Mechanism of Injury, Glasgow Coma Scale, Age, and Systolic Blood Pressure: A New Trauma Scoring System to Predict Mortality in Trauma Patients

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Background: Trauma is the most common cause of death in people aged 1 - 44 years and the third leading cause of death regardless of age. Early diagnosis can expedite emergency care and thus patients can be transferred more quickly to a treatment center.
Objectives: The purpose of this study was to evaluate the mechanism of injury, Glasgow coma scale, age, and arterial pressure (MGAP) scoring system in predicting mortality in trauma patients.
Patients and Methods: In this cross-sectional study, 5,484 victims over 12 years of age referred to a trauma referral hospital and were evaluated. The MGAP score was assessed based on type of injury, Glasgow coma scale (GCS), systolic blood pressure (BP) and patient's age. The area under the receiver operating characteristic (AUROC) curve was used as a measure of predictive performance. Data were analyzed using SPSS software version 16.
Results: Patients were divided into three groups : scores of less than 18, 18 - 22 and greater than 22; in which the mortality rates were 75.2%, 9.5% and 0.1%, respectively (P < 0.0001). The best cut-off point was 22 in our study, and the MGAP scoring system had 93.7% sensitivity and 91.3% specificity.
Conclusions: The MGAP scoring system can be used as an appropriate scoring system to predict mortality in triage trauma patients.

Keywords: Scoring System; Injury; Trauma; Mortality; MGAP; Glasgow Coma Scale

1. Background

Trauma is the most common cause of death in patients 1 to 44 years and the third leading cause of death in United States regardless of age (1). In recent years, road traffic accidents and the mortality rate due to these accidents have remarkably increased in Iran. Trauma is the second cause of death after cardiovascular diseases and the first cause of lost life years in Iran (2, 3).

The pre-hospital mortality rate of trauma patients depends on the severity of trauma. Rating of severity can be a helpful tool in identifying the patients who need more appropriate diagnostic and treatment procedures (4). The use of trauma scoring systems is appropriate in two situations that occur in trauma patient care; they can be used in the field to decide whether to send the patient to a trauma center or for clinical decision making when the trauma patient has just arrived at the emergency department (ED). Therefore, to assess the severity of trauma and proper triage of trauma victims, a quantitative and measureable scale seems prudent (5, 6). Several scoring systems have been devel-

oped over the past 50 years (7). The first comprehensive injury severity scoring system to measure injury severity was the abbreviated injury scale (AIS), introduced in 1971 (8, 9). The need to improve the quality of trauma care has led researchers to develop more accurate grading systems that allow physicians to predict the outcomes of injured patients. After that, other scoring systems such as the Glasgow coma scale (GCS), the injury severity score (ISS), the new injury severity score (NISS), the trauma injury severity score (TRISS), and A severity characterization of trauma (ASCOT) were introduced. Many researchers have studied the predictive performances of injury severity scoring tools but their results were not consistent. These disparities may be due to the differences in study populations and the differences between the formulas used to calculate severity (10). The MGAP was suggested in 2010 according to a study on 1360 patients. This scoring scale is calculated easily and patients graded from 3 to 29 in this scoring system (11-13).

2. Objectives

The aim of this study was to assess the MGAP scoring system to predict in-hospital mortality of trauma patients.

3. Patients and Methods

In this study, records of traumatic patients older than 12 years admitted to Poursina teaching and referral Hospital were studied from July 2011 to January 2012. During the study period, 7,749 trauma victims were hospitalized, of which 5,484 patients' records were reviewed randomly. Sample size estimation was performed according to Equation 1 and results of the Sartorius study and Kappa agreement between MGAP and mortality rate (11):

$$(1) \quad CI95\%kappa = kappa \pm z1 - \alpha/2 \sqrt{p(1-p)}/n(1-pe)^2$$

P = 0.825; Pe = 0.5; 1 - α = 0.95; d = 0.02; N = 5546; Sensitivity= 95%; Specificity= 75%.

Records of patients with incomplete necessary data and patients who were transferred to other hospitals were excluded. Data were derived from hospital information system (HIS) because there was no trauma registry. The data consisted of patient demographics, information at the scene of accident (recorded by EMS) or vital signs before reaching the hospital and at the first medical examination, diagnosis, treatment and information upon discharge from the hospital. The MGAP score was calculated as follows:

1. Injury mechanism: penetrating injury (zero score) and blunt injury (+ 4 scores); 2. GCS: the GCS score was exactly entered in the equation; 3. Patient age: age older than 60 years (zero score) and age under 60 years (+ 5 scores); 4. Systolic BP: BP > 120 mmHg (+ 5 scores) and 60 - 120 mmHg (+ 3 scores), and BP < 60 mmHg (zero score).

Total scores ranged from 3 to 29. After data collection, they were analyzed using SPSS version 16. For ethical considerations, data were collected anonymously. To test the normality of MGAP, the Kolmogorov-Smirnov test (K-S test) was used. Mann-Whitney U-test was also used to compare the mean of MGAP score in the groups. In this study, we used the Area under the receiver operating characteristic (AUROC) curve as a measure of predictive performance. The level of significance was set at P < 0.05.

4. Results

From a total of 5,484 patients, 77.2% (n = 4,233) were men, and mean age of the patients was 37.06 ± 18 years; the youngest one was 13 and the oldest 95 years old. More than 75% of the patients were younger than 49 years old. Also, 9.4% had penetrating trauma and 90.6% blunt trauma (Table 1).

The in-hospital mortality rate was 3.6%. The mean values of the MGAP in the injured survivors and dead were 25.5 ± 2.4 and 16.6 ± 3.7 (P < 0.0001), respectively (Table 2). Determining the specificity and sensitivity of different scores of MGAP (6 - 29) for in-hospital mortality prediction indi-

cated that the cut-off 23 had a sensitivity and specificity of 86.3% and 97.4%, respectively. Also, the positive and negative likelihood ratios for this cut-off were LR$^+$ = 7.1 and LR$^-$ = 0.03, respectively. However, the best sensitivity and specificity belonged to score 21, which was determined as a cut-off point (Figure 1).

With 93.7% sensitivity and 91.3% specificity, the mortality rate in high-risk patients (MGAP > 18) was 75.2%, in the moderate risk group (18-22) and was 9.5%, but in the low-risk group decreased to 0.1% (P < 0.0001, Table 3).

Table 1. Demographic Information of the Patients and Characteristics of Trauma Victims [a,b]

Variables	Values
Age Groups, y	
≤ 20	989 (18)
21 - 40	2584 (47.1)
41 - 60	1205 (22)
> 60	706 (12.9)
GCS	
3 - 5	82 (1.5)
6 - 8	95 (1.7)
9 - 15	5307 (96.8)
Gender	
Male	4233 (77.2)
Female	1251 (22.8)
Mechanism	
Penetrating	515 (9.4)
Blunt	4969 (90.6)
Outcome	
Alive	5289 (96.4)
Dead	195 (3.6)

[a] Abbreviations: GCS, Glasgow coma scale.
[b] Data are presented as No. (%).

Table 2. Comparing Mean, Standard Deviation and Other Statistical Indices of the Injury Mechanism, Glasgow Coma Scale, Age, and Arterial Pressure Scores Between Those That Died and Those Alive [a,b]

Outcome, n	Values	Min	Max	RV	IR
MGAP					
Alive (5289)	25.58 ± 2.40	12	29	17	3
Dead (195)	16.69 ± 3.78	7	27	20	6

[a] Abbreviations: IR, interquartile range; RV, range of variations.
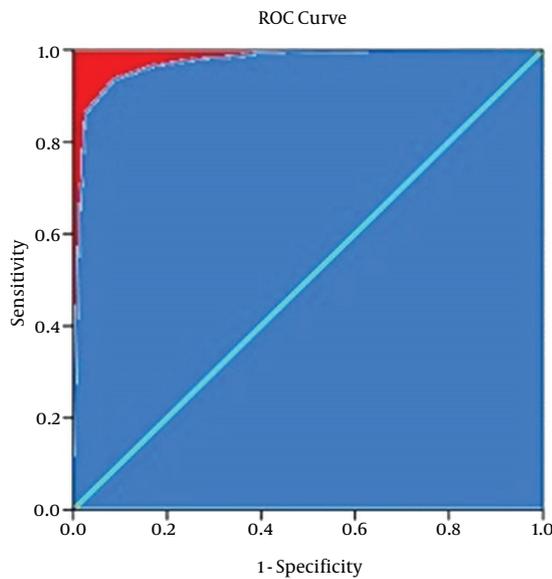[b] P value > 0.0001.

ROC Curve

Figure 1. Roc Curve of the Mechanism, Glasgow Coma Scale, Age, and Arterial Pressure Scoring System

Table 3. In-Hospital Mortality Rate According to Mechanism of Injury, Glasgow Coma Scale, Age, and Arterial Pressure Scoring System [a,b]

MGAP Groups	Died	Alive
< 18	39 (24.8)	118 (75.2)
18 - 22	685 (90.5)	72 (9.5)
23 - 29	4565 (99.9)	5 (0.1)

[a] P value = 0.0001.
[b] Data are presented as No. (%).

5. Discussion

Today, modern triage is based on the advances made in field of scoring systems (7). A measurable and quantitative scale is necessary to evaluate the patients, triage them and evaluate the results of trauma centers. Sartorius et al. published a study in 2010 showing that the MGAP system can accurately predict the mortality of trauma patients on admission. They also clarified that calculation, specificity and sensitivity of this system is much easier than that of revised trauma score (RTS) and triage revised trauma score (T-RTS) (11).

The calculation of TRISS needs the information of all injured organs which is not available and measurable on admission; this limits its use (10). This study evaluated the MGAP system for predicting mortality in trauma patients at Poursina Hospital. Most trauma patients in this study were men (77.2%) with mean age of 37.8 ± 18 and over 75% of the patients were younger than 49 years. Chabok et al. in Iran and other studies in other countries were not consistent with our study in terms of age of trauma patients (14, 15). In our study, blunt trauma accounted for 90.6% of

trauma cases and most deaths (98.97%) were due to blunt trauma. Other studies also suggest higher prevalence of blunt trauma compared to penetrating trauma in addition to higher mortality rate due to blunt trauma (2, 10, 11, 13, 16, 17). Despite that Sartorius and colleagues considered a score of 23 as an appropriate cut-off point in the MGAP system (11), in our study, the best sensitivity and specificity were observed at cut-off 22 (93.7% sensitivity and 91.3% specificity). Sensitivity and specificity score of 23 in our study were 86.3%, and 97.4%, respectively. Thus, here 21 was considered as the cut-off point, and on this basis, the individuals were divided into high-, moderate and low-risk groups. The rate of mortality in high-risk patients (MGAP > 18) was 75.2%, in moderate-risk (MGAP = 18 - 22) 9.5% and in low-risk (MGAP > 22) 0.01%. While in the study by Sartorius, mortality in high-risk individuals was 48% based on cut-off point of 23 and in patients with moderate risk 15% and in those with low risk was 2.8% (11). Of the surviving patients, only 0.6% had MGAP < 18 and those who died, only 1.2% had MGAP > 22. Regardless to controversies about the accuracy of different scoring systems (12, 13, 16, 17), it seems that according to results, MGAP is a suitable means to triage trauma patients due to its good prediction power and. This system is not useful for children's triage, and factors such as underlying diseases or certain medications, including some anticoagulant are not considered in this system.

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Authors' Contributions

Study design: Iraj Baghi, MohamadRasoul Herfatkar, Kazem Nezhad Ehsan, and Zahra Mohtasham Amiri. Data collection: Iraj Baghi, Leila Shokrgozar, and Mohamad Rasoul Herfatkar. Analysis and interpretation of data: Kazem Nezhad Ehsan and Zahra Mohtasham Amiri. Drafting of the manuscript: Iraj Baghi, Leila Shokrgozar, Mohamad Rasoul Herfatkar, and Zahra Mohtasham Amiri.

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