Original article

Comparison of Acute Physiology and Chronic Health Evaluation (APACHE) IV and Simplified Acute Physiology Score (SAPS) II in a Tertiary Care Hospital ICU in India

Anil Kalarickal, Saumy Johnson, Anitha Shenoy*
Email: anitharshenoy@gmail.com

Abstract

Background: APACHE IV and SAPS II are ICU scoring systems used to predict mortality in critically ill patients in the ICU. **Aim:** To compare mortality prediction using APACHE IV and SAPS II in an Indian ICU. **Methods:** This prospective study included 225 patients. SAPS II and APACHE IV scoring and predicted mortality were obtained for each patient using online calculators and correlated with actual mortality and length of stay. **Results:** 183/225 of these admissions were due to medical causes. The mean±SD SAPS II score was 37.97 (±15.85) and APACHE IV score was 64.15 (±20.04). The median SAPS II predicted mortality rate was 19.6% and by APACHE IV was 17.4%. Actual mortality was 25.33%. Area under the curve (AUC) for SAPS II was 0.723 and APACHE IV was 0.701. AUC for SAPS II and APACHE IV for medical admissions were 0.712 and 0.681 respectively and for surgical admissions was 0.803 and 0.811 respectively. The best cut off value of SAPS II was 37 and APACHE IV was 70.5 for surgical patients. The mean predicted mortalities for patients with SAPS II score <37 and ≥37 were 4.95±3.87% and 37.15±16.5% respectively and APACHE IV score <70.5 and ≥70.5 were 16.82±11.48% and 40.6±15.72% respectively. There was no correlation between predicted and actual length of stay. **Conclusions:** Both APACHE IV and SAPS II ICU scoring systems are inaccurate in predicting overall mortality in our ICU. APACHE IV is not reliable in predicting length of stay of all patients in our ICU.

Keywords: SAPS II, APACHE IV, ICU scoring systems, mortality

Introduction

ICU mortality prediction scores have developed and evolved over 30 years and indicate the seriousness of the patient condition. These include APACHE I, APACHE II, APACHE III, APACHE IV, SAPS I, SAPS II, SAPS III, Mortality Prediction Score, Multi Organ Dysfunction Score, Therapeutic Intervention Scoring System *etc.* Some of these are scored on a daily basis and some, on admission. The usefulness of these scoring systems to Indian critical care units is not known. Objective of this study was to compare APACHE IV and SAPS II in predicting the mortality in an Indian ICU and to know how efficient APACHE IV was in predicting the length of stay in an Indian ICU.

Anil Kalarickal, MSc RT
Manipal College of Allied Health Sciences, Manipal

Saumy Johnson, MSc RT
Associate Professor and In-charge,
Manipal College of Allied Health Sciences, Manipal

Anitha Shenoy, MD, FRCA
Professor of Anaesthesiology, Kasturba Medical College,
Manipal and Head of Respiratory therapy,
Manipal College of Allied Health Sciences, Manipal

Methods

This study is a prospective cohort study. Two hundred and twenty five patients admitted to the multidisciplinary intensive care unit (MICU - ICU 1)

How to cite this article: Kalarickal A, Johnson S, Shenoy A. Comparison of Acute Physiology and Chronic Health Evaluations (APACHE) IV and Simplified Acute Physiology Score (SAPS) II in a tertiary care hospital ICU in India . Ind J Resp Care 2012; 1(2):156-160

and ICU 2 of Kasturba Hospital, Manipal from 1st March 2010 to 28th February 2011 were included. Patients < 18 years, patients admitted to other areas of the hospital, those discharged against medical advice, patients admitted for < four hours and patients with burns were excluded. Institutional ethical committee approval was obtained.

An appropriate proforma was developed to collect the data and the collected data were used to calculate the scores and mortality online using online calculators of SAPS II and APACHE IV. The SAPS II score and the predicted mortality was obtained by using a online SAPS II calculator provided by OPUS 12 Foundation, Inc and the APACHE IV score, predicted mortality and predicted length of stay was obtained by using another online APACHE IV calculator provided by Middle East Critical Care Society.

The variables collected for SAPS II were type of admission, chronic disease, Glasgow coma scale (GCS), age, systolic blood pressure, heart rate, temperature, oxygenation status using PaO_2/FiO_2 ratio (if mechanically ventilated), urine output, serum urea or blood urea nitrogen, white cell count, serum potassium, sodium, bicarbonate and bilirubin.

The variables collected for APACHE IV were the highest and lowest values of the following variables during first 24 hours: temperature, systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, serum sodium, creatinine, blood urea, urine output, glucose, haematocrit, white blood cell count, oxygenation status, arterial carbon dioxide, albumin, bilirubin, GCS, age, chronic health condition and length of stay in the hospital prior to ICU admission. Information regarding admission such as whether it was a postoperative admission, re-admission and whether ventilated any time (first 24 hours) was also required.

All these patients were followed up to note their actual survival rate and length of stay in the ICU. This was correlated with the predicted mortality rate and predicted length of stay using both the ICU scoring systems. Statistical analysis was done using SPSS 16, SPSS, Chicago, Illinois.

Results

This prospective study conducted between April 2010 to February 2011 included 225 patients. The demographic data of these patients is shown in *Table 1*. Majority (183/225) of these admissions were due to medical causes.

Table 1: Demographic data

	All patients (n = 225)	Medical admissions (n = 183)	Surgical admissions (n = 42)
Age (years)	48.09 ± 16.77	48.12 ± 16.64	47.98 ± 17.55
Gender (M/F)	140/85	114/69	26/16

At admission, all the patients were scored using SAPS II and APACHE IV *(Table 2)*. No therapeutic decisions were made based on these scores. The survival or otherwise of the patients was noted. Thus, the actual mortality in these 225 patients was known. The results were also analysed according to the type of admission, medical or surgical. Most

Table 2: Comparison of predicted mortality using SAPS II and APACHE IV ICU scoring system and actual mortality

	All patients (n = 225)	Medical admissions (n = 183)	Surgical admissions (n = 42)
SAPS II score	37.97 ± 15	40.04 ± 15.43	28.92 ± 14.56
APACHE IV score	64.15 ± 19.58	64.27 ± 20.32	63.59 ± 18.97
Predicted mortality (SAPS II) Median (25th - 75th percentile)(%)	19.6 (7.9 – 43.8)	23 (8.8-48.97)	6.5 (3.7 – 28.5)
Predicted mortality (APACHE IV) Median (25th to 75th percentile) (%)	17.4 (9.4 – 30.2)	16.57 (8.93-29.55)	21.8 (12.39 – 33.74)
Actual mortality (%)	25.33	26.2	21.4

surgical patients (40 out of the total 42 surgical patients) were in ICU1 whereas there were only two surgical patients admitted to ICU2. There were a total of 183 medical admissions and were in ICU2. This analysis was done to look for any differences between medical and surgical admissions.

The mean scores and median predicted mortality rate according to SAPS II and APACHE IV are given in *Table 2*. Both SAPS II and APACHE IV seemed to underestimate mortality in our ICUs. Based on these values, the sensitivity and specificity of both SAPS II and APACHE IV in predicting mortality were calculated and receiver-operating characteristic (ROC) curves were constructed *(Figure 1)*. The area

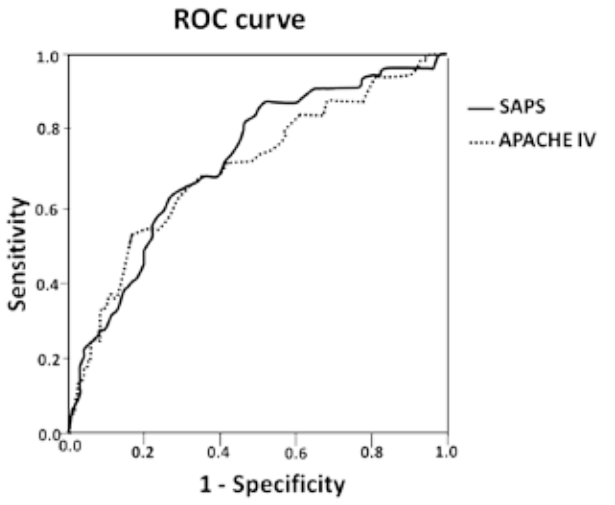

Figure 1: ROC curve for APACHE IV and SAPS II scoring systems for all patients (n =225)

under the curve (AUC) for SAPS II was 0.723 and APACHE IV was 0.701 suggesting that both are not accurate in predicting mortality in our ICUs.

The actual mortality among medical patients was 26.2% (48 out of 183 patients) and among surgical patients was 21.4% (nine out of 42 patients). Based on this, the sensitivity and specificity of both SAPS II and APACHE IV were calculated for medical and surgical admissions separately and receiver-operating characteristic curves were constructed *(Figures 2 and 3)*.

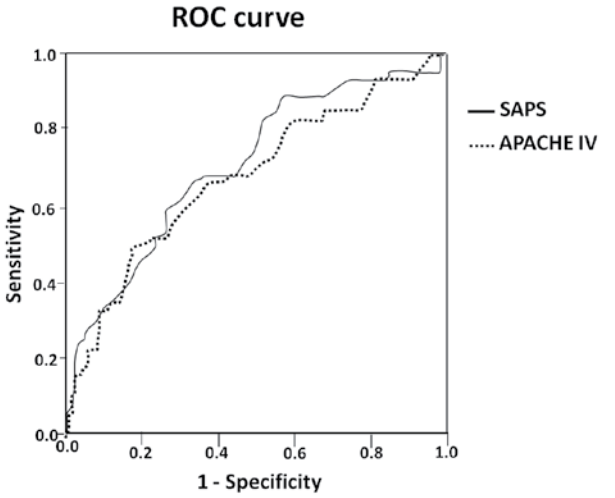

Figure 2: ROC curve for APACHE IV and SAPS II scoring systems for medical patients (n = 183)

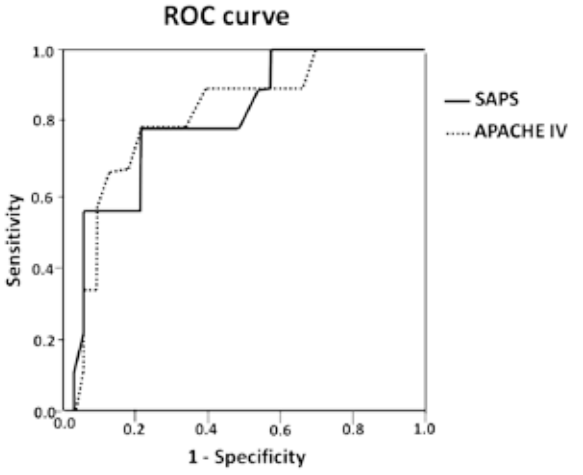

Figure 3: ROC curve for APACHE IV and SAPS II scoring systems for surgical patients (n = 42)

The area under the curve for SAPS II for medical admissions was 0.712 and APACHE IV was 0.681. Thus, both scores were not useful in predicting mortality for medical admissions in our ICUs and neither score seemed better than the other. The area under the curve for SAPS II for surgical admissions was 0.803 and APACHE IV was 0.811. Thus, both scores seemed more useful in predicting mortality for surgical admissions in our ICUs and both scores were comparable.

The best cut off value of SAPS II for surgical

patients could be derived as 37 with a sensitivity and specificity of 77.8%. Similarly, the best cut off value of APACHE IV for surgical patients was derived as 70.5 with both sensitivity and specificity of 77.8%.

The SAPS II mean predicted mortalities for patients with score < 37 and ≥ 37 were 4.95 ± 3.87% and 37.15 ± 16.5% respectively. The APACHE IV mean predicted mortalities for patients with score < 70.5 and ≥ 70.5 were 16.82 ± 11.48% and 40.6 ± 15.72% respectively. The observed mortality in surgical patients with APACHE IV score of < 70.5 was 7% whereas in patients with ≥ 37, it was 50%.

The length of stay can be predicted using APACHE IV scores. The median predicted length of stay calculated only for those patients who survived (168 patients) was 4.9 days with 25th and 75th percentiles at 3.66 and 6.53 days respectively (*Table 3*). The mean actual length of stay in the ICU for all patients who survived was six (3-9) days. There was no correlation between the predicted length of stay and actual length of stay (Pearson's correlation coefficient: 0.08), even when medical and surgical patients were analysed separately (Pearson's correlation coefficient: 0.12) (*Figure 4*).

Discussion

Intensive care units are areas of the hospital where the sickest of patients are cared for, requiring intense clinical vigilance and treatment. The available resources could be limited and may have a high demand on them. Several scoring systems have been devised to help stratify patients and to explain prognosis.

There has been no study in the literature comparing SAPS II and APACHE IV. However, Zimmerman *et al* studied APACHE IV, found good discrimination and calibration in US ICUs (ROC of 0.88).[1] In fact, APACHE IV was supposedly an improvement on APACHE II. Similarly, Lemeshow *et al* found SAPS II to be useful with a ROC AUC to be 0.88.[2] Bufalo DC *et al* compared SAPS II and APACHE II and concluded that APACHE II was a good predictor of hospital outcome and was better than SAPS II.[3] However, Katsaragakis S *et al* compared SAPS II and APACHE II in a single Greek ICU and found that both failed to predict mortality in their critically ill population.[4]

Table 3: Comparison of predicted length of ICU stay using APACHE IV and actual length of ICU stay

	All patients (n = 168)	Medical admissions (n = 135)	Surgical admissions (n = 33)
Predicted length of ICU stay (days) (Median (25-75)	4.9 (3.66-6.53)	4.66 (3.63 – 6.21)	6.29 (4.66 – 7.34)
Actual length of ICU stay (days) (Median (25-75)	6 (3-9)	6 (3-10)	5.5 (2-7)

Apolone G *et al* evaluated SAPS II in Italian ICUs and found that they obtained a ROC AUC at 0.8.[5] They concluded that even though satisfactory discrimination was found with SAPS II, the expected mortality did not fit those actually observed. They concluded that poor performance of the system is related to differences in case mix, methods of application and quality of care. They went on to opine that caution is warranted before implementing standard SAPS II scoring system outside formal research projects.

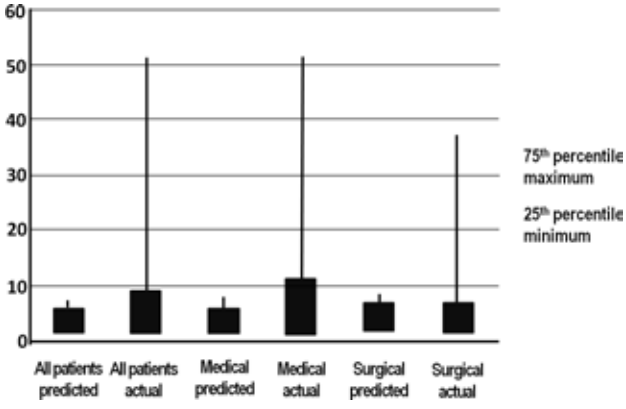

Figure 4: Actual and predicted length of stay for survivors (n = 168)

Of these several scoring systems, this study compared SAPS II and APACHE IV scores in our ICU. Unfortunately, neither of these scores was found to be useful to predict mortality in our ICU and was equally inefficient. Perhaps, these scoring systems should be validated/calibrated to Indian ICUs before usage.

When the length of stay as predicted by APACHE IV was compared with the actual length of stay in our ICU, there was very poor correlation. This was in contrast to the findings of Zimmerman *et al* whose rather large study conducted across 104 ICUS in 45 US hospitals showed that APACHE IV model provides clinically useful ICU length of stay predictions for critically ill patient groups.

Evaluation for any differences between medical and surgical admissions showed that surgical patients had a lower SAPS II score but similar APACHE IV compared to medical patients. Thus, the surgical patients seemed to be less sick compared to medical patients based on SAPS score. Thus, their mortality rate also would be expected to be less compared to medical patients.

The ROC curves for medical patients as predicted by SAPS II and APACHE IV had an AUC of 0.712 and 0.68. The ROC AUC for surgical patients as predicted by SAPS II and APACHE IV were 0.803 and 0.811. Thus, both scores seemed to be able to predict mortality better in surgical patients and neither was useful in medical patients.

There may be several factors, which are different in our ICUs pertaining to the care of critically ill patients, including resources in the ICU, late admissions, lack of appropriate nursing care (1:1 nursing), economic status of the caring families and even antibiotic resistance. Although SAPS II and APACHE IV scoring systems are validated in the developed countries, these need to be validated or calibrated in a developing country as India or alternative scoring systems need to be developed.

Conclusions

Both APACHE IV and SAPS II ICU scoring systems are not efficient and underestimate overall mortality in our ICUs (tertiary hospital in south India). However, both scores were equally more useful in predicting mortality in surgical admissions alone. SAPS II has a sensitivity and specificity of 77.8% with a cutoff value of 37. APACHE IV has a sensitivity and specificity of 77.8% with a cutoff value of 70.5. APACHE IV is not reliable in predicting length of stay of all patients in our ICUs.

References

1. Zimmerman JE, Kramer AA, McNair DS, Malila FM. Acute Physiology and Chronic Health Evaluation (APACHE) IV: Hospital mortality assessment for today's critically ill patients. *Crit Care Med* 2006; **34**: 1538-9.
2. Lemeshow S, Le Gall JR, Saulnier F. A new simplified Acute Physiology Score (SAPS II) based on a European/North American multicenter study. *JAMA* 1993; **270**: 2957-63.
3. Bufalo DC, Morelli A, Bassein L, *et al*. Severity scores in respiratory intensive care: APACHE II predicted mortality better than SAPS II. *Respir Care* 1995; **10**: 1042-7.
4. Katsaragakis S, Papadimitropoulos K, Antonakis P, Stregipoulos S, Konstadoulakis MM, Androulakis G. Comparison of Acute Physiology and Chronic Health Evaluation II (APACHE II) and Simplified Acute Physiology Score II (SAPS II) scoring systems in a single Greek Intensive care unit. *Crit Care Med* 2000; **28**: 426-32.
5. Apolone G, Bertolini G, D'Amico R, *et al*. The performance of SAPS II in a cohort of patients admitted to 99 Italian ICUs: Results from GiViTI. *Intens Care Med* 1996; **22**: 1368-78.