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# Comparison the Ability of Quantitative Trauma Severity Assessment Methods Based On GAP, RTS, and ISS Criteria in Determining the Prognosis of Accidental Patients

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## ABSTRACT

**Objective:** To compare the ability of quantitative trauma severity assessment methods based on Glasgow coma scale, age, and arterial pressure (GAP), revised trauma score (RTS), and injury severity score (ISS) criteria in determining the prognosis of accidental patients.
**Methods:** This cross-sectional study was performed on random patients referred to Imam Khomeini Hospital in Urmia from March 20, 2020 to September 21, 2020. The data were obtained by using a checklist includes items such as age, sex, respiration rate, oxygen saturation level, pulse rate, primary blood pressure, initial Glascow coma scale (GCS), patient outcome and injury to different parts of body. After collecting the data, it was entered into SPSS 18 and analyzed with the descriptive and analytical statistics include an independent t-test and receiver operating characteristic curve (ROC) curves.
**Results:** Out of 1930 studied patients, 365 (18.9%) were women and 1565 (81.1%) were men. The mean age of patients was 37.05±17.11 years and women were significantly older than men. The mortality rate was 4.8% and was significantly more in men compared to women. The mean blood pressure, GCS and oxygen saturation level were lower in deceased patients. The mean GAP, ISS and RTS values were 23.13±2.69, 4.07±3.82, 7.72±0.52, respectively. The mean values of GAP and RTS were significantly low in deceased patients whereas the mean ISS value was significantly high in the deceased patients. The Area under the curve (AUS) for ISS was greater than the other two scoring systems.
**Conclusion:** The findings of the current study showed that all three systems were adequately efficient to prognoses the final outcome in multi-trauma patients but the ISS measure was better than the other two criteria.

**Keywords:** Mortality; Injury; Emergency; Accidents.

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## Introduction

Traffic-related accidents are one of the most prevalent incidents in the world. Traffic accidents are one of the most important problems in the health community that endanger human health. In Iran, the mortality rate of traffic accidents has grown in the recent years [1, 2]. In 2004 and according to world health organization (WHO), traffic accident has gained such attention that it became the focus of the world's health day as the road safety day. Additionally, decreasing road accidents has also become one of the 21st goals of the organization in 2020. According to the definition, any death that occurs within 30 days after the accident is reported death due to road traffic accidents [3-5].

According to WHO, 1.24 million people (18 in 100,000) lose their lives and over 50 million people become wounded or disabled because of road traffic accidents. The death figure can raise to 1.9 million in few years, if no practical action takes place. In Asia, traffic accidents annually lead to 400,000 mortalities and over 4 million injuries based on WHO report. Over 90% of all traffic related accidents takes place in low to moderate-income countries in Africa and Eastern Mediterranean region [6-8]. In Iran, traffic accidents are the most common cause of injury and the 2nd leading cause of death [9, 10]. In the last decade, the death rate was 30 per 1000 people due to traffic accidents in Iran whereas this index was 22.6 and 13.9 in 100,000 people of global and Eastern Mediterranean region, respectively [11].

Injury is the major health risk in the world and the most common cause of death in adults aged 1-42 years is considered. Traffic accident injuries are one of the most important health problems in the world as predictable events. Every day, 30,000 people would seriously injured in traffic accidents in the world and 3,000 people lose their lives [12, 13].

The patients' trauma injury score is an important task and has been an essential part of pre-hospital triage, trauma mortality prognosis and an aid for physicians to assess the patient's condition for providing an appropriate care. Using scoring system during pre-admission actions can be crucial to mitigate the damage. Improper classification of trauma patients and choosing incorrect trauma assessment system can have irreversible consequences on the patient and might lead to increased mortality. The scoring system can be divided into three parts: anatomy score, physiology score or a combination of the two. In patients with severe trauma, the goal in the first stage is the survival of patients and the next goals includes avoiding organ failure, rapid recovery and finally achieve the desired quality of life [14-17].

Regarding the severity and mortality prognosis, there are several scoring systems in use of classifying multi-trauma patients. These systems include trauma and injury severity score (TRISS), revised trauma score (RTS), injury severity score (ISS), mechanism, Glasgow coma scale, age and arterial pressure (MGAP) and Glasgow coma scale, age and systolic blood pressure (GAP). Two simple systems of MGAP and GAP have shown high potential to prognosis the mortality in trauma patients particularly in recent years with the complexity of calculations in most of such systems, since, using standard and appropriate treatment has gained attention to reduce mortality of trauma patients. Studies showed that 50% of mortality cases occur in patients with no proper treatment. On the other hand, to have an equipped centers and proper actions can reduce the mortality rate of trauma patients from 30% to 9%. The third phase of mortality occurs between days 1 to day 30 after the trauma incidence which results in approximately 10 % to 20 % of mortality [6, 18]. The objective of this study was to compare the different methods of quantifying the trauma severity in determining the prognosis of random patients.

## Materials and Methods

This cross-sectional study was performed on multi-trauma patients admitted to Imam Khomeini hospital in Urmia and conducted from March 20, 2020 to September 21, 2020. The sampling methods was census. First, the inclusion criteria were established with being a multi-trauma patient and the patient's file were completed and the exclusion criteria includes the patient has died before entering the emergency room. The data were collected using a checklist containing patient's information such as age, sex, respiration rate, percentage of oxygen saturation level ($SPO_{2)}$ rate, pulse rate, initial blood pressure, initial Glasgow coma scale (GSC), the patient's final outcome and injury to body parts (head, face, chest, abdomen, pelvis and externals). To assess the severity of ISS injury, the body was divided into six areas includes the head, face, chest, abdomen, pelvis, and extremities. Also based on the severity of the damage to the six groups mild, moderate, serious, severe, and life-threatening crisis was divided.

To calculate the ISS, the AIS score of the injured members was determined in the first of the each area, then the three injuries that have the highest score of the AIS were selected and then reduced to the power of 2 and their sum was calculated ($ISS=x^2+y^2+z^2$). In the ISS scoring system, the minimum ISS score is 3 and the maximum is 75. It ranges from zero to 75 and its score increases with the severity of injuries [19-22]. Then, the ISS was calculated using AIS table for different degrees of damage, from 1 to 6, and the squared values of the highest scores were summed to obtain their score in the range of 1 to 75 [23]. In the GAP system, the patient's age below 60 years old gains the score of 3 while the age above 60 years old gains zero score. For systolic blood pressure, scores were given as follows: below 120 mmHg=6, 60-110 mmHg=4, and below 60 mmHg=0.

The GCS variable is scored from 3 to 15 based on the gained scores. In this system, the lowest final score indicates the highest trauma severity [24]. The RTS scale, ranges from 0 to 120, as the physiological system of the damage assessment was obtained by calculating GCS, systolic blood pressure, the recorded respiration rate upon admittance. The RTS system has the highest validity and influence the prognosis of concussion patients [25]. Finally, all data were collected and entered into SPSS 18 program. To describe the data, descriptive mean±SD (Mean±SD) test was used for the normal data distribution cases and in case of abnormal data distribution, median and mid-quarter amplitude indices were used. Frequency (percentage) was used for qualitative variables. Due to the normality of the data, independent t-test was used. The ROC curve was used to determine the predictive value of the studied scores. The area below the AUC curve, cut off point, sensitivity, specificity and J point were used. In all cases, *p* value less than 0.05 were considered significant.

## Results

The results showed that from 1930 patients, 365 patients (18.9%) were women and 1565 patients (81.1 %) were men (Figure 1). The mean age of the patients was 37.05±17.11. The women were significantly older than men ($p<0.001$). The mean blood pressure of the patients was 119.71±18.18 and the mean pulse rate and oxygen saturation rate were 96.43±6.39 beats per minute (BPM) and 95.91±1.58 percent, respectively. Also, the frequency of men in the deceased group was higher than discharged individuals ($p=0.022$). Also, the deceased group had low blood pressure ($p=0.041$), low oxygen saturation level ($p<0.001$) and low GCS ($p=0.001$) which was statistically significant (Table 1).

The mean score value of GAP, ISS and RTS were 23.13±2.69, 4.07±3.82 and 7.72±0.52, respectively. The deceased patients had higher ISS and lower GAP and RTS compared to discharged patients, which was statistically significant ($p<0.001$) (Table 1).

To determine the efficiency of the scoring systems, Receiver Operating Characteristics (ROC) curve was used. Based on the results, the cut off point for GAP was 14.5 additionally, the cut off point for RTS was 5.3 (sensitivity=0.96, specificity=0.98 and $p<0.001$) and in the study population, 92 patients (4.8%) deceased and 1838 patients (95.2%) were improved.

Additionally, the cut off point for RTS was 5.3 (sensitivity=0.97, specificity=0.97 and p<0.001). For ISS, the cut off point was 1.5 (sensitivity=0.95, specificity=0.71 and p<0.001). The AUC values for GAP, RTS and ISS were 0.70, 0.6 and 0.73, respectively. Given the high AUC value of ISS, this system can be more effective in prognosis of multi-trauma patients (Table 2). And the ISS system was the strongest in prognosis of the deceased and

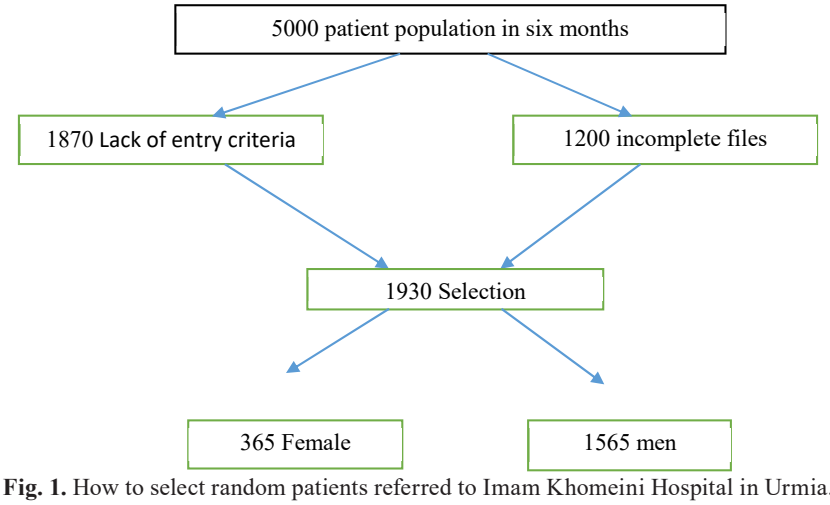


**Fig. 1.** How to select random patients referred to Imam Khomeini Hospital in Urmia.

**Table 1.** Investigation the study population regarding clinical signs and patients' final outcome.

| Variable | Mean±SD[b] | | | *p* value |
|---|---|---|---|---|
| | Deceased | Improved | Total | |
| Number of patients | 92(4.8) | 1838(95.2) | 1930(100) | |
| Blood pressure | 115.59±13.54 | 119.92±18.35 | 115.59±13.54 | 0.041[a] |
| Heart rate per minute | 96.34±4.90 | 96.44±6.45 | 96.34±4.90 | 0.951 [a] |
| Percentage of oxygen saturation | 95.26±1.45 | 95.94±1.58 | 95.26±1.58 | <0.001 [a] |
| GCS[c] | 14±1.79 | 14.62±1.40 | 14.59±1.43 | 0.001 [a] |
| GAP[d] | 21.94±2.69 | 23.19±2.69 | 23.13±2.69 | <0.001 [a] |
| ISS[e] | 6.68±4.31 | 3.94±3.75 | 4.07±3.82 | <0.001 [a] |
| RTS[f] | 7.50±0.63 | 7.74±0.51 | 7.72±0.52 | <0.001 [a] |

[a]: T test; [b]SD: Standard Deviation; [c]GCS: Glascow Coma Scale; [d]GAP: Glasgow Coma Scale, Age and Systolic Blood Pressure; [e]ISS: Injury Severity Score; [f]RTS: Revised Trauma Score.

**Table 2.** Determination and comparison of the GAP, ISS and RTS prognosis values in multi-trauma patients.

| Statistics Criterion | Cut off point | Sensitivity | Specificity | -LR[a] | +LR[b] | Level below chart (AUC[c]) | PPV[d] | NPV[e] | Youden Index (J) | *p* value |
|---|---|---|---|---|---|---|---|---|---|---|
| GAP[f] | 14.5 | 0.96 | 0.98 | 0.78 | 0.84 | 0.70 | 0.41 | 0.86 | 0.94 | <0.001 |
| ISS[g] | 1.5 | 0.95 | 0.71 | 0.12 | 0.24 | 0.73 | 0.61 | 1.00 | 0.66 | <0.001 |
| RTS[h] | 5.3 | 0.97 | 0.97 | 0.82 | 0.76 | 0.66 | 0.34 | 0.79 | 0.94 | <0.001 |

[a]-LR: Negative likelihood ratio=1-Sensitivity/specificity; [b]+LR: Positive likelihood ratio=Sensitivity/1-specificity; [c]AUC: Area under Curve; [d]PPV: Positive Predictive Value; [e]NPV: Negative Predictive Value; [f]GAP: Glasgow Coma Scale, Age and Systolic Blood Pressure; [g]ISS: Injury Severity Score; [h]RTS: Revised Trauma Score.

**Table 3.** Adjusted association between the study variables and patients' final outcome (death).

| Variables[a] | OR[b] | 95% CI[c] | *p* value |
|---|---|---|---|
| GAP[d] | 0.84 | 0.24-0.94 | <0.001 |
| ISS[e] | 1.28 | 1.12-4.23 | <0.002 |
| RTS[f] | 0.86 | 0.32-0.96 | <0.001 |
| Primary blood pressure | 1.12 | 1.09-1.29 | 0.04 |
| Oxygen saturation level | 0.89 | 0.41-0.98 | 0.03 |

[a]The full model included GAP, ISS, RTS, age, sex, respiration rate, oxygen saturation level, pulse rate, primary blood pressure, initial GCS; [b]OR: Odds Ratio ;[c]CI: Confidence Interval; [d]GAP: Glasgow Coma Scale, Age and Systolic Blood Pressure; [e]ISS: Injury Severity Score; [f]RTS: Revised Trauma Score.

discharged patients as well.

According to the other results, for one unit that increase in ISS value, the odds of death 28 % increases. Also, for one unit increase in GAP value, the odds of death 16 % decreases (Table 3).

## Discussion

Easy trauma scoring systems can help the physician to adopt a definite and appropriate method of managing trauma patients. The scoring systems can useful in two stages. First, before dispatching the patient to the trauma center and second, in clinical decision making immediately after the patient reaches the trauma center. This system can also help in preparation of patients present in the emergency ward in decide to transfer them to either the operation room or informing the patient's family about the severity of the damage [26]. There are various tools and diagnostic tests that are used on the patients by the emergency physicians. Meanwhile, the new tools are also assessed to obtain more accurate results and to reduce time and cost compared to the older ones. The ROC is a graphical tool to express the screening characteristics of a test. It is used to determine the best cut off point and compare the diagnostic value of two or more tests using the area under the curve. This study was conducted to compare the mortality-morbidity prognostic values of ISS and RTS systems with GAP system in multi-trauma patients of traffic accidents who were admitted to the emergency ward of Imam Khomeini hospital in Urmia city.

In our study, the mean age of patients was 37.05±17.11 years, which was consistent with the other studies [27-29]. This is an indication of higher risk-taking and excitement seeking behavior of younger generation compared to others in the age strata, which has a key role in years of potential life lost and the costs of death and disability. Gender-wise, 365 patients (18.9%) were women and 1565 (81.1%) were men. The statistical analysis showed that women patients were older than men, which was statistically significant [30-32]. This difference could be associated to factors such as men having more accessibility to automobiles, regional culture and their more susceptibility to dangers compared to women.

In this study, the patients' mean blood pressure was 119.71±18.18 mmHg. The pulse rate and SPO2 of the studied patients were 96.43±6.39 bpm and 95.91±1.58 percent. The mean value of GCS in the patients was 14.59. Based on the findings, the deceased patients had lower BP ($p$=0.02), SPO2 ($p$<0.001) and GCS ($p$=0.001), which was statistically significant. In the current study, the mortality rate was 4.8% and was significantly greater in men compared to women [33-35].

In Rahmani *et al*., study [36], the mean value of GCS was 12 and the overall mortality rate in the other wards and the emergency ward was 17.1%, which was lower than the value of the present study. This difference could be related to COVID-19 pandemic situation and travel restrictions from and to the cities as it has reduced the occurrence of road accidents between cities which is often more prevalent and had more severity and casualties in pre-pandemic era.

The mean scores of GAP, ISS and RTS were 23.13±2.69, 4.07±3.82 and 7.72±0.52. The analysis results revealed that the deceased patients had significantly greater ISS value and significantly lesser GAP and RTS values compared to the discharged patients ($p$<0.001). In Rahmani *et al*., study [36], the mean GAP value in the studied patients was 20.53, a rather lower value compared to our study. However, this difference was expected to be due to higher mortality in the current study. Similar to our

study, the mean GAP and RTS values were 23.5 and 6.9 in Kondo *et al*., study [37] that was also expected to be as the mortality rate and is close to both studies.

In the present study, mean (SD) RTS in deceased patients were 6±1.57. For the recovered patients, the mean and SD was 67.55 and 7. For ISS, these numbers were 56.32±25.02 and 62.63±21.17 in the deceased and recovered patients, respectively. The findings showed that all three systems were properly capable to assess the outcome of trauma patients, however, the ISS system was recognized as the most efficient with regard to the obtained AUS in all three systems. Additionally, the GAP system was found as the most efficient for patient prognosis, particularly with GAP and MGAP scores [28, 36, 37].

The results of the present study showed that men constitute a larger population in the community of multi-trauma patients; and the mean scores of GAP, ISS and RTS were significantly differed between deceased and discharged patients. All three scoring systems were capable of properly predict the final outcome in multi-trauma patient but with regard to AUC, the ISS was found to be more efficient than the other two systems. These findings were expected given the inclusion of anatomical condition and trauma type in the ISS system.

One of the strengths of this study is the lack of such a study in the province, especially since it was conducted on trauma patients. Incompleteness of some patient's files, patient discharge by personal consent, and patient death before admission to the emergency ward were of the shortcomings of the current study. It is suggested that these types of studies to be conducted periodically and at other universities in longer durations as well.

## Declarations

**Ethics approval and consent to participate:** This research was obtained from the research project approved by Urmia University of Medical Sciences, which has been approved by the ethics committee of the university with the ethics code IR.UMSU.REC.1398.362.

**Consent for publication:** None declared.

**Conflict of interests:** The authors declare that there is no conflict of interest.

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