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A comparative study of APACHE II and SOFA scoring systems in critically ill patients with sepsis in MICU in tertiary care hospital

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Abstract: Background: Sepsis and septic shock are among the leading causes of death and the most common cause of death among critically ill patients. Severity scores and prognostic models are used to evaluate the severity of illness in patients in the critical care unit. The present study aimed to compare the APACHE II and SOFA scoring systems in critically ill patients with sepsis in the medical ICU of a tertiary hospital.

Materials and Methods: The present study was a prospective observational study conducted on patients aged > 18 years, of either gender, admitted to the medical ICU for sepsis. All patients were evaluated using the APACHE II and SOFA scoring systems.

Results: The present study included 225 cases that met the study criteria. The mean age was 59.2 ± 12.3 years, the mean length of stay was 9.3 ± 4.2 days, and the mean length of ICU stay was 7.3 ± 3.7 days. The majority of the patients were male (63.56%). The mortality rate was 58.22%, 39.56% of patients had multiple organ dysfunction, 74.22% were diagnosed with septic shock, and positive blood culture was noted among 34.67% of patients. On the day of admission, a significantly higher APACHE II score was noted among non-survivors (23.8 ± 11.65) compared to survivors (16.59 ± 8.24). The daily SOFA score was higher among non-survivors than survivors, and the difference was statistically significant ($p < 0.001$). Both APACHE II and SOFA scoring systems were found to be equivalent in predicting mortality in patients diagnosed with sepsis, and there was no statistical significance.

Conclusion: The APACHE II and SOFA scoring systems are equivalent in predicting mortality in patients diagnosed with sepsis, and there was no statistical significance.

Keywords: SOFA score; APACHE II score; Non-survivors; Sepsis; ICU admission.

1. Introduction

Sepsis and septic shock are leading causes of death among critically ill patients. Acute infections have also been found to exacerbate pre-existing chronic diseases or result in new chronic conditions, leading to poor long-term outcomes for survivors of acute illness [1].

Prognostic models and severity scores are utilized to evaluate the severity of illness of patients in critical care units. Prognostic models, in addition to stratifying patients according to their severity, predict a specific outcome based on a set of prognostic variables and a modeling equation [2].

APACHE II (Acute Physiology and Chronic Health Evaluation II) is one of several ICU scoring systems that is applied within 24 hours of a patient's admission. It employs a point score that is based on initial values of 12 routine physiologic measurements, age, and previous health status to provide a general measure of disease severity [3]. The SOFA (Sequential Organ Failure Assessment) score is a simple yet effective method for describing organ dysfunction or failure in critically ill patients [4].

This present study aims to compare the effectiveness of APACHE II and SOFA Scoring Systems in predicting mortality in critically ill patients with sepsis in the medical intensive care unit (MICU) of a tertiary hospital.

2. Materials and Methods

The present study was a prospective observational study conducted at the Department of General Medicine, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research Centre, Melmaruvathur, India, over a period of one year, from January 2022 to December 2022.

2.1. Inclusion Criteria

The study included patients of age greater than 18 years, of either gender, who were admitted to the medicine ICU for sepsis, diagnosed as per the criteria laid down by the American College of Chest Physicians/Society of Critical Care Medicine (ACCP/SCCM) Consensus Committee in 1992 [5].

2.2. Exclusion Criteria

The following patients were excluded from the study: those primarily suffering from pancreatitis, pulmonary embolism, cardiac tamponade, drug overdose, anaphylaxis, adrenal insufficiency, burns, and tumour-associated lactic acidosis, as well as pregnant women and patients on treatment with immunosuppressive agents.

A detailed medical history, clinical examination, and relevant laboratory investigations were recorded in the case record proforma. All patients were evaluated using the APACHE II and SOFA scoring systems. The APACHE II score was calculated on the day of admission to predict mortality and assess the extent of multiorgan dysfunction. The SOFA score was determined daily from day 1 until the last day of hospitalization.

Data was collected and compiled using Microsoft Excel and analyzed using SPSS version 23.0. Continuous variables were presented as means and standard deviations (SD), while ratios and proportions were used for categorical variables. The chi-square test or Fisher's exact test was used to test for differences in proportions between qualitative variables. A P value less than 0.05 was considered statistically significant. Receiver operating characteristic (ROC) curves were plotted to define the discriminative value of scores as a prognostic factor for mortality.

3. Results

The present study included 225 cases that met the inclusion criteria, as shown in Table 1. The mean age of the patients was 59.2 ± 12.3 years, with a mean length of stay of 9.3 ± 4.2 days and a mean length of ICU stay of 7.3 ± 3.7 days. The majority of the patients were male (63.56%). The mortality rate was found to be 58.22%, while 39.56% of the patients had multiple organ dysfunction. Furthermore, 74.22% of the patients were diagnosed with septic shock, and a positive blood culture was noted in 34.67

On the day of admission, the non-survivors had a significantly higher APACHE II Score (23.8 ± 11.65) compared to the survivors (16.59 ± 8.24), as shown in Table 2. The daily SOFA score was found to be higher among the non-survivors compared to the survivors, and the difference was found to be statistically significant ($p < 0.001$), as presented in Table 3.

Receiver Operating Characteristic (ROC) curves were constructed to assess the prognostic ability of APACHE II and maximum SOFA scores (max SOFA) to predict mortality in sepsis patients. The frequency distributions of both scoring systems were compared and it was observed that both APACHE II and SOFA scoring systems were comparable in predicting mortality in patients with sepsis, and no statistically significant difference was observed between the two systems. The ROC curves are presented in Figure 1.

4. Discussion

According to the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3), sepsis can be diagnosed when there is an increased heart rate, increased respiratory rate, and increased or decreased body temperature and white blood cell count present [5]. The presence of all symptoms of sepsis accompanied by multiple organ damage defines severe sepsis. Scoring systems are composed of degrees of

Table 1. General characteristics

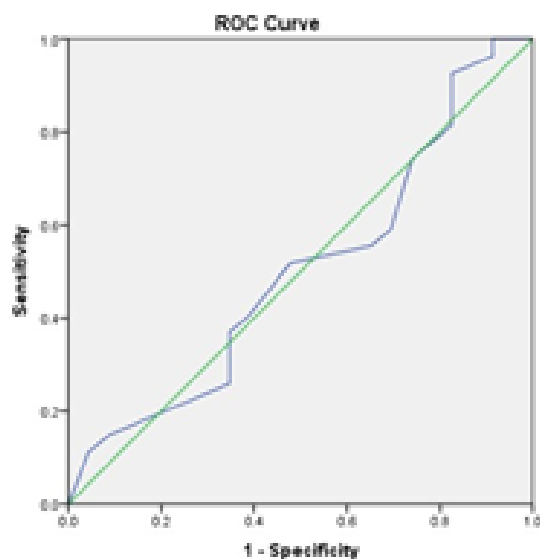
| Characteristics | Mean±SD / No of patients (%) |
|----------------------------|------------------------------|
| Age (years) | 59.2 ± 12.3 |
| Length of stay (days) | 9.3 ± 4.2 |
| Length of ICU stay (days) | 7.3 ± 3.7 |
| Gender | |
| Female | 82 (36.44 %) |
| Male | 143 (63.56 %) |
| Other characteristics | |
| Mortality rate | 131 (58.22 %) |
| Multiple organ dysfunction | 89 (39.56 %) |
| Septic shock | 167 (74.22 %) |
| Positive blood culture | 78 (34.67 %) |

Table 2. APACHE II Score

| Apache II | Non-Survived (n=64) | Survived | p value |
|-----------|---------------------|--------------|---------|
| <10 | 6 (9.38 %) | 19 (11.8 %) | |
| 10-20 | 15 (23.44 %) | 87 (54.04 %) | |
| 20-30 | 34 (53.13 %) | 46 (28.57 %) | |
| >30 | 9 (14.06 %) | 9 (5.59 %) | |
| Total | 64 | 161 | |
| Mean±SD | 23.8 ± 11.65 | 16.59 ± 8.24 | <0.001 |

Table 3. Serial SOFA Scores

| SOFA Score | Non-Survived | Survived | p value |
|-----------------|--------------|-------------|---------|
| Day 1 | 9.32 ± 3.81 | 6.94 ± 3.16 | <0.001 |
| Day 2 | 10.34 ± 4.73 | 7.28 ± 3.53 | <0.001 |
| Day 3 | 12.23 ± 4.34 | 6.84 ± 3.12 | <0.001 |
| Day 4 | 11.13 ± 4.77 | 6.98 ± 2.92 | <0.001 |
| Day 5 | 11.56 ± 5.38 | 5.88 ± 3.93 | <0.001 |
| Day 6 | 13.61 ± 5.83 | 4.96 ± 1.92 | <0.001 |
| Day 7 | 12.92 ± 4.43 | 3.29 ± 1.99 | <0.001 |
| Day 8 | 12.62 ± 4.32 | 2.49 ± 1.32 | <0.001 |
| Day 9 | 12.57 ± 5.98 | 2.41 ± 1.12 | <0.001 |
| Day 10/last day | 12.35 ± 5.91 | 2.38 ± 1.02 | <0.001 |

**Figure 1.** ROC Curve

organ dysfunction, organ failure, or multiple organ failures, and anatomical derangements which eventually contribute to morbidity and mortality.

Severity scores are tools that aim to stratify patients based on the severity of illness, assigning to each patient an increasing score as their severity of illness increases. Since the results of laboratory tests like culture and serology are available only after 24 to 48 hours, using scores like APACHE II and SOFA may help in predicting outcomes in the crucial initial hours of management [6].

APACHE II (Acute Physiology and Chronic Health Evaluation II) [3] is the sum of three units: an Acute Physiology Score, a Chronic Health Evaluation, and a score based on a patient's Age. Scoring is based on the most abnormal measurements during a 24-hour stay in the Intensive Care Unit (ICU). The maximum score is 71 points, although more than 80% of patients have a score of 29 or less. The relationship between APACHE II scores and hospital mortality differs for surgical and non-surgical patients, as the prognostic impact of altered physiology is less severe in post-operative patients.

SOFA (Sequential Organ Failure Assessment) [4] quantifies dysfunction of six organ systems ranging from zero (normal) to 4 (extremely abnormal), as follows:

1. Respiratory System: PaO₂/FiO₂ mmHg.
2. Coagulation System: Platelets $\times 10^3/\mu\text{l}$.
3. Hepatic System: Bilirubin (mg/dl).
4. Cardiovascular System: Hypotension.
5. Central Nervous System: Glasgow Coma Scale Score.
6. Renal System: Creatinine (mg/dl), urine output (ml/day).

Devee [7] noted that serial measurement of the SOFA score during the first week is a very useful tool in predicting the outcome, especially on day 3. The APACHE II score on the day of admission, though reliable, was not very effective in predicting the mortality rate in our setup.

In the study by Swamy et al. [8], the means of the APACHE II, IV, and SOFA D1 were 16.57 ± 6.49 , 71.91 ± 16.19 , and 8.75 ± 2.20 , respectively. There was a statistically significant difference in the mean APACHE II scores (14.23 ± 5.20 vs. 21.12 ± 6.38) and the mean APACHE IV scores (67.27 ± 13.21 vs. 80.91 ± 17.77) in the survivors and the non-survivors. A statistically significant difference was also evident in the mean ages of the survivors and the non-survivors (52.82 ± 14.67 years vs. 63.25 ± 16.98 years). The SOFA score was higher among the non-survivors than the survivors right from day-1 (10.24 ± 2.08 vs. 7.98 ± 1.86) to day-20 (15.00 ± 0.00 vs. 3.14 ± 0.38).

In the study by Mehta et al. [9], the mean age was 56.71 ± 16.77 years. The majority of patients were males (69%). Fifty-two patients were survivors (52%), and non-survivors 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 .

In the study by Samir et al. [10], the mortality rate was 48% in the study group, which had an alarming proportion of MODS patients (78%). The most common organ involved was the lung, and the most common organism causing sepsis was *Klebsiella*. On day 3, the mortality rate of patients with SOFA score less than nine was 9.1%, while the mortality rate of patients with a score more than nine was 78%. The trend of mean SOFA score was progressively declining in the survivor group. The mean APACHE II score was marginally higher in the non-survivor group compared to the survivor group, however, the difference was not statistically significant.

Kumar et al. [11] compared different scores with mortality and found that APACHE-II had a sensitivity of 89.9% and specificity of 97.6%, SOFA had a sensitivity of 90.1% and specificity of 96.6%, and mNUTRIC score had a sensitivity of 97.2% and specificity of 74.0%. In predicting the requirement of mechanical ventilation, APACHE-II had a sensitivity of 93.4%, SOFA had 90.5%, and mNUTRIC score had 92.3% but with a low specificity of 76.5%.

According to [12], the SOFA scoring system is better than the APACHE II system in predicting mortality in ICU surgical patients, and serial measurements of SOFA significantly improve their predictive accuracy. Additionally, vital organ dysfunctions that develop after the onset of sepsis have a marked influence on the outcome. Studies have shown that the APACHE II score at the onset of sepsis or the SOFA score and the number of organ dysfunctions developing thereafter are independent prognostic factors for patients with sepsis [13].

5. Conclusion

In conclusion, our study found that both APACHE II and SOFA scoring systems were effective in predicting mortality in patients diagnosed with sepsis. Specifically, non-survivors had significantly higher daily SOFA scores and on admission APACHE II scores compared to survivors. Interestingly, our analysis also showed that there was no statistically significant difference between the two scoring systems in terms of predicting mortality. These findings suggest that both APACHE II and SOFA scoring systems can be useful tools in identifying high-risk sepsis patients, and their combined use may enhance the accuracy of mortality prediction. Further research is needed to determine the most effective combination of these scoring systems in clinical practice.

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Conflicts of Interest: "Authors declare that they do not any competing interests."

References

- [1] Todi, S., Chatterjee, S., Sahu, S., & Bhattacharyya, M. (2010). Epidemiology of severe sepsis in India: an update. *Critical Care*, 14(Suppl 1), P382.
- [2] Gullo, A., & Lumb, P. D. (Eds.). (2007). *Intensive and Critical Care Medicine: Reflections, Recommendations and Perspectives*. Springer Science & Business Media.
- [3] Knaus, W. A., Draper, E. A., Wagner, D. P., & Zimmerman, J. E. (1985). APACHE II: a severity of disease classification system. *Critical Care Medicine*, 13(10), 818-829.
- [4] Vincent, J. L., De Mendonca, A., Cantraine, F., Moreno, R., Takala, J., Suter, P. M., ... & Blecher, S. (1998). Use of the SOFA score to assess the incidence of organ dysfunction/failure in intensive care units: results of a multicenter, prospective study. *Critical Care Medicine*, 26(11), 1793-1800.
- [5] American College of Chest Physicians. (1992). Society of Critical Care Medicine Consensus Conference Committee: American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference: Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. *Critical Care Medicine*, 20, 864-874.
- [6] Chaudhury, D., Paul, S., Chandraprakash., et al. (2017). SOFA or APACHE II, which deserves more attention in sepsis patients in ICU? A n experience from a tertiary care hospital in north east India. *Journal of Evidence-Based Medicine and Healthcare*, 4(29), 1700-1704.
- [7] Anjana, D. (2017). A Comparative Study of APACHE II and SOFA Scoring Systems in Critically Ill Patients with Sepsis. *International Journal of Health Research and Medico Legal Practice*, 3(1), 20-22.
- [8] Swamy, A. H. M., Kumararadhya, G. B., Thammaiah, S. H. et al. (2021). Comparison of sequential organ failure assessment (SOFA), acute physiology and chronic health evaluation II and IV (APACHE) scoring system validity as mortality predictors in ICU patients with multiple organ dysfunction syndrome in sepsis. *Journal of Evidence-Based Medicine and Healthcare*, 8(16), 1058-1063.
- [9] Mehta, P., & Patil, S. 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. *International Journal of Health Sciences*, (1), 4078-4089.
- [10] Desai, S., & Lakhani, J. D. (2013). Utility of SOFA and APACHE II score in sepsis in rural set up MICU. *Journal of the Association of Physicians of India*, 61(9), 608-611.
- [11] Kumar, S., Gattani, S. C., Baheti, A. H., & Dubey, A. (2020). Comparison of the performance of APACHE II, SOFA, and mNUTRIC scoring systems in critically ill patients: a 2-year cross-sectional study. *Indian Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine*, 24(11), 1057.
- [12] Azoulay, E., Adrie, C., De Lassence, A., Pochard, F., Moreau, D., Thiery, G., ... & Timsit, J. F. (2003). Determinants of postintensive care unit mortality: a prospective multicenter study. *Critical Care Medicine*, 31(2), 428-432.
- [13] Degoricija, V., Sharma, M., Legac, A., Gradišer, M., Šefer, S., & Vucicevic, Z. (2006). Survival analysis of 314 episodes of sepsis in medical intensive care unit in university hospital: impact of intensive care unit performance and antimicrobial therapy. *Croatian Medical Journal*, 47(3), 385-397.

