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A comparative study to evaluate use of apache ii and sofa score in sepsis patients in intensive care unit of a tertiary level hospital in Western Maharashtra

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Abstract---Background: Intensive care units (ICU) in most settings consume very high cost and sophisticated devices but mortality rates are still very high. There is no specific literature comparing APACHE II score and SOFA score in sepsis patient and this research topic will help to identify the score more appropriate to predict the seriousness, outcome and mortality of patients suffering from sepsis, which has been evaluated in our study. Methodology: This was a single centre hospital based cross sectional, observational, descriptive study conducted in patients in ICUs of our institute. 100 patients over age 16 years old admitted in intensive care unit who have fulfilled the criteria for sepsis were included in our study. Their clinical profile, APACHE II and SOFA scores were evaluated and compared with respect to patients' outcome in the form of survival. Results: The mean age was 56.71 ±16.77 years. Majority of patients were males (69%). 52 of patients were survivors (52%) and non-survivor were 48%. The mean SOFA score of survived patients was 3.54 ±2.57 lower than non-survivor patients of 6.02 ±3.17. The mean APACHE II score of survived patients was 11.23 ±5.69 lower than non-survivor patients of 17.10 ±6.77.

Keywords---Sepsis, Intensive care, APACHE II score, SOFA score, Comparison.

Introduction

APACHE II (Acute Physiology and Chronic Health Evaluation II) introduced in 1985 is a modification of the original APACHE developed in 1981.¹ It is a scoring system aimed to determine the severity of disease and also to predict mortality of adult patients admitted to intensive care units. It relates with 12 physiological, objective and numerical parameters which are routinely observed and measured in intensive care unit.^{2,3} Physiological parameter above and below the set range is given an assigned score which categorizes severity of physiological dysfunction in numbers, which eventually can predict the outcome. It encompasses most organ functions and thus logically and by validation has been found to be a useful predictive score. However, the question of concern is, to what extent APACHE II is useful for predicting prognosis and mortality of sepsis patients admitted to ICU?^{3,4}

Sepsis patients have multi organ dysfunction syndrome also, hence a score specific for organ dysfunction like SOFA (Sequential Organ Failure Assessment) which can assess the presence and severity of organ dysfunction. Is SOFA score a specific model for prediction of outcome in patients of sepsis? As no scoring system is ideal, which scoring system should be applied for sepsis, is a concern.^{5,6}

Intensive care units (ICU) in most settings consume very high cost and sophisticated devices but mortality rates are still very high. There is no specific literature comparing APACHE II score and SOFA score in sepsis patient and this research topic will help to identify the score more appropriate to predict the seriousness, outcome and mortality of patients suffering from sepsis. The evaluation of quality of intensive care can also be effectively determined.⁷⁻⁹ A single centre hospital based cross-sectional, prospective, observational, descriptive study conducted in patients in ICUs of our institute to evaluate APACHE II VS. SOFA SCORE in sepsis patients.

Aim of the study

This study was designed to determine the comparative efficacy of APACHE II and SOFA scores in assessing the prognosis, outcome and mortality of patients suffering from sepsis admitted in intensive care unit.

Methodology

This was a single centre hospital based cross sectional, observational, descriptive study conducted in patients in ICUs of our institute over a period of 18 months from October 2019 to March 2021. Diagnosed cases of sepsis were enrolled for study from in patient department in ICUs of Krishna Institute of Medical Sciences and Research Centre. All patients over age 16 years old admitted in intensive care unit who have fulfilled the criteria for sepsis were included in our study. Pregnant women and patients who were admitted for observation or readmission were excluded. The parameters which are taken to calculate APACHE II score are

- PaO₂
- Mean Arterial Pressure

- Temperature
- pH arterial
- Heart Rate
- Respiratory Rate
- Serum Sodium
- Serum Potassium
- Haematocrit (PCV)
- Serum Creatinine
- 11.WBC count
- Glasgow Coma Scale

SOFA score is calculated using

- Glasgow Coma Score
- Serum Creatinine
- Serum Total Bilirubin
- Mean Arterial Pressure
- Platelet count
- PaO₂

Sample size

Sample size is calculated using the formula:

$$n = 4 * p * q / d^2$$

Where,

N= sample size

P= prevalence of sepsis patients in ICU in India (13.1%)¹⁰

Q= 100-p

D= Error (0.1)

Therefore, $n = 4 * 0.131 * 0.869 / 0.01$

N=46.

The minimum sample to be included in the study was 46, but during our study period we got total 100 patients satisfying our inclusion criteria so we included all 100 cases in our study for analysis.

Statistical analysis

Data was collected using a semi structured pretested questionnaire and was entered in Microsoft Excel 2013. Data is represented in frequencies and percentages, charts and graphs. Mean and standard deviation of quantitative variables is shown. Appropriate statistical tests are applied using IBM SPSS software version 21 for analysis. Chi square test is used for association and student's t-test is used for comparison between the study variables. ROC curve analysis was used to evaluate the APACHE score and SOFA score. Statistical significance is considered at 'p' value < 0.05.

Ethical Clearance was taken from the institutional Ethics Committee before starting the study, a written informed consent was obtained from patients or their relatives before including them in the study.

Results

The mean age of the patients was 56.71 ± 16.77 years. It was observed that majority of patients were in age group 51-60 years (27%) followed by 31-40 years (16%) & 41-50 (15%). It was observed that majority of patients were males (69%) and females were 31%. Male: Female ratio was 2.23 :1. Out of total 100 cases with sepsis in our study, 52 of patients were survivors (52%) and non-survivor were 48%. The mean age of survived patients was 53.81 ± 16.13 years and non-survivor patients were 59.48 ± 15.54 years. The age among non survivors was higher as compared to survivor patients with statistical significance. ('p' value <0.05 by unpaired t test)

The mean SOFA score of survived patients was **3.54 ± 2.57** and non-survivor patients was **6.02 ± 3.17** . The mean SOFA score among non survivors was higher as compared to survivor patients with statistical significance. ('p' value <0.001 by unpaired t test) [Fig 1]

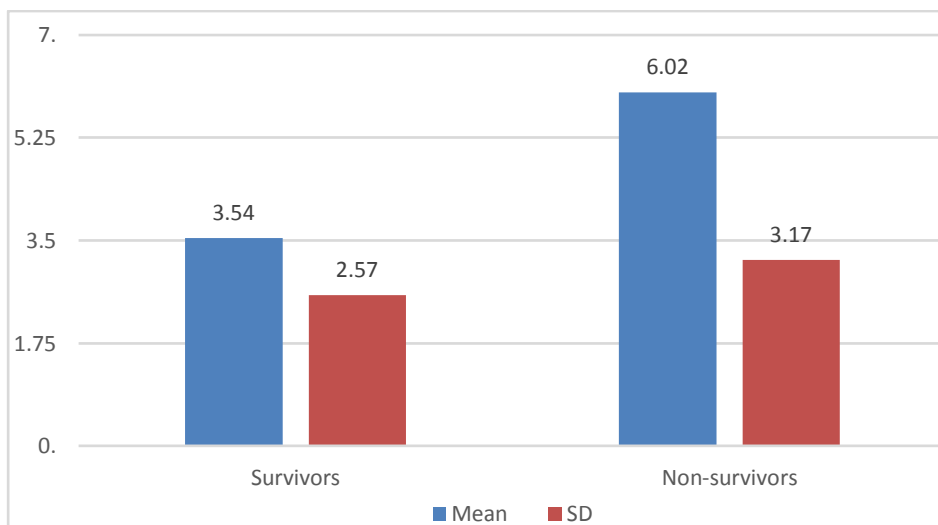


Fig 1: Mean SOFA score among survivors and non-survivors

The mean APACHE II score of survived patients was **11.23 ± 5.69** and non-survivor patients was **17.10 ± 6.77** . The mean APACHE II score among non survivors was higher as compared to survivor patients with statistical significance. ('p' value <0.001 by unpaired t test) [Fig 2]

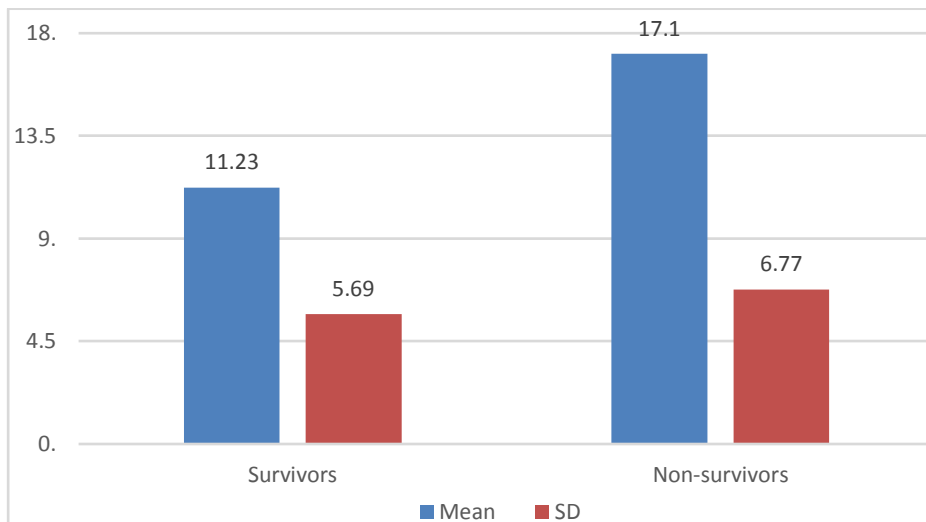


Fig 2: Mean APACHE II score among survivors and non-survivors

Comorbidities were present in 48 patients (48%) and absent in 52 (52%). Most common comorbidity was diabetes seen in 26 cases (26%) followed by hypertension (17%), IHD (5%), Asthma (4%) and Seizure disorders (2%). 16 cases had other comorbidities (16%) including 2 cases each of Alcoholic Liver Disease (2%), Chronic Kidney Disease (2%), Chronic Liver Disease (2%), Dilated Cardiomyopathy (2%) and Hypothyroidism (2%) and. One patient each had CA Bladder (1%), CA Uterus (1%), Cardiac cirrhosis (1%), Cerebrovascular accident (1%), Rheumatoid arthritis (1%) and Scleroderma (1%). Significant difference was seen between the presence of Diabetes Mellitus, Hypertension, other disorders and survival in our patients, patients with these comorbidities had less survival as compared to patients without any comorbidities. ('p' value <0.05)

Table 1
Mean SOFA score and APACHE II Score among patients with and without comorbidities

	Patients with Comorbidities	No Comorbidities	'p' value
Mean SOFA Score	5.72 ± 2.91	4.43 ± 2.37	0.023
Mean APACHE II Score	15.56 ± 7.60	12.42 ± 5.59	0.021

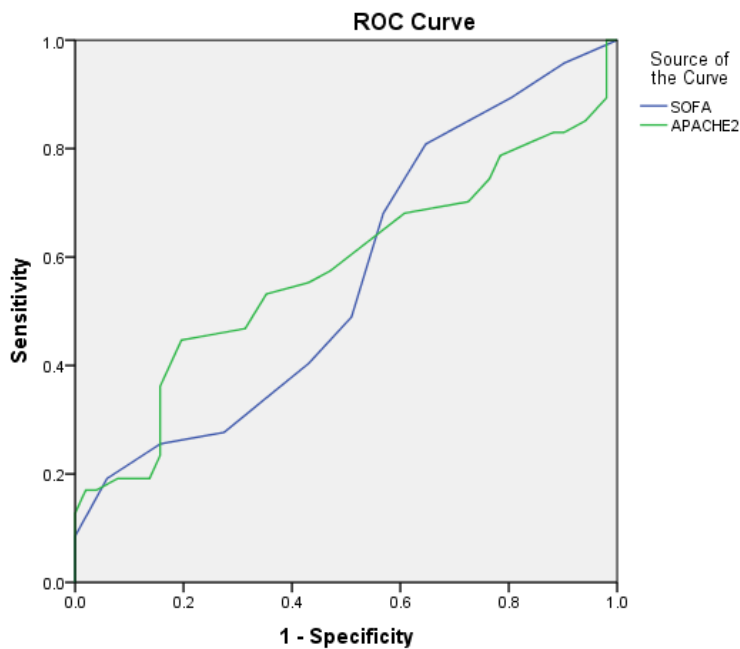
The mean SOFA score of patients with comorbidities was **5.72 ±2.91** and in patients without comorbidities was **4.43 ±2.37**. The mean SOFA score among patients with comorbidities was higher as compared to patients without comorbidities with statistical significance. ('p' value = 0.023 by unpaired t test). The mean APACHE II score of patients with comorbidities was **15.56 ±7.60** and in patients without comorbidities was **12.42 ±5.59**. The mean APACHE II score among patients with comorbidities was higher as compared to patients without

comorbidities with statistical significance. ('p' value = 0.021 by unpaired t test)

Table 2
Areas under curves (AUC) values observed distribution

Score	AUC value
APACHE II	0.64
SOFA	0.57

The above table shows distribution of patients according to AUC values. It was observed that on comparing different scoring system with mortality, APACHE-II (0.64) and SOFA (0.57) had better sensitivity and specificity. APACHE II has showed better calibration and discrimination power than SOFA.



Diagonal segments are produced by ties.

Fig 3: Areas under curves (AUC) values observed distribution

Table 3
Survival prediction amongst patients with SOFA scores and APACHE II Scores

APACHE II score	Number of Patients (n=100)	Non-Survivors (%)	SOFA score	Number of Patients (n=100)	Non-Survivors (%)	'p' value
0 to 4	8	1 (12.50)	0 to 1	17	5 (29.41)	0.35

5 to 9	20	7 (35.00)	2 to 3	19	5 (26.31)	0.55
10 to 14	26	9 (34.60)	4 to 5	25	12 (48.00)	0.33
15 to 19	24	14 (58.33)	6 to 7	17	9 (52.94)	0.73
20 to 24	14	10 (71.42)	8 to 9	19	14 (73.68)	0.88
25 to 29	7	6 (85.71)	10 to 11	2	2 (100)	0.57
30 to 34	0	0	11 to 14	0	0	-
>34	1	1 (100)	>14	1	1 (100)	-
Total	100	48	Total	100	48	

*Significant 'p' value < 0.05

Survival decreased with the increasing APACHE II and SOFA Scores in our study. No any significant difference was seen between the different APACHE II scores and corresponding SOFA Scores and mortality prediction by them in our study ('p' value >0.05). For APACHE II scores of 0 to 4 mortality prediction observed was 12.5%, which was less than the corresponding SOFA scores of 0 to 1 with 29.41% mortality prediction. For APACHE II scores of 5 to 9 mortality prediction observed was 35%, which was slightly higher than the corresponding SOFA scores of 2 to 3 with 26.31% mortality prediction.

For APACHE II scores of 10 to 14 mortality prediction observed was 34.60%, which was less than the corresponding SOFA scores of 4 to 5 with 48% mortality prediction. For APACHE II scores of 15 to 19 mortality prediction observed was 58.33%, which was slightly higher than the corresponding SOFA scores of 6 to 7 with 52.94% mortality prediction. For APACHE II scores of 20 to 24 mortality prediction observed was 71.42%, which was slightly less than the corresponding SOFA scores of 8 to 9 with 73.68% mortality prediction. For APACHE II scores of 25 to 29 mortality prediction observed was 85.71%, which was lower than the corresponding SOFA scores of 10 to 11 with 100% mortality prediction. Both APACHE II scores of >34 and SOFA scores of >14 predicted 100% mortality in our patients.

Discussion

The present prospective study was conducted to determine the comparative efficacy of different scoring system in assessing the prognosis, outcome and mortality of patients suffering from sepsis admitted in intensive care unit on admission itself.

The study was conducted in tertiary care Hospital from October 2019 to March 2021. A total sample size of 100 patients with evidence of sepsis on day of admission was included in the study. Patients with age less than 16 years and pregnant women were excluded. The study was conducted after taking ethical clearance from the institute and informed consent from the patients. The data was collected from patients regarding demographic profile, clinical profile and

investigations were done. SOFA score and APACHE II score calculated and analyzed by statistical software. Many studies have evaluated use of APACHE II and SOFA scoring system in ICU set ups. ^{11 - 15}

The mean age of the patients was 52.26 ± 19.85 years. Kumar S et al ¹⁶ in a study on Comparison of the Performance of APACHE II and SOFA Scoring Systems in critically ill patients observed that mean age of the patients were 50.48 ± 17.58 years. This finding was in accordance to present study. K.S. Abhinandan et al ¹⁷ observed age of patients varied from 18 years to 90 years with mean age of 48.36 years.

In a study done by Aditi Jain et al¹⁸ to determine the accuracy of sequential organ failure assessment (SOFA) score in predicting outcome of patients in Intensive Care Unit (ICU), the observed mean age among patients was 40 ± 16 years with more than 80% of subjects were <55 years of age.

The distribution of patients according to sex showed that majority of patients were in males (69%) and females were 31%. Kumar S et al ¹⁶ in their study observed that males were 63.2% and female were 36.8%. Deveen Anjana et al ¹⁰ reported that there were 28 males and 22 females in their similar study. This was in accordance to present study. Saeed Safari et al¹⁹ observed that out of 140 patients majority were males (53.5%).

In the present study, comorbidities were present in 48 patients (48%) and absent in 52 (52%). Most common comorbidity was type 2 diabetes mellitus seen in 26 cases (26%) followed by hypertension (17%), IHD (5%), Asthma and COPD (4%). K.S. Abhinandan et al ¹⁷ assessed in 50 patients, co-morbidities were present in 24 patients (48%) with diabetes mellitus being present in 14 patients (28%).

The distribution of patients according to mortality profile showed that among patients survivors were 52% and non-survivors were 48%. Deveen Anjana et al¹⁰ in their study observed that among 50 patients with sepsis, 18 patients died and 32 patients survived with mortality rate of 36%. Iftikhar Haider Naqvi et al, ²⁰ observed that mortality rate in their study was 35.4%. In a study done by Aditi Jain et al¹⁸ to determine the accuracy of sequential organ failure assessment (SOFA) score in predicting outcome of patients in Intensive Care Unit (ICU), the mortality rate was 39%. Saeed Safari et al¹⁹ evaluated the accuracy of SOFA score in predicting 1-month outcome of these patients in emergency department. They observed that out of 140 patients, 72 (51.43%) patients died.

The mean age of survived patients was 53.81 ± 16.13 years and non-survivor patients were 59.48 ± 15.54 years. The age among non survivors was higher as compared to survivor patients with statistical significance. (p value <0.05). K.S. Abhinandan et al ¹⁷ assessed morbidity and mortality of patients with multi-organ dysfunction syndrome in sepsis patients. The mean age among non survivors was little high compared to survivors (51.7 v/s. 46.84) which was not statistically significant (p value =0.411) Similar findings were seen in a study done by Aditi Jain et al¹⁸ to determine the accuracy of sequential organ failure assessment (SOFA) score in predicting outcome of patients in Intensive Care Unit (ICU). The mortality rate among survivors and non-survivors showed no statistical

significance.

The mean SOFA score of survived patients was **3.54 ±2.57** and non-survivor patients was **6.02 ±3.17**. The mean SOFA score among non survivors was higher as compared to survivor patients with statistical significance. ('p 'value <0.001 by unpaired t test) Iftikhar Haider Naqvi et al²⁰ observed the average SOFA score in non-survivors (9.68±4.88) was higher than survivors (5.63±3.63) with statistically significant 'p 'value (<0.001). This was in accordance to present study. In a study done by Aditi Jain et al¹⁸ the maximum score in survivors (3.92 ±2.17) was significantly lower than non-survivors (8.9 ±3.45). Duration of the stay did not correlate with the survival. K.S. Abhinandan et al¹⁷ also observed SOFA score was very high among non survivors as compared to survivors which was statistically very significant. (13.42 v/s. 6.84, 'p 'value<0.001)

The highest SOFA score can identify the critical point at which patients exhibit the highest degree of organ dysfunction during their ICU stay. Moreno et al²¹ also demonstrated a strong correlation of maximum SOFA score with mortality outcome. The mean SOFA score indicates the average degree of organ failure over time. Ferreira *et al.*²² also concluded that the mean SOFA score had a better prognostic value than the other SOFA derived variables. They opined that this may be because patients who present with a limited degree of organ dysfunction and have a long ICU stay still have a high likelihood of survival. Saeed Safari et al¹⁹ evaluated the accuracy of SOFA score in predicting 1-month outcome of these patients in emergency department. They observed that the mean SOFA score of the patients was 7.13 ±2.36 (minimum 2 and maximum 16).

The mean APACHE II score of survived patients was **11.23 ±5.69** and non-survivor patients was **17.10 ±6.77**. The mean APACHE II score among non survivors was higher as compared to survivor patients with statistical significance. ('p 'value <0.001 by unpaired t test) Iftikhar Haider Naqvi et al²⁰ observed that average APACHE II score in non-survivors (27.97±8.53) was higher than survivors (15.82±8.79) with statistically significant 'p 'value (<0.001). K.S. Abhinandan et al¹⁷ assessed morbidity and mortality of patients with multi-organ dysfunction syndrome in sepsis patients observed that APACHE II score was high among non survivors than survivors (23.28 v/s. 18.75)

The mean duration of stay of survived patients was 8.23 ±11.39 days and non-survivor patients were 12.83 ±9.74 days. The mean duration of stay among non survivors was higher as compared to survivor patients with statistical significance. ('p 'value <0.001 by unpaired t test) In a study done by Aditi Jain et al¹⁸ the mean duration of stay in the ICU was 9 days. This was similar to many studies that have been done. S Vosylius et al²³ in their study on 117 ICU patients with sepsis showed that the changes in the severity of organ dysfunction were closely related to the outcome of the patients admitted to ICU.

APACHE II has showed better predictive mortality of power than SOFA. It was observed that on comparing different scoring system with mortality, APACHE II (AUC = 0.64) and SOFA (AUC = 0.57) had better sensitivity and specificity. APACHE II has showed better calibration and discrimination power than SOFA. Similar findings were seen in Iftikhar Haider Naqvi et al²⁰ study where APACHE II

score showed better calibration and discrimination power than SOFA. Kumar S et al¹⁶ in a study on comparison of the performance of APACHE II and SOFA Scoring Systems observed on comparing different scoring systems with mortality, observed that APACHE-II had better sensitivity and specificity than and SOFA. Devee Anjana et al¹⁰ in a study on comparative study of APACHE II and SOFA Scoring Systems in Critically ill Patients with Sepsis observed the APACHE II score on day of admission, though reliable, was not very effective in predicting the mortality rate. This finding was in contrast to present study.

Survival decreased with the increasing APACHE II and SOFA Scores in our study. The frequency distributions of both scoring systems were compared and it was observed that both APACHE II and SOFA scoring systems were equivalent in predicting mortality in patients diagnosed as sepsis and there was no statistical significance was present.

Conclusion

It was observed that from the patients suffering from sepsis, majority were males. Hypertension, type 2 diabetes mellitus and CVA were amongst the most common associated diseases. It was observed that there was a 48% mortality in our patients. Older age, male sex, higher SOFA scores and APACHE scores were associated with mortality in our study. APACHE II has showed better predictive mortality of power than SOFA. Comparing different scoring system with mortality, APACHE II (AUC = 0.64) and SOFA (AUC = 0.57) showed better calibration and discrimination power than SOFA. The frequency distributions of both scoring systems were compared and it was observed that both APACHE II and SOFA scoring systems were equivalent in predicting mortality in patients diagnosed as sepsis and there was no statistical significance was present. Since SOFA has fewer parameters and has a bedside quicker version (qSOFA), it is easier and cost effective as compared to APACHE II.

Conflict of interest: None

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