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Comparison of APACHE II, SAPS II and SOFA Scoring Systems as Predictors of Mortality in ICU Patients

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Abstract
Objective: The comparison of the APACHE II, SAPS II and SOFA scoring systems as predictors of mortality in ICU patients. Study Design: A prospective observational study. Place and Duration of Study: Intensive care unit of Ch. Pervaiz Ellahi Institute of Cardiology and Nishtar Medical University and Hospital, Multan, from May 13, 2018 to September 24, 2018. Methodology: For 36 patients included in study, results for APACHE II, SAPS II and SOFA were calculated with the worst values recorded. At the end of ICU stay, patient outcome was labelled as survivors and non-survivors. Data was analyzed with SPSS v.23. Descriptive data was stated as median (minimum-maximum) or percentages. Pearson Chi square test and non-parametric statistics were applied accordingly. Linear regression analysis was also performed. Cut off value for statistical significance was taken as ≤0.05. Results: Of 36 patients, 22 survived and 14 died after being observed for 12 (2-17) days. On linear regression analysis, all the scoring systems were significantly associated with the mortality rates ($p<0.05$). However, after adjustment, only the APACHE II was a significant predictor of mortality ($p<0.001$). APACHE II scoring system calculated highest estimated mortality rates i.e. 19.3%, while SAPS II and SOFA scoring systems estimated 8.6% and 13.5% mortality, respectively. Conclusion: APACHE II scoring system was much superior to SAPS II and SOFA scoring systems as a significant predictor of the mortality among the ICU patients.
Keywords: Acute Physiology and Chronic Health Evaluation (APACHE II), Simplified Acute Physiology Score (SAPS II), Sequential Organ Failure Assessment (SOFA), Intensive care units (ICU), Mortality.
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Introduction

Assessment of the extent of disease plays a vital role in the medical management and prediction of morbidity and mortality in the acutely ill patients admitted in the ICU [1]. As the deviation of the physiological functions from the normal is had a better prognostic value, the scoring systems comprising of various physiological scores are preferred to the ones which focus mainly on the specific diagnosis [1]. Acute Physiology and Chronic Health Evaluation (APACHE), the Simplified Acute Physiology Score (SAPS) and the Sequential Organ Failure Assessment (SOFA) are some of the most commonly used physiology based scoring systems.

The APACHE scoring system was first introduced in 1981. It includes a vast number of physiological factors including physiologic variables, vital signs, neurological score, comorbid conditions, urine output and age [2]. These above mentioned variables have significant effect on the prognosis of the severely ill patients. APACHE II, a modification of APACHE scoring system, was introduced in 1985. The worst values recorded for the comprised variables, within 24 hours of admission, are included in this modified version. Many clinical trials have supported APACHE II system. This system is already being used vastly in the assessing the prognosis of the critically ill patients in ICU. APACHE III is a further modification of APACHE II which also focuses on the prior treatment location and diagnosis [3] but we are not including this in our study to avoid confusion.

The Simplified Acute Physiology Score (SAPS) simplifies the procedure of data collection concerning the physiological assessment without interfering with the diagnostic accuracy. SAPS II is the most commonly used version of this system. Seventeen variables are included in this scoring system and the highest values recorded within 24 hours of admission are used [4]. The Sequential Organ Failure Assessment (SOFA) is another scoring system commonly used in which functions of major organ systems are assessed. First assessment is done following 24 hours of admission and then repeated after every forty eight hours. A 30% increase in SOFA score is known to be related with 50% mortality rate [5]. Total of 1449 patients, admitted in 40 ICUs of 16 countries were studied and the original SOFA scoring system was devised [6]. In a prior systemic review, APACHE II, APACHE III, SAPS II and SOFA scoring systems were analyzed and the APACHE systems were observed to be superior to the SAPS II and SOFA systems in predicting ICU mortality [7].

The studies comparing APACHE II, SAPS II and SOFA scoring systems have not been performed in the South-East Asian population. We are conducting this prospective study to assess which system is better to predict the mortality in the critically ill patients admitted in the ICU regardless of the disease.

Material and methodology

We performed this prospective observational study in the Intensive care unit of Ch. Pervaiz Ellahi Institute of Cardiology and Nishtar Medical University and Hospital, Multan, from May 13, 2018 to September 15, 2018. Proper ethical approval was obtained from the Hospital review committee. We included 36 patients in this study as the sample size was calculated from the reference study [8]. Patients of the age of seventeen years and older were included in the study irrespective of the disease. All the patients who refused to participate, had terminal stage cancer with metastasis in the brain, and those who died within 24 hours of admission were exclude from the project. All the patients were explained about the observational nature of the study and appropriate consent was taken in written form the patients or the first degree adult relative.

APACHE II score was calculated by evaluating all the physiological components with the worst values observed within first 24 hours. Data recording of all the 12 physiological factors included in the APACHE II scoring system was compulsory and values were entered in a proper data form. As explained by Knaus et al. [3], worst value of APACHE score was calculated. Other factors noted were diagnosis at admission, age and gender, duration of illness before the patients were shifted to ICU and duration of stay at ICU. SOFA score was calculated after first 24 hours of the admission and was then repeated every 48 hours. SAPS II score was calculated by taking into account the important 17 variables included in the scoring system. The worst values of these physiological variables were documented within 24 hours of admission. All the data was compiled by the researchers themselves.

The results for APACHE II, SAPS II and SOFA were calculated by using the worst values recorded for the included factors. We followed all the patients who were included in the study, throughout their stay at the ICU. At the end of the ICU stay, the patient outcome was labelled as survivors and non-survivors. The data was analyzed with SPSS software version 23. The descriptive data was stated as median (minimum-maximum) or percentages. Pearson Chi square test was applied for comparison of percentages. Non-parametric statistics were applied for comparing the mortality groups (survivors vs. non-survivors) as the data was not uniformly distributed. To observe the association, we performed linear regression analysis. Significance was two tailed and the cut off value for statistical significance was taken as ≤ 0.05.

Results

A total of 36 patients were included in the study which included 12 males and 24 females. Median age of the patients was 39 years with 17 years being the youngest and 74 years being the oldest. Median duration of illness prior to the admission to ICU was 7 days with 3 days being the minimum and 21 days being the maximum. Median duration of stay in the ICU till the patient was shifted out of ICU or expired was 12 days, with 2 days being the minimum and 17 days being the maximum. Median APACHE II score 13. Minimum and maximum APACHE II scores were 4 and 36, respectively. Median SAPS II score 30. Minimum and maximum SAPS II scores were 16 and 68, respectively. Median SOFA score 8. Minimum and maximum SOFA scores were 2 and 12, respectively. The predicted mortality rates were significantly lower than the actual mortality rate. Highest morality rate calculated was with APACHE II scoring system and it was 19.3%. Estimated mortality rate calculated with SAPS II and SOFA scoring systems were 8.6% and 13.5%, respectively. Table-I

Of all the patients, 22 survived and 14 died after being observed for 12 (2 - 17) days. Scores of all three systems were significantly higher among the non-survivors than in the survivors ($p<0.001$). On linear regression analysis, all the scoring systems were significantly associated with the mortality rates ($p<0.05$). However, after adjustment, it was observed that only the APACHE II scoring system was a significant predictor of mortality ($p<0.001$). Table-II

Table-I
Demographic Data, APACHE II, SAPS II and SOFA scores and estimated mortality

Variable		Median	Minimum	Maximum
Age, years		39	17	74
Gender, male (%) / females (%)		12 (33.3%) / 24 (66.7%)		
Duration of illness prior to ICU admission, days		7	3	21
Duration of stay in ICU, days		12	2	17
APACHE II	Score	13	4	36
	Estimated mortality	19.3%	2.8%	8.6%
SAPS II	Score	30	16	68
	Estimated mortality	8.6%	4.3%	11.4%
SOFA	Score	8	2	12
	Estimated mortality	13.5%	2.8%	33.6%

Table-II
Survival score comparison between survivors and non-survivors

Survival Score		Survivors (n=22)	Non-survivors (n=14)	P value
APACHE II	Score (median)	11	25	<0.001
	Estimated mortality	5.7%	2.7%	0.011
SAPS II	Score (median)	22	57	<0.001
	Estimated mortality	5.4%	5.7%	0.022
SOFA	Score (median)	6	12	<0.001
	Estimated mortality	14.1%	33.6%	0.012

Discussion

In current study, we observed a higher mortality rate than the predicted. However, the actual mortality rate was closer to the one expected with APACHE II scoring system. On linear regression analysis, three scoring systems were independently associated with morality but APACHE II was the only true indicator of mortality. Saleh A et al. [8] conducted a study on a subpopulation of ICU admitted patients who were suffering from ARDS and they observed similar results. They also proposed that combining different scoring systems has the ability to be a better predictor of mortality. We observed APACHE II score range from 4 to 36. Saleh et al. [8] observed the range to be 5 to 34 and Parajuli et al. [9] observed the range to be from 6 to 35, in their respective studies conducted in 2015. In a prior systemic review, APACHE II, APACHE III, SAPS II and SOFA scoring systems were analyzed and the APACHE systems were observed to be superior to the SAPS II and SOFA systems in predicting ICU mortality [7].

Using variety of scoring systems for mortality prediction of the ICU patients and it plays a significant role in guiding the medical staff in improving the patients' care [10, 11] and focusing the use of hospital assets [12, 13, 14]. This approach can also help the related health professionals to evaluate the pros and cons of various therapeutic interpolations [15, 16]. The range observed in our study is similar to the ones observed in some other studies conducted by Gupta et al. [17] in India, by Faruq et al. [18] in Bangladesh and by Ayazoglu et al. [19] in Turkey.

Although APACHE II and APACHE III being similar systems, addition of various daily updates in the APACHE III scoring system gives it an upper hand [16]. The ability of APACHE III scoring system to predict ICU mortality is expected to be more precise but it was not feasible to use this system in our study as other systems depending upon the physiological parameters calculated with 24 hours of admission were already being used in current study and APACHE III interference was suspected with other systems. Combination of various scoring systems can help to determine the expected mortality more accurately in contrast to the comparison of various systems with one another and it has been observed in a previous study [8].

In a study conducted in Scottish ICU, six scoring systems were compared and significant results were observed by SAPS II and APACHE II scoring systems [11]. There is difference in the mortality rates expected with various scoring systems which may be due to differences in local admissions, treatment and management policies and the interpretation of various variables included in scoring systems [16]. These are the reasons due to which the score systems are susceptible to over- or underestimate the mortality rates. The estimated mortality rates are affected as the treatment progresses, therefore values recorded within first 24 hours of admission require to be as precise as possible and need to be revised as the worst values recorded have the potential to estimate more precisely.

Conclusion

All three scoring systems estimated significantly different mortality rates among the survivors and non-survivors. However, APACHE II scoring system was much superior to SAPS II and SOFA scoring system as a significant predictor of the mortality among the ICU patients.

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