Original Article

A Comparative Study on the Ability of Trauma Severity-assessing Methods in Determining the Prognosis of Patients having Accident and Referred to Imam Khomeini Hospital of Urmia in 2016

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Abstract

Introduction: Trauma is the leading cause of death and disability in developing countries. According to the World Health Organization projections by 2020, accidents alone are the second leading cause of missing year around the world. Therefore, the aim of this study was to compare the ability of trauma severity-assessing methods in determining the prognosis of accident patients referred to Imam Khomeini Hospital of Urmia in 2016. **Methodology:** In this study, the severity of trauma in traffic accident patients referring to Imam Khomeini Hospital of Urmia was determined using the Injury Severity Score (ISS), Revised Trauma Score (RTS), Trauma and Injury Severity Score (TRISS), and A Severity Characterization of Trauma (ASCOT), in a 1-year period, via the census method on 2015 hospitalized accident victims, and the ability of these methods to predict mortality and morbidity, length of stay in hospital, and hospital length charges were investigated by the receiver operating characteristic curve of regression methods. To this end, the hospital records of accident victims who were hospitalized for at least 1 day or whose deaths were examined along with their autopsy reports were the main components of this study. **Results:** The mean age of the patients was 33.63 ± 18.53 years, and their age range was 1–96 years. The ratio of males to females was 2.73. In addition, in terms of job status (46.8%), they were free. The majority of women were homemakers (70.8%). In the two gender groups, most accidents occurred within the city, The mean severity of lesions based on ISS system was 16.44 ± 16.28 and 16.8% of ISS injuries were above 25. The mean RTS of the patients was 7.69 ± 0.54, which ranged from 0 to 7.84, and the mean TRISS of the patients was 92.24 ± 15.87. The trauma means via the ASCOT method was 5.35 ± 1.85. The difference in the severity of trauma (calculated by each of the methods of ISS, RTS, TRISS, and ASCOT) was significant between those who survived and those who died. **Conclusion:** In this study, most of the accidents happened in males, married, undergraduate, and homemaker, and those on the street as well, and the RTS and TRISS methods showed the highest ability in predicting mortality. Given the usefulness and special applications of these methods, their use in designing a national care system in the trauma area is recommended.

Keywords: Patients having an accident, trauma, Urmia

Introduction

One of the most common accidents is traffic accidents.[1] Road accidents are one of the major health problems that endanger human health. The death toll from traffic accidents has had an increasing trend in recent years in Iran.[2] The importance of traffic accidents is to the extent that the World

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Health Organization (2004) called the World Health Day (Safe Roads Day) and considered the reduction of road accidents as one of the 21 goals of the organization by 2020.[3] In addition, any death that occurs within 30 days of an accident is reported as a result of road traffic accidents.[4]

Driving accidents with high death rates in drivers and pedestrians of all age groups impose large economic costs. Due to death at all age groups, it affects the life expectancy at birth and the economy of a community negatively. The cost estimated for road accidents was $518 billion in the world in 2004, of which $453 billion belonged to less developed countries. The economic costs of road accidents are 2% of the gross national product (GNP) in developed countries and up to 15% of GNP in countries with low and moderate incomes. Several studies have been conducted to estimate the cost of road accident casualties in Iran. The financial loss caused by road accidents is estimated to be about 180 billion Rials per year. The study conducted by Rezaei *et al.* in Tehran, titled "Economic burden of accidents," showed that the cost of accidents included 0.3%–0.4% of the gross domestic product of the country.[5-9]

Trauma is a major health risk for adults and the most common cause of death within the age range of 1–42 years. The traumas caused by traffic accidents as predictable events are one of the most important health problems in the world. Every day, 30,000 people are seriously injured in road accidents and 3000 people lose their lives. In the study conducted by Souri *et al.*, it was reported that traffic accidents were the cause of 37.5% of the unintentional injuries and the first cause of death in rural areas in Iran. In the study conducted by Roostaei *et al.* in Tehran, 50% of the deaths were due to trauma in people aged 15 years and less was due to traffic accidents. The study conducted by Kadkhodaei also showed that out of 7200 cases of hospital fractures, 6552 cases (91%) were due to traffic accidents.[10-16]

The scoring method in trauma patients is being used for many years, as a major element of in-hospital triage, to predict death after trauma and help physicians examine patients to provide appropriate care services. Using the scoring method in the outcome of trauma patients can play an important role in minimizing the losses through prehospital admission measures. Inappropriate classification of trauma patients due to the lack of appropriate traumatic evaluation systems will have irreparable consequences on the patient's condition, which will finally increase the mortality rate in trauma patients. To predict the outcomes, scoring can be divided into three categories as follows: anatomical scores, physiological scores, or a combination of them. In patients with severe trauma, the primary goal is their survival, and secondary goals include avoiding failure in organs, fast recovery, and maximizing the quality of life.[17-21]

Various survival predictors (A Severity Characterization of Trauma–Trauma and Injury Severity Score–Injury Severity Score–Revised Trauma Score) have been used widely in traffic injuries. In recent years, the use of standard and appropriate treatment, playing the key role in reducing the mortality rate of patients with trauma, has been considered. Results of studies suggested that 50% of deaths occur in patients due to the lack of proper treatment. The presence of well-equipped centers reduces the death rate by about 30% in the trauma patients. Studies indicated that having well-equipped and appropriate centers and taking proper measures by them to protect the traumatic patient will reduce the death rate from 30% to 9%. The third phase of death in trauma patients occurs between 1 and 30 days after the trauma, and about 10%–20% of the deaths occur during this period in the traumatic patients.[22,23] The present study was conducted to compare the abilities of trauma severity-assessing methods in determining the prognosis of patients who had an accident and referred to Imam Khomeini Hospital of Urmia in 2016.

Methodology

This cross-sectional study was designed to determine the severity of trauma in Urmia Imam Khomeini Hospital (West Azerbaijan Province Trauma Center) and to compare different trauma-scoring methods in determining the prognosis of patients. In this study, 2015 trauma victims who were hospitalized for at least 1 day in the hospital in 2016 or whose deaths were assessed with their autopsy report were selected by census methods. The main focus of this study was the discharge status of patients. Data were analyzed using a checklist that included demographic variables (age, gender, type of trauma [penetrating or nonpenetrating], type of injury, blood pressure, respiratory rate [RR], and state of consciousness), type of accident, and final variable (survival) extracted from the clinical records of all patients. Inclusion criteria included traffic accident injuries, living in the suburbs of West Azerbaijan Province for the last 3 months, the viability of the injured person at the time of admission to hospital, records of injuries in the hospital trauma system, and at least one injury. Exclusion criteria were nontraffic injuries and missing or incomplete data in the hospital's medical record system. The data obtained were initially used to evaluate the normality of the data distribution using the Kolmogorov–Smirnov test. For normal distribution of data, mean and standard deviation were then measured using Mann–Whitney tests, regression correlation coefficients, Fisher's z-transform, simple linear and logistic regressions, receiver operating characteristic (ROC) curves, and screening tests. All analyses were performed using SPSS software version 16 (Norman Nye at the University of Chicago in the United States).

Survival prediction systems include TRISS, RTS, and ISS. The ISS is an anatomic score for factors other than death that is mainly used for people with multiple injuries. The RTS is a physiologic scoring system for predicting death and eventually posttrauma injuries in the hospital. The TRISS is a combination of both anatomic and physiologic injury scores (ISS and RTS) to predict the effect of patient's age and posttrauma survival. Baker *et al.* presented an ISS system that is a system used for multiple trauma severity.[24-26]

The ISS system has changed since its emergence. To assess the severity of the injury in ISS, the body is divided into six areas, including the head, face, chest, abdomen, pelvis, and endpoints. Based on the severity, the injuries are divided into six groups (mild, moderate, serious, severe, critical and life-threatening). To calculate the ISS, the score of the Abbreviated Injury Scale (AIS) of the affected organs is first determined in each area. Then, the three injuries with the highest score in AIS are selected, are squared, and the sum of them is calculated (ISS = $x^2 + y^2 + z^2$). The minimum score of ISS is ($1^2 + 1^2 + 1^2$) = 3, and the maximum score is $5^2 + 5^2 + 5^2 = 75$. The trauma-scoring method consists of four elements, including assessing injury prevention, predicting injury severity, survival, and quality of hospital services.[24-29] The RTS is a physiological assessment criterion used for predicting death in the hospital and the result of the trauma. It has five independent variables, including the Glasgow Coma Scale (GCS), RR, systolic blood pressure (SBP), chest distension, and capillary refill. The numeric RTS criteria's range is from 0 to 4. The lowest score indicates the worst patient condition. The RTS criterion has the highest coefficient of validity in the prognosis of patients with brain trauma.[17,23,30]

The RTS criterion is also used for patient triage. Therefore, based on the logistic regression analysis model, a statistical model has been proposed to predict the outcome of the injury in patients according to the RTS criterion. In this model, the RTS value has been calculated based on the following formula:

Sum (resp. rate. point) × 0.2908 − SBP. points × 0.7326 − Glasgow. points × 0.9368.

A number is calculated and obtained between 0 and 7.84. This number is obtained using three measured indices and inserting the number obtained from each of them in the model. Using the RTS value, the patient's survival possibility can be calculated based on the following formula:

$P = 1/(1 + e^{-RTS + 3/5718})$.

To calculate the survival possibility in the age group under 15 years, the formula of Logit = −0.4499 + RTS × 0.8085+ ISS × 0.0835 + age point × 1.7430 was used, and for other age groups, the formula of logit = −2.5355 + RTS × 0.9934 + ISS × 0.0651 + age point × 1.1360 was used. In both cases, the patient's survival rate was equal to $P(S) = 1/1 + e^{logit}$. The number of expected deaths in the TRISS model included those whose survival possibility was calculated at <50%[31] [Table 1].

In 1990, another scale called ASCOT was used for the first time. In this study, the anatomical and physiological characteristics of the lesion, along with the patient's age, have been used to determine the patient's injury, and finally, a number has been obtained that relates to the survival possibility of the patient.[32] The anatomical description of the lesion is done with four elements of A, B, C, and D of Anatomic Profile (an anatomical method for determining the severity of the trauma): the element A includes all dangerous injuries (with AIS >2) to the head, brain, and spinal cord. Element B includes dangerous injuries to the chest and anterior part of the neck. Element C includes all dangerous injuries (except for the above-mentioned cases), and eventually, element D includes dangerous injuries with AIS = 1 or 2.

Table 1: Revised Trauma Score classification based on its variables

Class	RR	SBP	GCS
0	0	0	3
1	1-5	1-49	4-5
2	6-9	50-75	6-8
3	10-29	76-89	9-12
4	29<	<89	13-15

GCS: Glasgow Coma Scale, RR: Respiratory rate, SBP: Systolic blood pressure

To calculate the value of each of the four elements mentioned, the sum of the AIS squares in the injuries related to that element was obtained. The survival possibility of patients with a very good or very poor prognosis (according to their conditions) has been predetermined. This possibility for other patients was calculated through the equation: $Ps = \frac{1}{1 + e^{-k}}$ in which:

$K = K1 + K2G + K3S + K4R + K4R + K6B + K7C + K8$ (AGE)

where K is the regression coefficient considered for penetrating and nonpenetrating trauma according to Table 2.

A Severity Characterization of Trauma

As seen, element *D* was excluded from the equation as it was not considered an important factor in predicting death in patients. In this regard, *G*, *S*, and *R* represented GCS, SBP, and RR, respectively, on the RTS scale. AGE in the ASCOT method had a more detailed classification than TRISS, and for each patient, it can accept one of the values from 1 to 4, and the sum of the scores will be between 0.3 and 100. The closer the number to 100, the greater the chance of death and the number goes to survive.[22,33,34] In other words, ISS and ASCOT are the two criteria for predicting one's survival, for each patient. In this study, in addition to determining the severity of trauma in Imam Khomeini Hospital, using the methods of ISS, RTS, TRISS, and ASCOT, the accuracy of these methods has been compared in determining the prognosis of patients. Furthermore, the gold standard criterion, based on similar studies and worldwide studies, is considered in RTS 5,[35] ISS 20,[36] TRISS 50,[25] and ASCOT 3.[34] Patients below RTS 5, in ISS criteria above 20, in TRISS criteria below 50, and in ASCOT criteria above 3, are more likely to die. In other words, in addition to these numbers (criteria), we chose a different criterion for ourselves. In addition, in these studies, the higher the TRISS and RTS, the higher the probability of injury, whereas in the case of ISS and ASCOT, the opposite is the case, Downwardly, the amount of damage decreases.

Results

The research population included 2015 traffic incident

Table 2: A Severity Characterization of Trauma regression coefficients

Variable	Nonpenetrating	Penetrating
Constant	−1.1570	−1.1350
G	0.7705	1.0626
S	0.6583	0.3638
R	0.2810	0.3332
A	−0.3002	−0.3702
B	−0.1961	−0.2053
C	−0.2086	−0.3188
Age	−0.6355	−0.8365

Table 3: Demographic characteristics of the injured people studied

Variable	Frequency (%)		*P*
	Alive	Dead	
Job			
Unemployed	33 (1.7)	2 (2.9)	0.190
Farmer	49 (2.5)	3 (4.3)	
Homemaker	398 (20.5)	10 (14.5)	
Self-employed	671 (34.5)	33 (47.8)	
Retired	43 (2.2)	1 (1.4)	
School student	42 (2.2)	1 (1.4)	
Employee	67 (3.4)	0	
Others	642 (33)	19 (27.5)	
Education			
Illiterate	431 (22.1)	33 (47.8)	0.001
Under diploma	916 (47.1)	20 (29)	
Diploma	421 (21.6)	11 (15.9)	
Associate	45 (2.3)	1 (1.4)	
Bachelor	111 (5.7)	4 (5.8)	
Master	22 (1.1)	0	
Age			
0-14	263 (13.5)	7 (10.1)	0.001
15-54	1404 (72.1)	33 (47.8)	
>55	279 (14.3)	29 (42)	
Marital status			
Single	719 (36.9)	18 (26.1)	0.616
Married	1227 (63.1)	51 (73.9)	
Living place			
Rural area	1352 (69.5)	44 (63.8)	0.288
Urban area	594 (30.5)	25 (36.2)	
Operating room			
Yes	1106 (56.8)	45 (65.2)	0.155
No	840 (43.2)	24 (34.8)	
ICU			
Yes	279 (14.3)	50 (72.5)	0.001
No	1666 (85.6)	18 (26.1)	
Head injury			
Yes	1203 (61.8)	65 (94.2)	0.001
No	743 (38.2)	4 (5.8)	

ICU: Intensive care unit

patients hospitalized in Imam Khomeini Hospital of Urmia in 2016. The mean age was 33.63 ± 18.53 years, and the age range of them was between 1 and 96 years. The gender of the majority of the injured people (73.2%) was male. In both gender groups, most of the injured people belonged to the age group of 15–54 years. In terms of the level of education, the majority of male injured people were under diploma (n = 733, 49.7%) and most of the female injured people were illiterate (n = 214, 39.6%). In terms of marital status, most of the male injured people (n = 882, 59.8%) and female injured people (n = 396, 73.2%) were married. In terms of job status, most of the male injured people were self-employed (n = 690, 46.8%) and most of the female injured people were homemakers (n = 383, 70.8%). Finally, in terms of living place, majority of the male injured people (n = 1015, 68.9%) and majority of the female injured people (n = 381, 70.4%) were living in urban areas. Moreover, based on the results of this study, 61.1% of the male and 46.2% of female injured people were transferred to the operating room, and 17.4% of the male and 13.3% of the female injured people were transformed to the intensive care unit (ICU) [Table 1].

In this study, 91.6% of the injured people had nonpenetrating trauma and 8.4% of them had penetrating trauma. Most of the accidents resulted in a hospitalized trauma which were due to car accidents (n = 563, 27.9%) and the accident of a motorcycle with a car (n = 232, 11.5%). The mean length of stay in the hospital was 5.42 ± 6.09 for living people and 13.39 ± 34.89 for deceased people. The mean severity of lesions based on the ISS system was 16.44 ± 16.28 and 16.8% of the injured people had ISS over 25. The final status of some patients was not known due to personal satisfaction with the hospital or transfer to other centers. The mean RTS of the patients was 7.69 ± 5.54, ranging from 0 to 7.84, and the mean TRISS of the patients was 92.22 ± 15.87. The mean trauma using the ASCOT method was 5.35 ± 1.85. The mean hospital length charge of each person was 991 ± 1107 and out of 2015 hospitalized patients, 1945 (96.6%) survived and 69 (3.4%) died. There was also a significant relationship between education level, age, ICU, and head injury with the patient's final status Table 3.

In addition, there was a significant correlation between the numerical value of all the four systems, length of stay in the hospital, and the hospital length charges [Table 4], and using Fisher's z-transform, the ISS coefficients were found significantly higher than the equivalent correlation coefficients of other methods. In fact, it is the worst predictor of hospital costs.

The survival possibility of each patient was calculated using logistic regression methods and using numerical values of RTS, TRISS, and ASCOT. The ROC area under the curve for each of the methods is shown in Table 5. The cutoff points were also examined using the ROC curve and were determined for each of the methods. Table 5 shows the cutoff points along with the sensitivity, specificity, and likelihood ratio of each method. In other words, separation points were considered

based on similar studies or global criteria, with all sensitivity and specificity not based on these criteria.[25,34-36] In fact, we have our own separate criteria.

The strongest criteria were based on the ROC curve (TRISS, RTS, ASCOT, and ISS) [Figure 1]. The difference in the severity of trauma (calculated by each of the methods of ISS, RTS, TRISS, and ASCOT) was significant between those who survived and those who died.

Discussion

According to the findings of the present study, the male-to-female casualty ratio was approximately 4:1, which was also shown in a 2012 study by Akabari *et al.* There was a higher proportion of injuries in traffic accidents in men than in women.[13] The mean age of the victims was 33.63 (18.53) years, and most of the victims were in the age group of 15–54 years. These findings indicate that young people in the community are more at risk of injury due to traffic accidents. This has been confirmed by studies in Isfahan conducted by Mohammadian *et al.*,[37] in the study by Vieira Rde *et al.* in Brazil,[38] and in the study by Davoodi *et al.*[39]

In terms of job status, the job of most of the males was self-employed and the job of most of the females was homemakers, which is consistent with the results of the study conducted by Davoodi *et al.*[39] Based on the results of their study, most injured people had lower levels of education. In fact, more people injured by accidents had a low level of education, self-employed job status, and inappropriate material status. Thus, it could be concluded that the above-mentioned factors are associated with an increased risk of accidents.

In this study, 46.5% of the casualty admitted to undergraduate education are inconsistent with the results of a study conducted by Rodríguez *et al.*[40] In this study, the majority of the victims in both sexes had head trauma experience, while 94.2% of the deceased had experienced head trauma. In the study conducted by Nazari *et al.*[41] in Amol, the leading cause of death from accident was a blow to the head.

The results of this study showed that most traumatic patients were male, which is in line with the results of other studies. This study revealed that most of the patients hospitalized due to accidents were male and the ratio of male patients was higher.[13,42,43] This difference can be due to some reasons, namely, males having more access to automobiles and the culture of their living place and their exposure to risk. The mean age of the patients was 33.63 years, which is consistent with other studies, and this explains the main role of trauma burden.[41,44,45] This indicates that risk taking and excitement are higher in young people compared to other age groups. This issue plays an important role in lost years of life and causes death and disability.

The length of stay in the hospital for those who survived in our study (5.69) was not similar to the Major Trauma Outcome Study (MTOS) results (9.7 days). The highest ROC area under the curve to predict the mortality belonged to TRISS, followed by RTS and ISS, indicating the greater ability of these methods in predicting death, which is inconsistent with the results of Salari *et al.,* Menon *et al.,* and Osterwalder *et al.*[44,46] This is probably due to the use of TRISS of all criteria in predicting survival.

In this study, most of the trauma accidents were nonpenetrating. This result was in line with that of other studies.[23,47] This was

Table 4: Coefficients of correlation between trauma severity assessment methods and length of stay in hospital and hospital length charges

Variable	ISS	RTS	TRISS	ASCOT
Hospital stay	0.343	−0.325	−0.316	0.195
Hospital charge	0.409	−0.287	−0.307	0.178

ISS: Injury Severity Score, TRISS: Trauma and ISS, RTS: Revised Trauma Score, ASCOT: A Severity Characterization of Trauma

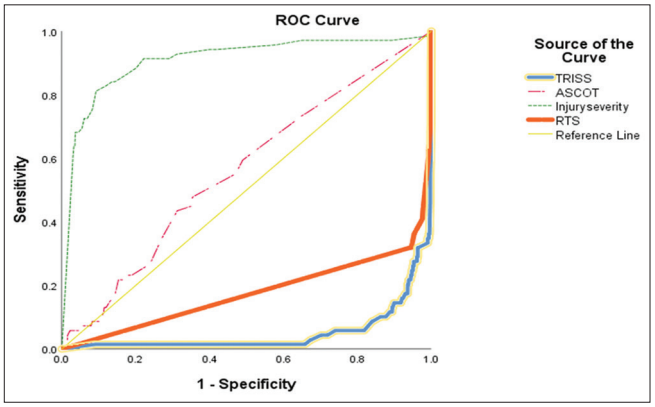

Figure 1: Receiver operating characteristic curve for all criteria (Injury Severity Score, A Severity Characterization of Trauma, Trauma and Injury Severity Score, Revised Trauma Score)

Table 5: Comparison of receiver operating characteristics area under the curve in different methods of trauma severity assessment methods and sensitivity and specificity at the desired cutoff points of the curve

Categories	Cutoff	Sensitivity (%)	Specificity (%)	*−LR	**+LR	***AUC	****PPV	*****NPV
ISS	ISS >31.5	0.72	0.06	0.86	0.95	0.90	0.19	0.83
TRISS	PS <3.30	0.89	0.99	0.01	0.08	0.05	0.74	1.00
RTS	PS <3.94	0.94	0.99	0.10	0.24	0.17	0.22	1.00
ASCOT	PS >3.5	0.08	0.08	0.49	0.62	0.55	0.02	0.74

*-LR=Negative likelihood ratio=1-Sensitivity/specificity, **+LR=Positive likelihood ratio=Sensitivity/1-specificity, ***AUC=Area under Chart, ****PPV: Positive predictive value, *****NPV: Negative predictive value

probably due to the low level of accident-related injuries. It requires proper planning to prepare and take the necessary measures to treat and heal these injuries.

The investigated systems did not have good collinearity with hospital stay and hospital costs. The best system in each case was ASCOT, due to the association of this method with anatomic indices. However, the utility of this method in predicting accurate hospital stay and hospital costs (using regression methods) is scarce. This may be due to the nature of the length of hospital stay and the cost of the hospital, which may be influenced by several factors (severity of the injury, location of injury, surgical procedures, or critical measures taken in the early stages of an accident, age or illness, and transmission seizures). These results are inconsistent with the results of Osler *et al*.[48] and Lam *et al*.[49] In fact, they proposed alternative models.

The highest positive likelihood ratio (+LR) in predicting mortality belonged to TRISS patients. These results show that TRISS identifies patient problems (triage) and determines the need for the use of special treatment, a higher value which is inconsistent with the results of similar studies.[50-52] RTS also has the lowest negative true likelihood ratio (−LR), which also means that RTS is a good criterion for identifying patients without problems and can be of great use in clinical decision analysis. It does not sound the same.[52]

Conclusion

In this study, most of the accidents happened in males, married, undergraduate, and homemaker and those on the street as well. In addition, the mean age of the patients was 33.63 years. The RTS and TRISS methods also had the highest ability in predicting death.

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Conflicts of interest

There are no conflicts of interest.

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