The comparison of modified early warning score and Glasgow coma scale-age-systolic blood pressure scores in the assessment of nontraumatic critical patients in Emergency Department

Ö Köksal, G Torun, E Ahun[1], D Sığırlı[2], SB Güney, MO Aydın

Departments of Emergency Medicine and [2]Biostatistics, Faculty of Medicine, Uludag University, Bursa, [1]Department of Emergency Medicine, Sabuncuoğlu Şerefeddin Research and Training Hospital, Amasya University, Amasya, Turkey

Abstract

Introduction: The purpose of this study is to assess and compare the discriminatory ability of the Glasgow coma scale (GCS)-age-systolic blood pressure (GAP) score and modified early warning scoring system (mEWS) score for 4-week mortality, for the patients being in the triage category 1 and 2 who refer to Emergency Department (ED).
Methods: Five hundred and two nontraumatic cases being in the triage category 1 and 2 who were ≥18-year-old and who referred to ED were assessed prospectively. Reason of referral, fashion of referral, age, gender, vital signs, GCS/alert/verbal/painful/unresponsive scores, consultations, diagnoses, and treatments and final outcome (hospitalization, transfer, discharge, treatment rejection, and exitus) were recorded. The mEWS and GAP scores and the mortality ratios of the cases were calculated by observing both in ED and 4-week survivals of the patients.
Results: When the mEWS and GAP scores were compared in the prediction of 4-week mortality, no statistically significant difference was found between them ($P > 0.05$). The power of mortality estimation was found significant for both scoring systems (for both; $P < 0.001$).
Conclusion: GAP score with a simple use being a score developed for the estimation of mortality of trauma patients seems to be usable also for the nontraumatic patients with triage category 1–2 in the ED.

Key words: Glasgow coma scale-age-systolic blood pressure score, modified early warning scoring system, mortality, nontraumatic critical patient

Introduction

Nowadays, many scoring systems for the purpose of mortality estimation in the patient care are used. In this respect, the practical use of the scoring systems in the healthcare of the patients in Emergency Department (ED) and delays in their treatments in which mortality calculation is done or in the detection of deficiencies comes into prominence. The simplicity and the ease of calculation of the scoring systems to be used, having a higher power of mortality estimation and ability of orientation the clinician to be more careful

Address for correspondence:
Dr. Ö Köksal,
Department of Emergency Medicine, Faculty of Medicine,
Uludag University, Bursa 16059, Turkey.
E-mail: koksalozlem@gmail.com

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are required. The ideal scoring system to be used in the ED should include physiological variables in limited number that can be collected easily from the moment of reference, and it should predict properly clinically important results.[1] An early warning scoring system (EWS) was defined by Morgan *et al*. on 1997.[2] Stenhouse *et al*. attempted to achieve the modification of the early warning scoring system of Morgan *et al*. and as a result, they defined modified EWS (mEWS) in which urinary excretion was included.[3] Afterward, Subbe *et al*. developed mEWS constituted of five parameters which also used nowadays in a study that they conducted.[4] Modified early warning score is calculated by measuring pulse, respiratory rate, fever, level of conscious (assessed by alert/verbal/painful/unresponsive [AVPU]), and systolic blood pressure. Grading varies between 0 and 14 [Table 1].

Glasgow coma scale (GCS)-age-systolic blood pressure (GAP) score is a physiological scoring system defined in an 114-centered study conducted in Japan by Kondo *et al*.[5] To be able to calculate the GAP score, it is sufficient to know the GCS of the patient, the systolic blood pressure of the patient and the age of the patient. The mortality risk of the patient with respect to the score that the patient has received is evaluated as low as 19–24 points, moderate for 11–18 points, high for 3–10 points [Table 2]. There were a few studies on the literature about GAP score in trauma patients.[5-8] However, GAP score has not previously been validated in nontrauma patients.

In this study, we aimed to compare the power of mortality estimation of mEWS which is commonly used with that of GAP scores developed for trauma patients in patients of nontraumatic triage category 1 and 2.

Methods

According to the Australian National Triage Scale,[9] 502 nontraumatic patients who referred to the ED of the Medical Faculty of Uludag University and who were ≥18-year-old in triage-1 category and in triage-2 category were assessed prospectively (Ethic Board number: 2012-25/23). Triage categories of patients were performed by emergency physicians. Trauma patients and patients who were younger than 18-year-old were not included in the study. Reason of referral, fashion of referral, age, gender, vital signs GCS/AVPU score, consultations, diagnoses, and treatments with their final outcome (hospitalization, transfer, discharge, treatment rejection, and exitus), and their unit of hospitalization (clinic/Intensive Care Unit [ICU]) were recorded. The patients were monitored by recording the contact information during this period of time and followed up during a 4-week period to calculate the short-term (24 h) and long-term (4-week) mortality prediction rates. By calculating mEWS and GAP scores, their powers of mortality estimation were compared. For mEWS, the scoring system of Subbe *et al*. was used and the scoring system of Kondo *et al*. was used for GAP scores.

For statistical analyses, all data were analyzed by recording into IBM SPSS for Windows® 21.0 (SPSS Inc., Chicago, IL, USA) program. Mann–Whitney U-test was used in comparing two groups and receiver operating characteristic (ROC) analysis was performed to assess the performances of GAP and mEWS scores in predicting mortality. The determination of the most suitable cutoff value was done according to Youden J index criterion. In the comparison of the categorical variables, Pearson Chi-square, Fisher exact Chi-square, and Fisher–Freeman–Halton tests were used. The statistical significance level was considered as $P < 0.05$.

Results

Totally 502 patients were included in the study. The median age of the patients was 62 years (minimum–maximum: 18–103). Two hundred and forty-eight of them were males (49.40–95% confidence interval [CI]: 45.05–53.76), and 254 (50.60–95% CI: 46.24–54.95) of them were females. Other characteristics of the patients are shown in Table 3.

About 16.73% (95% CI: 13.72–20.25) of the patients (n = 84) who referred to the ED and who were included in the study were hospitalized in the ICU and 35.86% (95% CI: 31.79–40.15) of them (n = 180) were hospitalized in the clinic. While 1.99% (95% CI: 1.08–3.63) of the patients (n = 10) were exitus in the ED, 11.75% (95% CI: 9.22–14.86) of them (n = 59) were exit us within 4 weeks. Gender and age distribution belonging to the scoring systems of the patients are shown in Tables 4 and 5.

Table 1: Modified early warning scoring system

	Score						
	3	2	1	0	1	2	3
Systolic blood pressure	<70	71-80	81-100	101-199	-	>200	-
Heart rate	-	<40	41-50	51-100	101-110	111-129	>130
Respiratory rate	-	<9	-	9-14	15-20	21-29	>30
Fever	-	<35.0	-	35-38.4	-	>38.5	-
AVPU	-	-	-	A	V	P	U

AVPU=Alert/verbal/painful/unresponsive

Table 2: Glasgow coma scale, age, and systolic blood pressure score grading systems

	Points
GCS	3-15
Age (years)	
<60	3
>60	0
Systolic blood pressure (mmHg)	
>120	6
60-120	4
<60	0

GCS=Glasgow coma scale

Table 3: General characteristics of the patients

Parameters	Descriptive statistics
Age (years)	62 (18-103)
Gender#	
Male	248 (49.40)
Female	254 (50.60)
Temperature (°C)	36.50 (33.00-39.20)
Pulse rate/min	88 (40-216)
SBP (mm/Hg)	120 (40-200)
Respiratory rate/min	17 (9-30)
GCS	15 (3-15)
mEWS	2 (0-14)
GAP score	21 (3-24)
In-hospital mortality#	10 (1.99)
	95% CI: 1.08-3.63
4-week mortality#	59 (11.75)
	95% CI: 9.22-14.86

Data are given as median (minimum-maximum) or #*n* (%) - 95% CI of percentage. GAP=Glasgow coma scale, age, and systolic blood pressure; GCS=Glasgow coma scale; SBP=Systolic blood pressure; mEWS=Modified early warning score; CI=Confidence interval

On the basis of the GAP scoring system, there were 2.79–95% CI: 1.67–4.63 ($n = 14$) patients in high risk, 19.32–95% CI: 16.10–23.00 ($n = 97$) in moderate risk, and 77.89–95% CI: 74.06–81.30 ($n = 391$) patients in low risk, the study group. 85.71–95% CI: 60.05–95.99 of the patients who were categorized as high risk were hospitalized in the ICU ($n = 12$) and 21.43–95% CI: 7.57–47.59 of them ($n = 3$) were exit us in the ED.

We performed ROC analysis to investigate the predictive performances of the scores for the 4-week mortality. Area under the ROC curve (AUC) was 0.846 ($P < 0.001$) for mEWS. For cutoff = 3, sensitivity was found as 77.97 (95% CI = 65.3–87.7), and specificity was found as 79.91 (95% CI = 75.9–83.5). AUC was found 0.821 ($P < 0.001$) for GAP score. For cutoff = 18, sensitivity was found as 67.80 (95% CI = 54.4–79.4) and specificity was found as 83.97 (95% CI = 80.2–87.3). There was not found a significant difference between the performances of two scores ($P = 0.440$) in predicting 4-week mortality [Table 6].

Table 4: On the basis of the Glasgow coma scale, age, and systolic blood pressure scoring system gender and age distribution

GAP score	Female (*n*)	Male (*n*)	Total (*n*)	*P*	Median (age)	Minimum	Maximum	*P*
>18	57	54	111	0.857	72	24	103	<0.001
≤18	197	194	391		58	18	91	
Total	254	248	502		62	18	103	

GAP=Glasgow coma scale, age, and systolic blood pressure

Table 5: On the basis of the modified early warning scoring system gender and age distribution

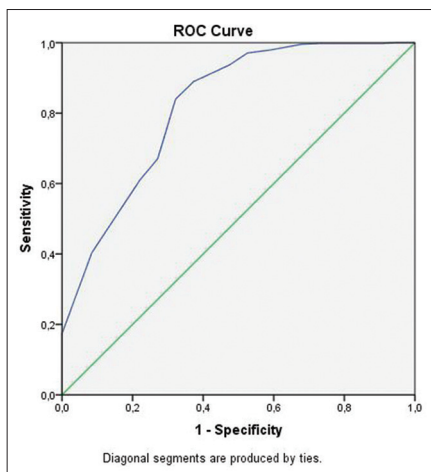| mEWS	Female (*n*)	Male (*n*)	Total (*n*)	*P*	Median (age)	Minimum	Maximum	*P*
>3	72	63	135	0.457	65	18	103	<0.001
≤3	182	185	367		59	18	91	
Total	254	248	502		62	18	103	

mEWS=Modified early warning score

Figure 1: Receiver operating characteristic curve for Glasgow coma scale-age-systolic blood pressure score in the mortality estimation
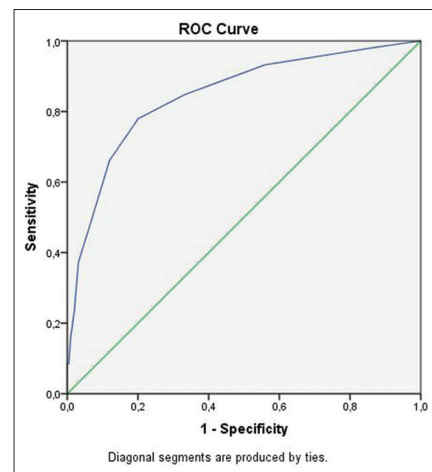

Figure 2: Receiver operating characteristic curve for modified early warning scoring system score in the mortality estimation

Table 6: Receiver operating characteristic analysis of Glasgow coma scale, age, and systolic blood pressure and modified early warning scores in predicting 4-week mortality

	Cut-off value	95% CI		AUC	P
		Sensitivity	Specificity		
GAP	18	67.80	83.97	0.821	<0.001
		54.4-79.4	80.2-87.3		
mEWS	3	77.97	79.91	0.846	<0.001
		65.3-87.7	75.9-83.5		

CI=Confidence interval; AUC=Area under the ROC curve; ROC=Receiver operating characteristic

The ROC curves of mEWS and GAP scores are shown in Figures 1 and 2.

Discussion

In this study, it was aimed to compare the power of mortality estimation of mEWS which is commonly used in the mortality estimation with that of GAP scores developed for trauma patients in nontraumatic triage category 1 and 2 categories. In the literature, no study on the mortality and morbidity estimation with GAP score in referral to ED was found. According to the results of this study, since GAP score has a prediction power in the patients for mortality and for hospitalization, we suggest that its application in ED can be useful to either improve the prognosis or prevent the delays in critical patients. In the conducted studies, it was shown that a higher mEWS in the hospitalization demonstrates correlation between the need to transfer to higher healthcare level and that a score higher than 5 is related with a 5-fold increase in death risk in the hospital.[4] Armagan *et al.* have evaluated the patients having mEWS value >4 as patients with higher risk in a study that they conducted on 309 patients referring to ED.[10] They demonstrated that the ratios of hospitalization of the patients with higher risk into ICU and their mortalities within the hospital and in the ICU were higher. In a study that they conducted Akgün, it was reported that there were increased mortality and increased hospitalization ratios into ICU in mEWS values ≥5.[11] In a study that they conducted, Ludikhuize *et al.* detected mEWS values of the critical patients as 3 or higher, and they considered those being in arrest, those requiring immediate surgery and those hospitalized in the ICU within 48 h as critical patient.[12] The use of mEWS as triage tool in the ED conditions was evaluated in a pilot study demonstrating that three or higher values are related with the probability of hospitalization.[13] In our study, mEWS values ≥4 were found related with the increased mortality and the hospitalization similar to other studies.

In a study that they conducted on 709 clinic patients, Subbe *et al.* determined that mEWS can predict death, hospitalization in the ICU, cardiac arrest, survival, and discharge from the hospital within 60 days following the referral to hospital.[4] In another study that they conducted, although Subbe *et al.* suggested mEWS is a convenient method in identifying the risky patients, since there are many factors affecting the decision of hospitalization and the patient termination, they expressed that these scores could not be effective as expected on the survival of patients and on the decision of hospitalization.[14] In a retrospective study that they conducted on trauma patient, Patel *et al.* used mEWS score to investigate its efficiency in monitoring the impairment in the physiological parameters of the follow-up scores.[15] The practical use some of the trauma scoring systems being used are restricted due to either the difficulty in calculation or the need for laboratory results for calculation. In a study that they conducted, Ahun *et al.* determined that since GAP score possesses fewer parameters, its power of mortality estimation is closer to Trauma Related Injury Severity Score system with the characteristic of being usable either on site or in ED at the moment of referral and its components are simple and easier to calculate, it is usable scoring system in performing triage before hospital.[6]

Lower scores for GAP, i.e., increased risk can be seen in the earlier period, and it is in the character of showing the useful effects of the treatment in most of the patients and score in the study conducted by Subbe *et al.*, it seems that it tends to be modified similarly to the modified early warning.[4] Therefore, GAP score may play a role as another method to evaluate the efficiency of the medical interventions in one sense.

In this study, there are several limiting factors such as small sampling in addition to be a single-centered study. Although none of the scoring systems seem to be suitable for the evaluation of the patients of the clinic in routine practice, since it simply blends the results of the collected variables routinely similar to mEWS, GAP score has been shown as a tool to be more useful. GAP score with a simple use being a score developed for the estimation of mortality of trauma patients seems to be usable also for the nontraumatic patients with triage category 1–2 in the ED.

Conclusion

More prospective multi-centered studies in which there is a higher number of cases are required.

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Conflicts of interest
There are no conflicts of interest.

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