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**Original Research Article**

# Paediatric assessment score as predictor of mortality in pediatric intensive care units

**Mitesh Chaudhari, Mansi Bhavsar, Sonal P. Shah*, Aditya Parmar, Dhruvi Dhamsaniya**

Department of Pediatrics, MP Shah Medical College, Jamnagar, Gujarat, India

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***Correspondence:**
Dr. Sonal P. Shah,
E-mail: drsonalpshah@yahoo.com



## ABSTRACT

**Background:** To study paediatric assessment score (pSOFA) as predictor of mortality in PICU.
**Methods:** This prospective study is conducted in children of age group one month to 12 yrs, who were admitted in the PICU of a tertiary care hospital, G.G Hospital, Jamnagar in 1 year time period of around 150 patients. The variables include SpO2: FiO2 ratio, platelet counts, Total S. bilirubin (mg/dl), mean blood pressure by age group with use of vasoactive, Glasgow Coma Scale and S. creatinine (mg/dl). Observed values were noted in case record form, scores were given for individual components according to p-SOFA score assessment chart. A total score was calculated for each patient.
**Results:** The use of a scoring system and audit of ICUs has not been widely reported in India. In our study, The pSOFA score demonstrated good performance in predicting mortality, with an area under the ROC curve of 0.86 (95% CI: 0.79-0.93). A score ≥ 6 had a sensitivity of 84.6%, specificity of 69.4%, positive predictive value of 50.7% and negative predictive value of 92.2% for mortality.
**Conclusions:** Pediatric SOFA score (pSOFA) score can be used as a reliable prognostic predictor of mortality among PICU patients. pSOFA score provides an objective assessment of severity of illness. Earlier assessment of disease severity based on pSOFA score helps in vigorous management and better patient treatment, which helps in patient survival. Factors such as need for mechanical ventilation and inotrope use were significantly associated with mortality.

**Keywords:** Pediatric sequential organ failure assessment score, Pediatric intensive care units

## INTRODUCTION

PICUs are designed to provide intensive care and close monitoring for critically ill infants, children and adolescents. These units are distinct from general pediatric wards in that they offer a higher level of care, specifically tailored to the complex and often rapidly changing needs of pediatric patients. Many illnesses severity scoring systems are being used for predicting the outcome of patients admitted to ICUs. Although it is difficult to predict individual outcomes of ICU patients accurately, there have been attempts to codify and validate models which may prognosticate groups of patients having similar presentations of the illness. Scoring systems are primarily being used to predict the general prognosis of patients but are also used as performance indicators of ICUs. Multiple scoring systems have been developed to predict outcomes in critically ill patients which includes, APACHE (Acute physiology and chronic health evaluation) score, widely used in ICUs to assess the severity of disease based on physiological variables, including vital signs and laboratory results. It provides an estimate of mortality risk. PRISM (pediatric risk of mortality) is another pediatric-specific score that evaluates the severity of illness using 17 physiological variables. PRISM has been

extensively used in PICUs and is known for its accuracy in predicting mortality. The PELOD (pediatric logistic organ dysfunction) score, designed for pediatric patients, evaluates organ dysfunction across multiple systems and correlates closely with patient outcomes. It's highly regarded for its applicability in PICUs. Another commonly used score is the SOFA (Sequential Organ Failure Assessment) score, which evaluates organ failure and is used to track patient condition over time in ICUs.

pSOFA, adapted from SOFA, includes age-adjusted parameters for better application in pediatric patients. While each score provides critical insight into patient outcomes, pSOFA has shown promise in focusing specifically on pediatric organ dysfunction, enabling more accurate assessments for children. The pSOFA score offers several advantages in evaluating critically ill pediatric patients. First, it is an adaptation of the widely validated SOFA score, specifically modified to account for the physiological dysfunction differences in children. This makes pSOFA a more reliable tool for predicting organ dysfunction and mortality in pediatric populations.[1]

Unlike other mortality scores that focus solely on mortality risk, pSOFA tracks organ dysfunction across multiple systems, providing a dynamic assessment of a child's health status. The score incorporates age-adjusted criteria, which improves its applicability in younger patients where physiological responses differ from adults.[2] For instance, a study conducted in a tertiary care PICU in South India demonstrated that pSOFA scores on days 1 and 3 were highly discriminative for in-hospital mortality, outperforming PRISM III and PELOD-2 in predictive accuracy.[3] Additionally, pSOFA is non-invasive, requiring standard clinical data like lab results and vital signs, making it feasible to use in routine clinical practice.[4] Its straightforward approach helps clinicians monitor organ dysfunction and make informed decisions on interventions, improving patient outcomes and optimizing resource allocation in PICUs.

There is a need for early identification of organ dysfunction in critically ill pediatric patients. The pSOFA score provides a validated and structured approach to assess organ dysfunction, allowing timely intervention. Research has shown that pSOFA scores can effectively predict outcomes in pediatric sepsis, with higher scores correlating with increased mortality risk.[5] Given the limited studies focusing on pediatric populations, this research addresses a critical gap by analyzing outcomes based on pSOFA scores. Moreover, the rising demand for robust scoring systems in PICUs calls for better understanding and refinement of tools like pSOFA. A recent review highlighted pSOFA's role as a prognostic marker in PICUs, emphasizing its ability to predict sepsis-related mortality and its potential for broader clinical application.[6]

Studying this specific cohort enables the evaluation of its utility in predicting mortality and improving patient care strategies. Our institution provides a diverse and large pediatric population, offering a unique opportunity to assess the applicability and reliability of pSOFA in routine clinical practice. For example, an automated algorithm for calculating pSOFA scores was developed and validated in a single-center study, demonstrating high accuracy and improved performance over manual methods, further supporting its practical utility.[7]

This research also seeks to provide insights into resource optimization by predicting outcomes early in the patient's hospital course.

## METHODS

### *Study design*

The present prospective observational study was conducted over one year in G.G. Hospital, a tertiary care hospital in Jamnagar. A total of 150 patients, age group 1 month to 12 years, who were admitted to the pediatric intensive care unit (PICU), were taken into the study. Data were collected within 24 hours of the patient's admission by a resident doctor who was posted in the PICU. The data includes 6 variables.

Respiratory system- SpO2: FiO2 ratio, coagulation profile: platelet counts, hepatic system- Total S. bilirubin (mg/dl). Cardiovascular system- mean blood pressure by age group with use of vasoactive. Neurological system- Glasgow Coma Scale. renal system- S. creatinine (mg/dl)

### *Sample size and study population*

As per previous 1-month records from our department, the admission rate of 1-month to 12 years children was around 18 to 20 at PICU. So, we are estimating our sample size to be around 150 by using the Universal Sampling method. And according to eligibility criteria all the patients admitted will be included in the study.

### *Inclusion criteria*

The inclusion criteria were All patients admitted in PICU directly from a pediatric emergency or pediatric ward aged 1 month to 12 years.

### *Exclusion criteria*

Parents, who give negative consent and refuse to participate in the study. Age<1 months or>12 years.

### *Data collection*

A prospective observational study was conducted after obtaining clearance from the Institutional Ethics Committee. Informed and written consent was taken from the parents of the patients. Any query regarding understanding of question was solved during interview only. Those who had provided consent to participate in

the study were evaluated for inclusion and exclusion criteria by doing clinical evaluation and various laboratory. The relevant data was entered in a carefully prepare customized and pretest proforma. The following tests were performed in patients, CBC, total S. bilirubin, S. creatinine and others according to patient's condition. Blood pressure was measured manually using mercury sphygmomanometer, systolic and diastolic blood pressure were noted. Mean blood pressure was calculated using f=formula: MAP=DP+1/3(SP–DP). For neurological examination, Modified Glasgow Coma Scale for Infants and Children was used. For SpO2:FiO2 ratio: Pulse oximeter was used to measure the oxygen saturation (SpO2) of the patient. This is typically expressed as a percentage. FiO2 (fraction of inspired oxygen) is the percentage of oxygen the patient is inhaling. Room air has an FiO2 of approximately 21% (or 0.21). If the patient is on supplemental oxygen, FiO2 will be higher. For example, 2 litters per minute (L/min) of oxygen via nasal cannula typically corresponds to an FiO2 of about 28% (or 0.28). for patients using invasive or non-invasive ventilation, FiO2 taken according to ventilatory settings.

### *Statistical analysis*

The collected data were tabulated and analyzed using SPSS version 16 software. Categorical data were presented as numbers and percentages. Chi square test or Fisher's exact test (FET) were used to analyze categorical variables. Quantitative data were expressed as mean±standard deviation, median and range. Student "t" test was used to analyze normally distributed variables among 2 independent groups or Man Whitney U test for nonparametric ones. Difference among 3 independent means was analyzed using ANOVA for parametric variables or Kruskal Wallis test (KWT) for nonparametric ones. Spearman's correlation coefficient (rho) was used to assess correlation between non parametric variables. ROC curve was used to detect cutoff values with optimum sensitivity and specificity. The accepted level of significance in this work was stated at 0.05. ($p<0.05$ was considered significant).

## RESULTS

Total number of patients admitted in PICU from May 2023 to April 2024 were 300. Among them, 150 patients who met with the inclusion criteria and whose parents consented for study were analysed. The observation were discussed below.

### *Gender distribution with outcome (n=150)*

Table 2 indicates, out of 150 patients enrolled, 87 (58%) were male and 63 (42%) were female. There is male predominance in PICU admissions with a male-to-female ratio of 1.4:1. Mortality was slightly higher in males (23 deaths) compared to females (17 deaths), but the gender difference in mortality did not reach statistical significance ($p>0.05$).

### *Age distribution with percentage (n=150)*

Table 3 indicates, Age was found to be a significant predictor of mortality in this study, with younger children facing worse outcomes. Infants under one year of age accounted for 44.6% of admissions but 50% of deaths, indicating a disproportionately high mortality rate in this age group.

### *pSOFA scores and mortality*

The pSOFA score was central to the study's investigation and its predictive capacity was confirmed, with mortality rates increasing sharply as pSOFA scores rose.

The pSOFA score was central to the study's investigation and its predictive capacity was confirmed, with mortality rates increasing sharply as pSOFA scores rose. Table 4 suggestive of, for patients with scores between 0-5, mortality was only 7.8%, while scores in the 6-10 range were associated with 29.7% mortality. Scores of 11 and above were predictive of a 76.9% mortality rate, showing a highly significant correlation between pSOFA score and patient outcomes ($p<0.001$).

### *Distribution according to diagnosis of patient (n=150)*

This section explains distribution of cases according to diagnosis of the patients. The diagnosis of the children enrolled was classified based on the system involved and the distribution of the diseases, was shown in Figure1.

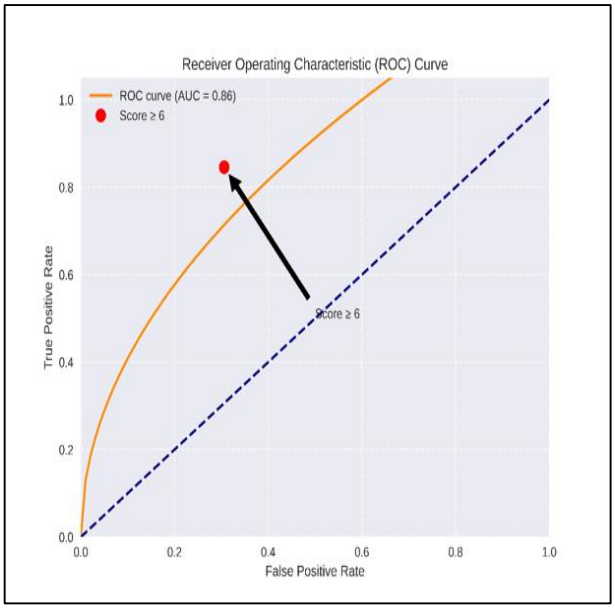


**Figure 1: ROC curve for pSOFA score performance in predicting mortality.**

Respiratory diseases emerged as the most common cause of PICU admission in this cohort, accounting for 34% of cases. This was followed by central nervous system (CNS) conditions (18%) and trauma or toxicological

cases (17%). Respiratory illnesses, such as pneumonia and bronchiolitis, have consistently been reported as leading causes of pediatric ICU admissions globally. A high prevalence of respiratory diseases, particularly in children under five, is well-documented, especially in regions with high air pollution levels, poor nutrition limited access to preventive care.

***pSOFA score components by outcome***

In this section, Individual components of the p SOFA score were analyzed. Individual components of the p SOFA score were analyzed. It was noted that Patients who died had significantly worse pSOFA score components like s. creatinine, GCS, SpO2/FiO2 ratio, Platelet count, mean arterial pressure and bilirubin compared to those who survived. All of these differences in pSOFA score components between survivors and expired patients were statistically significant, indicating that each component plays an important role in determining patient outcomes.

***pSOFA score and length of PICU stay***

Our study found a direct correlation between higher pSOFA scores and longer PICU stays. Patients with pSOFA scores of 0-5 had a median stay of 3 days, while those with scores above 11 had a median stay of 8 days. The value was statistically significant (p value=<0.001). This association between severity of illness and length of stay has been consistently reported in the literature. This finding reflects the complexity of managing critically ill patients with multiple organ dysfunctions, as prolonged intensive care often correlates with the severity of illness and the extent of organ support required.

***pSOFA score performance in predicting mortality***

The pSOFA score demonstrated good performance in predicting mortality, with an area under the ROC curve of 0.86 (95% CI: 0.79-0.93). A score≥6 had a sensitivity of 84.6%, specificity of 69.4%, positive predictive value of 50.7% and negative predictive value of 92.2% for mortality.

**Table 1: p-SOFA score assessment chart.**

| System | | Score | | | | |
|---|---|---|---|---|---|---|
| | | **0** | **1** | **2** | **3** | **4** |
| **Respiration** | $PaO_2/FiO_2$ | ≥400 | <400 | <300 | <200 with respiratory support | <100 with respiratory support |
| | SpO2:FiO2 | ≥292 | 100-149 | 50-99 | 20-49 | <20 |
| **Coagulation** | Platelets ($X10^3/\mu l$) | ≥150 | 100-149 | 50-99 | 20-49 | <20 |
| **Hepatic** | Bilirubin (mg/dl) | <1.2 | 1.2-1.9 | 2.0-5.9 | 6.0-11.9 | >12.0 |
| **Cardio-vascular** | MAP | MAP ≥70 mm Hg | <70 mm Hg | DA ≤5 or Db (any dose) | DA 5.1-15 or E≤0.1 or NE≤0.1[b] | DA>15 or E>0.1 or NE>0.1[b] |
| **CNS** | GCS | GCS=15 | GCS=13-14 | GCS=10-12 | GCS=6-9 | GCS<6 |
| **Renal** | Creatinine (mg/dl) | <1.2 | 1.2-1.9 | 2.0-3.4 | 3.5-4.9 | >5.0 |
| | Creatinine (µmol/l) | (110) | (110-170) | (171-299) | (300-440) | >440 |

**Table 2: Gender distribution with outcome.**

| | Total no. of patient studied n=150 | Male n=87 | Female n= 63 | M:F |
|---|---|---|---|---|
| **No. of patients survived** | 110 (73.3%) | 64 (58.1%) | 46 (41.8%) | 1.4:1 |
| **No. of patient expired** | 40 (26.66%) | 23 (57.5%) | 17 (42.5%) | |

**Table 3: Age distribution with percentage.**

| Age group | N (%)=150 | No. of patients expired, n=40 |
|---|---|---|
| **<1** | 67 (44.66) | 20 (50) |
| **2-5** | 50 (33.33) | 15 (37.5) |
| **6-12** | 33 (22) | 5 (12.5) |

**Table 4: pSOFA scores and mortality.**

| pSOFA score | N (%)=150 | Mortality, N (%) | P value |
|---|---|---|---|
| **0-5** | 77 (51.3) | 6 (7.8) | <0.001 |
| **6-10** | 47 (31.3) | 14 (29.7) | |
| **11+** | 26 (17.3) | 20 (76.9) | |

**Table 5: Distribution according to diagnosis of patient.**

| System affected | Cases (n=150) | Mortality (n=40) |
|---|---|---|
| **Respiratory** | 51 (34%) | 17 (33%) |
| **CNS** | 27 (18%) | 7 (26%) |
| **Trauma and toxicology** | 25 (17%) | 5 (20%) |
| **CVS** | 10 (7%) | 3 (30%) |
| **Infectious diseases** | 10 (7%) | 4 (40%) |
| **Postoperative** | 11 (7%) | 1 (9%) |
| **Nutritional cause** | 6 (4%) | 1 (16.6%) |
| **Renal** | 4 (3%) | 1 (25%) |
| **Hepatobiliary** | 4 (2%) | 1 (25%) |
| **DKA** | 2 (1%) | 0 (0%) |

**Table 6: pSOFA score components by outcome.**

| Component | Survived (n=110) | Expired (n=40) | P value |
|---|---|---|---|
| **SpO2/FiO2 ratio, median (IQR)** | 145 (48-300) | 40 (16-88) | <0.001 |
| **Platelet count (X10^9/l), median (IQR)** | 176 (126-406) | 143 (70-238) | 0.003 |
| **Bilirubin (mg/dl), median (IQR)** | 0.9 (0.5-1.3) | 1.3 (0.6-2.0) | 0.002 |
| **Mean arterial pressure (mmHg), median (IQR)** | 64 (56-70) | 56 (50-66) | 0.001 |
| **Glasgow coma scale, median (IQR)** | 14 (12-15) | 9 (5-12) | <0.001 |
| **Creatinine (mg/dl), median (IQR)** | 0.4 (0.3-0.7) | 0.7 (0.4-1.0) | <0.001 |

**Table 7: pSOFA score and length of PICU stay.**

| pSOFA score | Length of stay (days) | | | P value |
|---|---|---|---|---|
| | **median (IQR)** | **< 5 days, n=82** | **≥ 5 days, n=68** | |
| **0-5 (n=77)** | 3 (2-5) | 58 | 19 | <0.001 |
| **6-10 (n=47)** | 7 (4-10) | 17 | 30 | |
| **11+ (n=26)** | 8 (4-15) | 7 | 19 | |

**Table 8: pSOFA score performance in predicting mortality.**

| Measure | Value (95% CI) |
|---|---|
| **Area under ROC curve** | 0.86 (0.79-0.93) |
| **Sensitivity (Score≥6)** | 84.6% (69.5-94.1%) |
| **Specificity (Score≥6)** | 69.4% (59.9-77.8%) |
| **Positive predictive value (Score≥6)** | 50.7% (38.4-63.0%) |
| **Negative predictive value (Score≥6)** | 92.2% (84.0-97.0%) |

## DISCUSSION

In our study, there is a male predominance in PICU admissions, with a male-to-female ratio of 1.4:1. This gender disparity has been well-documented in the literature. A study also reported a male predominance in pediatric critical care admissions, with males accounting for 60% of total admissions.[8]

This trend is often attributed to biological differences, such as hormonal effects on the immune response and behavioral factors that may expose boys to more trauma and infections during early childhood. Similar findings further support the notion that boys are at higher risk for severe illnesses, especially during the neonatal and infant stages.[9] Discrepancies across studies may stem from differences in healthcare access, cultural factors or even the timing of hospital admission, all of which can influence outcomes. In our study, the male predominance in mortality is likely influenced by these multifactorial elements. In a patriarchal society, gender stereotypes also play a major role, but this finding underscores the need for further research into gender-specific risk factors in pediatric critical care.

Infants under 1 year accounted for 44.6% of admissions but 50% of deaths, indicating a disproportionately high mortality rate in this age group. This observation is consistent with studies that highlight infants' higher risk for mortality in critical care settings due to their underdeveloped immune systems, greater susceptibility to infections and increased likelihood of respiratory complications.[10] The vulnerability of this age group necessitates focused intervention strategies, such as more vigilant monitoring, earlier escalation of care and prioritization of preventive measures like vaccination.

While mortality decreases with age, the youngest patients in the PICU face the highest risks due to factors such as underdeveloped organ systems and the difficulty of diagnosing severe illnesses in infants.[11] The findings from both our study and the literature emphasize the need for specialized care protocols for infants and younger children in PICUs to address their unique vulnerabilities. The decreased mortality rate observed in older children (6–12 years) in this study, which aligns with the literature, suggests that as children age, they develop stronger immune systems and greater resilience to critical illnesses. However, the fact that 12.5% of children in this age group still succumbed to their illnesses highlights the continued need for tailored interventions across all pediatric age groups within the PICU.

The sharp rise in mortality with pSOFA scores above 10 may reflect the threshold beyond which multiorgan dysfunction becomes unmanageable despite aggressive treatment. The use of the pSOFA score in this setting allows for early identification of patients at higher risk for mortality, enabling timely interventions aimed at preventing the progression of organ failure. The initial SOFA score can quantify the degree of organ dysfunction or failure present on admission, the pSOFA score can demonstrate the degree of dysfunction or failure developing during an ICU stay and the total maximum SOFA score can represent the cumulative organ dysfunction experienced by the patient.[12] These parameters also demonstrated a strong correlation with mortality outcomes.

In our study, a high prevalence of respiratory diseases, particularly in children under five, is well-documented, especially in regions with high air pollution levels, poor nutrition and limited access to preventive care. Previous studies have also indicated that respiratory infections remain the leading cause of death in critically ill children, further supporting our findings of a 33% mortality rate among patients with respiratory diagnoses.[13] Interestingly, infectious diseases accounted for only 7% of total admissions but had the highest mortality rate (40%).

This discrepancy between the number of cases and the severity of outcomes could be attributed to the rapid progression of sepsis and septic shock in children, which often leads to multiple organ dysfunction syndrome (MODS). The high mortality associated with infectious diseases emphasizes the critical need for early identification and aggressive management of pediatric sepsis in the PICU setting. Previous studies have similarly reported disproportionately high mortality in pediatric sepsis cases compared to other diagnostic categories.[14]

The association between severity of illness and length of stay has been consistently reported in the literature. This finding reflects the complexity of managing critically ill patients with multiple organ dysfunctions, as prolonged intensive care often correlates with the severity of illness and the extent of organ support required. Higher severity scores in PICU patients were associated with prolonged stays and increased resource utilization.[15]

Longer PICU stays are often necessary for patients with multiorgan dysfunction, who require extended periods of mechanical ventilation, inotropic support and close monitoring. Our findings align with those who highlighted that while longer stays are necessary for managing critically ill patients, they also increase the risk of adverse outcomes, particularly in resource-limited settings.[16] This emphasizes the need to optimize care protocols to reduce the duration of PICU stays while ensuring the highest quality of care for critically ill children.

However, prolonged stays can also lead to secondary complications, such as infections, which can further increase morbidity and mortality. Our findings align with studies by Pollack et al, which similarly reported that the need for inotropic support in critically ill pediatric patients is indicative of severe cardiovascular dysfunction and a high risk of death.[17] This is consistent with the observation that the need for inotropic support and mechanical ventilation are independent predictors of mortality in critically ill pediatric patients.[18] The use of inotropes reflects severe cardiovascular dysfunction, often seen in conditions such as septic shock, where organ perfusion is critically compromised.

The pSOFA score demonstrated good performance in predicting mortality, with an area under the ROC curve of 0.86 (95% CI: 0.79–0.93). A score≥6 had a sensitivity of 84.6%, specificity of 69.4%, positive predictive value of 50.7% and negative predictive value of 92.2% for mortality. These findings align with a previous study that also demonstrated that higher pSOFA scores strongly predict mortality in pediatric ICU settings.[19] In their study, pSOFA scores above 10 were associated with a significantly increased risk of death, with an area under the receiver operating characteristic (ROC) curve of 0.85, similar to the 0.86 AUC observed in our study.

The PIM score, while useful in predicting mortality risk at the time of PICU admission, may not be as effective in capturing the dynamic changes in organ function over time as the pSOFA score. The PIM score's predictive

accuracy declines over time, especially in patients who develop new organ dysfunctions during their PICU stay.[20] In contrast, the pSOFA score can be recalculated daily, providing clinicians with a more accurate assessment of a patient's prognosis throughout their PICU stay. This advantage is supported by our study's findings, where the dynamic nature of the pSOFA score allowed for better mortality prediction as patients' clinical conditions evolved.

***Limitations***

*Variability in scoring*

Differences in how clinicians assess organ dysfunction can affect the accuracy of the pSOFA score.

*Survivorship bias*

Missing data for patients who die during assessment can skew results.

*Single-center research*

Studies in one hospital may not reflect practices across different hospitals.

*Mortality vs. morbidity*

pSOFA measures mortality but not long-term outcomes or disabilities.

*Resource utilization*

pSOFA score does not determine PICU resource use or admissions.

*Laboratory dependence*

pSOFA requires lab tests which may vary or be unavailable in some hospitals, highlighting the need for simpler scoring systems.

## CONCLUSION

Pediatric SOFA score (pSOFA) score can be used as a reliable prognostic predictor of mortality among PICU patients. It provides an objective assessment of severity of illness. Earlier assessment of severity of disease based on pSOFA score helps in vigorous management and better treatment of the patient which helps in patient survival. Associated factors such as need for mechanical ventilation, inotrope use were significantly associated with mortality.

In summary, the pSOFA score is a reliable prognostic predictor that aids in the accurate prediction of mortality and helps guide treatment strategies in the PICU.

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