EDITORIAL

Predicting Pediatric ICU Outcomes: Yet Another SOFA (Study) on the PODIUM?

Rekha Solomon

Keywords: Intensive care unit, Pediatric, Sequential organ failure assessment.
Indian Journal of Critical Care Medicine (2023): 10.5005/jp-journals-10071-24513

Department of Pediatric Intensive Care, Bai Jerbai Wadia Hospital for Children, Mumbai, Maharashtra, India

Corresponding Author: Rekha Solomon, Department of Pediatric Intensive Care, Bai Jerbai Wadia Hospital for Children, Mumbai, Maharashtra, India, Phone: +91 9820957669, e-mail: rekhasolomon1@gmail.com

How to cite this article: Solomon R. Predicting Pediatric ICU Outcomes: Yet Another SOFA (Study) on the PODIUM? Indian J Crit Care Med 2023;27(8):526–528.

Source of support: Nil

Conflict of interest: None

Scoring systems are useful to objectively classify the severity of illness, study epidemiology, prognosticate, and aid in enrolment in clinical trials and in quality improvement. Prognostic scores, such as pediatric index of mortality-III (PIM-3) and pediatric risk of mortality-IV (PRISM-4), predict outcomes, and data is collected on the day of pediatric intensive care unit (PICU) admission. These scores are used on patients both with and without organ dysfunction.

Diagnostic criteria for pediatric multiorgan dysfunction score (MODS) such as the International Pediatric Sepsis Definition Consensus Conference (IPSDCC) Criteria[1] and Pediatric Organ Dysfunction Information Update Mandate (PODIUM)[2] are designed to maximize MODS detection. The presence of new and progressive MODS is being studied as an outcome measure.

Descriptive scores include scores such as MODS, pediatric logistic organ dysfunction score 2 (PELOD-2), and pediatric sequential organ failure assessment (pSOFA). These scores describe the clinical course and response to treatment and data may be collected from PICU admission till discharge. Descriptive scores are useful for stratification and can also be used as an outcome measure. Also, PELOD-2 was derived from studies in European PICUs and assesses dysfunction of five organs (cardiovascular, respiratory, neurological, renal, and hematological).[3] Pediatric SOFA score assesses six organs (liver in addition to the five abovementioned ones) and is modified from the adult SOFA score along with age-adjusted criteria for cardiovascular and renal dysfunction adapted from PELOD-2 and addition of the non-invasive saturation FiO_2 (SF) ratio along with the PaO_2 and FiO_2 ratio for respiratory criteria.[4]

Multiorgan dysfunction syndrome may be seen in 6–57% of critically ill children in PICU.[5] It may occur due to various causes such as sepsis, trauma, acute respiratory distress syndrome, liver failure, pancreatitis, envenomation, and hypoxic–ischemic injury. Analysis of 194,017 PICU admissions from a database in North America showed higher mortality in children with MODS on PICU admission compared to children without MODS (10.3% vs 0.7%; $p < 0.0001$).[6] Similarly, a recent study in sepsis showed that the presence of new or progressive multiorgan dysfunction is a risk factor for mortality and long-term morbidity such as functional disability.[7]

In this issue of the *Indian Journal of Critical Care Medicine*, Lois A and Save S[8] performed a prospective observational study to assess whether SOFA scores at admission (T0, 72 hours or Delta SOFA were predictive of mortality in children admitted to PICU). Children who stayed in PICU for less than 72 hours or those who were referred from other PICUs or hospitals were excluded. There were 160 children who were almost equally distributed in the age groups for less than 1 year, 1–5 years, and 5–12 years. Nearly two-thirds (102/160) of the patients were male. Mortality was 10.6% (17/160). An initial SOFA score of 7.5 or more predicted mortality with a sensitivity of 64.71%, and specificity of 89.51% and an area under the curve (AUC) on the receiver operating characteristic curve (ROC) of 0.852.

The study has certain limitations. Adult SOFA score was used where a score of 1 for the cardiovascular system has a cutoff mean arterial blood pressure (MAP) of 70. Similarly, the renal component has adult cutoff values such as creatinine 1.2–1.9 mg/dL for a score of 1 and creatinine above 5 mg/dL or urine below 200 mL/day for a score of 4. This would underestimate the level of kidney and cardiovascular dysfunction especially in infants. There is no mention of the number of eligible patients and how many were excluded and for what reason. Comorbidities or chronic conditions are not mentioned. The details and number of children who were mechanically ventilated, received inotropes or renal replacement therapy is not mentioned. As children who died within 72 hours were excluded, the calculated predictive value of 24-hour SOFA may not be totally accurate.

The pSOFA was not designed to estimate the probability of death. There are, however, many studies being published studying the association of the PELOD-2 and SOFA scores with mortality (Table 1). However, different studies use different versions of the score [such as adult SOFA, pediatric SOFA, quick SOFA (qSOFA), or SOFA with lactate (LSOFA)] and different timing of evaluation or cutoff scores making comparison difficult.

There are certain limitations to the descriptive scores such as PELOD-2 and pSOFA. The scores do not take into account treatment such as renal replacement therapy (RRT) and extracorporeal membrane oxygenation (ECMO) which may lead to normal renal

Table 1: Studies on association of SOFA score with mortality

Author, year	*Patient population*	*Number of patients*	*Study type, duration*	*Mortality*	*Score and cutoff*	*ROC–AUC*
Lois A and Save S,[8] 2023	PICU admission, 29 days to 12 years	160	Prospective September 2019 to September 2020	10.6%	SOFA T0: 7.5 T 72: 10.5 ΔSOFA: -1.5	T0: 0.852 T72: 0.932 ΔSOFA: 0.8
Matics and Sanchez–Pinto,[4] 2017	PICU admission, <21 years	6,303 patients with 8711 admissions	Retrospective single-center 2009–2016	2.6%	pSOFA	AUC: 0.94
Schlapbach et al.,[9] 2018	ICU admission <18 years	2,594 admissions for infection	Retrospective multicentric 2000–2016	7.4%	Age-adjusted SOFA: ≥2 criteria PELOD-2: score of ≥ 8	pSOFA AUC: 0.829 PELOD-2 AUC: 0.812
Kumbar and Chandrashekhara,[10] 2020	PICU with MODS, 1 month to 18 years	75	Prospective single-center November 2017 to April 2019	37%	pSOFA L: Cutoff 10.5 points	AUC 0.85
El-Mashad et al.[11] 2020	PICU, critically ill children 1 month to 18 years	281	Prospective 2 centers March 2018 to November 2018	day 28.1%	pSOFA cutoff 6.5 points	AUC 0.886
Lalitha et al.[12] 2021	PICU with sepsis, 1 month to 18 years	240	Prospective single center, 2 years	17.5%	pSOFA cutoff: 8 points	SOFA D1 AUC 0.84 D3 AUC 0.87 PELOD-2 D3 AUC 0.81

function tests and blood gases, or sedation and paralysis which may affect the assessment of the Glasgow Coma Scale. Furthermore, PELOD-2 does not take into account inotrope use, while pSOFA mentions some but not all inotropes. The scores may not be appropriate for children with chronic illnesses such as chronic kidney disease. The scores discussed above have been validated in developed countries. Low- and middle-income countries (LMICs) have issues such as malnutrition, limited resources, more patients of certain sex likely to reach hospitals, tropical diseases, and delayed access to appropriate care associated with higher mortality as compared to high-income countries. There is a need to detect factors affecting mortality and morbidity locally and develop prognostic and descriptive scoring systems as well as regional databases.

In developed countries, universal electronic health record (EHR) system availability along with data sharing in national PICU registries such as the Australian and New Zealand Paediatric Intensive Care Registry (ANZPICR), Virtual PICU Performance System (VPS), and Paediatric Intensive Care Audit Network (PICANet) has helped in studying epidemiology, outcome indicators, and quality improvement. This is an area for improvement for LMICs. There is also a need for studies on functional outcomes (e.g., Pediatric Critical Care Core Outcome Set)[13] after PICU discharge.

Orcid

Rekha Solomon https://orcid.org/0000-0001-8611-9237

References

1. Goldstein B, Giroir B, Randolph A, International Consensus Conference on Pediatric Sepsis. International Pediatric Sepsis Consensus Conference: Definitions for Sepsis and Organ Dysfunction in Pediatrics. Pediatr Crit Care Med 2005;6(1):2–8. DOI: 10.1097/01.PCC.0000149131.72248.E6.
2. Bembea MM, Agus M, Akcan–Arikan A, Alexander P, Basu R, Bennett TD, et al. Pediatric Organ Dysfunction Information Update Mandate (PODIUM) Contemporary Organ Dysfunction Criteria: Executive Summary. Pediatrics 2022;149(1 Suppl. 1):S1–S12. DOI: 10.1542/peds.2021-052888B.
3. Leteurtre S, Duhamel A, Salleron J, Grandbastien B, Lacroix J, Leclerc F, et al. PELOD-2: An update of the PEdiatric logistic organ dysfunction score. Crit Care Med 2013;41(7):1761–1773. DOI: 10.1097/CCM.0b013e31828a2bbd.
4. Matics TJ, Sanchez–Pinto LN. Adaptation and validation of a pediatric sequential organ failure assessment score and evaluation of the sepsis-3 definitions in critically ill children. JAMA Pediatr 2017;171(10):e172352. DOI: 10.1001/jamapediatrics.2017.2352.
5. Watson RS, Crow SS, Hartman ME, Lacroix J, Odetola FO. Epidemiology and outcomes of pediatric multiple organ dysfunction syndrome. Pediatr Crit Care Med 2017;18(3_suppl Suppl. 1):S4–S16. DOI: 10.1097/PCC.0000000000001047.
6. Typpo K, Watson RS, Bennett TD, Farris RWD, Spaeder MC, Petersen NJ, et al. Outcomes of day 1 multiple organ dysfunction syndrome in the PICU. Pediatr Crit Care Med 2019;20(10):914–922. DOI: 10.1097/PCC.0000000000002044.
7. Lin JC, Spinella PC, Fitzgerald JC, Tucci M, Bush JL, Nadkarni VM, et al. New or progressive multiple organ dysfunction syndrome in pediatric severe sepsis: A sepsis phenotype with higher morbidity and mortality. Pediatr Crit Care Med 2017;18(1):8–16. DOI: 10.1097/PCC.0000000000000978.
8. Lois A, Save S. Serial evaluation of sequential organ failure assessment score (SOFA) as a predictor of outcome in children admitted in pediatric intensive care unit (PICU) at tertiary care hospital. Indian J Crit Care Med 2023;27(8):588–593.
9. Schlapbach LJ, Straney L, Bellomo R, MacLaren G, Pilcher D. Prognostic accuracy of age-adapted SOFA, SIRS, PELOD-2, and qSOFA for in-hospital mortality among children with suspected

infection admitted to the intensive care unit. Intensive Care Med 2018;44(2):179–188. DOI: 10.1007/s00134-017-5021-8.
10. Kumbar S, Chandrashekhara. Assessment of pSOFA-L score in predicting the clinical outcome of critically ill children. Int J Contemp Pediatr 2020;7(4):925–931. DOI: https://doi.org/10.18203/2349-3291.ijcp20201156.
11. El-Mashad GM, El-Mekkawy MS, Zayan MH. Paediatric sequential organ failure assessment (pSOFA) score: A new mortality prediction score in the paediatric intensive care unit. An Pediatr (Engl Ed) 2020;92(5):277–285. DOI: 10.1016/j.anpedi.2019.05.018.
12. Lalitha AV, Satish JK, Reddy M, Ghosh S, George J, Pujari C. Sequential organ failure assessment score as a predictor of outcome in sepsis in pediatric intensive care unit. J Pediatr Intensive Care 2021;10(2):110–117. DOI: 10.1055/s-0040-1714705.
13. Fink EL, Maddux AB, Pinto NSorenson S, Notterman D, Dean JM, et al. A core outcome set for pediatric critical care. Crit Care Med 2020;48(12):1819–1828. DOI: 10.1097/CCM.0000000000004660.