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Adverse Sequential Organ Failure Assessment Score as a Predictor of Mortality in Patients Requiring Critical Care in Pakistan

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ABSTRACT

Objective: To determine the sensitivity, specificity, and diagnostic accuracy of the Sequential Organ Failure Assessment score in predicting one-month mortality in patients requiring critical care.

Study Design: Cross-sectional validation study.

Place and Duration of Study: Department of Surgery, Combined Military Hospital, Rawalpindi, Pakistan Apr to Oct 2020.

Methodology: This study was conducted on 173 patients requiring intensive care. All patients aged between 20 and 70 years diagnosed with disorders secondary to traumatic causes or otherwise who were admitted for critical care were included. Patients were assessed at the time of admission to the intensive care unit, and their Sequential Organ Failure Assessment scores were calculated. A cut-off level of ≥7 was considered to be a high risk for mortality within thirty days of admission. All patients were followed up for thirty days for the mortality.

Results: Mean age of our patients was 43.04±11.26 years, of whom 109(60.6%) patients were male. A SOFA score of ≥7 in predicting the mortality within thirty days of admission for critical care carried a sensitivity of 31.40%, a specificity of 25.53%, a positive predictive value of 27.84%, a negative predictive value of 28.92% and a diagnostic accuracy of 28.33%.

Conclusion: The Sequential Organ Failure Assessment score lacks the diagnostic accuracy to precisely predict the mortality in critically ill patients within thirty days of developing the requirement for critical care.

Keywords: Critical care, Mortality, Sensitivity, Specificity, SOFA score.

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INTRODUCTION

The global burden of critical-care disease is challenging to assess due to the myriad manners in which such cases present. However, the problem is undoubtedly significant: COVID-19 alone was responsible for over six million deaths in a period of less than three years, which were managed in the critical-care setting.[1,2] Certain centres have reported a mortality rate of as high as 34% in patients admitted, for any reason, to critical-care units.[3] Predicting the degree of severity of a patient's condition, including the potential for the mortality, provides the treating clinician with valuable information which can dictate the course and intensity of management and has been shown to improve outcomes when correctly employed.[4,5] In addition, predicting outcomes is paramount when discussing the patient's condition and offering management options to the patients themselves or their attendants.[6]

Several different scoring systems have been proposed to assess the clinical condition of critically ill patients to accurately predict clinical course, including mortality, including Acute Physiology and Chronic Health Evaluation Score (APACHE) II, Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments (SUPPORT) prognostic model, and the Simplified Acute Physiology Score (SAPS) II system, among others.[7,8] The Sequential Organ Failure Assessment (SOFA) scoring system is a simple method for predicting mortality incorporating clinical and laboratory parameters, which can be readily applied in the intensive care setting.[9,10]

This study aimed to determine the accuracy of SOFA scores in predicting mortality within thirty days of admission to the critical care setting and establish a local perspective, as there is a paucity of data on this aspect. Pakistan's healthcare system is hampered by a lack of resources, rising costs of healthcare, and a burgeoning population. Applying scoring systems to critically ill patients can help them make appropriate decisions in a timely manner, allowing for early detection and categorization of severe, sometimes terminally ill, patients. Doing so will help the clinician take appropriate management steps and provide a clearer picture to the patient and/or attendants.

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METHODOLOGY

We conducted the cross-sectional validation study from April to October 2020 at the Department of Surgery, Combined Military Hospital, Rawalpindi after obtaining IERB approval (IERB Ltr no. 98/08/20). The EPI sample size calculator was used to calculate the sample size, keeping an expected sensitivity of 75.00%, expected specificity of 63.23%, expected prevalence of 51.43%, for SOFA score in predicting mortality in the intensive care setting within one month of admission, from Safari *et al*.[11]

Inclusion Criteria: Patients aged from 20-70 years, of either gender, diagnosed with disorders secondary to traumatic causes or otherwise, who were admitted for critical care in the intensive care unit, were included.

Exclusion Criteria: Patients who were currently pregnant or suffering from hepatitis C, B or HIV, those suffering from neoplastic disease, hypo- or hyperthyroidism, malnutrition or chronic infections such as tuberculosis, were excluded.

All the study participants were selected via consecutive, non-probability sampling. One hundred eighty patients requiring critical care who were admitted to the surgical intensive care unit after receiving written, informed consent from the patients or their legal guardians and all patients were documented for a brief history, which included demographic information. Patients were assessed at admission to the intensive care unit by a consultant surgeon with a minimum five-year post-fellowship experience, who also calculated the SOFA score. A cut-off level of ≥7 was considered to be a high risk for mortality within thirty days of admission. All patients were followed up for thirty days for the mortality.[11]

Data was analyzed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows version 26, IBM Corp; Armonk, USA). Mean and standard deviation were calculated for quantitative variables. Qualitative variables were recorded in frequency and percentage. A 2x2 table was constructed to calculate the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of SOFA score in predicting mortality within one month of admission.

RESULTS

We conducted this research protocol on 180 patients admitted in the critical-care setting. Our patients had a mean age of 43.04±11.26 years. Male patients comprised the majority: 109(60.6%). The mean body mass index was 25.62±1.87 kg/m^2. The majority of admissions were for a primary pulmonary disorder (59,32.8%), followed closely by generalized sepsis (50,27.8%), and polytrauma (36,20.0%). Less common primary reasons for admission included renal, hepatic and cardiac/neurological indications for admission, which accounted for 16(8.9%), 15(8.3%) and 4(2.2%) cases, respectively. Prior to admission for critical care, the mean duration of illness was 2.52±3.02 days. The mean SOFA score for the complete sample at the time of admission was 8.57±7.15. 86(47.8%) patients died during the study period. Table-I shows the patient characteristics and study results, distributed according to SOFA score. Table-II displays the 2x2 contingency table used for SOFA score to determine the various test characteristics. A SOFA score of ≥7 in predicting the mortality within thirty days of admission for critical care carried a sensitivity of 31.40%, a specificity of 25.53%, and a diagnostic accuracy of 28.33%, as shown in Table-III.

Table-I: Patients' Characteristics According to SOFA Score (n=180)

Variables	SOFA<7 (n=97)	SOFA ≥7 (n=83)
Gender		
Males	57(58.8%)	52(62.7%)
Females	40(41.2%)	31(37.3%)
Age (years)	41.33±11.11	45.04±11.17
Body Mass Index	25.48±1.84	25.78±1.92
Primary Indication for Admission		
Pulmonary Disorder	30(30.9%)	29(34.9%)
Generalized Sepsis	29(29.9%)	21(25.3%)
Polytrauma	19(19.6%)	17(20.5%)
Renal Disorder	8(8.2%)	8(9.6%)
Hepatic Disorder	9(9.3%)	6(7.2%)
Cardiac/Neurological	2(2.1%)	2(2.5%)
Duration of Primary Illness (days)	2.52±2.95	2.52±3.13
SOFA Score on Admission	2.99±1.83	15.09±5.28
Mortality	27(27.8%)	59(71.1%)

Table-II: Contingency Table for SOFA Score (n=180)

		Mortality According to History at Follow Up		Total
		Yes	No	
Mortality According to SOFA Score	Yes	True Positive: 27	False Positive: 70	97
	No	False Negative: 59	True Negative: 24	83
Total		86	84	180

Table-III: Diagnostic Parameters (n=180)

Test	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Diagnostic Accuracy
MPV	31.40%	25.53%	27.84%	28.92%	28.33%

DISCUSSION

Prediction models are required in the critical-care setting to determine the potential for patient deterioration and mortality, which dictates both timing and intensity of management. They provide a helpful idea of prognosis and can help counsel the patient and/or attendants. Our study demonstrated that SOFA score alone is insufficient in predicting the mortality within thirty days of admission to the critical-care setting for patients who have received trauma or surgery.

A SOFA score of ≥7 in predicting the mortality within thirty days of admission for critical care carried a sensitivity of 31.40%, a specificity of 25.53%, a positive predictive value of 27.84%, a negative predictive value of 28.92% and a diagnostic accuracy of 28.33% in the current study. López-Izquierdo *et al*. studied thirty-day mortality in patients suffering from sepsis. They found that the SOFA score with a cut-off of >6 was associated with a sensitivity of 86.7%, a specificity of 88.0% and a diagnostic accuracy of 87.9% in predicting the morality within thirty days of admission.[12] Safari *et al.* reported slightly lower figures with a sensitivity of 75.00%, a specificity of 63.23% and diagnostic accuracy of 73.00% in their study.[11] Conversely, Mehta *et al*. noted that the diagnostic accuracy of SOFA score at a cut-off of 6 was associated with a lower diagnostic accuracy of 52.94%, but which improved to 73.68% with a cut-off of 9.[13] There is considerable variation between the results of our study and the results of other studies about the diagnostic accuracy of SOFA score in predicting thirty-day mortality, for which we believe the reasons are multifactorial. However, the principal reasons appear to be the primary pathology for admission. While our patients were under treatment for complications secondary to trauma or surgery, the studies quoted above studied patients suffering from sepsis and its complications, which may account for the differences in our results. In addition, the differences may have arisen due to other patient characteristics, such as age, which are described in detail. To our knowledge, a study based on trauma patients has not been previously reported despite an extensive literature search.

Our patients had a mean age of 43.04±11.26 years. Studies such as Lu *et al*. and Bubenek-Turconi *et al*. have demonstrated that older patients have a higher risk for mortality for different diseases in the critical-care setting when compared to younger patients with the same degree of organ dysfunction; thus, the application of SOFA score to older patients may yield more accurate predictions than when it is applied to younger ones, an aspect of our research which requires further study, and may also account for the differences between our study and the aforementioned ones.[14,15]

Male patients accounted for 60.6% of our study sample. This is in keeping with existing literature: studies such as Hollinger *et al*. and Lat *et al*. have demonstrated that males have higher rates of admission to the critical-care setting but have better functional outcomes.[16,17] Moreover, males have a higher rate of trauma, which may account for a higher number of male patients in our study sample.[18]

The majority of admissions in our study were for a primary pulmonary disorder, sepsis or polytrauma, which accounted for 32.8%, 27.8% and 20.0% cases, respectively. In contrast, less common indications for admission included renal, hepatic and cardiac /neurological disorders, which comprised 8.9%, 8.3% and 2.2% cases, respectively. Khwannimit *et al*. noted that while the SOFA score had a diagnostic accuracy of 87.4% in predicting the mortality within the first month of admission, this accuracy varied considerably with the primary pathology present and was as low as 59.5% in patients with a primary respiratory disorder and 56.1% for those with renal dysfunction.[19] Thus, SOFA score appears to have a varying degree of diagnostic accuracy depending on the primary dysfunction present, and may account for the differences in accuracy seen between our study and those previously conducted. Further research on trauma and surgery patients may be in order before concrete conclusions can be drawn.

LIMITATIONS OF STUDY

The SOFA score is mainly based on laboratory-based indices. However, individual variables within the score, such as the Glasgow coma scale (GCS), are subject to clinical interpretation and may have been reported with some degree of variability between observers, which may have had some, albeit minimal, influence on the results. Moreover, our study had a great degree of heterogeneity regarding the aetiology responsible, i.e., the organ system affected, for the requirement for critical care; a study with a less diverse population in this regard may yield different results. Furthermore, while a variety of organ systems were indeed

affected in our patients, the primary cause for organ dysfunction was either surgery or trauma, which may have affected our results.

CONCLUSION

The use of the SOFA score in predicting the mortality during the first thirty days after admission to a critical care setting for complications resulting from trauma or surgery was associated with poor sensitivity, specificity and diagnostic accuracy in our study. Employing this score with other mortality predictors may be of greater use in making such predictions and combinations, which may serve as the subject for future research.

Conflic of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AAJ & RQ: Data acquisition, critical review, approval of the final version to be published.

AA & TF: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

SMN & AC: Conception, data analysis, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1 Vincent JL. The continuum of critical care. Crit Care 2019; 23(Suppl 1): 122. https://doi.org/10.1186/s13054-019-2393-x

2 Crawford AM, Shiferaw AA, Ntambwe P, Milan AO, Khalid K, Rubio R, et al. Global critical care: a call to action. Crit Care 2023; 27(1): 28. https://doi.org/10.1186/s13054-022-04296-3

3 Eya J, Ejikem M, Ogamba C. Admission and Mortality Patterns in Intensive Care Delivery at Enugu State University of Science and Technology Teaching Hospital: A Three-Year Retrospective Study. Cureus 2022; 14(7): e27195. https://doi.org/10.7759/cureus.27195

4 Johnson AEW, Mark RG. Real-time mortality prediction in the Intensive Care Unit. AMIA Annu Symp Proc 2018; 2017(1): 994-1003.

5 Quintairos A, Pilcher D, Salluh JIF. ICU scoring systems. Intensive Care Med 2022: 1–3. https://doi.org/10.1007/s00134-022-06914-8

6 Jana S, Dasgupta T, Dey L. Predicting medical events and ICU requirements using a multimodal multiobjective transformer network. Exp Biol Med 2022; 247(22): 1988-2002. https://doi.org/10.1177/15353702221126559

7 Sinuff T, Adhikari NK, Cook DJ, Schünemann HJ, Griffith LE, Rocker G, et al. Mortality predictions in the intensive care unit: comparing physicians with scoring systems. Crit Care Med 2006; 34(3): 878-885. https://doi.org/10.1097/01.CCM.0000201881.58644.41

8 Li J, Liu S, Hu Y, Zhu L, Mao Y, Liu J, et al. Predicting Mortality in Intensive Care Unit Patients With Heart Failure Using an Interpretable Machine Learning Model: Retrospective Cohort Study. J Med Internet Res 2022; 24(8): e38082. https://doi.org/10.2196/38082

9 Moreno R, Rhodes A, Piquilloud L, Hernandez G, Takala J, Gershengorn HB, et al. The Sequential Organ Failure Assessment (SOFA) Score: has the time come for an update? Crit Care 2023; 27(1): 15. https://doi.org/10.1186/s13054-022-04290-9

10 Moreno R, Rhodes A, Piquilloud L, Hernandez G, Takala J, Gershengorn HB, et al. The Sequential Organ Failure Assessment (SOFA) Score: has the time come for an update? Crit Care 2023; 27(1): 15. https://doi.org/10.1186/s13054-022-04290-9

11 Safari S, Shojaee M, Rahmati F, Barartloo A, Hahshemi B, Forouzanfar MM, et al. Accuracy of SOFA score in prediction of 30-day outcome of critically ill patients. Turk J Emerg Med 2016; 16(4): 146-150. https://doi.org/10.1016/j.tjem.2016.09.005

12 López-Izquierdo R, Brio-Ibañez Pd, Martín-Rodríguez F, Mohedano-Moriano A, Polonio-López B, Maestre-Miquel C, et al. Role of SOFA and SOFA Scoring Systems for Predicting In-Hospital Risk of Deterioration in the Emergency Department. Int J Environ Res Public Health 2020; 17(22): 8367. https://doi.org/10.3390/ijerph17228367

13 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. Int J Health Sci 2022; 6(S1): 4078-4089. https://doi.org/10.53730/ijhs.v6nS1.5747

14 Lu P, Cao Z, Gu H, Li Z, Wang Y, Cui L, et al. Association of sex and age with in-hospital mortality and complications of patients with intracerebral hemorrhage: A study from the Chinese Stroke Center Alliance. Brain Behav 2023; 13(1): e2846. https://doi.org/10.1002/brb3.2846

15 Bubenek-Turconi SI, Andrei S, Văleanu L, Ştefan MG, Grigoraş I, Copotoiu S, et al; COVATI-RO Collaborative. Clinical characteristics and factors associated with ICU mortality during the first year of the SARS-Cov-2 pandemic in Romania: A prospective, cohort, multicentre study of 9000 patients. Eur J Anaesthesiol 2023; 40(1): 4-12. https://doi.org/10.1097/EJA.0000000000001776

16 Hollinger A, Gayat E, Féliot E, Paugam-Burtz C, Fournier MC, Duranteau J, et al; FROG ICU study investigators. Gender and survival of critically ill patients: results from the FROG-ICU study. Ann Intensive Care 2019; 9(1): 43. https://doi.org/10.1186/s13613-019-0514-y

17 Lat TI, McGraw MK, White HD. Gender Differences in Critical Illness and Critical Care Research. Clin Chest Med. 2021 Sep; 42(3): 543-555. https://doi.org/10.1016/j.ccm.2021.04.012.

18 Bedada AG, Tarpley MJ, Tarpley JL. The characteristics and outcomes of trauma admissions to an adult general surgery ward in a tertiary teaching hospital. Afr J Emerg Med 2021; 11(2): 303-308. https://doi.org/10.1016/j.afjem.2021.04.002

19 Khwannimit B, Bhurayanontachai R, Vattanavanit V. Ability of a modified Sequential Organ Failure Assessment score to predict mortality among sepsis patients in a resource-limited setting. Acute Crit Care 2022; 37(3): 363-371. https://doi.org/10.4266/acc.2021.01627