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Accuracy of pSOFA Score in Predicting Outcomes in Critically Ill Children

Saba Zamir, Muhammad Tariq Nadeem, Samina Tabussam

Pak Emirate Military Hospital/National University of Medical Sciences (NUMS) Rawalpindi Pakistan, CMH Institute of Medical Sciences, Bahawalpur Pakistan

ABSTRACT

***Objective*:** To determine the diagnostic accuracy of the pSOFA score in predicting mortality in critically ill pediatric patients.
***Study Design*:** Cross-sectional validation study.
***Place and Duration of Study*:** Department of Paediatrics, Pak-Emirates Military Hospital, Rawalpindi Pakistan, Aug 2021 to Feb 2022.
***Methodology*:** We studied 76 critically ill paediatric patients. All patients underwent pSOFA scoring on admission and then at 72 hours post-admission and were followed up till discharge or till mortality occurred. A pSOFA score of >10 was considered a high mortality risk. The two-by-two table was constructed to calculate the sensitivity, specificity and diagnostic accuracy of the pSOFA score in predicting the occurrence of death.
***Results*:** The pSOFA score had a sensitivity of 88.9% at Day-0, which improved to 100% by Day-7 in predicting whether mortality occurred. The specificity was 80.6% on Day-0 and 97.0% on Day-7. The diagnostic accuracy of pSOFA in predicting mortality was 81.6% when performed on the day of admission, which increased to 90.8% when calculated on Day 3 and was the highest on Day-7 when it was 97.4%.
***Conclusion*:** The pSOFA score has good diagnostic accuracy in predicting the occurrence of mortality in paediatric patients admitted to intensive care, which increases as the length of stay increases.

Keywords: Children, Critical illness, pSOFA score.

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INTRODUCTION

In Pakistan, an estimated 12.9% of all paediatric age group admissions end in mortality in certain populations.[1,2] Efforts to predict the risk of mortality have resulted in the creation of different scoring systems which incorporate different aspects of a patient's clinical condition and laboratory investigations.[3] Risk stratification allows for the identification of patients that are most vulnerable and require more intensive management, and also allows the physician to paint a clearer picture for the attendants.[4,5]

Ideally, a prognostic score should be small, easy to apply, cheap, non-invasive and accurate and, as such, the scores mentioned above leave much to be desired.[6,7] Multi-organ dysfunction syndrome is widely seen as a poor prognostic factor, failure of management for which is known to progress to death rapidly, the Sequential Organ Failure Assessment (SOFA) score was developed as a measure for predicting the presence of multiorgan dysfunction which and thus has also served as a prognostic measure in adults.[8] A paediatric version of the SOFA score, known as the PaediatricSequential Organ Failure Assessment (pSOFA)score, has been introduced in recent years, but has undergone few validation studies in different populations.[9] and while some studies have that the SOFA score is of use in Pakistani populations, the pSOFA score has yet to be validated here.[10]

Critical illness in the paediatric population is common in Pakistan, where a large proportion is younger than 18 years. Effective management methods to cater to this large segment of the population during critical care administration, which are tailored to their specific needs, are a requirement of the hour, especially during the COVID-19 pandemic, where resources are scarce. Accurate assessment of the patient in order to determine the risk to life is an essential part of care in this setting which requires adequately created, calibrated and validated tools, and this study was carried out to determine the diagnostic accuracy of the pSOFA score in determining the occurrence of mortality in paediatric patients receiving critical care.

METHODOLOGY

The cross-sectional validation study was conducted from August 2021 to February 2022 at the Department of Paediatrics, Pak-Emirates Military Hospital, Rawalpindi, on 76 critically ill paediatric patients, selected via non-probability consecutive sampling after obtaining informed consent from their parents/

Correspondence: Dr Saba Zamir, Department of Paediatric, Pak Emirate Military Hospital Rawalpindi-Pakistan
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guardians. The Ethical Committee of Pak-Emirates Military Hospital, Rawalpindi, approved this study (A/28/158/EC/442/2022) The WHO sample size calculator was used to calculate the sample size keeping an expected sensitivity of 95.3%, expected specificity of 76.32%, expected prevalence of 50.0%, a desired precision of 3 and a confidence level of 95%.[11]

Inclusion Criteria: The study included patients between the ages of 1 and 12 years with at least one new-onset organ system dysfunction.

Exclusion Criteria: Patients without intensive care or requiring it for less than seven days were excluded from the study.

All patients were thoroughly evaluated with a history and clinical examination at the time of inclusion in the study. Once the patients were admitted to the paediatric intensive care unit (which was based on the presence of dysfunction in at least one organ system), they underwent scoring with a pSOFA score of 12, which was repeated at 72 hours, and at seven days post-admission.12 All patients were followed up till discharge from the intensive care unit or till mortality occurred and outcomes were documented. A pSOFA score of >10 was considered a high mortality risk. A trained phlebotomist with a minimum of two years of experience in paediatric phlebotomy was responsible for drawing any blood sample required to calculate the pSOFA score.

Statistical Package for Social Sciences (SPSS) version 26.0 was used for the data analysis. Mean, and SD were calculated for quantitative variables. In addition, qualitative variables like gender, presence of comorbidities, indication for admission in intensive care and outcome (recovered, residual organ damage or mortality)were recorded in frequency and percentage. Finally, the 2x2 table was constructed to calculate the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of the pSOFA score in predicting mortality at day 0, 3 and 7 post-admission to intensive care.

RESULTS

We studied 76 critically ill children in our study sample, with a mean age of 5.71± 3.03 years. A total of 43(56.6%) patients were male, while the mean birth weight was 3139.99±492.97g. The mean length of hospital stay for the complete sample was 16.32±6.50 days. Considering the primary indication for admission to the intensive care unit, a total of 35(46.1%) patients suffered from sepsis, respiratory and renal compromise were present in 17(22.4%) and 14 (18.4%) patients, respectively. At the same time, trauma, cardiovascular dysfunction and neurological disorders occurred in 5(6.6%), 4(5.3%) and (1.2%) patients, respectively. The pre-admission details of the study are displayed in Table-I.

Table-I: Patient Characteristics According to Gender on Admission (n=76)

Variables	Males	Females	*p*-value
Gender	43(56.6%)	33(43.4%)	-
Age (years)	5.81±3.10	5.58±2.98	0.737
Birth Weight (g)	2898.35±488.48	3454.85±275.14	<0.001
Length of Hospital Stay (days)	18.05±7.29	14.06±4.47	0.007
Indication for Admission in Intensive Care			
Sepsis	20(46.5%)	15(45.5%)	0.584
Respiratory Failure	7(16.3%)	10(30.3%)	
Renal Dysfunction	10(23.2%)	4(12.0%)	
Trauma	3(7.0%)	2(6.1%)	
Cardiovascular Dysfunction	2(4.7%)	2(6.1%)	
Neurological Compromise	1(2.3%)	-	

A total of 9(11.8%) patients died during admission to intensive care, while 67(88.2%) survived. The mean pSOFA score of the sample on day 0 was 7.62 ±5.65, while this number was 5.50±5.90 and 3.92 ± 6.89 on Day 3 and Day 7, respectively. The results for the study according to gender are shown in Table-II. We constructed a 2 x 2 table, shown as Table-III, to determine the various test parameters such as sensitivity and specificity of pSOFA score in predicting the occurrence of mortality at 0, 3 and 7 days post-admission to our intensive care unit.

Table-II: Study Results According to Gender (n=76)

Variable	Males	Females	*p*-value
Outcome of the Case			
Complete Recovery	36(83.7%)	31(93.9%)	0.172
Mortality	7(16.3%)	2(6.1%)	
pSOFA Score at Day 0	8.35±5.86	6.67±5.31	0.201
pSOFA>11 at Day 0	13(30.2%)	6(18.1%)	0.229
pSOFA Score at Day 3	6.37±6.59	4.36±4.71	0.142
pSOFA>11 at Day 0	12(27.9%)	2(6.1%)	0.015
pSOFA Score at Day 7	4.98±7.97	2.55±4.94	0.128
pSOFA>11 at Day 0	8(18.6%)	3(9.1%)	0.243

The pSOFA score had a sensitivity of 88.9% on Day 0, which increased to 100% by Day 7. However, its specificity was lower; it was 80.6% on Day 0, which increased to 97.0% by Day 7. The diagnostic accuracy of pSOFA in predicting mortality was 81.6% when

performed on the day of admission, which increased to 90.8% when calculated on Day 3. The diagnostic accuracy was the highest on Day 7, 97.4%. The results for the various characteristics of the tests are shown in Table-IV.

Table-III: pSOFA Scores at Day Zero, Three and Seven (n=76)

		Mortality	
		Yes	No
Prediction of Mortality according to Day 0 pSOFA Score	Yes	True Positive: 8(10.5%)	False Positive: 13(17.1%)
	No	False Negative: 1 (1.3%)	True Negative: 54(71.1%)
Prediction of Mortality according to Day 3pSOFA Score	Yes	True Positive: 8(10.5%)	False Positive: 6(7.9%)
	No	False Negative: 1 (1.3%)	True Negative: 61(80.3%)
Prediction of Mortality according to Day 7pSOFA Score	Yes	True Positive: 9(11.8%)	False Positive: 2(2.7%)
	No	False Negative: 0(0%)	True Negative: 65(85.5%)

Table-IV: Diagnostic Parameters (n=76)

Test	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Diagnostic Accuracy
pSOFA Day 0	88.9%	80.6%	38.1%	98.2%	81.6%
pSOFA Day 3	88.9%	91.0%	57.1%	98.4%	90.8%
pSOFA Day 7	100.0 %	97.0%	81.82%	100.0%	97.4%

DISCUSSION

Predicting outcomes for critically-ill paediatric patients is important in deciding the timely and appropriate application of therapeutic interventions. The pSOFA score is one of several methods available to assess the criticality of such patients.[12,13] This combination of clinical findings and investigative modalities assists in the foreshadowing of the deterioration of patients' physical state, thereby predicting the requirement for more intensive management.[14] Furthermore, the pSOFA score is based on various clinical symptoms /signs and laboratory tests based on detecting multi-organ dysfunction syndrome (MODS), which correlates directly with mortality. Therefore, we conducted this study to determine the diagnostic accuracy of the pSOFA score, at different times during admission, in predicting whether mortality occurred or not.

Our study sample comprised a male majority (43 , 56.6%) cases were males. Research protocols such as Meert *et al.* have determined that males have a higher chance of being admitted to intensive care units with a critical illness.[13] This difference between genders is attributed to the male disadvantage hypothesis wherein the higher rates of mortality in this gender are attributed to genetic differences between males and females resulting in a higher susceptibility to insults in males.[14] One of these factors is low birth weight, and males tend to be born with a lower birth weight than females, making them more susceptible to different illnesses[15], a finding that was also seen in our study.

Most cases admitted to critical care in our study suffered from sepsis: 35(46.1%). Respiratory failure was second in line, accounting for 17(22.4%) cases, followed closely by renal dysfunction, which occurred in 14(18.4%) patients. Less common causes included trauma, cardiovascular dysfunction and neurological disorders, which occurred in 5(6.6%), 4(5.3%) and 1(1.2%) patients, respectively. These findings are in keeping with other studies on the subject, such as Seifu *et al*. They reported that sepsis was the major cause of admission to intensive care in children (45.7%).[16]

Our study carried a total mortality rate of 11.8%, which was similar to Rashma *et al*. They reported a total mortality of 10.6% in paediatric patients admitted to intensive care in their study.[17]

Our study showed that the pSOFA score had a good sensitivity of 88.9%, a specificity of 80.6% and a diagnostic accuracy of 81.6% at admission. This increased sensitivity, specificity and diagnostic accuracy by 88.9%, 91.0% and 90.8% by the third day of admission. As the admission length progressed, the sensitivity went up to 100.0%, the specificity to 97.0%, and the diagnostic accuracy to 97.4%, at the end of one week of admission, in predicting the occurrence of mortality. Kamber *et al*. studied the *p*-SOFA score combined with lactate, using a cut-off of 10.5 as a predictor of mortality and found that it carried a sensitivity of 96.4% and a specificity of 80.9% at the time of admission, which was similar to our study.11 Matics *et al*. reported diagnostic accuracy of 96%,9 while El-Mashad *et al*. reported a sensitivity of 80.9% and a specificity of 81.8%.[1] Lastly, Sun *et al*. reported a sensitivity of 83%, a specificity of 72%and a diagnostic accuracy of 85%.[18] While all the studies report that pSOFA has an adequate prediction ability in terms of mortality, there is a discrepancy within the results. We assume that this occurred because while other studies assessed patients at the time of admission, we conducted serial assessments, which improved diagnostic accuracy.

We found the pSOFA score a useful indicator for mortality in critically ill paediatric patients. In addi-

tion, the scoring system showed an increasing trend in diagnostic accuracy as the admission progressed and served as a useful measure of the foundation on which management decisions could be based.

LIMITATIONS OF STUDY

Anticipating a deterioration in the condition is very useful in managing a patient in the intensive care setting, which is estimated using prognostic scoring systems such as pSOFA. However, the assessment of the utility of this scoring system is fraught with confounding factors, as were seen in our study: the physiology of each individual is inherently different, and the human body responds with a great degree of variability to different kinds of stress, in different populations. Furthermore, this study was conducted in a single centre with a small population. Moreover, our study lacked a comparison with other scoring systems, which would have been useful to determine how the pSOFA score compared to theirs.

CONCLUSION

The pSOFA score is a good scoring system that can accurately predict mortality in paediatric patients admitted to intensive care. The diagnostic accuracy of the score improves with the lengthening duration of admission and can serve as a guide for instituting more intensive measures. Furthermore, this score can be used in isolation to grade the prognosis of critically-ill children in intensive care setting with confidence. Further research should look at comparing the diagnostic accuracy of this system with other such scoring systems to determine which one is superior. Furthermore, efforts can be directed towards reducing the number of elements in the score without compromising its accuracy to make it easier, faster, and cheaper.

Conflict of Interest: None.

Authors' Contribution

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

SZ: Conception, interpretation of data, drafting the manu-script, approval of the final version to be published.

MYN: Study design, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

ST: Critical review, 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 work are appropriately investigated and resolved.

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