

Clinical Profile, Risk Factors and Outcomes of Critically Ill Children Admitted to a Pediatric Intensive Care Unit: A Prospective Observational Study

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Abstract

Background: Critically ill children admitted to pediatric intensive care units (PICUs) are at increased risk of morbidity and mortality due to severe underlying illnesses, multiorgan dysfunction, hemodynamic instability, and acute kidney injury (AKI). Early identification of risk factors and prognostic indicators is essential to improve outcomes and optimize resource utilization in critically ill pediatric patients.

Aim: To evaluate the clinical profile, risk factors, and outcomes of critically ill children admitted to a Pediatric Intensive Care Unit and to assess factors associated with adverse outcomes including acute kidney injury and mortality.

Methods: A prospective observational study was conducted among 300 children admitted to the PICU of a tertiary care teaching hospital from September 2022 to February 2024. Children aged 1 month to 18 years requiring intensive care admission were enrolled. Demographic characteristics, nutritional status, primary diagnosis, need for mechanical ventilation, vasopressor support, nephrotoxic medication exposure, duration of PICU stay, Pediatric Risk of Mortality (PRISM-III) scores, Renal Angina Index (RAI), and outcomes were recorded. AKI was diagnosed using Kidney Disease: Improving Global Outcomes (KDIGO) criteria. Statistical analysis was performed using SPSS software.

Results: Among 300 enrolled children, 57.0% were aged below 2 years and 50.7% were males. Gastrointestinal (33.0%), respiratory (28.0%), and central nervous system disorders (19.3%) were the most common primary diagnoses. Malnutrition was observed in 18.7% of patients. Mechanical ventilation was required in 11.0%, vasopressor support in 7.3%, and nephrotoxic medications were administered to 28.7% of patients. The mortality rate was 4.7%. Higher PRISM-III scores were significantly associated with mortality. Patients with RAI ≥ 8 demonstrated significantly increased mortality and higher risk of AKI development. RAI showed significant correlation with illness severity and KDIGO staging.

Conclusion: Critically ill pediatric patients admitted to the PICU are at substantial risk for adverse outcomes. Younger age, severe illness, requirement for organ support, nephrotoxic exposure, elevated PRISM-III scores, and higher RAI values were associated with worse outcomes. Early risk stratification and intensive monitoring may improve clinical outcomes and reduce mortality.

Keywords: Pediatric Intensive Care Unit; Acute Kidney Injury; Critical Illness; Mortality; PRISM-III Score; Renal Angina Index; Risk factors.

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Introduction

Advances in pediatric critical care have substantially improved survival among critically ill children; however, morbidity and mortality remain significant concerns, particularly among patients with multiorgan dysfunction, severe infections, respiratory failure, neurological disorders, and acute kidney injury (AKI)[1]. AKI is increasingly recognized as an important contributor to poor outcomes in critically ill children and is associated

with prolonged hospitalization, increased healthcare costs, mechanical ventilation, renal replacement therapy, and mortality [2-3]. The epidemiology of pediatric critical illness varies according to geographical location, healthcare resources, and referral patterns [4]. In developing countries, respiratory infections, gastrointestinal illnesses, sepsis, and central nervous system disorders remain major causes of PICU admission

[5]. These conditions frequently result in hemodynamic instability, systemic inflammation, and organ dysfunction, predisposing patients to adverse outcomes [6]. Assessment of illness severity plays a crucial role in prognostication and clinical decision-making in PICU settings [7]. The Pediatric Risk of Mortality (PRISM-III) score is a validated tool that quantifies severity of illness and predicts mortality risk [8]. Similarly, the Renal Angina Index (RAI) has emerged as a useful tool for identifying children at risk of developing AKI before significant changes in serum creatinine occur [9].

Several studies have demonstrated that early recognition of critically ill children at risk of AKI and adverse outcomes can facilitate timely interventions and improve survival [10-11]. However, data from Indian PICUs regarding clinical characteristics, risk factors, and outcomes remain limited.

Therefore, the present study was undertaken to evaluate the clinical profile, risk factors, and outcomes of critically ill children admitted to a tertiary care PICU and to identify factors associated with poor outcomes.

Aim: To evaluate the clinical profile, risk factors, and outcomes of critically ill children admitted to a Pediatric Intensive Care Unit.

Objectives

Primary Objectives

1. To assess the clinical profile of critically ill children admitted to the PICU.
2. To determine the outcomes of critically ill children admitted to the PICU.

Secondary Objectives

1. To identify risk factors associated with adverse outcomes.
2. To evaluate the relationship between illness severity scores and mortality.
3. To assess the occurrence of acute kidney injury using KDIGO criteria.
4. To determine the association between RAI and clinical outcomes.

Materials and Methods

This prospective observational study was conducted in the Pediatric Intensive Care Unit (PICU) of a tertiary care teaching hospital over a period of 18 months, from September 2022 to February 2024. The study included children admitted to the PICU during the study period who fulfilled the predefined eligibility criteria. Consecutive sampling was employed, and a total of 300 eligible pediatric patients aged between 1 month and 18 years were enrolled. All patients were followed throughout their PICU stay to assess

their clinical characteristics, severity of illness, need for organ support, development of acute kidney injury, and clinical outcomes. The study was designed to evaluate the clinical profile, associated risk factors, and outcomes of critically ill children admitted to the PICU under routine clinical care without any intervention from the investigators.

Inclusion Criteria

- Children aged 1 month to 18 years.
- Admission to PICU for critical illness.
- Expected PICU stay ≥ 24 hours.
- Availability of informed consent from parent or guardian.

Exclusion Criteria

- Chronic kidney disease.
- Maintenance dialysis.
- Renal transplantation.
- Pre-existing KDIGO stage 2 or stage 3 AKI at admission.
- Congenital renal anomalies.
- Incomplete clinical records.

Data Collection: A detailed history and clinical examination were performed at admission. Demographic characteristics including age, sex, nutritional status, and primary diagnosis were recorded. Clinical data including requirement for mechanical ventilation, vasopressor support, nephrotoxic medication exposure, and duration of ICU stay were documented.

Investigations, Severity Assessment, and Outcome Measures: All enrolled patients underwent a comprehensive clinical and laboratory evaluation as part of routine PICU management. Baseline investigations included complete blood count, renal function tests, serum electrolytes, liver function tests, arterial blood gas analysis, and continuous urine output monitoring. Additional investigations such as chest radiography and ultrasonography were performed whenever clinically indicated. These investigations were used to assess the severity of illness, monitor organ function, and identify complications during the PICU stay.

The severity of illness was assessed using the Pediatric Risk of Mortality (PRISM-III) score, which was calculated at admission and subsequently monitored at predetermined intervals during the PICU stay. The risk of developing acute kidney injury (AKI) was evaluated using the Renal Angina Index (RAI), which was calculated at 24, 48, 72, and 96 hours after admission. AKI was diagnosed and staged according to the Kidney Disease: Improving Global Outcomes (KDIGO) criteria based on changes in serum creatinine levels and urine output measurements.

The primary outcome measures of the study were survival and mortality during the PICU stay. Secondary outcome measures included the development of acute kidney injury, requirement for mechanical ventilation, need for vasopressor support, and duration of PICU stay. These outcomes were analyzed to identify factors associated with adverse clinical outcomes among critically ill children admitted to the PICU.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25. Continuous variables were expressed as mean \pm

standard deviation, while categorical variables were presented as frequencies and percentages.

Chi-square test and Fisher's exact test were used for categorical variables.

Independent t-test was used for continuous variables. Odds ratios were calculated to determine risk factors associated with AKI development. A p-value <0.05 was considered statistically significant.

Results

Baseline Characteristics: A total of 300 children were included in the study.

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Frequency (%)
Age <2 years	171 (57.0)
Age ≥ 2 years	129 (43.0)
Male	152 (50.7)
Female	148 (49.3)
Malnutrition	56 (18.7)
Normal nutrition	244 (81.3)

The majority of patients were below two years of age (57.0%). Gender distribution was nearly equal, with males constituting 50.7% of the study population. Malnutrition was present in 18.7% of children (Table 1).

Table 2: Primary Diagnoses at Admission

Diagnosis	Frequency (%)
Gastrointestinal disorders	99 (33.0)
Respiratory disorders	84 (28.0)
CNS disorders	58 (19.3)
Others	59 (19.7)

Gastrointestinal disorders constituted the most common reason for admission, followed by respiratory and neurological illnesses (Table 2).

Table 3: Clinical Risk Factors and Interventions

Variable	Frequency (%)
Mechanical ventilation	33 (11.0)
Vasopressor support	22 (7.3)
Nephrotoxic medications	86 (28.7)
ICU stay 1–5 days	177 (59.0)
ICU stay 6–10 days	107 (35.7)
ICU stay >10 days	16 (5.3)

Mechanical ventilation and vasopressor support were required in a substantial proportion of critically ill children. Nearly one-third received nephrotoxic medications (Table 3).

Table 4: Outcome Measures

Outcome	Frequency (%)
Discharged	286 (95.3)
Death	14 (4.7)

Overall mortality was 4.7%, while 95.3% of patients were successfully discharged from the PICU (Table 4).

Association of PRISM-III Score with Outcome: The association between PRISM-III scores and patient outcomes was evaluated at multiple time points during the PICU stay.

Children who succumbed to their illness had significantly higher PRISM-III scores compared to those who survived and were discharged. At admission, the mean PRISM-III score among non-survivors was 15.50 ± 2.44 compared to 2.49 ± 3.51 among survivors ($p < 0.001$). Similar statistically significant differences were observed at 24 hours (17.93 ± 2.62 vs. 2.12 ± 3.21 , $p < 0.001$), 72 hours (21.18 ± 1.33 vs. 0.81 ± 2.19 , $p < 0.001$),

and 96 hours (19.17 ± 9.60 vs. 0.49 ± 1.69 , $p < 0.001$). Although the difference at 48 hours was not statistically significant, likely due to extreme variability in scores, the overall trend demonstrated consistently higher PRISM-III scores among patients who died.

These findings indicate that increasing illness severity, as reflected by higher PRISM-III scores, is strongly associated with mortality and adverse clinical outcomes in critically ill children. Thus, PRISM-III proved to be a valuable prognostic tool for early identification of high-risk patients requiring intensive monitoring and aggressive management.

Association of Renal Angina Index (RAI) with Clinical Outcome: The relationship between Renal Angina Index (RAI) and patient outcomes was assessed to determine its prognostic significance in critically ill children. Patients with an RAI score ≥ 8 demonstrated significantly higher mortality rates at all evaluated time points. At 24 hours, 7 of the patients with RAI ≥ 8 died compared to 6 who were discharged ($p < 0.001$).

Similarly, at 48 hours, 8 patients died while 6 survived; at 72 hours, 7 patients died and only 3 were discharged; and by 96 hours, all remaining patients with RAI ≥ 8 experienced mortality, with no survivors recorded. The consistent and statistically significant association between elevated RAI scores and mortality suggests that children identified as high risk by the RAI are substantially more likely to experience poor outcomes. These findings support the utility of the RAI not only as a predictor of acute kidney injury but also as an important prognostic marker for overall disease severity and mortality in the PICU setting.

Multivariate Analysis for Risk of Developing Acute Kidney Injury: Multivariate analysis was performed to evaluate the independent association between Renal Angina Index and the subsequent development of acute kidney injury (AKI).

The analysis demonstrated that elevated RAI scores were significantly associated with an increased risk of AKI development at different time points during the PICU stay. The highest predictive value was observed at 24 hours, where the odds ratio (OR) for AKI development was 5.682, indicating that patients with elevated RAI scores were nearly six times more likely to develop AKI compared to those with lower scores. A similarly strong association was observed at 72 hours (OR = 4.785), while the odds ratios at 48 hours (OR = 1.268) and 96 hours (OR = 2.567) were comparatively lower. These findings suggest that the first 24 to 72 hours following PICU admission represent a critical

period during which the RAI is most effective in identifying children at risk for AKI.

The results highlight the usefulness of early RAI assessment for timely risk stratification, close monitoring, and implementation of preventive interventions aimed at reducing the incidence and severity of AKI in critically ill pediatric patients.

Discussion

The present prospective observational study evaluated the clinical profile, risk factors, and outcomes among 300 critically ill children admitted to a tertiary care PICU. The study demonstrated that younger children constituted the majority of admissions and that gastrointestinal and respiratory illnesses remained the leading causes of critical illness.

More than half of the study population was below two years of age, reflecting the increased susceptibility of infants and toddlers to severe infections and organ dysfunction. Similar observations have been reported by Basu et al., Zulu et al., and Raman et al., who observed that younger children constituted a major proportion of PICU admissions [12-14]. Malnutrition was identified in nearly one-fifth of patients. Malnutrition has been recognized as an important determinant of adverse outcomes through impaired immunity, increased susceptibility to infections, delayed recovery, and higher rates of organ dysfunction. Similar findings have been reported in pediatric critical care literature [15-16].

Respiratory and gastrointestinal illnesses constituted the predominant disease categories in the present study. Severe respiratory infections may contribute to hypoxia, inflammation, and multiorgan dysfunction, whereas gastrointestinal illnesses frequently result in dehydration and electrolyte disturbances, both of which predispose to AKI [17-18]. Mechanical ventilation was required in 11% of patients. Previous studies have consistently demonstrated that the need for mechanical ventilation reflects increased illness severity and is associated with prolonged hospitalization and mortality. Alkandari et al. reported that ventilated children had significantly higher mortality and longer PICU stays [19-20]. Vasopressor support was required in 7.3% of patients, reflecting significant cardiovascular instability. Hemodynamic compromise is a recognized risk factor for organ dysfunction and mortality. Similar findings have been reported in studies evaluating critically ill pediatric populations [21-24]. Exposure to nephrotoxic medications occurred in 28.7% of children. Nephrotoxic drugs remain one of the most important modifiable risk factors for AKI in PICUs. Careful monitoring and judicious use of nephrotoxic agents are essential for

preventing renal injury [25-27]. The mortality rate observed in this study was 4.7%, which is comparable to mortality rates reported in several contemporary PICU cohorts. Mortality was significantly associated with higher illness severity scores and elevated RAI values [28].

PRISM-III scores demonstrated significant prognostic utility. Higher scores were associated with increased mortality, confirming findings reported by Basu et al., Ribeiro-Mourão et al., and Menon et al [29-30]. Patients with RAI ≥ 8 had significantly higher mortality and increased risk of AKI development. The strongest association was observed at 24 hours, with an odds ratio of 5.682.

These findings support previous studies demonstrating the usefulness of RAI as an early warning tool for identifying children at high risk of AKI and adverse outcomes. The findings emphasize the importance of comprehensive monitoring, early risk stratification, and multidisciplinary management of critically ill children admitted to PICUs.

Strengths: The strengths of this study include its prospective design, inclusion of a relatively large PICU cohort, comprehensive assessment of demographic and clinical variables, and the use of validated scoring systems such as PRISM-III and Renal Angina Index (RAI) for risk stratification and outcome prediction.

Limitations: This study has certain limitations that should be acknowledged. Being a single-center study, the findings may not be generalizable to all PICU settings. The relatively small number of mortality events may have limited the statistical power for outcome analysis.

Additionally, the potential influence of unmeasured confounding factors cannot be excluded, and variations in treatment protocols among patients were not specifically evaluated, which may have affected the observed outcomes.

Conclusion

Critically ill children admitted to PICUs are at substantial risk for adverse outcomes. Younger age, severe illness, requirement for mechanical ventilation, vasopressor support, nephrotoxic medication exposure, and elevated severity scores were associated with worse outcomes. PRISM-III and RAI proved valuable for risk stratification and prognostication.

Early identification of high-risk patients and prompt institution of targeted interventions may reduce morbidity and mortality and improve overall PICU outcomes.

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