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Comparison of Acute Physiology and Chronic Health Evaluation II and Sequential Organ Failure Assessment intensive care unit scoring system as mortality predictors in intensive care unit patients with sepsis

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ABSTRACT

Background: Sepsis is a life-threatening organ dysfunction caused by a deregulated host response to infection. It is one of the leading causes of in-hospital mortality and morbidity among patients. It also results in significant morbidity and financial burden. **Aims and Objectives:** (1) To study the etiological profile of patients admitting with sepsis to ICU. (2) To compare between APACHE II and SOFA ICU scoring system of patients with sepsis at admission and at 24 h in predicting the 5th-day mortality. **Materials and Methods:** This was a single center hospital based prospective, observational, study conducted in patients in ICUs of ESICMC PGIMSR and Model Hospital Rajajinagar, Bangalore. Patients over age 18 years admitted in ICU who have fulfilled the criteria for sepsis were included in our study. Their clinical profile, APACHE II and SOFA scores were evaluated and followed up to 5th day of admission and data were compared with respect to patients' outcome in the form of survival. **Results:** In this study, out of 53 patients the maximum number of patients belong to the age groups of >60 years (23 patients). Male-to-female distribution in this study noted was 30 and 23 patients, respectively. Aspiration Pneumonitis (17%) and Community-Acquired Pneumonia (17%) were the most common causes of septic. Out of 53 patients, 31 patients did not survive. In this study, it was observed that the SOFA scoring had the highest specificity (87.10%) and APACHE II had the highest sensitivity (96.77%) at admission. However at 24 h of admission, both the highest sensitivity and highest specificity was more for APACHE II score. The most area under the Receiver-operating characteristic curve was better for SOFA score (AUROC = 58.0%) at admission than APACHE II score with AUROC of 53.7%, however AUROC of both SOFA and APACHE II score calculated at 24 h of admission were equally good in predicting 5th-day mortality. **Conclusion:** We found that the SOFA score outperformed APACHE II scores in predicting survival in septic shock patients at admission. SOFA and APACHE II calculated at 24 h of admission and both scores provided equal efficacy in predicting 5th-day mortality in patients with sepsis.

Key words: Sepsis; Acute Physiology and Chronic Health Evaluation II; Sequential Organ Failure Assessment score; Intensive care unit

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INTRODUCTION

Sepsis is a life-threatening organ dysfunction caused by a deregulated host response to infection.[1] It is one of the leading causes of in-hospital mortality and morbidity. The high mortality connected with severe sepsis and septic shock, combined with significant morbidity and financial burden, is a major concern. The overall incidence of sepsis

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ranges from 10% to 30% with mortality ranging from 10% to 56%. Available data from India suggest that the overall mortality of all septic patients is approximately 14% and that of severe sepsis is higher than 50%.[2]

The Global Burden of Disease Study reported that in 2017, an estimated 48.9 million incident cases of sepsis are reported. Approximately 11 million deaths were reported, representing 19.7% of all global deaths.[3] To ensure an absolute quality of care in the Intensive care units (ICUs), prognostication of the patients in a systematic way plays a fundamental role. Conventionally, ICU physicians differentiate survivors and non-survivors based on their clinical proficiency. However, prognostication is best achieved by the analysis of definite objective data. Moreover, it also helps in early decision-making based on predictive scores will reduce the observation time by addressing patients to the more appropriate intensity level of assistance in the form of mechanical ventilation, ECMO, inotropic supports.[4,5]

There are many scoring systems for assessment of severity of sepsis and predicting their mortality, few examples are Acute Physiology and Chronic Health Evaluation II (APACHE II), Simplified Acute Physiology Score II (SAPS II), Sequential Organ Failure Assessment (SOFA) and other scoring systems are mortality prediction model (MPM), organ system failure, organ dysfunction and infection system, multiple organs dysfunction score, logistic organ dysfunction.

Among them, the 2 commonly used scoring systems are APACHE and SOFA. The present study was conducted to assess APACHE and SOFA ICU scoring system in Prediction of Mortality in patients with severe sepsis.

Aims and objectives

1. To study the clinic etiological profile of patients admitting with sepsis
2. To compare APACHE II and SOFA ICU scoring systems at the time of admission and after 24 h in predicting the patient outcome at the 5th day of admission.

MATERIALS AND METHODS

The prospective study was conducted in patients admitted to medical college hospitals affiliated to ESICMC PGIMSR and MODEL HOSPITAL Rajajinagar, Bangalore, Karnataka, from November 2022 to March 2024. All patients, meeting the specified inclusion and exclusion criteria, admitted in the medical ICU and surgical ICU during the study period were included.

Inclusion criteria

1. Patients are willing to give written informed consent
2. Age >18 years
3. Patient meeting the sepsis Case definition Based on the SCCM/ESICM Sepsis-3 consensus (2021) definition of SEPSIS includes
   - Organ dysfunction is defined as an increase of two or more points in the SOFA score including
   - Respiratory system: PaO_2/FiO_2 <400 mmHg
   - Coagulation: Platelets count $<150\times10^3/mm^3$
   - Cardiovascular system: Mean arterial pressure (MAP) <70 mm Hg
   - Central nervous system: Glasgow Coma Scale (GCS) <13
   - Renal system: Creatine >1.2 mg/dL or Urine output <500 mL/day
   - Infection: Documented or clinical suspicion derived from the signs and symptoms of infection as well as supporting radiologic and microbiologic data and response to therapy.

   (OR)
4. Based On the Centers for Medicare and Medicaid Services.
   Severe sepsis: Sepsis that was associated with tissue hypo-perfusion
   - Elevated lactate >4 mmoL/L
   - Oliguria urine output <400 mL/day
   - Organ dysfunction (Defined Above)

   (OR)
5. Septic shock: Based on SCCM/ESICM includes patients who fulfill the criteria for sepsis who, despite adequate fluid resuscitation, require vasopressors to maintain a MAP ≥65 mmHg and have a lactate >2 mmoL/L (>18 mg/dL).

Exclusion criteria

1. Patients with pre-existing chronic kidney disease (CKD)
2. Patients with pre-existing heart failure
3. Pregnancy
4. The patient admitted with septic shock did not survive for more than 24 h of admission.

Study protocol

A standard proforma was used to record a detailed history of present complaints specific to Infectious Sources, and past history including tuberculosis, Ischemic heart disease, heart failure, dilated cardiomyopathies, neurological, CKD, and endocrine problems. A detailed drug history suggestive of Immunosuppression was also recorded. Detailed clinical examination containing blood pressure, temperature, Heart rate, and respiratory rate including the signs of end-organ perfusion such as warmness of skin and capillary refill, mental status, urine output, and bowel sounds of patient assessed and recorded. Any examination findings pointing to underlying disease attributing to septic foci were also assessed. Further investigations for evaluation were sent for

analysis and the data were recorded. Routine laboratories-Complete blood count with differential, chemistries, liver function tests, renal function tests, serum electrolytes, coagulation studies (including D-dimer level), serum lactate, Peripheral blood cultures (aerobic and anaerobic cultures from at least two different sites), urinalysis, and microbiologic cultures from suspected sources (eg, sputum, urine, intravascular catheter, wound or surgical site, body fluids, rapid antigen or polymerase chain reaction tests) from readily accessible sites. APACHE II and SOFA indices were calculated at baseline at admission and after 24 h to assess the severity of illness and patients were followed up for next 5 days for the outcome (dead or alive).

Statistical analysis

The data collected were analyzed using SPSS software. The data were represented using charts and tables. Continuous variables were expressed as mean, standard deviation, and median. Categorical variables were expressed as percentages. Comparisons between data were done by student t-test and chi-square. A $P<0.05$ was taken as significant. The descriptive statistics used were mean, median, standard deviation, minimum value, maximum value, and range.

RESULTS

Out of 53 patients in the study population, 23 (43.4%) were females and 30 (56.6%) were males. The majority of patients (43.4%) are over the age of 60, followed by the age group 40–50 (24.5%), then the age group 51–60 (20.8%), and finally the age group <40 (11.3%). The various etiological profile of the patients is given in Table 1 and Figure 1. Comparison of APACHE II SCORE-related variables at admission and after 24 h studied given in Table 2, which shows among the APACHE II SCORE variables Rectal Temperature ($P<0.001$), MAP ($P=0.002$), Heart Rate ($P<0.001$), Respiratory Rate ($P=0.031$), Arterial pH ($P=0.022$), Serum Sodium ($P=0.018$), Serum Creatinine ($P<0.001$), Hematocrit ($P=0.006$), White Blood Count ($P=0.002$), GCS ($P<0.001$), and APACHE II SCORE ($P<0.001$) were statistically significant. Table 3 depicts the COMPARISON OF SOFA SCORE-related variables at admission and after 24 h studied, which shows among the SOFA SCORE variables PaO_2/FiO_2 (mmHg) ($P<0.001$), GCS ($P<0.001$), MAP ($P=0.002$), and Creatinine ($P<0.001$) were statistically significant. Table 4, Figures 2-5 depicts receiver operating characteristic curve analysis of APACHE II and SOFA score.

In this study, both the scores performed equally at 24 h of admission with an AUROC of 83.7%, however among the scores calculated at the time admission the best discrimination was provided by SOFA (AUROC=58.0%) followed by APACHE II (AUROC=53.7%) in predicting the 5th-day mortality of sepsis patients admitted to ICU.

DISCUSSION

This study compares the 2 most regularly used severity-scoring systems. The current study's mortality rate was 58%, which is close to previous research from India (40.3%), Indonesia (39.8%), Germany (9%), Australia (16%), and Saudi Arabia (31.6%).[6-8]

The high fatality rate can be linked to the severity of sepsis and organ dysfunction at the time of presentation. Poor nutritional status during ICU admission may also be a significant contributor to India's high mortality rate. Poor nutrition decreases immunity, increasing the risk of infection which is related to poor socioeconomic status.[9]

Older patients ≥65 years of age account for the majority (60–85%) of all episodes of sepsis; with an increasing ageing population, the incidence of sepsis will likely continue to increase in the future.[10]

In the study conducted by Zimmerman JE et al.,[11] found that mortality was highest in the age group of 56–65 years.

Table 1: Etiological diagnosis

Variables	No. of patients (n=53)	%
Aspiration pneumonitis	9	17.0
Community-acquired pneumonia	9	17.0
Spontaneous bacterial peritonitis	7	13.2
Urosepsis	7	13.2
Pyelonephritis	6	11.3
Acute gastroenteritis	5	9.4
Cellulitis	2	3.8
Febrile neutropenia	2	3.8
Necrotizing fasciitis	2	3.8
Liver Abscess	1	1.9
Lung abscess	1	1.9
Pulmonary tuberculosis	1	1.9
Wet gangrene	1	1.9

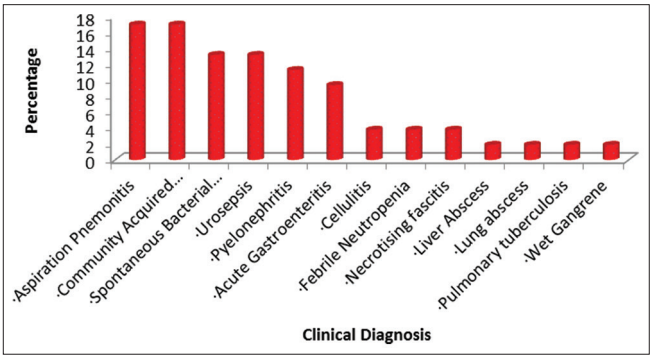

Figure 1: Etiological diagnosis

Table 2: Comparison of APACHE II score-related variables at admission and after 24 h of admission

Variables	At Admission	After 24 h	t-value	P-value
Age	58.64±15.1	58.83±14.9	0.065	0.948
Rectal temperature	38.45±1.33	39.53±1	4.696	<0.001**
Mean arterial pressure,	71.02±19.12	60.89±13.43	3.157	0.002**
Heart rate	101.32±13.41	112.42±12.01	4.487	<0.001**
Respiratory rate	24.72±5.57	27.62±7.88	2.192	0.031*
Oxygenation	90.09±17.63	93.71±13.11	1.199	0.233
Arterial pH	7.3±0.12	7.25±0.11	2.332	0.022*
Serum sodium	137.2±4.31	139.72±6.26	2.414	0.018*
Serum potassium	4.14±0.55	4.16±0.92	0.100	0.921
Serum creatinine	1.41±1.08	2.66±1.69	4.521	<0.001**
Hematocrit	35.49±7.45	31.28±7.84	2.834	0.006**
White blood count	12161.98±6083.98	17010.36±9588.65	3.108	0.002**
Glasgow Coma Scale	11.25±5.07	6.55±5.09	4.760	<0.001**
APACHE II score	18.57±13.21	30.72±11.03	5.140	<0.001**

APACHE II: Acute Physiologic Assessment and Chronic Health Evaluation II, **P value significant, *P value not significant

Table 3: Comparison of SOFA score-related variables at admission and after 24 h studied

Variables	At Admission	After 24 h	t-value	P-value
PaO_2/FiO_2*, mmHg	285.58±139.05	190.64±127.5	3.664	<0.001**
Platelets, $\times 10_3/\mu L$	1.92±0.82	1.66±1.02	1.484	0.141
GCS	11.19±5.04	6.49±5.01	4.810	<0.001**
Bilirubin, mg/dL (µmoL/L)	2.73±5.46	4.57±7.92	1.387	0.168
Mean arterial pressure	71.72±19.05	61.53±14.26	3.118	0.002**
Creatinine	1.45±1.09	2.74±1.78	4.514	<0.001**
SOFA score	6.17±5.67	11.57±3.73	5.792	<0.001**

SOFA: Sequential Organ Function Assessment, GCS: Glasgow Coma Scale

Table 4: ROC curve analysis of APACHE II and SOFA score

Variables	ROC results to predict mortality				Cut-off	AUROC (%)	SE	P-value
	Sensitivity	Specificity	LR+	LR-				
@Admission								
APACHE II score	51.61	77.27	2.27	0.63	≤12	53.7	0.084	0.6579
SOFA score	41.94	86.36	1.03	0.98	≤1	58.0	0.0795	0.3145
@After 24 h								
APACHE II score	96.77	63.64	2.75	0.00	>29	83.7	0.0595	<0.001**
SOFA score	93.55	59.09	2.29	0.011	>9	83.7	0.085	0.004**

SOFA: Sequential Organ Function Assessment, APACHE II: Acute Physiologic Assessment and Chronic Health Evaluation II

In study conducted by Hebert et al.,[12] supports our findings by stating that age is an important factor that increases the risk of death due to multiple organ failure and that worse prognoses are seen in patients older than 65 years of age. However, Chen et al.,[13] through their study on patients suffering from severe sepsis proposed that age may not be an important predictor of mortality and that the physicians should consider other risk factors for the purpose.

Reasons for a possible increased rate of sepsis include advancing age, immunosuppression, and multidrug-resistant infection.[14]

Aspiration Pneumonitis and Community-Acquired Pneumonia were noted to be the most common causes of septic shock 17% and 17%, respectively, in our study.

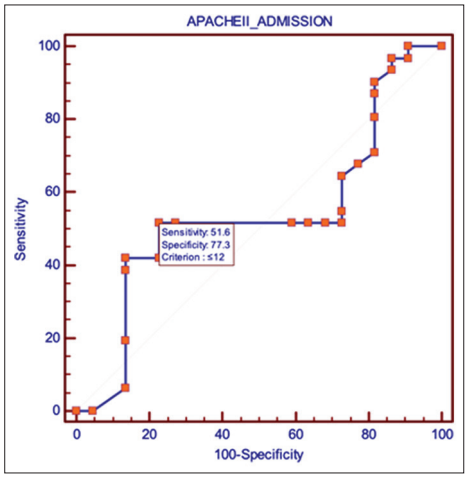

Figure 2: Acute Physiology and Chronic Health Evaluation II at admission

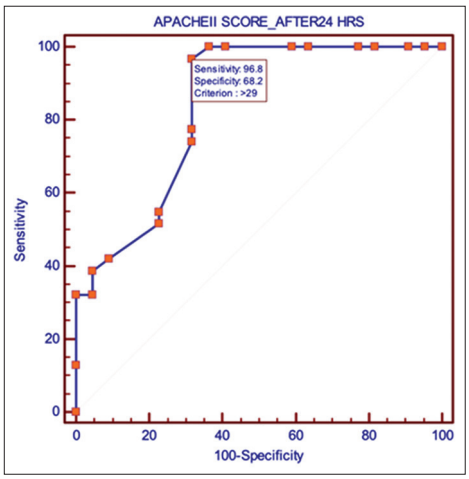

Figure 3: Acute Physiology and Chronic Health Evaluation II 24-h admission

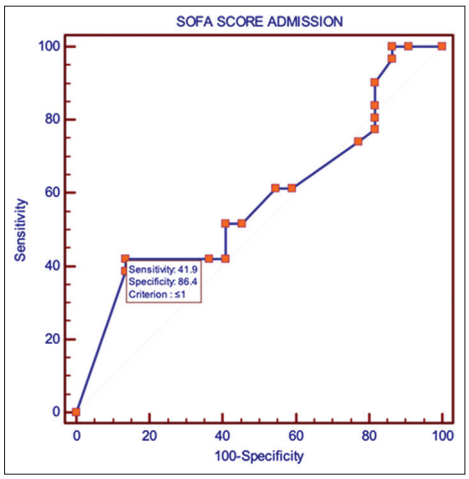

Figure 4: Sequential Organ Failure Assessment score at admission

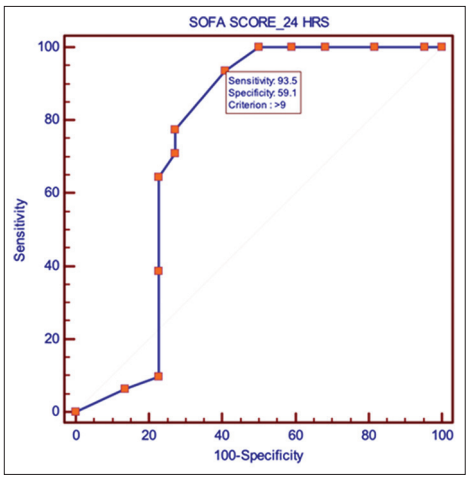

Figure 5: Sequential Organ Failure Assessment score 24-h admission

APACHE II and SOFA ICU scores calculated at 24 h of admission showed equal AUROC (83.7%) and however SOFA score calculated at the time of admission outperformed APACHE II in predicting 5th-day mortality. Several studies have compared and contrasted the various outcome prediction scoring schemes. In study conducted by Swamy et al.,[15] in Karnataka made it evident that APACHE II was significantly associated with mortality prediction and ranked the second most competent one at predicting mortality, preceded only by the SOFA score. And in a study of 10,393 patients from Scottish ICUs, Livingston and colleagues examined the APACHE II and APACHE II with United Kingdom-derived coefficients (UK APACHE II), SAPS II, and MPM0 and MPM24. These authors reported that all models performed well.[16]

In the study conducted by Castella et al.,[17] and Capuzzo et al.,[18] have found good discrimination for both models.

In a study by Georgescu et al.,[19] the APACHE II, SOFA, and SAPS II scores were determined prospectively, in the first 24 h after admission, for all 56 patients with septic shock who were included in their study. The study concluded that the APACHE II score was superior to the other scores for predicting survival in patients with septic shock (APACHE II: 26.76±6.742 versus 23.18±8.175, respectively, for SOFA: 8.029±3.099 versus 7.136±3.342). In contrast our study SOFA score was better predictor of mortality at admission and both score were equal at 24 h of admission.

Limitations of the study

- Only a small number of the population is taken for the study
- As it is a hospital-based study, it may not be representative of the general population
- The results of this study vary based on different areas as the etiology of Septic varies with different regions
- In this study, patients were followed up till 5th day, Hence the mortality is underestimated.

CONCLUSION

We found that the SOFA score outperformed APACHE II scores in predicting survival in septic shock patients at admission. At 24 h after admission both the score provided the same mortality prediction in patients with sepsis.

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Authors Contributions:
LSB- Concept, design, sample collection, analysis, manuscript preparation, preparation of 1st draft of the manuscript, review of result analysis and interpretation, review of manuscript, ICU case management; **LV-** Protocol, sample collection, edition, manuscript revision, statistical analysis, ICU case management and literature survey.

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