

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

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ABSTRACT

Aim: To compare the APACHE II, SAPS II and SOFA scoring systems as predictors of mortality in ICU patients in terms of sensitivity, specificity and accuracy.

Methodology: A prospective observational study. Intensive care unit from May 13, 2018 to September 15, 2021. For 1368 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. The cut off value for APACHE II, SAPS II and SOFA was taken as 50% of the highest possible score, with <50% expected to survive and with ≥50% expected to die during their ICU stay. Cross tables were made against real outcome of the patients, and sensitivity, specificity and accuracy for APACHE II, SAPS II and SOFA were calculated.

Results: Sensitivity, specificity and accuracy were 77.53%, 94.28% and 85.45% for APACHE II scoring system; 47.29%, 87.32%, and 66.23% for SAPS II scoring system; and 73.37%, 60.28%, and 67.18% for SOFA scoring system, respectively.

Conclusion: Apache II scoring system has highest sensitivity, specificity and accuracy in mortality prediction in ICU patients as compared to SAPS II and SOFA scoring systems, with SAPS II being least sensitive and accurate.

Keywords: Sensitivity, specificity, accuracy, Acute Physiology and Chronic Health Evaluation (APACHE II), Simplified Acute Physiology Score (SAPS II), Sequential Organ Failure Assessment (SOFA), Intensive care units (ICU), Mortality.

INTRODUCTION

For the prediction of mortality of the severely ill patients admitted in intensive care units, assessing the extent of disease is a vital part of medical management¹. Scoring systems based on the physiologic status are more reliable than the ones based on the specific diagnosis as the deviation of the physiologic functions of the major organ systems from the normal is a better predictor of the prognosis¹. Many scoring systems have been devised so far which include the APACHE, SAPS and the SOFA.

The Acute Physiology and Chronic Health Evaluation (APACHE) scoring system was introduced in 1981. A large variety of parameters is included in this system. These parameters include vital signs, physiologic variables, the neurological score, urine output, comorbid conditions and age, and these variables affect the prognosis of critically ill patients to a much greater extent². The modified version of APACHE scoring system, APACHE II was introduced in 1985. APACHE II includes the worst parameters which are available within first 24 hours of the admission. APACHE II has been endorsed in multiple clinical trials and is a broadly used system for assessing the severity of the disease in the patients admitted in intensive care settings. APACHE III is a further modified version of APACHE II which includes diagnosis as well as previous treatment location³ but this will not be included in current study.

The Simplified Acute Physiology Score (SAPS) has the ability to simplify the process of collecting data regarding the assessment and does not interfere with the diagnostic precision. The most commonly used version of this system is SAPS II. It includes 17 variables for which the worst values measured within first 24 hours are used⁴. The Sequential Organ Failure Assessment (SOFA) includes the assessment of major organ system functions. It is a simple method and first calculation is done after first 24 hours of admission and then these calculations are repeated every 48 hours. Mortality can be predicted with mean and the highest scores calculated. An increase of 30% in the score is known to be associated with 50% mortality rate⁵. Original SOFA scoring system was a derivative of a cohort of 1449 patients who were admitted in 40 ICU settings across 16 countries⁶. In a previous systemic review, APACHE II, APACHE III, SAPS II and SOFA scoring systems were compared and they found the APACHE systems to be better than the SAPS II and SOFA scoring systems for predicting the mortality in ICU settings⁷.

The studies comparing APACHE II, SAPS II and SOFA have not been performed in the South-East Asian population. We are conducting this prospective study to assess which system has higher sensitivity, specificity and accuracy in predicting the mortality in the severely ill patients admitted in the ICU regardless of the disease.

METHODOLOGY

This prospective observational multi centre study was conducted in the ICU at CMH Lahore, Medical & Dental College, Chaudhry Pervaiz Ellahi Institute of Cardiology (CPEIC), Multan, and Peoples University of Medical & Health Sciences, Nawabshah, from May 2018 to September 2021. Proper ethical approval was obtained from the Hospital review committee. We included 1368 patients in this study. The study by Kim YH et al.⁸ was taken as reference. 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 expired within 24 hours of admission were not included in the project. All the patients were explained about the observational nature of the study and appropriate consent was taken in written from 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 II 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 score for APACHE II, SAPS II and SOFA was calculated by using the worst values recorded for the included factors. All the patients included in the study were followed throughout their stay at the ICU. The patient outcome was labelled as survivors and non-survivors at the end of stay in ICU. The data was entered in SPSS software version 23. The cut off value for APACHE II, SAPS

II and SOFA scoring systems was taken as 50% of the highest possible score. Patients who had less than 50% of the highest possible score were expected to survive while the patients who had equal to or more than 50% of the highest possible score were expected to die during their ICU stay. All these expected scores were cross tabulated against real outcome of the patients, and sensitivity, specificity and accuracy for APACHE II, SAPS II and SOFA scoring systems were calculated separately in the prediction of mortality in the patients admitted in ICU.

RESULTS

We included 1368 patients in this study. APACHE II, SAPS II and SOFA scoring systems were applied on all the patients. After complete follow up, 647 patients survived while 721 patients died.

After taking 50 % of the highest possible APACHE II score as cut off value, 772 of all the patients were expected to survive and 596 patients were expected to die during their stay at ICU. Of 772 patients expected to survive, 610 patients survived while 162 patients died. . Of 596 patients expected to die, 559 patients died while 37 patients survived. (Table-I) The calculated sensitivity, specificity and accuracy for APACHE II scoring system was 77.53 %, 94.28% and 85.45 %, respectively.

After taking 50 % of the highest possible SAPS II score as cut off value, 945 of all the patients were expected to survive and 423 patients were expected to die during their stay at ICU. Of 945 patients expected to survive, 565 patients survived while 380 patients died. . Of 423 patients expected to die, 341 patients died while 82 patients survived. (Table-II) The calculated sensitivity, specificity and accuracy for SAPS II scoring system was 47.29 %, 87.32 % and 66.23 %, respectively.

After taking 50 % of the highest possible SOFA score as cut off value, 582 of all the patients were expected to survive and 786 patients were expected to die during their stay at ICU. Of 582 patients expected to survive, 390 patients survived while 192 patients died. . Of 786 patients expected to die, 529 patients died while 257 patients survived. (Table-III) The calculated sensitivity, specificity and accuracy for SOFA scoring system was 73.37 %, 60.28 % and 67.18 %, respectively.

Table-I: 2 X 2 table for APACHE II scoring system

APACHE II scoring system results		Patients Outcome		Total
		Non-Survivors	Survivors	
	Non-Survivors	559	37	596
	Survivors	162	610	772
Total		721	647	1368

Table-II: 2 X 2 table for SAPS II scoring system

SAPS II scoring system results		Patients Outcome		Total
		Non-Survivors	Survivors	
	Non-Survivors	341	82	423
	Survivors	380	565	945
Total		721	647	1368

Table-III: 2 X 2 table for SOFA scoring system

SOFA scoring system results		Patients Outcome		Total
		Non-Survivors	Survivors	
	Non-Survivors	529	257	786
	Survivors	192	390	582
Total		721	647	1368

DISCUSSION

The use of various severity scoring systems for predicting the mortality in the ICU patients is vital for guiding about the management of the patients' care ^{9, 10} and proper use of the hospital resources ¹¹⁻¹³. This can also help the medical staff with the evaluation of the therapeutic interventions ^{14, 15}. APACHE III and APACHE II are similar systems but there are some more data and daily updates are added to APACHE III scoring system which

makes it superior ¹⁵. APACHE III scoring system is expected to predict mortality more accurately than other systems ¹⁴ but we did not include this system in our study as there were other scoring systems included based on the reading observed in first 24 hours of admission and there were chances of interference by APACHE III scoring system with others. Combining different scoring systems can predict mortality to greater precision rather than competing against one another as shown in a previous study ⁸.

According to Chaivone PA et al. ¹⁶, higher APACHE II score was concomitant with higher mortality rates. From 2 x 2 decision matrix, they observed that the classification of 72.2% patients was correct; and the sensitivity and specificity of the APACHE II scoring system was 35.1% and 92.6%, respectively. Naveed SA et al. ¹⁷ observed that, after classification of the patients on the basis of APACHE II score, observed mortality rates were higher in the patients with higher APACHE II score i.e. 31-40.

Tempe A et al. ¹⁸ performed a study on 57 patients who were admitted in obstetrics ICU and observed 40.35% mortality rates. Survivors had lower SAPS II score i.e. 22.6 (9 - 43) as compared to the score of non-survivors i.e. 40.04 (23 - 71). After application of goodness of fit test model, SAPS II score predicted 88.2% survivors and 73.9% non-survivors correctly. Raith EP et al. ¹⁹ conducted a study on 184875 patients admitted in ICU with suspected infection. They compared SOFA scoring system with SIRS and qSOFA scoring systems; and observed that a 2 points or more increase in SOFA score was highly accurate in predicting the mortality. In a study directed by Gursel G et al. ²⁰, significantly higher APACHE II and SOFA scores were observed in non-survivors as compared to the survivors. Upon logistic regression analysis, APACHE II was able to predict mortality independently.

Kim YH et al. ⁸ compared APACHE II, SAPS II and SOFA scores in the 131 patients of organophosphate poisoning while we studied patients admitted in ICU irrespective of the disease. The sensitivity, specificity and accuracy of the APACHE II system was observed to be 65.5%, 68.6% and 67.9% in the study by Kim et al. while 77.53%, 94.28% and 85.45% in our study, respectively. For SAPS II score, we observed 47.29% sensitivity, 87.32% specificity and 66.23% accuracy as compared to 86.2%, 77.5% and 79.4%, respectively, observed by Kim et al. The sensitivity, specificity and accuracy of SOFA score was 86.2%, 82.4% and 83.2% in the above mentioned study, while 73.37%, 60.28% and 67.18% in our study, respectively. SOFA score had the highest sensitivity, specificity and accuracy in the study by Kim et al.⁸ In contrast, we observed highest sensitivity, specificity and accuracy with APACHE II scoring system. SOFA scoring system was second best in its predictive qualities. The results observed in our study tend to hold greater impact as our sample size was much bigger and the scoring systems were applied on all the patients instead of a group of patients suffering from some specific disease.

CONCLUSION

APACHE II scoring system has highest sensitivity, specificity and accuracy in mortality prediction in ICU patients as compared to SAPS II and SOFA scoring systems, with SAPS II being least sensitive and accurate.

Conflict of interest: NIL

Funding Source: NIL

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