Original Article

The Prognastic Efficiencies of Modified Early Warning Score and Mainz Emergency Evaluation Score for Emergency Department Patients

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Abstract

Background: Recently, there is an increasing interest for scoring systems to evaluate the critically ill patients by means of the severeness of their disease and their availibility for discharge in the emergency departments and intensive care units. Our aim in this study is to evaluate the efficiency of the mEWS and MEES scoring systems in assessing the severeness of the disease and predicting the mid term prognosis of the patients hospitalized following their emergency care in our emergency room. **Material and Method:** Patients, who attended to Inonu University Department of Emergency Medicine and hospitalized following their emergency care were included to our study. The effects of age, sex, triage categories, mEWS and MEES scores on the site of hospitalization and mortality was evaluated. Statistical analyses were performed by SPSS for Windows version 16.0. The data was summarized as means, standart deviation and percents. Univariate and multiavriate analyses were performed for risk factor calculations. **Results:** The mean age of the patients was 58±19 and 584 (56%) were male. Triage group 1 patients accounted for 21 of all (2%), while 646 (61%) were in group 2 and 384 (37%) were in triage group 3. Of all patients, 341 (32%) were hospitalized to ICU. While discharged patients accounted for 89% (935 patients) of the study group, 116 patients (11%) died at the hospital. The GCS, AVPU and mEWS values were statistically significant by means of patient mortality ($P < 0.0001$), but the delta MEES value was not ($P < 0.127$). **Conclusion:** The results of our stuy suggests that mEWS evaluation is an effective and reliable tool for predicting outcome and hospitalization areas of ED patients. Our results also displayed that the easily available GCS and AVPU scales are reliable guides in patient management. MEES values, on the other hand, are not convenient for ED use.

Keywords: *AVPU, critical patient, emergency department, Glasgow Coma Scale, mainz emergency evaluation scoring, Modified Early Warning Score, prognosis*

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Introduction

Recently, along with the rapid development of emergency medicine (EM) system, the rising number of emergency department (ED) visits, prolonged ED admissions and overcrowding in the hospitals caused the necessity to provide care for a vast number of critical patients in the EDs.[1] Although this increase caused –and was temporarily tolerated by-an increased admission of patients to intensive care units (ICU), the low turn-over rates causing the ICU beds to be constantly occupied, inevitably forced the EDs to play an alternative role for critical patient care.[2] Defining the condition and determining the prognosis of the patients via classifications intending to anticipate the severity of the disease depending on routinely recorded

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physiological measures is of great importance.[1] The overall risk that patients are under may be calculated by simple point of care algorithms using respiratory, cardiac, and mental status evaluations.[3,4]

The scoring systems that help discharge decisions or determine the severity of the disease in the ED or ICU, are a growing focus of interest.[5] The precursor of these systems in ED and ICU since 1974 is the Glasgow Coma Scale (GCS) which is followed by other routinely EM scoring systems.[6] Mainz Emergency Evaluation Scoring (MEES) is a definitive scoring system which involves GCS.[7] Despite not facilitating discharge decisions, MEES is a reliable and easy to use tool for patient evaluation in the pre-hospital area.[8,9] Besides being more coherent and significant than other scoring systems for predicting outcomes in critical patients, MEES has a special place in the pre-hospital setting since it helps evaluate a variety of patient groups including trauma patients.[7,10]

Modified Early Warning Score (mEWS) is another point of care algorithm which is clinically validated for ED use. mEWS value is shown to predict death in 60 days, ICU hospitalization, cardiac arrest, survival and discharge rates.[11] The purpose of the system is to build the communication between the physician and the nurse when a patient deteriorates, in order to provide early measures to prevent unnecessary delays in interventions and early transfer to the ICU.

Since not all the scoring systems are appropriate for ED patients, we aimed in our study to compare the effectivity of the MEES and mEWS systems for determining the disease severities of the ED patients and predicting the outcomes of the hospitalized patients.

Materials and Methods

Following the local ethical commitee approval, the relevant data of all patients who attended to the ED of Inonu University Turgut Ozal Medical Center (TOMC) between 1st of January and 15th of February were recorded prospectively to the standart data study forms. All study parameters were prospectively collected irrespective of the patients' complaints. TOMC is largest and most busy health care center of the territory with 38777 patient visits annually.

There were 4563 patient visits to the ED in the study period. Patients who matched the following exclusion criteria were not involved in the study: 1) Younger than 18 years of age, 2) those who refused to participate in the study, 3) patient visits related to active labor, injections, vital sign measurements etc., 4) those with missing data in the study form. The remaining 2962 adult patients with consent –either from themselves or their relatives-were included in the study. Our study universe was comprised by 1051 hospitalized patients following the ED care.

Patients visiting our ED were first evaluated with a three category triage system. Patients with immediately life or limb threatening complaints were accepted as triage category 1 (TC 1) and were taken to the ressuscitation room. Urgent patients requiring prompt care, but not fitting TC 1 were taken to monitorized observation area (TC 2) and non urgent patients (TC 3) were taken to non-monitorized observation units. In these areas, patients' mental status (AVPU or GCS), vital signs (pulse rate, systolic blood pressure, body temperature, SPO_2) and ECG rhythms were recorded to study forms. The recorded data was used to calculate the mEWS value and Delta MEES which is the difference between MEES values right pror to hospitalization (MEES 2) and at first contact (MEES 1). Prognostic data of the patients taken from the ENLİL® hospital operation system were categorized discharge or exitus during hosptalization. The effects of the age, gender, triage category, mEWS value and delta MEES value on area of hospitalization (ward or ICU) and mortality rates were evaluated.

Nurses and emergency medical technicians recorded pulse rates, systolic blood pressures (sBP), and SPO_2 values using Datex-Ohmeda S/5™ FM (Madison, USA) monitors and temperatures using Tyco Healthcare (USA) thermometers. ECGs were recorded via Nihon-Cohden Cardiofax M ECG-1350 (Tokyo, Japan), and patient's cardiac rhytm was recorded by the evaluating emergency medicine resident/specialist.

The diagnoses of the study patients were classified into 13 groups as cardiovascular (CVS) diseases, respiratory system (RS) diseases, neurological (NS) diseases, gastrointestinal system (GIS) diseases, genitourinary system (GUS) diseases, haematological and oncological diseases, nephrological diseases, endocrinological diseases, infectious diseases, psychiatric diseases, intoxications, trauma and others [fatigue, anorexia, fever, allergies, any bleeding (other than GIS bleedings), wound infections and hiccups].

Statistical analysis

Statistical analyses were conducted using Statistical Package for Social Science (SPSS 16.0, SPSS Inc., Chicago, IL, USA) for Windows. Data are reported as means, standart deviation (SD) and percentages. Percentages are presented as the nearest whole number. Variables with quantitative data were validated via Shapiro-Wilks test and those with qualitative data were validated with Chi-Square and Fisher's Exact Test. A P value <0.05 is accepted to be significant. Data

with normal distribution were validated with Unpaired-t test, while abnormally distributed data were validated using Mann-Whitney U test. Multivariate analysis with Forward-Stepwise Test was applied to evaluate the effects of age, mEWS values at presentation and hospitalization, delta MEES value, AVPU score, GCS value and ECG rhytm on mortality and hospitalization units.

Results

During study period, 1051 adult patients who visited our ED and were hospitalized to either ICU or wards were analyzed. Mean age of the patients was 58 ± 19 and 587 (56%) of them were male. According to the triage categories, 21 (2%) of the patients were in TC 1, 646 (61%) were in TC 2 and 384 (37%) were in TC 3. Of these patients, 341 (32%) were hospitalized to ICU and 710 (68%) were hospitalized to related wards; and while 953 (89%) of the patients were discharged, 116 (11%) were deceased during hospitalization.

The mortality rate of the patients was significantly related with mean age, triage category and hospitalization data ($P \leq 0.004$, $P \leq 0.0001$ and $P \leq 0.0001$; respectively), but not with gender ($P = 0.119$). As expected, the triage categories were strongly related with hospitalization units ($P \leq 0.0001$). On the other hand, when age groups were assessed, age over 40 was significantly related with higher ICU hospitalization rates ($P = 0.001$).

Table 1: Complaints at presentation to emergency department

	n (%)
Gastrointestinal system	274 (26.1)
Respiratory system	184 (17.5)
Cardiovascular system	168 (16)
Neurological system	165 (15.7)
Trauma	78 (7.3)
Musculoskeletal system	28 (2.7)
Genitourinary system	27 (2.6)
Psychiatric disorders	14 (1.3)
Others	113 (10.8)
Total	1051 (100)

Table 2: Data related to Mainz Emergency Evaluation Scoring and Modified Early Warning Score calculations in relation with mortality data

	Mean±SD			*P*
	Mortality	Survival	Total	
GCS initial*	10.6±4.5	15±1.6	14.2±2.5	0.0001
GCS final§	10.4±4.7	14.6±1.8	14.1±2.6	0.0001
sBP initial	130.3±49.5	142.4±32.3	141.1±34.7	0.0001
sBP final	126.7±37	131.5±26	130.9±27.5	0.069
PR initial	99.9±36	92.3±22.5	93±24.5	0.002
PR final	100±23.8	88±19.5	89.3±20.4	0.0001
RR initial	24.8±13.7	24.8±6.3	25±8	0.971
RR final	23±13.2	23.4±5.4	23.3±6.6	0.602
BT initial	36.4±0.8	36.7±0.8	36.6±0.8	0.0001
BT final	36.4±0.7	36.6±1.4	36.6±1.3	0.060
SPO_2 initial	74±35	93.4±11.6	91.3±17	0.0001
SPO_2 final	72.2±37.4	93.8±11.8	91.4±17.9	0.0001
mEWS initial	5.8±2.5	3.1±1.6	3.4±1.9	0.0001
mEWS final	5.2±2.3	2.7±1.5	3±1.8	0.0001

*Initial: Value at ED presentation; §Final: Value prior to hospitalization. PR=Pulse rate; RR=Respiratory rate; BT: Body temperature; SPO_2=Pulse oxymeter value; mEWS=Modified Early Warning Score; ED=Emergency department; sBP=Systolic blood pressures; SD=Standard deviation

Table 3: Data relat to MEES and Modified Early Warning Score calculations in relation with hospitalization area

	Mean±SD			*P*
	Ward	ICU	Total	
GCS initial*	14.8±0.8	12.7±3.8	14.2±2.5	0.0001
GCS final§	14.8±0.8	12.6±4	14.1±2.6	0.0001
sBP initial	140.6±30.1	142±42.2	141.1±34.7	0.549
sBP final	128.7±23.6	135.5±33.8	130.9±27.5	0.0001
PR initial	94±22	91±29	93±24.5	0.085
PR final	89±18.7	89.8±23.5	89.3±20.4	0.579
RR initial	25±6	24±10	25±8	0.041
RR final	23.7±4.5	22.6±9.7	23.3±6.6	0.008
BT initial	36.8±0.8	36.4±0.6	36.6±0.8	0.0001
BT final	36.7±1.4	36.4±1	36.6±1.3	0.0001
SPO_2 initial	94.2±6.7	85.4±27.4	91.3±17	0.0001
SPO_2 final	94.9±3.9	84.3±29.8	91.4±17.9	0.0001
mEWS initial	3±1.6	4.2±2.4	3.4±1.9	0.0001
mEWS final	2.6±1.4	3.8±2.3	3±1.8	0.0001

*Initial: Value at ED presentation; §Final: Value prior to hospitalization. PR=Pulse rate; RR=Respiratory rate; BT=Body temperature; SPO_2=Pulse oxymeter value; mEWS=Modified Early Warning Score; ED=Emergency department; sBP=Systolic blood pressures; ICU=Intensive Care Unit; SD=Standard deviation

Table 4: Multivariate analysis according to the mortality and area of hospitalization of the patients studied

	Mortality			Area of hospitalization		
	OR	%95 CI	*P*	OR	%95 CI	*P*
Age groups (age)						
18-29	7.6	2.1-27.1	0.002	2.1	1.2-3.7	0.007
30-39	1.6	0.6-4.4	0.336	2.1	1.1-3.9	0.022
40-49	2.4	0.9-6.4	0.069	0.8	0.5-1.4	0.448
50-59	3	1.4-6.4	0.004	0.7	0.4-1.1	0.095
60-69	1	0.6-1.1	0.959	1.1	0.7-1.6	0.748
GCS						
11-14	2.7	1.3-5.7	0.011	5.9	2.1-16	0.001
15	15.3	8.2-28.6	0.0001	9.3	2.7-31.5	0.0001
mEWS initial	3.2	1.9-5.4	0.0001			
AVPU				3.9	1.5-10.5	0.007

CI=Confidence interval; OR=Odds ratio; GCS=Glasgow Coma Scale; AVPU=Assessment of neurological functioning; MEWS=Modified Early Warning Score

Patients' complaints at the time of their ED visit are grouped and presented at Table 1. Five groups according to systemic classification with highest hospitalization rates were GIS (n: 221, 21%), CVS (n: 219, 20.8%), NS (n: 127, 12.1%), infectious diseases (n: 112, 10.7%) and RS (n: 88, 8.4%). Four patients who presented with neurological complaints, but later found to have trauma related subarachnoidal and subdural hematomas were listed under trauma group.

The initial sBP values, initial and final pulse rates, initial body temperatures, initial and final SPO_2 values, initial and final GCS scores, and initial and final mEWS scores were significantly related with mortality rates ($P \leq 0.0001$; $P = 0.002$, $P = 0.0001$; $P = 0.0001$; $P = 0.0001$, $P = 0.0001$; $P = 0.0001$, $P = 0.0001$, $P = 0.0001$; respectively). On the contrary, final sBP was not related with mortality rates ($P = 0.069$) as well as initial or final respiratory rates and final body temperatures ($P = 0.971$, $P = 0.602$, $P = 0.060$; respectively) [Table 2] and delta MEES values were not related with either mortality rates or the area of hospitalization ($P = 0.127$, $P = 0.359$; respectively).

While initial sBP values did not effect the area of hospitalization ($P = 0.549$), final sBP values were significantly related with this variable ($P \leq 0.0001$) [Table 3].

The initial AVPU score was significantly related with mortality and the area of hospitalization ($P \leq 0.0001$, $P \leq 0.0001$) and final AVPU score was significantly related with mortality rates, regardless of the hospitalziation area ($P \leq 0.0001$).

The initial and final ECG rhytms were also significantly related with hospitalization area and final outcomes ($P \leq 0.0001$, $P \leq 0.0001$).

Multivariate analysis indicated age, GCS and mEWS values as risk factors for mortality, and age, GCS and AVPU scores as determinants of area of hospitalization [Table 4].

Discussion

Patients of all ages who had any kind of complaints may present to EDs and some of those patients are critically ill patients. Although critically ill patients should be given medical care at the ICUs, they mostly visit EDs first in the course, and their medical care begins at this area. Therefore, ED physicians have a prominent position and responsibility in the management and treatment of these patients. In this sense, early warning scores should not only be studied as risk identifying screening tools, but also for their prognostic values as well.

Point of care (POC) evaluation of the alterations of some physiological parameters may help determine and even hinder some otherwise inevidable problems. In this study, the vital signs of our patients, mostly both at presentation and prior to hospitalization, were found to be related to mortality rates and areas of hospitalization. Mean age value of our patients was 58 ± 19, coherent with Armagan *et al*.'s 57.1 ± 15.[12] Mean age was 63 ± 20 at Subbe *et al*'s study.[11] Cei *et al*., on the other hand, found different mean ages for male and female patients, 80.6 and 77.1 respectively.[13] This discrepancy is most probably due to already given differences in life expectancies of different societies.

Due to the increase in both overall and critical patient visits to the EDs, triage became one of the most important functions of ED system.[14] The purpose of triage is to sort the patient while guiding the "right patient, to the right care giver, at the right time and place".[15] Our ED had a three levels triage system. When we evaluated the triage and hospitalization area data, triage to monitored area and resuscitation room was significantly related with higher hospitalization rates to ICU.

In the study by Hennes *et al*., data of 356 patients were evaluated and MEES score was shown to be effective for interpreting the pre-hospital condition of the patients and tracking the changes during or after the transport or any intervention and suggested that this score is an easy to use and reliable with no extra burdens for the physician.[9] On the other hand, they also suggested that this score is not sufficient enough to predict patient outcome without additional in-hospital data. Gremec *et al.* performed a similar study in 2007 on traumatic cardiac arrest patients with an Injury Severity Score over 14.[16] Their results pointed that when combined with capnometry MEES score performed significantly better then MEES alone and they suggested that "capnometry combined MEES score" would provide an effective communication protocol between pre-hospital team and the hospital staff. In the literature we could not find a study that evaluates the use of MEES system in the ED, all previous studies were performed at the pre-hospital area. In our study, univariate analysis showed no significant difference in mortality related to delta MEES scores of the patients. We concluded that differences in time periods between each patient when MEES 1 and MEES 2 values were calculated, variations in patients' interventions and a wide variety of diagnosis leading to heterogenity of the patient group were the main reasons for this result. Likewise, MEES scores had no effect on patients' areas of hospitalization over their final diagnosis.

Gremec *et al*. evaluated the efficiency of APACHE II, GCS and MEES scores for predicting mortality rates of

286 non-traumatic comatose patients.[5] While MEES and GCS were more successful than APACHE II in all aspects at the pre-hospital area, GCS was better in predicting disease severity and mortality than APACHE II and MEES scores. In accordance with Gremec *et al*.'s study, our univariate analysis showed that initial and final GCS values were significantly related with mortality rates.

Patel *et al*. retrospectively evaluated 32149 trauma patients with mEWS in order to define the utility of point of care scores to follow the deterioration of physiological parameters. They suggested that, although this score did not help lowering mortality rates, it is an effective, useful and inexpensive method for patient care.[17] Subbe *et al*. evaluated 709 ward patients in 2001 with mEWS and reported that the score successfully may predict death in 60 days, ICU hospitalization, cardiac arrest, survival and discharge.[11] In 2003, Subbe *et al*. reported that, regardless of the success of these scores in defining high risk patients, their efficacy on patient survival and hospitalization is limited due to multi-factorial pattern of hospitalization decisions.[18] Cei *et al*. asserted in their study on 1107 hospitalized geriatric patients that, mEWS is a simple and useful tool that may predict the unfavorable outcome in the hospital, even with a single assessment.[13] In our study, we determined that mEWS has a significant strength in predicting mortality and hospitalization areas. Although we did not directly study the effects of this score on ED dynamics, utilization of this system in the ED seems promising regarding both short and long term prognosis of the patients.

About a 25% of all ICU hospitalizations are due to cardiorespiratory arrests. Medical patients are under high risk for arrest and alarming physiological alternations occur prior to arrest.[19,20] These changes in 85% of hospitalized patients may begin 24 hours prior to arrest, but 54% of them were not timely recognized and 69% were under treated.[11] In our study the scores of the patients hospitalized to ICU were worse than those hospitalized to the wards. While delta MEES scores could not predict hospitalization areas and prognosis; our results suggest that regular evaluation of mEWS, GCS and AVPU scales and their guidance in hospitalization decisions are beneficial.

Although scoring systems are studied and utilized in pre-hospital area and ICUs, they are underestimated in the EDs both by means of academic studies and patient care.[11,18,21,22] Our results suggest that scoring systems that are appropriately studied for validity and reliability in the ED are effective in guiding hospitalization decisions.

There are limitations to our study. Although, due to high patient volume of our hospital, we had the chance to evaluate a significant number of patients, our study was conducted in a short time period. The fact that the study was conducted in a single academic center may make our results hard to interpret as a widely acceptable data, poiinting out the need for multicentric studies.

In conclusion mEWS, GCS and AVPU scores are reliable and effective tools in the ED for predicting negative outcomes. Despite its user friendly format and reliability in the pre-hospital area, MEES is not utilizable for the ED setting. Applicability of point of care scoring systems should be further evaluated with targeted prospective multicenter studies and algorithms to guide hospitalization and discharge decision related to these systems should be built.

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Conflicts of interest

There are no conflicts of interest.

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