.S, Kh.N, M.H, and M.Z contributed to study conceptualization. V.B contributed to methodology and formal analysis. A.Kh, V.R, S.Po, S.Pi, S.M contributed to writing the original draft. E.F, S.S, V.H, H.S, A.Z, S.D, M.N, V.R, M.H, R.A, M.K contributed to providing useful resources. A.kh, V.B, M.Z, V.R, M.H, Kh.N, P.S also contributed to review and editing the manuscript. All authors have read and approved the manuscript. All authors agreed to be accountable for all aspects of this work.

7.3. Conflict of interest

None.

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