

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

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

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<sup>1</sup> and Pediatric Organ Dysfunction Information Update Mandate (PODIUM)<sup>2</sup> 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).<sup>3</sup> 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  $\text{FiO}_2$  (SF) ratio along with the  $\text{PaO}_2$  and  $\text{FiO}_2$  ratio for respiratory criteria.<sup>4</sup>

Multiorgan dysfunction syndrome may be seen in 6–57% of critically ill children in PICU.<sup>5</sup> 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%;  $p < 0.0001$ ).<sup>6</sup> 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.<sup>7</sup>

In this issue of the *Indian Journal of Critical Care Medicine*, Lois A and Save S<sup>8</sup> 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

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**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

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, <sup>8</sup> 2023           | PICU admission, 29 days to 12 years               | 160                                 | Prospective September 2019 to September 2020          | 10.6%     | SOFA<br>T0: 7.5<br>T 72: 10.5<br>ΔSOFA: -1.5            | T0: 0.852<br>T72: 0.932<br>ΔSOFA: 0.8                     |
| Matics and Sanchez–Pinto, <sup>4</sup> 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., <sup>9</sup> 2018           | ICU admission <18 years                           | 2,594 admissions for infection      | Retrospective multicentric 2000–2016                  | 7.4%      | Age-adjusted SOFA: ≥2 criteria<br>PELOD-2: score of ≥ 8 | pSOFA AUC: 0.829<br>PELOD-2 AUC: 0.812                    |
| Kumbar and Chandrashekhara, <sup>10</sup> 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. <sup>11</sup> 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. <sup>12</sup> 2021              | PICU with sepsis, 1 month to 18 years             | 240                                 | Prospective single center, 2 years                    | 17.5%     | pSOFA cutoff: 8 points                                  | SOFA<br>D1 AUC 0.84<br>D3 AUC 0.87<br>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)<sup>13</sup> after PICU discharge.

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