

Comparing the Prognosticative Value of APACHE II and mSOFA Scores in Critically Ill Patients: A Prospective Study

Sonal K Ginoya*, Anjali Bala Bhabhor**, Samira Parikh***

Abstract:

Objective: Several predictive scoring systems measuring disease severity are used to predict outcomes, typically mortality, of critically ill patients in the intensive care unit (ICU). Two common validated predictive scoring systems include acute physiology and chronic health evaluation II (APACHE II) and modified sequential organ failure assessment score (mSOFA). To compare performance of APACHE II and mSOFA score in critically ill patients regarding the outcomes in the form of morbidity and mortality in ICU. **Methods:** This prospective observational clinical study was conducted on 100 patients over 6 months. For each patient, APACHE II score on day of admission and serial mSOFA scores on day 0, 3, 7 and 10 were calculated and compared. **Results:** The age of the non-survivors was significantly older than survivors was (57.1 ± 11.76 and 54.28 ± 15.16). [In our study we found that the mean length of ICU stay of non-survivors was (5.41 ± 4.81) & survivors (8.63 ± 4.81) days.] In our study mortality rate was 40%. The APACHE II score with cut-off point of 23 demonstrated a sensitivity rate of 98.33% & specificity rate of 17.5%, accuracy of 66.00%. Serial mSOFA scores with cut-off of 11 on day0, day3, day7 better differentiated survivors from non-survivors with 98.3% sensitivity, 27.5% specificity and 70% accuracy. **Conclusion:** Both APACHE II and mSOFA scores can help ICU physicians as a significant predictive marker for mortality in critically ill patients. The serial measurement of mSOFA score in the first week is a better mortality predictor tool than APACHE II score in critically ill patients.

Keywords: Acute Physiology and Chronic Health Evaluation (APACHE II), Critically ill patients, ICU mortality, Modified Sequential Organ Failure Assessment (mSOFA)

Introduction:

Several predictive scoring systems measuring disease severity are used to predict outcomes, typically mortality, of critically ill patients in the intensive care unit (ICU). It is an important tool for clinical decision making, classifying the critically ill patients according to their health status and improving the quality of services provided to the patients. Two common validated predictive scoring systems include acute physiology and chronic health evaluation II (APACHE II) and modified sequential organ failure assessment score (mSOFA). Organ dysfunction and failure is one of the main causes of mortality and morbidity in hospitalized patients in ICU.

APACHE II uses a point score based upon initial values of 12 routine physiologic measurements, age, and previous health status to provide a general measure of severity of disease. It is widely used to quantify the severity of illness in the ICU and has been validated in many clinical trials. It estimates the risk based on the worst variable available within the first 24hr of admission.⁽¹⁾

mSOFA is an objective scoring tool useful in critically ill patients. It is derived from the original SOFA score and it has some advantages. mSOFA does not require specific laboratory equipment, is calculated easily on the patient's bedside, and is available for daily re-assessment.^(2,3,7) It quantifies dysfunction of six organ systems ranging from zero (normal) to 4 (extremely abnormal), as follows:

Respiratory System: PaO₂/FiO₂ (mmHg.)
Coagulation System: Platelets $\times(10^3/\mu)$
Hepatic System: Bilirubin (mg/dl).
Cardiovascular System:

* Assistant Professor

** Resident,

*** Professor & Head, Department of Emergency Medicine, GCS Medical College, Ahmedabad, Gujarat, India

Correspondence : Dr. Sonal K Ginoya

E-mail : sonalginoya@yahoo.com

Hypotension. Central Nervous System: Glasgow Coma Scale Score. Renal System: Creatinine (mg/dl), urine output (ml/day). Higher score suggests more severe illness and higher risk of mortality.⁽²⁾ It has also been demonstrated to predict mortality as well in several studies. There is paucity of data of use of scoring systems in ICUs of Western India. It is important to check the validity of their use in the local population. Therefore, this study was undertaken to individually evaluate and compare the ability of APACHE-II and mSOFA scoring systems to predict mortality of critically ill patients in ICU.

Methods:

Our present study was a prospective observational clinical study. It was conducted in ICU at a tertiary centre. The study duration was 6 months from May 2022 to October 2022. Informed written consent was taken. Ethical approval for this study was obtained from Institutional Ethics Committee.

Inclusion criteria: Age >12 years, Patients who gave consent for study, critically ill patients (tachycardia, hypotension, tachypnoea, signs of organ failure)

Exclusion criteria: Age <12 years and Patients unwilling to give consent

A total 100 patients were included in the study. Data was collected on day1 of admission and were followed up until ICU discharge/death. The Detailed history and clinical examination, and relevant laboratory investigations were done for all new ICU patients admitted. We used two scoring systems, APACHE II &

mSOFA to predict ICU mortality.

Both APACHE II & mSOFA was recorded on day 1 ICU admission. mSOFA was serially recorded on admission, day3, day7, day10. All the data was entered in data collection form. The patient outcome was labelled as survivor or non-survivor at the end of stay in ICU. The data was entered in Microsoft Excel. The cut off value for APACHE II and mSOFA for predicting mortality was taken as 23 and 11, respectively.

All statistical analysis was done using Epi info (version7.3.2.1) CDC software. Sensitivity, specificity and accuracy for APACHE II & mSOFA scoring systems were calculated separately in prediction of mortality in patients admitted in ICU.

Results:

A total 100 patients were included in the study. There were 57 males with mean age of 53.70±12.83 years and 43 females with mean age of 57.67±15.08 years. The age of the non-survivors was significantly older than survivors (57.1±11.76 and 54.28±15.16 years). Out of total 100 patients, 39 patients required mechanical ventilation & out of them 3 survived and 36 didn't-survive. 61 patients did not require mechanical ventilation & out of them 57 survived and 4 didn't-survive. Out of total 100 patients, 47 patients required vasopressors & out of them 12 survived and 35 didn't-survive. 53 patients did not require vasopressors & out of them 48 survived and 5 didn't-survive. (Table1).

Table 1 : Characteristics of patients

Factors examined	Survivors	Non-survivors	Total (n=100)
Mean Age (in years)	54.28±15.16	57.1±11.76	100
Gender			
Male	36 (63.15%)	21 (36.84%)	57(53.70±12.83)
Female	24 (55.81%)	19 (44.18%)	43(57.67±15.08)
Need mechanical Ventilation			
Yes	3 (7.6%)	36 (92.30%)	39
No	57 (93.44)	4 (6.5%)	61
Need vasopressors			
Yes	12 (25.53%)	35 (74.46%)	47
No	48 (90.56%)	5 (9.4%)	53

In our study maximum study subjects were in the age group 47-66 years (Figure 1). In our study the mortality rate was 40%. Mean length of ICU stay of non-survivors was 5.41 ± 4.81 days. It was slightly shorter than survivors (8.63 ± 4.81) (Table 2). This was statistically significant ($p < 0.0005$) and this was probably because some patients with non-progressive, multiple organ failure may stay for shorter time in the ICU. The average of APACHE II score in non-survivors (15.07 ± 6.23) was higher than survivors (8.56 ± 4.94) with statistical significance (p value < 0.000). The average of mSOFA score in non-survivors (8.1 ± 4.62) was higher than survivors (2.38 ± 2.68) with statistical significance (p value < 0.05).

In our study we obtained serial measurement of mSOFA scores on admission, on day3, day7, day10. We observed that non-survivors had significantly

higher scores than survivors. In our study we have taken cut off point for the APACHE II score for prediction of mortality as 23 and above. The APACHE II score with cut-off point of 23 demonstrated a sensitivity of 98.33%, specificity of 17.5%, positive predictive value of 64.13%, negative predictive value of 87.50%, and accuracy of 66.00%. (Table 3).

We have taken cut off point for the mSOFA score for prediction of mortality as 11 and above. The mSOFA score with cut-off point of 11 demonstrated a sensitivity of 98.33%, specificity of 27.5%, positive predictive value of 67.05%, negative predictive value of 91.67% and accuracy of 70.00%. Serial examination of mSOFA on day3, day7, day10 show sensitivity, specificity, accuracy was 95%, 60%, 81.00%; 97.77%, 47.36%, 82.81%, and 96%, 71.42%, 90.62% respectively (Table 3).

Fig. 1 : Age wise distribution of patients

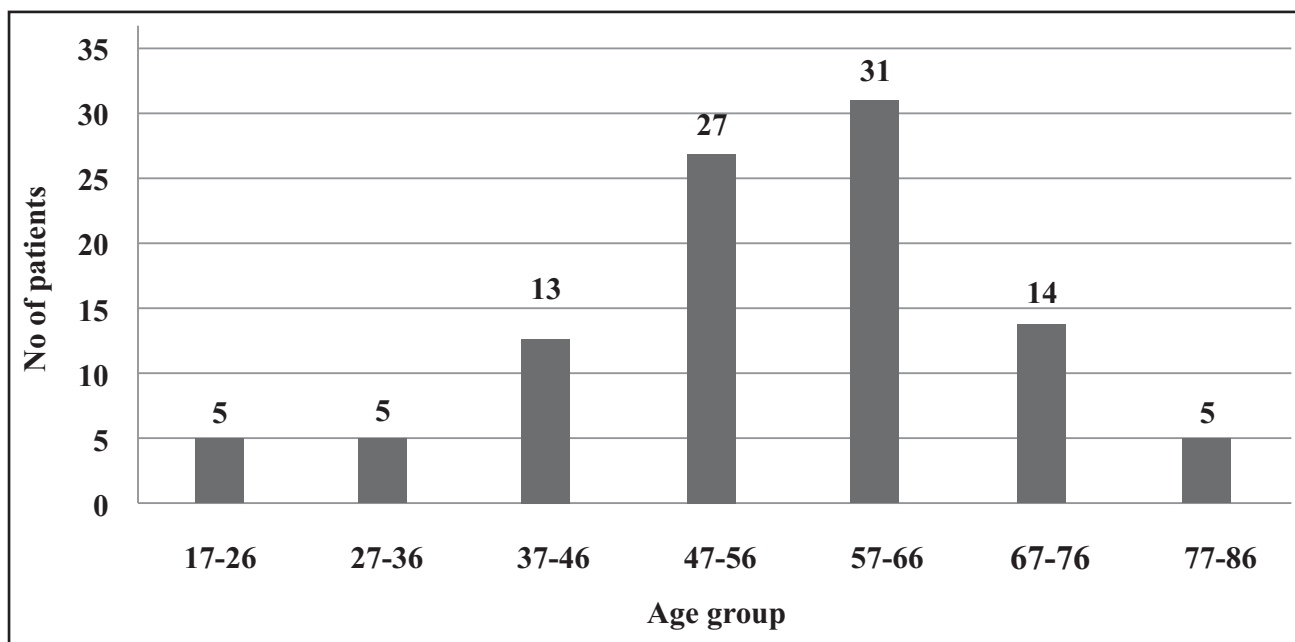


Table 2 : Comparison of survivors & non-survivors

Factors	Survivors	Non-survivors	p-value
Length of ICU stay (in days)	8.63 ± 4.81	5.41 ± 3.54	< 0.0005
APACHE II	8.56 ± 4.94	15.07 ± 6.23	< 0.000
mSOFA	2.38 ± 2.68	8.1 ± 4.62	< 0.05

Table 3 : Relationship of mortality with APACHE II & mSOFA

Score	Survivors	Non survivors	Sensitivity	Specificity	NPV	PPV	Accuracy	Z-test	P value
APACHE II									
<23	59	33	98.33%	17.5%	87.50%	64.13%	66.00%	2.316	0.02
>23	1	7	—	—	—	—	—	—	—
mSOFA-1									
<11	59	29	98.33%	27.5%	91.67%	67.05%	70.00%	2.908	0.003
>11	1	11	—	—	—	—	—	—	—
mSOFA-3									
<11	57	16	95%	60%	88.89%	78.08%	81.00%	4.966	0.0001
>11	3	24	—	—	—	—	—	—	—
mSOFA-7									
<11	44	10	97.77%	47.36%	90.00%	81.48%	82.81%	3.312	0.0009
>11	1	9	—	—	—	—	—	—	—
mSOFA-10									
<11	24	2	96%	71.42%	83.33%	92.31%	90.62%	3.102	0.001
>11	1	5	—	—	—	—	—	—	—

Discussion:

Treating critically ill patients and predicting mortality in ICU remains a challenge despite the modern advances in critical care. It affects various aspects of patient care and resource allocation. The present study was a prospective observational study on 100 critically ill patients over 6 months carried out at a tertiary centre.

In the present study 57% with mean age 53.70±12.83 were males and 43% female with mean age 57.67±15.08. While study by Jentzer J C et al⁽³⁾ had a mean age of 67.5±15.2 years. In our study, maximum patients were present in 57-66 year age group (31%) followed by 27% in 47-56 year age group, 14% & 13% in 67-76 & 37-46 year age group, respectively. This is comparable to Mane RR et al⁽⁴⁾ with maximum patients present in 61-70 years age-group (32%). Durbesula A T et al⁽⁵⁾ found females (52%) were slightly more than the male patients in total 50 patients and the most common age group was 31-50 years. In our study observed mortality rate was 40% in comparison with mortality rate of Mane R R et al⁽⁴⁾ 70%, Jain A et al⁽⁷⁾ 39% and Jentzer J C et al⁽³⁾ 9%.

Our study showed as age of patients increased death rate increased. The age of non-survivors was significantly older than the survivors (57.1±11.76 and 54.28±15.16 years). Nair R et al⁽⁶⁾ found no significant association between age and survival status. While Saleh A et al⁽⁸⁾ observed survival rate was 47.7% and survivors were younger than non-survivors (41.4±15.4 vs 54.1±16.9 years). In our study APACHE II score was more in non-survivors as compared to survivor patients & this difference was statistically significant (p<0.004) (Table 3). This is in accordance with Lin W Tet al⁽¹¹⁾, Rojek-Jarmula A et al⁽¹³⁾, Saleh A et al⁽⁸⁾ and Mansour M et al⁽¹⁰⁾ Godinjak A et al⁽¹²⁾ found that APACHE II score was significantly different between survivors and non-survivors. Furquan A et al⁽¹⁴⁾ found sensitivity, specificity and accuracy were 77.53%, 94.28%, & 85.45% for APACHE II scoring system. In our study APACHE II score had sensitivity, specificity and accuracy of 98.33%, 17.5% and 66%.

Gholipour Baradari A. et al⁽²⁾ found highest mSOFA predicted mortality on day 2 and day 3 and had sensitivity and specificity of mSOFA day1 82.9%, &

68.4%, mSOFA day2 94.7% and 97.1% and mSOFA day3 7.4% and 93.1%. While in our study highest mSOFA predicted mortality was on day3 and day7. mSOFA day1 had sensitivity 98.33% and specificity rate of 27.5%, sensitivity and specificity of mSOFA day3 was 95%, 60%, mSOFA day7 score was 97.77%, 47.36%, mSOFA day10 score was 96% and 71.42%.

Edipoglu I. S. et al⁽¹⁵⁾ concluded APACHE II score with a cut-off point of 23, demonstrated 74.14% sensitivity, 60.87% specificity. Grissom C K et al⁽¹⁶⁾ demonstrated mSOFA score with cut-off point of 11 with highest mortality was 53% and 58% respectively. In our study the APACHE II score with cut-off point of 23 demonstrated 98.33% sensitivity & 17.5% specificity. The mSOFA score with cut-off point of 11 demonstrated a sensitivity of 98.33% & specificity of 27.5%.

Limitations:

This study was done in single centre and sample size is relatively small in number. Further study with greater number of patients and comparison with different scoring systems can help in improving the accuracy.

Conclusion:

Both APACHE II and mSOFA scores can help ICU physicians as a significant predictive marker for mortality in critically ill patients. Mortality prediction system based on day 3 score or on serial score measurement is more accurate than with the first 24 hr data. The serial measurement of mSOFA score in the first week is a better mortality predictor tool than APACHE II score in critically ill patients.

References:

- Rao MH, Venkatraman A, Naga Divya R, Madhusudhan M, Alladi M, Samantharay A. Comparison of Performance of APACHE II and SOFA Scoring Systems in Critically Ill Patients Admitted to Intensive Care Unit. *Indian J Chest Dis Allied Sci* 2019; 61:69-74.
- Gholipour Baradari A, Sharifi H, Firouzian A et al. Comparison of proposed modified and original sequential organ failure assessment scores in predicting ICU mortality: A prospective, observational, follow-up study. *Scientifica (Cairo)* (2016)20:1-5.
- Jentzer JC, Bennett C, Wiley BM, Murphree DH, Keegan MT, Barsness GW. Predictive value of individual Sequential Organ Failure Assessment sub-scores for mortality in the cardiac intensive care unit. *PLoS One*. 2019 May 20;14(5):e0216177. doi: 10.1371/journal.pone.0216177. PMID: 31107889; PMCID: PMC6527229.
- Mane RR, Singh L. Study on Outcome of Patients with Acute Respiratory Failure on Mechanical Ventilation Monitored on SOFA and APACHE II Score. *J Adv Med Dent Sci Res* 2018;6(10):114-119.
- Durbesula A T, Chetan Reddy K, Usham G et al. A study on the prevalence of direct vs indirect etiology, prognostic determinants and mortality in ARDS. *Annals of Tropical Medicine and Public Health*, 2017, 10, 409 - 416.
- Nair R, Bhandary NM, D'Souza AD. Initial Sequential Organ Failure Assessment score versus Simplified Acute Physiology score to analyze multiple organ dysfunction in infectious diseases in Intensive Care Unit. *Indian Journal of Critical Care Medicine*. 2016 Vol.20:(4)210-215.
- Jain A, Palta S, Saroa R, Palta A, Sama S, Gombar S. Sequential organ failure assessment scoring and prediction of patient's outcome in Intensive Care Unit of a tertiary care hospital. *J Anaesthesiol Clin Pharmacol*. 2016 Jul-Sep; 32(3): 364-368.
- Saleh A, Ahmed M, Abdel-lateif A. Comparison of the mortality prediction of different ICU scoring systems (APACHE II and III, SAPS II, and SOFA) in a single-center ICU sub population with acute respiratory distress syndrome. *Egyptian Journal of Chest Diseases and Tuberculosis* (2015) 64, 843-848.
- Shabir A, Maqbool M. Accuracy of SOFA Score in Predicting Outcome in Medical Patients with Various Diagnosis in Intensive Care Unit in a Tertiary Care Hospital in Northern India. *Int J Contemp Med Res [Internet]*. 2017;483(1):77-2393.
- Mansour M, Galal I, Kassem E. Study of the role of different severity scores in respiratory ICU. *Egyptian Journal of Bronchology* 2013 7:55-59.
- Lin WT, Chen WL, Chao CM, Lai CC. The outcomes and prognostic factors of the patients with unplanned intensive care unit readmissions. *Medicine* (2018) 97:26.
- Godinjak A, Iglia A, Rama A et al. Predictive value of SAPS II and APACHE II scoring systems for patient outcome in a medical intensive care unit. *Acta Medica-Academica* 2016;45(2):97-103.
- Rojek-Jarmuła A, Hombach R, Krzych J. Does the APACHE II score predict performance of activities of daily living in patients discharged from a weaning center? *Kardiologia i Torakochirurgia Polska* 2016; 13(4): 353-358.
- Furqan A, Naseer M, Tabassum R. Comparison of sensitivity, specificity, accuracy of APACHE II, SAPS II, And SOFA scoring systems as predictors of mortality in ICU patients. *PJMHS vol.15, no.12, (2021) 3364-3366*.
- Edipoglu IS, Dogruel B, Dizi S, Tosun M, Çakar N. The association between the APACHE II scores and age groups for predicting mortality in an intensive care unit: a retrospective study. *Rom j anesthes intensive care* 2019; 26:53-58.
- Grissom C K, Brown SM, Kuttler KG et al. A modified sequential organ failure assessment (mSOFA) score for critical care triage. *Disaster med public health* 2010, 4(4), 277-284.