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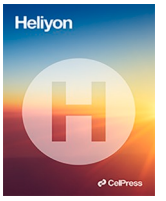

Research article

Comparison of GAP, R-GAP, and new trauma score (NTS) systems in predicting mortality of traffic accidents that injure hospitals at Mashhad University of medical sciences

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ABSTRACT

Background: There are several trauma scoring systems with varying levels of accuracy and reliability that have been developed to predict and classify mortality in trauma patients in the hospital admission. Considering the importance of the country's emergency organization and the World Health Organization in the category of traffic accidents, we used this information in the study. The objective of this study is to evaluate and compare the predictive power of three scoring systems (R-GAP, GAP, and NTS) on traffic accident injuries.

Methods: In an analytical cross-sectional study, all the data related to the mission of traffic accidents at the pre-hospital emergency management of Mashhad University of Medical Sciences in 2022 were extracted from the automation system, and the outcome of the patients in the hospital was recorded from the integrated hospital system. Then, GAP, R-GAP, and New Trauma Scores (NTS) were calculated, and their results were compared using ROC curve and logistic regression.

Results: In this study, 47,971 injuries from traffic accidents were evaluated. Their average age was 30.16 ± 10.93 years. R-GAP showed negligible difference than GAP and NTS scores (the area under the curve equals 0.904, 0.935, and 0.884, respectively), and the average scores of R-GAP, GAP, and NTS are equal to 22.45/45 ± 1/9, 22.25 ± 1.5, and 22.49 ± 1.3, respectively. Injury severity based on R-GAP, GAP, and NTS scores was mild in most patients. The effect of these models on the patient outcome based on OR values, R-GAP, GAP, and NTS models showed high values. All analysis was performed in SPSS 26.

Conclusion: According to the study results, it seems that R-GAP, GAP, and NTS, have the highest power to predict death in traffic accident injuries. It is recommended to include these points in the electronic file of the pre-hospital emergency for the injured. Also, the severity and outcome of the patient can be predicted by these scores, which play an important role in the triage of the injured and determining the appropriate treatment center.

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1. Introduction

In the management of trauma patients from traffic accidents, timely and accurate assessment is crucial, as the majority of deaths occur before ambulance arrival or in the early hours following injury [1]. Traffic accidents remain a significant global health concern, with the World Health Organization (WHO) projecting that they will become the second leading cause of death and disability worldwide by 2024 [2].

The unique characteristics of traffic accident-related trauma necessitate specialized approaches to patient assessment and care. Unlike other trauma mechanisms, such as falls or workplace injuries, traffic accidents often result in complex, multi-system injuries due to the high-energy impact and potential for multiple collision points [3]. This complexity underscores the importance of accurate trauma scoring systems specifically tailored to traffic accident scenarios. Several trauma scoring systems have been developed to predict mortality and classify injury severity in trauma patients upon hospital admission [4]. Various applications of scoring systems include injury prevention, injury severity prediction, mortality rate prediction, and improvement of hospital service quality [5,6].

These systems are particularly relevant in the context of traffic accidents, where rapid and accurate triage can significantly impact patient outcomes. The Revised Trauma Score (RTS), while valuable, has limitations in the prehospital setting, especially for traffic accident injuries [7].

More recent scoring systems, such as the Glasgow Coma Scale, Age, and Systolic Blood Pressure (GAP) score, have gained attention due to their simplicity and applicability in the field. The GAP score is especially relevant for traffic accident triage, as it can be quickly implemented at the scene, allowing for more efficient patient stratification and resource allocation [8,9]. The New Trauma Score (NTS), which replaces the Respiratory Rate (RR) with arterial blood oxygen saturation percentage (SpO2), has shown improved performance over RTS in predicting mortality for trauma patients, including those from traffic accidents [10]. However, its performance relative to GAP in the specific context of traffic accidents remains an area of interest. Given the high rate of traffic accidents in Iran and the need for a robust national trauma system, evaluating the effectiveness of these scoring systems specifically for traffic accident injuries is crucial [11].

The mortality rate is the most accurate measure of trauma prognosis. Various studies show that 25–50 % of trauma deaths are preventable [12].This study aims to compare the performance of R-GAP, GAP, and NTS scoring systems in predicting hospital outcomes for traffic accident injuries, addressing a critical gap in the literature regarding the applicability of these systems to this specific trauma mechanism. By focusing on traffic accidents, this research seeks to provide valuable insights into the most effective scoring systems for this prevalent cause of trauma, potentially informing improvements in prehospital care, triage protocols, and overall trauma management specific to road traffic injuries also Expected death which was introduced based on the study of Kondo et al. [7]. Considering the high rate of traffic accidents in Iran, the existence of a national trauma system, the creation of trauma teams and related training programs, and increasing the level of pre-hospital care for multi-trauma patients seem necessary [13].

2. Methods

In this analytical cross-sectional study, traffic accident data from January 2021 to January 2022 were collected from the pre-hospital emergency automation system, including demographic characteristics (age, gender) and the patient's vital signs (Glasgow coma scale, blood pressure, and arterial blood oxygen saturation percentage. The outcome of the injury was tracked using the hospital information system (HIS). The sample size was 47971 trauma injuries from traffic accidents. The sampling method is a census. Inclusion criteria included all traffic accident injuries that were transported by the pre-hospital emergency to Khorasan Razavi University of Medical Sciences (Mashhad) hospitals, and exclusion criteria included death before the ambulance arrived or incomplete documentation in the pre-hospital emergency file. The number of trauma injuries from traffic accidents that excluded was 4220. This study was approved by the ethics committee of Mashhad University of Medical Sciences with code IR.MUMS.REC.1402.228.

Variables include age, sex recorded, and, vital signs (Glasgow coma scale, blood pressure, and arterial blood oxygen saturation) measured by emergency technicians and hospital outcome of patients at the time of discharge (death or survival) were recorded. Three scoring systems, R-GAP, GAP, and NTS, were calculated based on the introduced formula (Table 1) [1,7]. In the classification of the

Table 1
Scoring GAP, R-GAP and NTS scoring systems based on the parameters in the three systems.

Score	Age	Systolic Blood Pressure	GCS	Oxygen saturation
GAP	<60=3 >60 = 0	>120 = 6 60-110 = 4 <60 = 0	3–15	–
R-GAP	<50 = 3 50-70 = 0 >70 = −3	≥120 = 6 90-119 = 4 60-89 = 2 <60 = 0	3–15	–
NTS	_	110-149 = 4 ≥150 = 3 90-109 = 2 70-89 = 1 <70 = 0	3–15	≥94 = 4 80-93 = 3 60-79 = 2 40-59 = 1 <40 = 0

GAP score, the score is divided into three groups: low risk with a score of 19–24, medium risk with a score of 11–18, and high risk with a score of 3–10. To classify the R-GAP score, this score is divided into four risk categories: low (20–25), medium [14–19], high [8–13], and very high (0–7), and finally, the NTS category is Four categories were divided into low risk (18–23), medium risk [12–17], high risk [6–11], and very high risk [14–16].The severity of the injury was determined based on the score obtained at each of the points for each injured person. The expected death rate in each severity category was compared with the deaths that happened in each category. In this study, using R-GAP, GAP, and NTS scoring systems, the quality-of-service delivery was evaluated based on the hospital outcome of traffic accident injuries, and the actual death was compared with the expected death in each severity category based on these scores.

We show the frequency of traffic accidents injures by vehicle and gender in Table 2. The data were entered into SPSS statistical software version 26. The Shapiro-Wilk test was used to evaluate the normal distribution of the data. Frequency (percentage) was used to describe qualitative data, and mean (standard deviation) was used for quantitative variables. An independent sample's T-test and chi-square tests were used to compare quantitative and qualitative variables between the two groups, respectively. In cases of non-normal distribution of quantitative data, the median (first quartile–third quartile) was used to describe and compare between two groups; the Mann-Whitney *U* test was used. The ROC curve was used to evaluate the accuracy of different trauma scoring systems and detect sensitivity and specificity, and logistic regression was used to calculate the odds ratio (OR) between different scores. A significance level of less than 0.05 was considered in all tests.

3. Results

In this study, out of a total of 47,971 traffic accident injuries, 35,871 were men (74.7 %) and 12,100 were women (25.3 %). It is noticeable that 4241 injuries were excluded from the study due to a lack of documentation. The average age of the patients was 30.10 $\pm$ 16.93 years, and the main mechanism of injury was related to a motorcycle accident with a car (23.3 %). In total, the injured motorcyclists accounted for the highest number of injuries, with around 35 %. Out of all the injured, 326 (0.68 %) died. Table 2 shows the frequency of traffic accident injuries by type of vehicle and the gender of the injuries. Among the traffic accidents, men are most injured in motorcycle-car accidents, and women are injured in car-car accidents.

Table (3) demonstrates the comparison of demographic variables, vital signs, and the location of the traffic accident based on the outcome of the patient (death or alive). The results of this table show that there is a significant difference between the outcome variable of the injured in the hospital and all the studied variables.

Table 4 compares the three scores of GAP, R-GAP, and NTS between the dead and alive groups and compares the actual mortality with the expected mortality obtained from previous studies. The average GAP of the total traffic injured was 22.25 $\pm$ 1.5, the R-GAP score of the injured was 22.45 $\pm$ 1.9, and the average NTS of the injured was 22.49 $\pm$ 1.3. According to the information in this table, in the comparison of the injured who died according to the level (low, medium, high GAP), it can be seen that in the GAP score, out of the number of 145 people who were in the high intensity group, 99 people (68.3 percent), in the R-GAP score out of 125 people, 90 people (72 percent), and in the NTS score out of 163 people, 106 people (65 percent) died. Regarding the GAP index, the performance in the low and high classifications is appropriate, but in the average category, the death rate is higher than expected. In the R-GAP score, the performance in all categories is appropriate. In the NTS score, the performance in the low, medium, and high classifications is appropriate. However, in the very severe classification, the death rate is higher, but these deaths cannot be judged because of their small number. The statistical analysis based on this index shows that the hospitals associated with Mashhad University of Medical Sciences in the traffic accident injures have demonstrated well performance in the management of patients with low and high severity, while in patients with moderate severity in the GAP index, the mortality rate is higher than expected death rate. Also, there is a significant difference between three indicators.

The ROC chart was used to calculate the area under the curve, cut-off point, sensitivity, and specificity of the three scoring systems (GAP, R-GAP, and NTS) in predicting the outcome of traffic accident injuries in (Fig. 1). The results of the study showed that these scores have good predictive power for the number of deaths of injured people in traffic accidents. However according to this curve and the level below it, the predictive power of the R-GAP index is higher than other indices.

To evaluate the power of predicting the death rate of traffic accident injuries in the hospital, GAP, R-GAP, and NTS scores were entered into the logistic regression model (Table 5). The result shows that, the area under the curve in the R-GAP score is higher than

Table 2
The frequency of traffic accidents injuries by vehicle and gender.

Accident type	Frequency	Male	Female
Car pedestrian accident	7525 (15.7 %)	5010 (13.9 %)	2515 (20.8 %)
Motorcycle-pedestrian accident	3667 (7.6 %)	2695 (7.5 %)	972 (8.1 %)
Car accident with a heavy vehicle	397 (0.8 %)	274 (0.8 %)	123 (1 %)
Two-car accident	10799 (22.5 %)	6558 (18.3 %)	4241 (35.1 %)
Motorcycle accident with a heavy vehicle	267 (0.6 %)	241 (0.7 %)	26 (0.2 %)
Motorcycle accident with car	11169 (23.3 %)	9976 (27.8 %)	1193 (9.8 %)
Two-Motorcycle accident	1131 (2.6 %)	977 (2.6 %)	154 (1.2 %)
Overturning car	4456 (9.3 %)	3133 (8.7 %)	1323 (10.9 %)
Overturning motorcycle	4326 (9.1 %)	3660 (10.2 %)	666 (5.5 %)
Other	4234 (8.4 %)	3347 (9.4 %)	887 (7.3 %)
Sum	47971	35871 (74.7 %)	12100 (25.3 %)

Table 3
Comparison of variables of three trauma scores (GAP, R-GAP and NTS).

Variable		Death (326)	Alive (47637)	P value	
Age		44.11±22.21	29.98±16.85	<0.001[a]	
Sex	Female	12043(25.3%)	57(17.4%)		<0.002[b]
	Male	36502(74.7%)	269(82.6%)		
Vital Signs	SBP	52.72±81.75	117.41±14.85	<0.001[a]	
	GCS	9.28±4.85	14.93±0.64	<0.001[a]	
	$O2_{sat}$	94.12±10.02	96.82±1.15	<0.001[a]	
The place of the accident	Urban	39647(83.3%)	256(78.6%)		<0.003[b]
	Rural	7971(16.7%)	70(21.4%)		

[a] Independent Sample T-Test
[b] Chi-Squre

Table 4
Comparison of three scoring points between dead and alive injured groups.

Scoring points	index	Death (326)	Alive (47637)	The percentage of death occurred	Expected death	P-Value
Mean ± **SD**	**GAP**	**14.86 ± 6.5**	**1.2 ± 22.3**			**0.001[a]>**
GAP category	Low	124	47298	0.3 %	1.8 %	**0.001[b]>**
	Middle	103	300	25.6 %	21.4 %	
	High	99	46	68.3 %	74.2 %	
Mean ± **SD**	**R-GAP**	**13.87 ±6.4**	**1.6 ± 22.5**			**0.001[a]>**
R-GAP category	Low	68	45040	0.2 %	0.5 %	**.001[b]>**
	Middle	127	2515	4.8 %	10.1 %	
	High	41	54	43.2 %	57.3 %	
	Very High	90	35	72.1 %	86.7 %	
Mean ± **SD**	**NTS**	**15.25 ± 6.2**	**1.1 ± 22.6**			**0.001[a]>**
NTS category	Low	134	47362	0.3 %	2.7 %	**0.001[b]>**
	Middle	84	225	27.2 %	29.8 %	
	High	106	57	65.1 %	76.2 %	
	Very High	3	0	100 %	98 %	

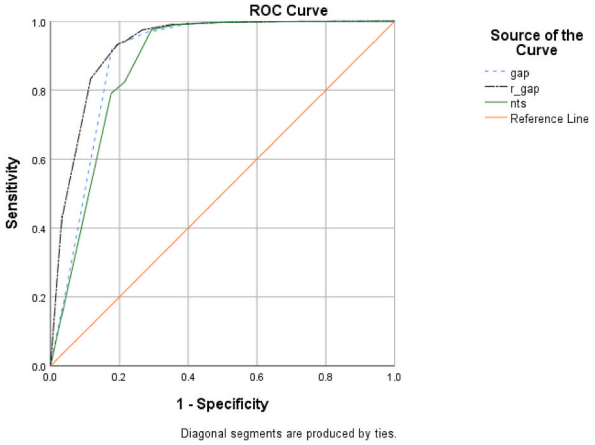

Fig. 1. ROC curve of GAP, R-GAP, and NTS variables in predicting hospital survival.

Table 5
Predictive values of GAP, R-GAP and NTS trauma scores in traffic accident injuries using ROC curve.

Score	Cut off point	AUC	Sensitivity	Specificity	P value
GAP	21.5	0.904	0.926	0.835	<0.001[a]
R-GAP	20.5	0.935	0.934	0.817	<0.001[a]
NTS	21.5	0.884	0.824	0.784	<0.001[a]

[a] Independent sample's *t*-test.

other scores.

The results of Table 6 show the odds ratio that for each unit increase in GAP, R-GAP, and NTS scores, keeping other variables constant, the probability of injured death is increased by 1.687, 1.754 and 1.192, respectively.

4. Discussion

Examining scoring systems is a controversial issue, and the superiority of each one over the other is a challenge. In the present study, the predictive power of the GAP, R-GAP, and NTS scoring systems was evaluated and compared based on the outcomes of the injured in the hospital. Based on the results of the evaluation of injury severity scores in predicting the outcome of traffic accident victims transported by the pre-hospital emergency, it is clear that the death rate was almost within the expected range of death. According to the area under the ROC curve and the sensitivity and specificity of two indicators, R-GAP and GAP showed a better prognosis, although, at the level under the curve, the R-GAP score performed a little better. These results are consistent with the study of Rahmani et al. [17]. The study by Yadollahi et al., in 2020 examined the trauma scoring systems ISS, GAP, MGAP, and GCS and found the accuracy of both GAP and MGAP methods to be suitable for predicting mortality. Also, GAP and ISS had the best specificity and sensitivity, respectively [18]. Kondo et al. also reported in their study that the GAP scoring system can predict hospital mortality more accurately than previously developed trauma scoring systems [7]. Another study by Rahmani et al. (2021), which aimed to evaluate the GAP score, modified trauma score (RTS), and NTS to predict the mortality rate in multiple trauma patients in Tabriz, based on the values Probability of chance showed that RTS and NTS models performed better [19] and also Ji Yong et al., in 2017 showed that NTS scores significantly predict in-hospital mortality better than GAP, MGAP, and RTS scores. Kend [10], according to our results, NTS is also one of the scoring systems that shows good performance. Soltani et al., 's 2018 research on trauma patients showed that both GAP and MGAP scores can predict mortality rates. Therefore, these scores can be used as a triage tool in predicting the severity of injuries and mortality [5]. The results of our study showed that the accuracy of the R-GAP score was slightly better than the other scores examined, and also in the odds ratio (OR) analysis, the R-GAP score had a higher odds ratio than the other scores. Also, the results of comparing the vital signs between the two groups of injured people showed that there is a statistically significant difference between the two groups in this regard. These results are similar to the results of the study by Khajooi et al., in 2021 [19].These variables can be easily evaluated at the patient's bedside, either at the scene of the accident before the hospital or in the emergency department of the hospital. Scoring systems can help the emergency medical forces prioritize the transfer of trauma patients to the hospital and determine the level of the destination hospital at the pre-hospital stage and at the scene of the accident. Considering the occurrence of errors in triage, it should be noted that excessive triage of traffic accident victims wastes many socio-economic and medical resources [20].Therefore, the injured should be transferred to the appropriate hospitals according to their trauma scores. Injured people with mild injuries can be transferred to low-level trauma centers to provide diagnostic and therapeutic services. Regarding the injured with severe and very severe injuries, before transferring the injured to the high-level trauma center, necessary warnings should be given to the hospital to prepare the emergency department and activate the trauma team, which consists of emergency department doctors, surgeons, anesthesiologists, and other Specializations are based on need. Based on the results of the studies, the activation of this team has improved the outcome of the injured [21,22]In addition, the injured with moderate injury severity can be transferred to the second-level hospital with regular monitoring of the patient's vital signs and clinical conditions [19].

5. Conclusion

In this study, the accuracy of all three evaluated scores was in the same range; however, the accuracy of the R-GAP score was slightly higher. In terms of comparing the expected death and the occurred death in each severity category in the evaluated scores, except the medium category of the GAP score, were within the range of the expected death. It is suggested to carry out further studies in the medical centers of other universities of medical sciences in the country to compare the results. Also, premature death under 24 h should be evaluated as one of the outcomes in future studies.

6. Limitations

This study offers valuable insights into the comparative performance of GAP, R-GAP, and NTS for predicting mortality in traffic accident injuries. However, our study has several limitations. First of all, it was conducted at a single university, which may limit the generalizability of the findings to other settings. Also, our study focused on adult patients and may not apply to children traffic accident injuries, who have distinct physiological responses to trauma. While pre-hospital emergency medical services personnel undergo training to ensure standardized data collection, variations in documentation practices, experience levels, and challenging field conditions can introduce inconsistencies or inaccuracies in recorded variables. These inconsistencies could impact the accuracy of the trauma scores and subsequent outcome predictions. Despite efforts to minimize missing data, some variables required for the trauma scores (e.g., GCS components) might have been unavailable for all patients. We addressed missing data using appropriate statistical methods, but it remains a potential source of bias. In addition, mortality is a critical outcome in trauma care, it does not capture the full spectrum of potential consequences following a traffic accident. Long-term morbidity, disability, functional limitations, and quality of life are important considerations that were not addressed in this study. Future research should explore the relationship between these trauma scores and a broader range of outcomes.

Table 6
Logistic regression analysis results for GAP, R-GAP and NTS trauma scores in the outcome of traffic accident injuries.

Score	B	OR	P value
GAP	0.239	1.687	<0.001
R-GAP	0.562	1.754	<0.001
NTS	0.176	1.192	<0.001

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Data availability statement

The datasets will be available upon reasonable request from the corresponding author.

CRediT authorship contribution statement

Taiebe Kenarangi: Writing – review & editing, Formal analysis. **Farzad Rahmani:** Supervision. **Ali Yazdani:** Conceptualization. **Ghazaleh Doustkhah Ahmadi:** Resources, Conceptualization. **Morteza Lotfi:** Conceptualization. **Toktam Akbari Khalaj:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

No conflict of interest exists. We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

References

[1] F. Rahmani, H. Ebrahimi Bakhtavar, S. Shams Vahdati, M. Hosseini, R. Mehdizadeh Esfanjani, Evaluation of MGAP and GAP trauma scores to predict prognosis of multiple-trauma patients, Trauma Mon. 22 (3) (2017).
[2] World Health Organization, Global Status Report on Road Safety 2023, WHO, Geneva, 2023.
[3] C.S. Rau, et al., Comparison of injury patterns between road traffic accidents and other trauma mechanisms: analysis of the TraumaRegister DGU, World J. Emerg. Surg. 17 (1) (2022) 1–10.
[4] R.H. Javali, A. Patil, M. Srinivasarangan, Comparison of injury severity score, new injury severity score, revised trauma score and trauma and injury severity score for mortality prediction in elderly trauma patients, Indian J. Crit. Care Med.: peer-reviewed, official publication of Indian Society of Critical Care Medicine 23 (2) (2019) 73.
[5] Y. Soltani, T. Mohammadi, M. Adib, E. Kazemnejad, I. Aghaei, A. Ghanbar, Comparing the predictive ability for mortality rates by GAP and MGAP scoring systems in multiple-trauma patients, Journal of Mazandaran University of Medical Sciences 27 (2018) 118–132.
[6] S. Manoochehry, M. Vafabin, S. Bitaraf, A. Amiri, A comparison between the ability of revised trauma score and Kampala trauma score in predicting mortality; a meta-analysis, Archives of academic emergency medicine 7 (1) (2019).
[7] Y. Kondo, T. Abe, K. Kohshi, Y. Tokuda, E.F. Cook, I. Kukita, Revised trauma scoring system to predict in-hospital mortality in the emergency department: glasgow Coma Scale, Age, and Systolic Blood Pressure score, Crit. Care 15 (4) (2011) R191.
[8] E.A. van Rein, R.M. Houwert, A.C. Gunning, R.A. Lichtveld, L.P. Leenen, M. van Heijl, Accuracy of prehospital triage protocols in selecting severely injured patients: a systematic review, J. Trauma Acute Care Surg. 83 (2) (2017) 328–339.
[9] E. Ahun, et al., Comparison of the glasgow coma scale and the alert, voice, pain, unresponsive scale in the prehospital setting, Prehospital Disaster Med. 35 (6) (2020) 675–681.
[10] J.H. Jeong, Y.J. Park, D.H. Kim, T.Y. Kim, C. Kang, S.H. Lee, et al., The new trauma score (NTS): a modification of the revised trauma score for better trauma mortality prediction, BMC Surg. 17 (1) (2017) 77.
[11] G. Mbanjumucyo, N. George, A. Kearney, N. Karim, A.R. Aluisio, Z. Mutabazi, et al., Epidemiology of injuries and outcomes among trauma patients receiving prehospital care at a tertiary teaching hospital in Kigali, Rwanda. African journal of emergency medicine. 6 (4) (2016) 191–197.
[12] N. Farzan, S.Y. Foroghi Ghomi, A.R. Mohammadi, A retrospective study on evaluating GAP, MGAP, RTS and ISS trauma scoring system for the prediction of mortality among multiple trauma patients, Annals of Medicine and Surgery 76 (2022) 103536.
[13] H. Sadeghi-Bazargani, B. Samadirad, N. Shahedifar, M. Golestani, Epidemiology of road traffic injury fatalities among car users; A study based on forensic medicine data in east Azerbaijan of Iran, Bulletin of emergency and trauma 6 (2) (2018) 146–154.
[14] M. Rehn, P. Perel, K. Blackhall, H.M. Lossius, Prognostic models for the early care of trauma patients: a systematic review, Scand. J. Trauma Resuscitation Emerg. Med. 19 (2011) 17.
[15] R. Orhon, S.H. Eren, S. Karadayı, I. Korkmaz, A. Coşkun, M. Eren, et al., Comparison of trauma scores for predicting mortality and morbidity on trauma patients, Ulusal travma ve acil cerrahi dergisi = Turkish journal of trauma & emergency surgery : TJTES 20 (4) (2014) 258–264.
[16] I. Feldhaus, M. Carvalho, G. Waiz, J. Igu, Z. Matthay, R. Dicker, et al., Thefeasibility, appropriateness, and applicability of trauma scoring systems in low and middle-income countries: a systematic review, Trauma surgery & acute care open 5 (1) (2020) e000424.

[17] P. Sepehri Majd, A. Alimohammadi Siyabani, H. Ebrahimi Bakhtavar, F. Rahmani, A new method to predict the in-hospital outcome of multi-trauma patients: r-gap, Journal of Emergency Practice and Trauma 8 (2) (2022) 128–133.
[18] S. Khari, M. Zandi, M. Yousefifard, Glasgow Coma Scale versus physiologic scoring systems in predicting the outcome of ICU admitted trauma patients; a diagnostic accuracy study, Archives of academic emergency medicine 10 (1) (2022).
[19] R. Khajoei, M.Z. Abadi, T. Dehesh, N. Heydarpour, S. Shokohian, F. Rahmani, Predictive value of the glasgow coma scale, age, and arterial blood pressure and the new trauma score indicators to determine the hospital mortality of multiple trauma patients, Archives of trauma research 10 (2) (2021) 86–91.
[20] J.L. Ryan, E. Pracht, B. Langland-Orban, M. Crandall, Association of mechanism of injury with overtriage of injured youth patients as trauma alerts, Trauma surgery & acute care open 4 (1) (2019) e000300.
[21] S. Khetarpal, B.S. Steinbrunn, M.D. McGonigal, R. Stafford, A.L. Ney, D.C. Kalb, et al., Trauma faculty and trauma team activation: impact on trauma system function and patient outcome, J. Trauma Acute Care Surg. 47 (3) (1999) 576–581.
[22] D. Tiel Groenestege-Kreb, O. van Maarseveen, L. Leenen, Trauma team, Br. J. Anaesth. 113 (2) (2014) 258–265.