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Original Research Article

Comparative study of scoring systems in ICU and emergency department in predicting mortality of critically ill

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ABSTRACT

Background: Scoring systems can be used to define critically ill patients, estimate their prognosis, help in clinical decision making, and guide the allocation of resources and to estimate the quality of care. It remains unclear whether the additional data needed to compute ICU scores improves mortality prediction for critically ill patients compared to the simpler ED scores.
Methods: We have done a prospective observational study of consecutively admitted 400 critically ill patients to ICU directly from Emergency Department in Dr PSIMS and RF over a period of 2 years. Clinical and laboratory data conforming to the modified early warning score (MEWS), rapid emergency medicine score (REMS), acute physiology and chronic health evaluation (APACHE II), and simplified acute physiology score (SAPS II) were recorded for all patients. A comparison was made between ED scoring systems MEWS, REMS and ICU scoring systems APACHE II, SAPSII. The outcome was recorded in two categories: survived and non-survived with a primary end point of 30-day mortality. Discrimination was evaluated using receiver operating characteristic (ROC) curves.
Results: The ICU scores outperformed the ED scores with more area under curve values. The predicted mortality percentage of ICU based scoring systems is high compared to emergency scores (predicted mortality % of SAPS II-63%, APACHE II-33.3%, MEWS-18.5%, REMS-14.8%).
Conclusions: ICU scores showed more predictive accuracy than ED scores in prognosticating the outcomes in critically ill patients. This difference is seemed more due to complexity of ICU scores.

Keywords: APACHE, MEWS, Mortality outcome, REMS, SAPS

INTRODUCTION

Critical care medicine is a complex, multidisciplinary speciality, designed to care for all sort of patients with critical illnesses. In the interest of allocating resources to those who might potentially benefit most from clinical interventions, several scoring systems have been proposed as a triaging tool.

Prognostic models apart from their ability to stratify patients according to their severity, predict a certain outcome based on a given set of prognostic variables and a certain modelling equation.[1]

Evolution of majority of scoring systems is from multivariate regression analysis applied to large clinical data bases to identify the most relevant factors for prediction of mortality.[2]

Patients doing very poorly or very well are easily identified, but when assessing the in-between groups, scoring systems were better than clinical experience.

Short term outcomes such as admission rate, speedy changes in physiology as a result of ED treatment, or time to treatment are important, population based data will become more important in the future. While it seems intuitive that scores using a larger number of data inputs would perform better than simpler scores which may actually outperform more complex scores when the population has been well-defined.[3]

The first general severity of illness score applicable to most critically ill patients was the acute physiology and chronic health evaluation (APACHE). It was developed by William Knaus et al at the Georg Washington University Medical Centre in 1981.[4]

APACHE II and APACHE III have been compared in 1144 patients from the United Kingdom. APACHE II showed better calibration, but discrimination was better with APACHE III.[5] The SAPS II was described in 1993 by Jean-Roger Le Gall et al based on the European-North American Study (ENAS) database17.[6]

The systematic approach to the recognition of critical illness can be simplified by using Emergency department based scores like rapid emergency medicine score (REMS), the modified early warning score (MEWS), and the Prince of Wales emergency department score (PEDS).[5,7]

The main goals of the health system are the reduction in cost of treatment, assessment of the length of stay in the ICU and the hospital in general is of great importance.[8]

METHODS

This study was carried out at the Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation (Dr. PSIMS and RF), which is a tertiary care, teaching hospital with 780 beds. The critically ill patients admitted to the ICU directly from the ED during October 2014 to September 2016 who met the inclusion criteria were included in the study.

Inclusion criteria

Critically ill patients admitted to the ICU directly from the ED at an academic, tertiary care medical center.

Exclusion criteria

- Patients less than 18 years of age
- Those with a documented pregnancy,
- Trauma patients,
- Patient with primary neurological disorders.

Patient's demographic data, medical history, clinical data were noted

Emergency department scoring systems (REMS and MEWS) were performed in patients who were admitted in emergency initially and ICU scoring systems (APACHE II and SAPS II) were performed on those patients after shifting to ICU.

Measurements

- Variables in scoring systems are as follows:
- REMS scoring require RR, heart rate, MAP, GCS, age and oxygen saturation.
- MEWS score includes systolic BP, heart rate, respiratory rate, and GCS.
- The SAPS II includes 17 variables: 12 physiology variables, age, type of admission (scheduled surgical, unscheduled surgical, or medical), and three underlying disease variables (acquired immunodeficiency syndrome, metastatic cancer, and hematologic malignancy).
- APACHE 2 scoring system involves A-aPO2 or PaO2 (depending on FiO2), temperature, mean arterial pressure, pH (arterial), heart rate, respiratory rate, serum eletrolytes, creatinine and Glasgow coma scale.

Statistical analysis

- Data analysis was performed using the statistical package for social sciences software program version 22 (SPSS).
- Continuous variables were described using mean and SD.
- Categorical variables were described using frequency and percentage.
- A multivariate logistic regression analysis was performed.
- The discriminate power was compared using the AUC.
- Statistical tests were two tailed and value of $p<0.05$ was considered to be the cut off value of significance.

RESULTS

A total of 680 patients were enrolled in the study; of the total study population, 210 had not met the inclusion criteria and 70 were having insufficient data and therefore excluded. Complete data was available to calculate severity of illness scores on 400 patients.

The overall mortality for all subjects 54 (13.5%).

The median age of the cohort was 55.93±11.47 of which 242 (60.5%) were men, 158 (39.5%) were women. Of the patients 61.5% had hypertension, 53% had diabetes. The Distribution among them are cardiac 23%, renal 13.5%, Respiratory causes constitute 9%, GIT 9.5%, neurology 9%, infectious etiology 23.5, others 12.5%.

Table 1: Survived and non-survived for different coexistent diseases in study cohort.

Variable	Categories	Mortality				P value
		Yes		No		
		Count	%	Count	%	
Age	>59	22	40.7%	128	37.0%	0.83
Sex	Male	30	55.6%	212	61.3%	0.67
	female	24	44.4%	134	38.7%	
DM	Present	38	70.4%	174	50.3%	0.06
HTN	Present	40	74.1%	206	59.5%	0.2
Cardiac	Present	16	29.6%	76	22.0%	0.46
Renal	Present	10	18.5%	44	12.7%	0.38
Respiratory	Present	6	11.1%	30	8.7%	0.72
GIT	Present	10	18.5%	28	8.1%	0.15
Neurology	Present	4	7.4%	32	9.2%	1
Others	Present	6	11.1%	44	12.7%	1

Table 2: Value in SAPS II, APACHE II, REMS and MEWS mean scores between survivors and non-survivors.

Variable	Mortality				P-value
	Yes		No		
	Mean	SD	Mean	SD	
Age	55.93	11.47	53.75	15.37	0.41
REMS	5.19	4.49	2.49	2.14	<0.001
MEWS	5.07	2.74	2.50	1.77	<0.001
APACHE II	22.89	12.24	10.46	6.50	<0.001
SAPS II	55.37	18.97	26.05	10.51	<0.001

Table 1 shows survived and non-survived for different coexistent diseases in study cohort. Table 2 shows that there were significant differences in SAPS II, APACHE II, REMS and MEWS mean scores between survivors and non-survivors. Discrimination for all the four scoring systems was good. The best Yuden index (sensitivity + specificity -1) was used to determine the best cut off point for each scoring system.

Table 3 shows cut off point and predicted hospital mortality for ED and ICU based scores. When all four scores were compared using ROC curves there is more area under curve distribution for ICU based scoring systems. This difference seems to be driven by differences between the ED-based scores and the ICU-based scores. Specifically, when compared to the best performing ICU-based scoring system, SAPS II and APACHE II which had an area under the ROC curve (AUC) of 0.89 and 0.81 respectively, the ED-based scores REMS, MEWS, had significantly lower AUC of 0.72 and 0.79 respectively. On visual inspection of the deciles, the ICU scores in general appeared to have a more appropriate slope with observed mortality more closely following predicted mortality (Figure 1 and 2).

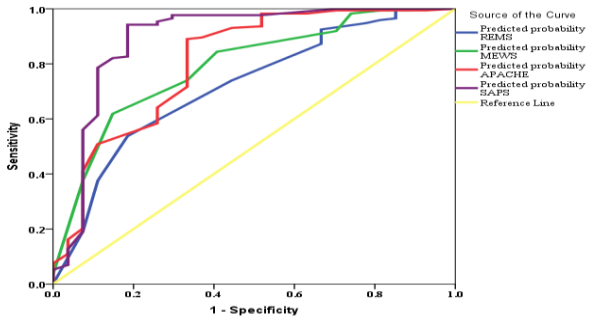

Figure 1: Receiver operator characteristics curves for REMS, MEWS, APACHE II and SAPS II.

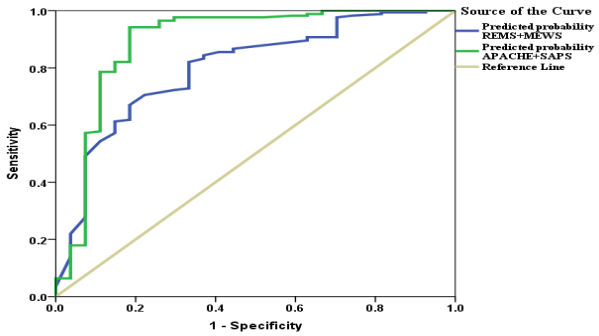

Figure 2: Receiver operator characteristics curves for Emergency department and ICU scoring systems.

Table 3: Cutoff values and mortality predictability of scoring systems.

Variable	Cut-off	AUC	LL	UL	Predicted
REMS	10	0.72	0.61	0.82	14.80%
MEWS	7	0.79	0.7	0.88	18.55%
APACHE	28	0.81	0.7	0.91	33.30%
SAPS	53	0.89	0.8	0.98	63%

DISCUSSION

When assessing acutely admitted medical patients, the use of scoring systems can help identifying patients at risk. Clinical assessment to predict the outcome has been criticized because it is not very reproducible, over estimates the mortality risk and bias is introduced by the ability to recall particularly memorable rare and recent events.

In present study we have interpreted four different systems, most of which rely on vital signs in prognosticating the patients. Scoring systems will continue to be applied widely to compare different patient populations for research and these are being used increasingly in discriminating various groups of patients.

In present study mortality percentage was 13.5%. Age, although a main variable of almost all the scoring systems used in critically ill patients, may not be the main parameter for admission or discharge from the ICU. In present study most of the patients are above 60 years.

This constitutes about 35% of present study population. There was no statistically significant difference between age and prediction of mortality (P= 0.41). In present studied population, most included were males constituting about 60%. According to present study, sex was not a significant factor in predicting mortality in critically ill (p=0.67).

The 70% of the patients who had 30-day mortality are diabetic. But diabetes is not statistically significant in relation to mortality according to present study (P=0.06). 75% of the patients who died within 30 days are hypertensive and there is no significant correlation between mortality and hypertension (P=0.2).

Many causes were entitled for mortality in present study, the major cause being related to infectious etiology. However, the cause and effect relationship could not be explained as there was no significance between any cause and mortality. The difference between predicted and actual mortality rates may be explained by the limited accuracy of mortality prediction models because they are limited by the items included and subjected to interpretation and influenced by many factors including local admission, discharge, and management policies.

The use of REMS and MEWS is highly feasible in the ED setting, because the two systems use data that are either readily available from patients at the time of admission or routinely collected in the ED.

Disease specific scoring systems already exist such as those describing acute coronary syndromes, stroke and asthma but most of these specific systems require data to be collected that are not easily available in ED.[10,11] The ICU scores like APACHE II and other extensively studied scoring systems are being used to stratify patients into equal groups for prospective trails to compare performances and different treatment between hospitals for quality assurance purposes and for resource utilization analysis.[12]

Comparing the accuracy of different scoring systems is difficult because of differences in populations used to derive these scores and different statistical methods.[2]

Some studies suggest that the ICU scores may be better calibrated to critically ill patients than the ED scores, particularly at the upper score range in the sickest patients with greater disease severity.

The mean value of REMS among survivals and non-survivals were 5.19±4.49 and 2.49±2.14 respectively (P<0.001).

According to present study REMS with a cutoff score value of 10 has a predicted mortality value of 14.8%.

In the study done by Moseson EM et al where REMS was developed, the AUC was 0.852 which was higher than present observed AUC (0.72) and the mortality rate was 2.4%, which is much lower than our study's value. REMS was designed initially to predict the risk of in-patient mortality, whereas in our study the outcome was 30-day mortality, and this difference could partly explain the difference in AUC values.

Therefore, even if initially the model discriminates well, it is possible that following an improvement or deterioration and quality of care, the performance of the model would change and would result in reducing applicability of the scoring systems. These problems might be overcome by recalibrating the model frequently.

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