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Original Research Article

A Study of Acute Physiological and Chronic Health Evaluation (APACHE) Index in Critically Ill Patients

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Abstract

Objective : This study aims at (1) validating the use of Acute Physiology and Chronic Health Evaluation II (APACHE II) scoring system in the medical intensive care unit (MICU) for prediction of the risk for mortality, (2) to compare the predicted death rate with the observed death rate of the patients gender wise and age wise. ***Design:*** Hospital based prospective study. ***Setting:*** Hospitals in South India, affiliated to medical colleges. ***Methods:*** A total of 350 patients admitted in the MICU between the age of 18-57 were enrolled for this study. APACHE II score was calculated in each patient on the day of admission within 24 hours. The predicted mortality was calculated on the basis of this score. ***Results:*** The mean APACHE II score was 9.42 ± 3.4. The ICU mortality rate within 24 hours after admission was 14%. The area under the Receiver operating characteristic curve (ROC curve) was 0.8 indicating good discrimination. The standardized mortality ratio (SMR) was 0.9. ***Conclusion:*** The study validates that APACHE II can be a reliable tool in predicting the mortality rate in MICU patients of Indian population within 24 hours of their admission.
Keywords: APACHE II score, discrimination, intensive care unit, mortality rate, prognosis.

INTRODUCTION

A wide range of mortality models have been proposed over the last 30-38 years for determining their validity in critically ill patients. These models have been evaluated, compared and contrasted to emphasize on the aspects of forecasting the outcome in the intensive care unit. Acute Physiology and Chronic Health Evaluation (APACHE II) scoring system is one of them which has been widely used in different countries for this purpose [1-5].

APACHE scoring system was developed by Knaus *et al*., [1] to measure the severity of disease. Later it was refined and simplified in 1985 and called as APACHE II [3] which helped in assessing the probability of death. The Apache II score is in the range of 0-71. Scores above 71 indicate poor prognosis [3, 5].

It is a general notion that critical care is economically very high and poses economic constrain. India is a developing country where the intensive care unit (ICU) resources are limited and ICU expenditure is one of the major economic constraint on the patient.

The present study was designed to evaluate performance of APACHE II score in prediction of mortality risk, as well as in determination of model validity in critically ill patients of Indian context. This is because there is a need, not only to provide quality care to the critically ill patients but also to optimally utilize ICU resources. Therefore an attempt is made to evaluate and validate the performance of APACHE II regarding patient outcome within 24 hours of admission to the ICU in the Indian scenario.

MATERIALS AND METHODOLOGY

After obtaining the approval of the ethical committee, informed consent was obtained from either the patient or their family/caregivers. This study was conducted on 350 patients admitted in the MICU. The sample size for this study was derived by statistical analysis. Parameters for calculating APACHE II were obtained from patients within 24 hours of their admission. The outcome (i.e., survivors/non-survivors)

was considered within these 24 hours of admission as in the study conducted in Brazil [6]. The inclusion criteria consisted of patients between the age of 18-57 years of both genders. Patients who were discharged and re-admitted for the same purpose were excluded. As the study involved only collection of data, interventions on the patient based on data obtained were excluded in this study.

The clinical data for calculating acute physiology score (APS) included physiological and biochemical parameters for 12 variables. Scoring was also based on age and chronic health condition of the patients. Depending on these three criteria APACHE score was calculated, i.e., APACHE II score = (APS) + (age points) + (chronic health points). Lower APACHE II score means good prognosis of patients and higher score implies a more severe disease and poor prognosis.

Mortality Rate

Predicted mortality was calculated by using the equation used by Knaus *et al*., [3] and the Standardized mortality ratio (SMR) was also calculated.

STATISTICAL ANALYSIS

Descriptive statistics was used to summarize the data of the study. Data for continuous variables were presented as mean ± SD (standard deviation) depending on the distribution of the variable. Categorical data were presented as frequencies with percentages. Discrimination of the model was assessed by using the ROC curve.

Data were analysed using SPSS software version 17(SPSS Inc, Chicago IL).

All statistical tests were 2-tailed and $p<0.05$ was considered to be statistically significant.

RESULTS

The total number of patients in the MICU considered for the current study were 350, ranging from the age of 18-57 years.

Table-1: Demographic details of the study groups and the scores evaluated in this study (n=350)

Sl. No.	Variable	Patient group
1.	Age (years) mean ± SD	43.29 ± 10.02
2.	Gender	
	Male	213 (60.9%)
	Female	137 (39.1%)
3.	Score evaluated (mean ± SD)	
	APACHE II score	9.42 ± 3.4
4.	ICU outcome in terms of mortality within 24 hours of admission	
	a) Survivors	301 (86%)
	b) Non-survivors	49 (14%)
5.	Gender	
	a)Survivors (n=301)	Male 184 (86.4%)
		Female 117 (85.4%)
	b)Non-survivors (n=49)	Male 29 (13.6%)
		Female 20 (14.6%)

The overall mean age of these patients was 43.29 ± 10.02). Among these patients, 213 were male (Table-1).

Mortality Rate

There was not much difference between the observed mortality rate and predicted mortality rate for the 350 patients as the observed mortality rate was 14% (Table-1) predicted mortality rate was 14.6%. The standardized mortality rate was 0.9 which indicated that the observed and predicted mortality rates were almost similar.

Table-2: Comparison of APACHE II score between non-survivors (death) and survivors (survived) in the study group (n = 350)

Serial No.	Score	Mortality	Frequency (n)	Mean ± SD	t	p
1.	APACHE II	Non-survivors	49	13.4 ± 4.6	10	p<0.001
		Survivors	301	8.8 ± 2.7		

Statistical test used Student t test. Level of significance of p<0.001 was considered to be very highly significant.

Mean APACHE II score of the non-survivors (13.4 ± 4.6) was significantly different ($p<0.001$) from that of the survivors (8.8 ± 2.7) (Table-2).

Table-3: Age wise standardized mortality rate and comparison of the frequencies and APACHE II score between various age groups

Serial no.	Age group	Frequency	APACHE II Mean ± SD	χ^2 'p' value	SMR
1	18-27	26	8.7 ± 3.5	15.4 <0.001	0.6
2	28-37	80	8.3 ±3.7		0.8
3	38-47	99	8.5 ±2.6		0.8
4	48-57	145	10.8 ± 3.2		0.8

The mean APACHE II score was slightly higher in the age group between 48 - 57 (10.8 ± 3.2) than below the age group between 18 - 47 (8.7 ± 3.5) (Table-3). This indicates that mortality risk was higher in the age group between 48 - 57 as the average APACHE II score was higher (Table-3).

The standard mortality rate was 0.8 for >28 yrs and 0.6 for 18 - 27 years age group (Table 3 and Figure-1).

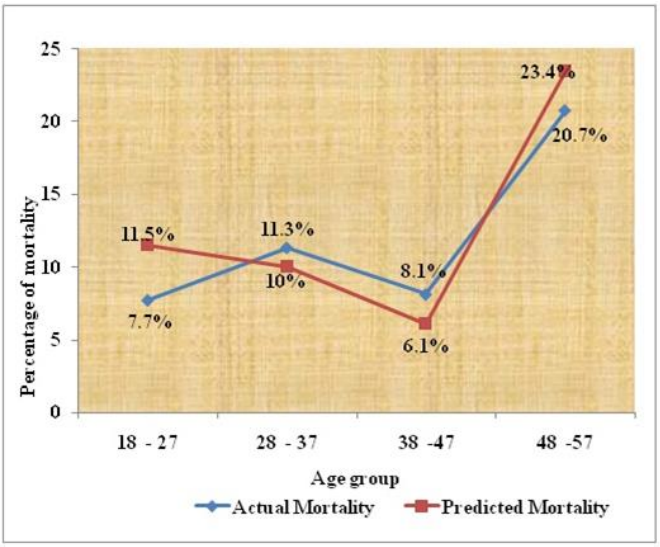

Fig-1: Comparison of actual mortality and predicted mortality in various age groups

The actual mortality was lower than predicted mortality for the age group 18-27 and 48-57 whereas predicted mortality was lower than actual mortality for the age group 28-47 (Figure-1).

Table-4: Genderwise standardized mortality rate and comparison of APACHE II score (n=350)

Serial no.	Gender	No.	Mean ± SD	t value (p value)	SMR
1	Male	213	9.5 ±3.1	0.42 (p>0.05)	0.9
2	Female	137	9.3 ± 3.8		1.1

Statistical test used: Student t test. Level of significance of p>0.05 was considered to be non significant (ns).

There was no significant (p>0.05) difference between the mean APACHE II score gender wise (Table-4).

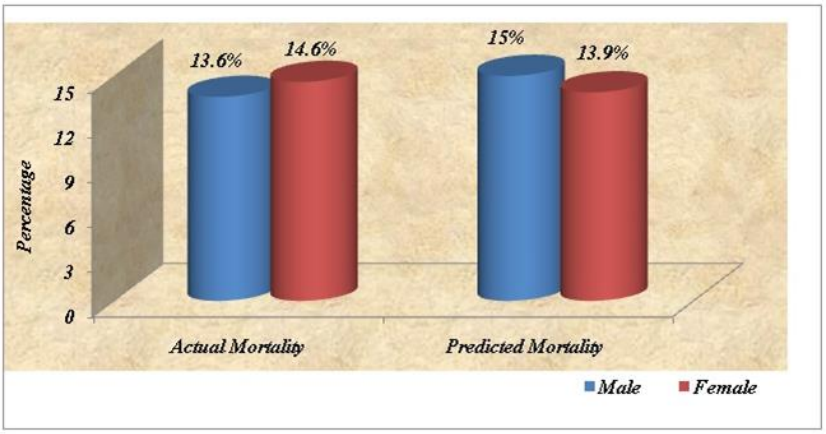

Fig-2: Comparison of actual mortality and predicted mortality in male and female

There was no significant difference (p>0.05) between observed and predicted mortality rates of male and female (Figure-2).

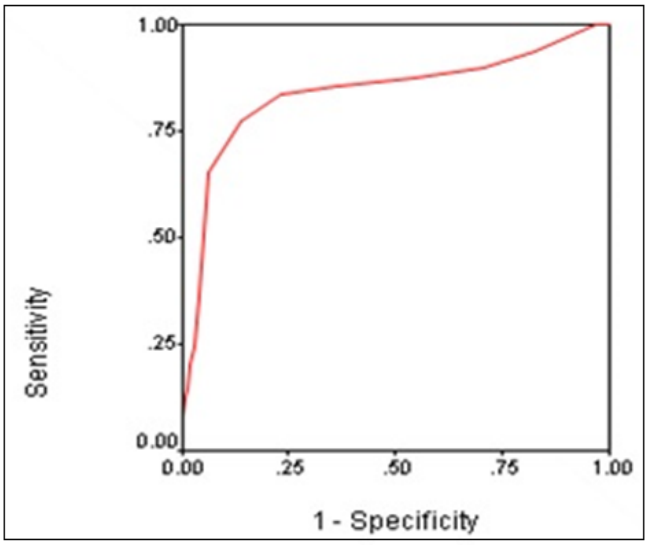

Fig-3: ROC curve for Apache II

The risk of mortality prediction - assessed by plotting the area under the ROC curve for Apache II - was 0.8 and indicated good discrimination (Figure-3). The negative predictive value was 94.3%, positive predictive value 62.7%, sensitivity 65.3%, specificity 93.7% and accuracy rate 89.7% (Figure-3).

DISCUSSION

The present study showed a significantly lower mean APACHE II score for the 350 I.

The present study showed a significantly lower mean APACHE II score for the 350 ICU patients. This value is somewhat similar when compared with the study conducted in USA [7] and Korea [8], but considerably low when compared to the studies in Sweden [9], Australia [10], India [11-13], West Indies [14], Taiwan [15], Brazil [6], Iran [16], Pakistan [17] and Canada [18]. The lower APACHE II reported in this study may be because variables relevant to the disorders were considered and other parameters were assumed to be normal as done by Knaus *et al*., [5].

A significantly higher APACHE II score was observed in non-survivors compared to survivors as reported by studies in India [11], West Indies [14], Pakistan [17], Germany [19], and Iran [20]. A higher APACHE II score suggests greater mortality risk.

The observed mortality rate was similar to the predicted mortality rate in this study which is also reported by studies conducted in Iran [16, 20], Pakistan [17] and Hong Kong [21]. In contrast to this, the study conducted in Brazil reported a lesser predicted mortality than observed mortality [6].

The calculated overall SMR, 0.9, in the present study is similar to the SMR reported by the studies in Iran [16], Pakistan [17], and Hong Kong [21]. However, it was slightly lower when compared with an earlier

study from India [11]. This is because SMR is a ratio of observed and predicted mortality, a higher value could result from higher observed mortality and decreased predicted mortality as in the study reported in India [11]. This study shows, the calculated SMR for genders to be 0.9 for male and 1.1 for female, which is similar with the result obtained, i.e., the observed mortality is somewhat similar to the predicted mortality between the male and female patients (Figure-1). The calculated SMR is <1 for different age groups as predicted mortality is greater than observed mortality (Figure-2), which indicates that less mortality has occurred than expected.

The higher predictive ability of Apache II score was evidenced by a greater area under the ROC curve in this study (Figure-3). The area under the ROC curve obtained in this study was slightly lower than recorded by Knaus *et al.*, [3-5] and studies from India [13], Iran [20], and Hong Kong [21]. The area under the ROC curve obtained in this study was similar to the recordings in Brazil [6], Pakistan [17] and Germany [19]. This indicates that APACHE II score is a good prognostic tool that can be used for patients admitted to the ICU within 24 hours after admission

CONCLUSION

The study indicates that APACHE II score can be applied to predict mortality rate in the MICU for the Indian patients within 24 hours of their admission as the study shows good discrimination, making it suitable to be compared gender wise, age wise and also with the ICU performance in other countries.

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