

Evaluation of MGAP and GAP Trauma Scores to Predict Prognosis of Multiple-trauma Patients

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Received 2015 September 18; Revised 2015 November 15; Accepted 2015 December 23.

Abstract

Background: Early diagnosis of major trauma and rapid transmission of patients to appropriate therapeutic centers have always been issues of concern. Several prognostic models for rapid clinical decision-making and estimating the mortality rate of multiple-trauma patients have been presented previously.

Objectives: The current study aimed to evaluate the GCS, Age, and systolic blood pressure (GAP) and mechanism, GCS, age, and systolic blood pressure (MGAP) scores of patients with multiple traumas and determine the cut-off points of these scores for predicting mortality rates.

Patients and Methods: This cross-sectional descriptive study was conducted in the emergency department (ED) of Imam Reza medical research and training hospital in Tabriz, Iran, and it included 374 patients with multiple traumas. Data regarding age, mechanism of injury, systolic blood pressure, and Glasgow coma score were collected. GAP and MGAP scores were calculated, and their relationship with the need for surgery, mortality in the ED, and mortality in the hospital ward were investigated.

Results: Mean \pm SD of the MGAP and GAP scores of patients were 24.36 ± 5.04 and 20.53 ± 5.08 , respectively. For no need for surgery, survival in the ED, and survival in the hospital ward, areas under the Roc curves for MGAP were 0.75, 0.93, and 0.99, respectively, and for GAP, they were 0.74, 0.80, and 0.99.

Conclusions: MGAP and GAP scores were used to accurately predict outcomes for patients with multiple traumas. We recommend that these simple triage tools for use by emergency medical technicians in pre-hospital settings to refer patients to appropriate trauma centers.

Keywords: Multiple Trauma, Mortality, Outcome Assessment, Emergency Service, Hospital

1. Background

Trauma is a leading cause of early death and disability throughout the world. Progress in pre-hospital and hospital interventions, however, has reduced the number of disabilities caused by major trauma (1). The majority of deaths caused by trauma occur in the early hours after injury and in the pre-hospital period. Pre-hospital emergency service providers must rapidly assess a patient and determine trauma severity to accurately refer patients (2,3). Trauma is a time-related condition. Specifically, the management, resuscitation, and assessment of patients with multiple traumas in the early hours after injury are important (4-6). Providing definitive treatment to trauma patients in the early hours after injury reduces mortality (4,7).

Conventionally, evaluating trauma severity has included assessing clinical findings, previous anatomical problems, injury mechanism, and level of health before

trauma. These assessments can lead to appropriate prognosis of trauma patients (8). The ideal prognostic model for trauma is one that is clinically sensitive, well-calibrated, and highly discriminatory (9,10).

Readily available trauma scores can aid emergency care providers in recognizing the severity of trauma and determining the management of trauma patients as soon as possible (11). These scores can be used in two places: at the scene of trauma (effective in dispatching a patient to an appropriate center) and in the hospital (for rapid diagnosis of patients needing surgery or therapeutic-diagnostic facilities). For this purpose, various scoring systems have been established. revised trauma score (RTS) and trauma-injury severity score (TRISS) are two widely used and most important scoring systems (12,13).

Sartorius et al. deduced in their study that the mechanism, GCS, age, and systolic blood pressure (MGAP) score can accurately predict the mortality rate of trauma pa-

tients in the hospital (14). Furthermore, Yutaka Kondo et al. concluded that the GCS, age, and systolic blood pressure (GAP) score can accurately predict the mortality rate of trauma patients in the hospital (15). Table 1 summarizes the details of the GAP and MGAP scoring systems and their scores. In this study, we used the calculated scores to predict the prognosis of trauma patients. Scores ranged from 6 to 29. Based on previous studies, the total scores were divided into 3 risk groups:

1. Low-risk group (score of 23 - 29 for MGAP and 19 - 25 for GAP); mortality rate: 2.8%.
2. Moderate-risk group (score of 18 - 22 score for MGAP and 11 - 18 for GAP); mortality rate: 15%.
3. High-risk group (score < 18 score for MGAP and < 11 for GAP); mortality rate: 48% (14-16).

Table 1. Details of GAP and MGAP Scoring Systems and Their Scores (Mechanism of Trauma Is Not Used for GAP Score)

Variables	Scores
Age	
< 60	+5
> 60	0
GCS	GCS value (range 3 - 15)
Mechanism of trauma	
Blunt trauma	+4
Penetrating trauma	0
Systolic blood pressure	
> 120	5
60 - 120	3

2. Objectives

We evaluated the MGAP and GAP scoring systems for multiple-trauma patients and to determine their ease of calculation as well as their ability to predict mortality rates and need for surgery in trauma patients. In our study, multiple trauma was defined as a case in which there are two or more severe injuries in at least two areas of a patient's body (17).

3. Patients and Methods

In this cross-sectional descriptive study, we investigated 374 multiple-trauma patients referred to the ED of Imam Reza medical research and training hospital (which has an admission rate of 25,000 trauma patients per year) between March 2014 and October 2014. Imam Reza medical research and training hospital is government-owned,

referral-type general hospital in Tabriz, East Azerbaijan, Iran, and it is the trauma center of the east Azerbaijan province. The sample size was determined based on sensitivity of 95% and specificity of 70% for the MGAP score (14), $\alpha = 0.05$, prevalence of multiple-trauma patients that meet our inclusion criteria = 30%, and 95% confidence level using Dr. Lin Naing's software (18). We employed the convenience sampling strategy. This study was approved by the ethics committee of Tabriz University of Medical Sciences and registered under the code number 11871 on 9 March, 2014.

Inclusion criteria were patients over 18 years of age with multiple traumas who were primarily referred to the ED by the pre-hospital emergency system and/or family members. In our study, multiple trauma was defined a case in which there are two or more injuries in a patient. Exclusion criteria included refusal to participate in the study, patients with isolated trauma, patients who had been transferred from other therapeutic centers, and patients suffering cardiac arrest on arrival at the ED. The study was explained to all patients and/or their immediate families, and informed consent was obtained. Patient information including mechanism of injury (blunt or penetrating), age, Glasgow coma score (GCS), and systolic blood pressure was recorded. The MGAP and GAP scores were calculated, and their relationships with need for surgery (laparotomy, chest tube insertion, craniotomy, spinal column and orthopedic procedures), mortality in the ED, and mortality in the hospital ward after admission were evaluated. Patient MGAP and GAP scores and GCS levels were evaluated with mortality and need for surgery.

Data were analyzed with SPSS 15.0, and we used descriptive statistical approaches (domains, frequency, percentage, and mean \pm SD). To determine the predictive values of the MGAP, GAP, and GCS scores, we applied the ROC curve. P value < 0.05 was considered significant in all cases.

4. Results

In this study, we investigated 374 patients with multiple traumas, of which 307 were male. Three hundred and five patients arrived to the hospital via emergency medical services. Mean \pm SD of patient age was 40.42 ± 18.05 years. Mean \pm SD of the MGAP, GAP, and GCS scores of patients were 24.36 ± 5.04 (range 10 - 29), 20.53 ± 5.08 (range 6 - 25), and 12 ± 3 (range 3 - 15), respectively. Table 2 summarizes patient demographics, namely, gender, age, injury mechanism, need for surgery, and mortality.

We used ROC curves to study the sensitivity and specificity of MGAP, GAP, and GCS in predicting traumatic patients' outcomes. The surface area under the curve (AUC) values for surgery required were 0.25, 0.26, and 0.34; those

Table 2. Demographic Features of Patients

Variables	Value ^a
Age	40.42 ± 18.05
GCS	12 ± 3
MGAP	24.36 ± 5.04
GAP	20.53 ± 5.08
Sex	
Male	307 (82.1)
Female	67 (17.9)
Mechanism of Trauma	
Blunt	359 (96)
Penetrated	15 (4)
Need Surgery	
Yes	146 (39)
No	228 (61)
Mortality in	
ED	53 (14.2)
Hospital Ward	11 (2.9)

^aValues are presented as mean ± sd or no.(%)

for predicting ED mortality were 0.073, 0.069, and 0.08; and those for predicting hospital mortality were 0.009, 0.009, and 0.024, respectively. Given the low surface area, and low sensitivity and specificity of these scores, we could not determine the cut-off point. In addition, the ROC curves were used to evaluate the sensitivity and specificity of these scores for estimating the patients' survival rates (ED and hospital ward) and lack of need for surgery. Table 3 lists the cut-off point, sensitivity, specificity, and area under curve (AUC), negative predictive value (NPV), positive predictive value (PPV), and Youden index (J) of the MGAP, GAP, and GCS scores based on the patients' survival (in the ED and hospital ward) and lack of need for surgery. Figure 1-3 show the ROC curves of the scores based on these variables.

5. Discussion

The initial predictive scores for trauma severity are usually dependent on variables that are quickly quantifiable, such as blood pressure, capillary refilling time, consciousness level according to the Glasgow scale, heart rate, and respiratory rate (19). The injury severity score (ISS), a trauma-measuring system, was introduced in 1971 and uses the dividing criteria of abbreviated injury score (AIS) (20).

RTS is another model used for this purpose, and it includes the three criteria of GCS, systolic blood pressure, and respiratory rate (12). The trauma-injury severity score (TRISS) system is also used in several centers. It predicts a patient's survival probability by scoring injury mechanism in addition to anatomical and physiological factors. It is

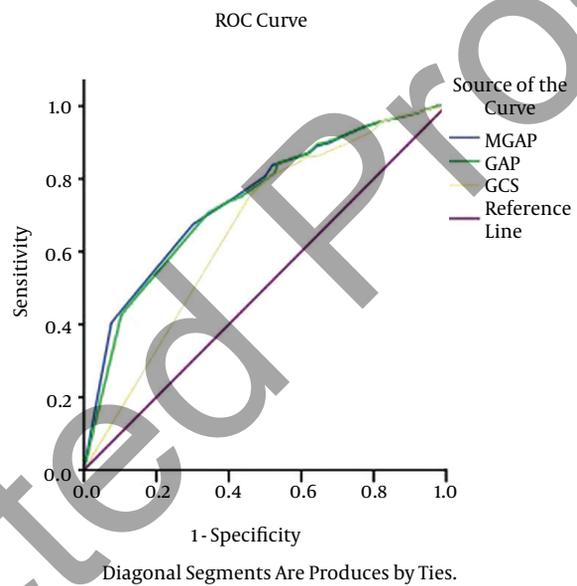


Figure 1. Receiver Operating Characteristic Curve for Sensitivity and Specificity of Three Scoring Systems for Lack of Need for Surgery

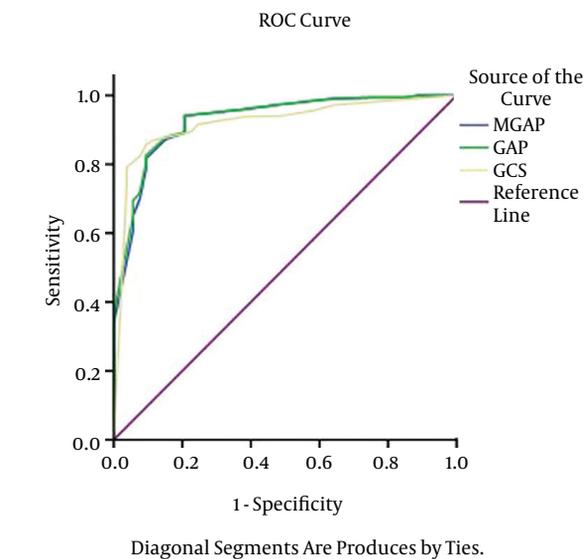


Figure 2. Receiver Operating Characteristic Curve for Sensitivity and Specificity of Three Scoring Systems for ED Survival

Table 3. Cut-off point, AUC, Sensitivity, Specificity, PPV, and NPV of MGAP, GAP, and GCS Scores

	No Need for Surgery			Survival in ED			Survival in Hospital Ward		
	GAP	MGAP	GCS	GAP	MGAP	GCS	GAP	MGAP	GCS
Cut-off point	21	25	14	18	22	11	14	18	10
AUC	0.74	0.75	0.66	0.93	0.93	0.92	0.99	0.99	0.98
Sensitivity	0.75	0.74	0.80	0.88	0.87	0.87	0.98	0.98	0.91
Specificity	0.57	0.60	0.49	0.85	0.85	0.89	0.91	0.91	0.91
PPV	0.64	0.65	0.61	0.85	0.85	0.89	0.91	0.91	0.91
NPV	0.70	0.70	0.71	0.88	0.87	0.87	0.98	0.98	0.91
Youden Index (J)	0.32	0.34	0.29	0.73	0.72	0.76	0.89	0.89	0.82

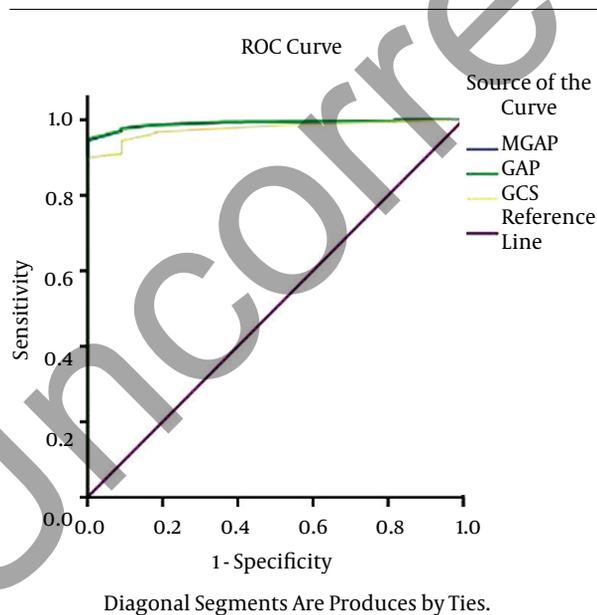
very complicated to use, however, and to calculate TRISS correctly, a 24-h period is needed (21). Emergency trauma score (EMTRAS) was introduced by Raum MR in 2009, and the parameters of this score are age, pre-hospital GCS, prothrombin time, and base excess. All parameters are divided into four classes (from 0 to 3). EMTRAS can accurately predict a multiple-trauma patient's outcomes (22, 23).

Perel et al. studied the prediction of early death in patients with hemorrhagic trauma. Among the studied variables, GCS, age, and arterial blood pressure were significantly associated with mortality. Their prognostic model to predict mortality in traumatic patients included an appropriate relationship with hemorrhage (24). Sartorius et al. developed a new model (MGAP) for evaluating trauma patients. According to their results, the specificity of the MGAP score in predicting mortality was higher than that

of the RTS and TRISS scores (14). Yotaka et al. compared a new trauma scoring system (GAP) with older models and found that the GAP system was significantly more accurate in predicting intra-hospital mortality than the previous models (14). Hasler et al. showed that MGAP and GAP scores are valid triage tools for risk stratification of traumatic patients (25). Baghi et al. concluded that the MGAP score was appropriate for traumatic patient's triage (26). Ahun. et al. showed that the GAP score could be easily used in the field and in emergency departments to accurately predict a traumatic patient's outcomes (27). Selim et al. compared two trauma scores (RTS and MGAP). They showed that in predicting mortality of traumatic patients, there was a difference between the two scores for low- and moderate-risk group patients, but for high-risk group patients, there was no difference between the two scores (28).

In the current study, multiple-trauma patients were separated into two groups: short-term survival (in the ED) and long-term survival (in the hospital ward). An evaluation of the short-term survival group showed that approximately all of the three scores had the same predictive value in terms of patient outcome. The evaluation of long-term survival showed that the accuracy of the MGAP and GAP scores was higher than that of GCS. The evaluation of lack of need for surgery in trauma patients showed that the sensitivity of the GCS score was higher than that of the other two scores, and the specificity of the MGAP score was higher, but all three scores had low Youden index values, implying that the accuracy of these scores for this variable was low.

The present study showed that MGAP and its modified model, the GAP system, are more powerful than other systems for evaluating patient survival (ED and hospital ward) and the lack of need for surgery. Additionally, the ease of using the GAP scoring system makes it more acceptable than MGAP. Based on our study, the sensitivity, specificity, PPV, and NPV of the MGAP and GAP scores in prediction of survival and lack of need for surgery were similar. It showed that the mechanism of trauma did not af-

**Figure 3.** Receiver Operating Characteristic Curve for Sensitivity and Specificity of Three Scoring Systems for Hospital Ward Survival

fect patient outcome. In patients with severe trauma or long pre-hospital transfer time, the mortality rate was high (29), so the use of pre-hospital trauma scores (MGAP and GAP) could reduce mortality by helping care personnel refer trauma patients to an appropriate care center.

The current study is a cross-sectional descriptive study. One limitation of this study is that it was conducted in one center, which means the effect of quality of service delivered to patients on mortality rates or other variables was not accounted for. Patient data collection was performed in specific hours of the day only (8AM until 3PM), so that we did not entered all multiple-trauma patients that they could be evaluated in our study.

5.1. Conclusion

According to the results of this study, application of the MGAP and GAP scoring systems is recommended in the case of multiple-trauma patients, whether in the pre-hospital stage (to conduct timely interventions and select an appropriate trauma center) or in the hospital stage (to begin diagnostic and therapeutic interventions as soon as possible to reduce mortality and determine the most important action with the highest benefit for the patient). These scoring systems can help emergency medical service providers in the pre-hospital setting to select the type of transfer for a patient (helicopter, or stay/play versus scoop/run). Further studies with larger sample sizes and multi-center studies should be conducted.

Acknowledgments

The authors are grateful to all health personnel and patients who participated in the study, in addition to the data collectors, supervisors, and administrative staff of the Emergency department of Imam Reza hospital. This article was written based on a dataset of an MD thesis registered in Tabriz University of Medical Sciences [Number: 92/1 - 10/18, approved date: 13.07.2013]

Footnotes

Authors' Contribution: All authors have read and approved the manuscript. FR, HEB, and MH performed the data collection, as well as writing, critical revision, and drafting of the manuscript. SSV and RMS undertook major parts of the study design and performed the statistical analysis, data analysis, and data interpretation.

Financial Disclosure: The authors declare they have no financial disclosure.

Funding/Support: This article is not supported by any funding organization. There is no sponsor of this work.

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