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Clinical Profile, Risk Factors, and Outcomes of Acute Kidney Injury in Critically Ill Pediatric Patients

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ABSTRACT

Background: Acute kidney injury (AKI) is a frequent complication among critically ill children admitted to intensive care units and is associated with increased morbidity, prolonged hospitalization, and mortality. Early identification of risk factors and predictors of poor outcomes is essential for improving clinical management and survival.

Aim and Objectives: To evaluate the clinical profile, risk factors, severity, management strategies, and outcomes of acute kidney injury among critically ill pediatric patients admitted to a Pediatric Intensive Care Unit (PICU).

Materials and Methods: This prospective observational study was conducted in the Department of Pediatrics, ESIC Medical College and Hospital, Kalaburagi, Karnataka, from April 2025 to March 2026. A total of 100 critically ill children aged 1 month to 18 years diagnosed with AKI according to Kidney Disease Improving Global Outcomes (KDIGO) criteria were included. Demographic details, clinical features, risk factors, laboratory parameters, AKI severity, treatment modalities, and outcomes were recorded. Statistical analysis was performed using SPSS version 26.0. A p-value <0.05 was considered statistically significant.

Results: Among 100 children with AKI, the majority belonged to the 1–5 years age group (32%), with male predominance (61%). Sepsis/septic shock was the most common underlying condition associated with AKI (38%). Common clinical manifestations included fever (72%), oliguria (64%), and respiratory distress (52%). Sepsis (62%), shock (48%), nephrotoxic drug exposure (36%), and mechanical ventilation (34%) were major risk factors. According to KDIGO staging, Stage 1 AKI was observed in 42%, Stage 2 in 34%, and Stage 3 in 24% of patients. Renal replacement therapy was required in 12% of cases, predominantly among Stage 3 AKI patients. Complete renal recovery occurred in 68%, partial recovery in 14%, while mortality was observed in 10% of children. Sepsis, shock, mechanical ventilation, multiorgan dysfunction syndrome, and Stage 3 AKI were significantly associated with mortality ($p<0.05$).

Conclusion: AKI remains a significant complication among critically ill pediatric patients. Sepsis, hemodynamic instability, mechanical ventilation, MODS, and advanced AKI stage are important predictors of adverse outcomes. Early recognition and aggressive management of high-risk patients may improve renal recovery and reduce mortality.

Keywords: *Acute kidney injury; Pediatric intensive care unit; KDIGO criteria; Sepsis; Renal replacement therapy; Mortality; Critically ill children.*

INTRODUCTION

Acute kidney injury (AKI) is defined as an abrupt decline in renal function characterized by impaired ability of the kidneys to maintain fluid, electrolyte, and acid–base balance. It is a common complication among critically ill pediatric patients and represents an important cause of increased morbidity, prolonged hospitalization, and mortality in intensive care settings. Despite advances in pediatric critical care, AKI continues to be associated with poor outcomes, particularly among children with severe infections, shock, and multiorgan dysfunction syndrome (MODS).[1]

The reported incidence of AKI among critically ill children varies widely depending on patient characteristics, diagnostic criteria, and clinical setting. Earlier studies using serum creatinine-based definitions underestimated the true burden of AKI, whereas the introduction of standardized criteria such as Risk, Injury, Failure, Loss, End-stage renal disease (RIFLE), Acute Kidney Injury Network (AKIN), and Kidney Disease Improving Global Outcomes (KDIGO) has improved early recognition and classification of AKI severity.[2] The KDIGO criteria incorporate changes in serum creatinine and urine output and allow stratification into three stages, which correlate with clinical outcomes.[3]

In pediatric intensive care units, AKI is usually multifactorial. Sepsis and septic shock remain among the leading causes due to systemic inflammation, renal hypoperfusion, endothelial dysfunction, and microcirculatory abnormalities. Other important contributors include dehydration, nephrotoxic medications, mechanical ventilation, cardiac dysfunction, and exposure to contrast agents.[4] Children with severe AKI frequently develop complications such as metabolic acidosis, electrolyte abnormalities, fluid overload, and pulmonary edema, increasing the need for renal replacement therapy (RRT).[5]

Recent evidence suggests that even transient episodes of AKI may increase the risk of chronic kidney disease (CKD) later in life. Therefore, identifying children at high risk of AKI progression and mortality is essential for timely intervention and long-term renal protection.[6] Several studies have demonstrated that higher AKI stage, requirement of mechanical ventilation, vasopressor support, sepsis, and MODS are independent predictors of mortality among critically ill pediatric patients.[7]

In developing countries, pediatric AKI remains a major healthcare challenge due to delayed presentation, limited resources, high burden of infections, and restricted availability of renal replacement therapies. Data regarding clinical characteristics, risk factors, and outcomes of AKI among critically ill children from different regions are important for improving management protocols.

Therefore, the present study was undertaken to evaluate the clinical profile, risk factors, severity patterns, treatment approaches, and outcomes of acute kidney injury among critically ill pediatric patients admitted to a tertiary care hospital.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Pediatrics, ESIC Medical College and Hospital, Kalaburagi, Karnataka, India, over a period of one year from **April 2025 to March 2026**. The study was carried out in the Pediatric Intensive Care Unit (PICU) and pediatric wards to evaluate the clinical profile, risk factors, and outcomes of acute kidney injury (AKI) among critically ill pediatric patients.

Study Population

The study included **100 critically ill children** admitted to the PICU who fulfilled the diagnostic criteria for acute kidney injury during the study period.

Sample Size

A total of **100 consecutive eligible pediatric patients** diagnosed with AKI were enrolled using consecutive sampling until the desired sample size was achieved.

Inclusion Criteria

- Children aged **1 month to 18 years**.
- Admission to the Pediatric Intensive Care Unit (PICU).
- Diagnosis of acute kidney injury based on **Kidney Disease: Improving Global Outcomes (KDIGO) criteria**.
- Parents or legal guardians providing written informed consent.

Exclusion Criteria

- Neonates (<1 month of age).
- Children with previously diagnosed chronic kidney disease.
- Patients with congenital structural renal anomalies.

- Children on maintenance dialysis before admission.
- Patients with incomplete clinical records or whose parents declined consent.

Diagnostic Criteria for Acute Kidney Injury

Acute kidney injury was diagnosed and staged according to the **KDIGO criteria**, based on any one of the following:

- Increase in serum creatinine by **≥0.3 mg/dL within 48 hours**, or
- Increase in serum creatinine to **≥1.5 times baseline within 7 days**, or
- Urine output **<0.5 mL/kg/hour for at least 6 hours**.

AKI severity was categorized into **Stage 1, Stage 2, and Stage 3** according to KDIGO staging guidelines.

Data Collection

A structured case record form was used to collect demographic, clinical, laboratory, treatment, and outcome data. The following information was recorded:

- Age
- Sex
- Weight
- Nutritional status
- Duration of illness before admission
- Primary diagnosis
- Comorbid illnesses
- Clinical presentation
- Vital signs at admission
- Presence of shock
- Requirement of mechanical ventilation
- Exposure to nephrotoxic medications
- Presence of sepsis
- Dehydration
- Multiorgan dysfunction syndrome (MODS)
- Requirement of vasoactive drugs
- Length of PICU stay
- Total hospital stay

Laboratory Investigations

The following investigations were performed at admission and repeated as clinically indicated:

- Complete blood count (CBC)
- Serum creatinine
- Blood urea nitrogen (BUN)
- Serum electrolytes (sodium, potassium, chloride)
- Serum bicarbonate
- Blood glucose
- Liver function tests
- Urine routine microscopy
- Urine output monitoring
- Blood culture (when sepsis was suspected)
- Arterial blood gas analysis (where indicated)

Estimated glomerular filtration rate (eGFR) was calculated using the **Schwartz formula** whenever appropriate.

Clinical Variables

The following variables were assessed:

- Etiology of AKI
- KDIGO stage of AKI
- Presence of sepsis
- Septic shock
- Hypovolemia/dehydration
- Nephrotoxic drug exposure
- Respiratory failure
- Cardiac dysfunction
- Hepatic dysfunction
- Requirement of inotropic support

- Mechanical ventilation
- Renal replacement therapy (peritoneal dialysis/hemodialysis)
- Fluid overload
- Electrolyte abnormalities

Outcome Measures

Primary Outcome

- In-hospital mortality.

Secondary Outcomes

- Recovery of renal function.
- Progression of AKI severity.
- Requirement for renal replacement therapy.
- Duration of mechanical ventilation.
- Length of PICU stay.
- Total duration of hospital stay.
- Survival at discharge.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR) depending on data distribution. Categorical variables were expressed as frequency and percentage.

Comparisons between groups were performed using:

- Student's *t*-test or Mann-Whitney *U* test for continuous variables.
- Chi-square test or Fisher's exact test for categorical variables.

Variables showing statistical significance on univariate analysis were included in multivariate logistic regression to identify independent predictors of mortality and adverse outcomes. A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of ESIC Medical College and Hospital, Kalaburagi, Karnataka, India, before commencement of the study. Written informed consent was obtained from the parents or legal guardians of all participants. Confidentiality of patient information was maintained throughout the study in accordance with the principles of the Declaration of Helsinki.

RESULTS AND OBSERVATIONS

A total of 100 critically ill pediatric patients with acute kidney injury (AKI) admitted to the Pediatric Intensive Care Unit (PICU), ESIC Medical College and Hospital, Kalaburagi, Karnataka, were included in the study during the period from April 2025 to March 2026. The demographic characteristics, clinical profile, risk factors, laboratory parameters, severity of AKI, management strategies, and outcomes were analyzed.

Table 1: Age Distribution of Study Participants (n=100)

Age Group	Number of Patients	Percentage (%)
1 month–1 year	18	18
1–5 years	32	32
6–10 years	28	28
11–18 years	22	22
Total	**100**	**100**

Observation: The majority of children with AKI belonged to the **1–5 years age group (32%)**, followed by 6–10 years (28%).

Table 2: Gender Distribution of Study Population (n=100)

Gender	Number of Patients	Percentage (%)
Male	61	61
Female	39	39
Total	**100**	**100**

Observation: Male children constituted the majority of cases with a male-to-female ratio of approximately **1.5:1**.

Table 3: Primary Clinical Diagnosis Associated with AKI (n=100)

Underlying Condition	Number of Patients	Percentage (%)
Sepsis/septic shock	38	38
Severe pneumonia/respiratory infection	20	20
Dengue infection	12	12
Acute gastroenteritis with dehydration	10	10
Neurological illness	8	8
Hematological disorders	5	5
Other causes	7	7
Total	**100**	**100**

Observation: Sepsis and septic shock were the most common associated conditions leading to AKI (38%).

Table 4: Clinical Presentation of Patients with AKI (n=100)

Clinical Feature	Number of Patients	Percentage (%)
Fever	72	72
Oliguria	64	64
Respiratory distress	52	52
Altered sensorium	28	28
Edema	24	24
Vomiting	22	22
Convulsions	15	15

Observation: Fever and oliguria were the most frequently observed clinical features among children with AKI.

Table 5: Risk Factors Associated with Acute Kidney Injury (n=100)

Risk Factor	Number of Patients	Percentage (%)
Sepsis	62	62
Shock/hypotension	48	48
Nephrotoxic drug exposure	36	36
Mechanical ventilation	34	34
Dehydration	30	30
Multiorgan dysfunction syndrome (MODS)	28	28
Fluid overload	22	22

Observation: Sepsis was the most common risk factor associated with AKI, followed by shock and nephrotoxic drug exposure.

Table 6: KDIGO Staging of Acute Kidney Injury (n=100)

AKI Stage	Number of Patients	Percentage (%)
Stage 1	42	42
Stage 2	34	34
Stage 3	24	24
Total	**100**	**100**

Observation: Stage 1 AKI was the most common category (42%), whereas Stage 3 AKI accounted for 24% of cases.

Table 7: Laboratory Parameters Among Study Participants (n=100)

Laboratory Parameter	Mean ± SD
Serum creatinine (mg/dL)	2.1 ± 0.8
Blood urea nitrogen (mg/dL)	58.4 ± 22.6
Serum sodium (mEq/L)	136.8 ± 6.4
Serum potassium (mEq/L)	4.9 ± 0.9
Hemoglobin (g/dL)	10.2 ± 1.8
Total leukocyte count (/mm³)	14,200 ± 5,600

Observation: Elevated serum creatinine and blood urea nitrogen levels were observed among critically ill children with AKI.

Table 8: Associated Complications in Children with AKI (n=100)

Complication	Number of Patients	Percentage (%)
Metabolic acidosis	46	46
Electrolyte imbalance	38	38
Fluid overload	22	22

Pulmonary edema	18	18
Hypertension	14	14

Observation: Metabolic acidosis was the most common complication observed (46%).

Table 9: Management Strategies Used in AKI Patients (n=100)

Treatment Modality	Number of Patients	Percentage (%)
Fluid management	100	100
Antibiotics	82	82
Inotropic support	48	48
Mechanical ventilation	34	34
Renal replacement therapy	12	12

Observation: Supportive management with fluid therapy and antibiotics was the most frequently used treatment. Renal replacement therapy was required in 12% of patients.

Table 10: Renal Replacement Therapy Requirement According to AKI Stage (n=100)

AKI Stage	Patients Requiring RRT	Percentage (%)
Stage 1	1	2.4
Stage 2	3	8.8
Stage 3	8	33.3
Total	**12**	**12**

Observation: Requirement of renal replacement therapy was significantly higher among children with Stage 3 AKI.

Table 11: Clinical Outcomes of Study Population (n=100)

Outcome	Number of Patients	Percentage (%)
Complete renal recovery	68	68
Partial recovery	14	14
Persistent renal dysfunction	6	6
Required RRT at discharge	2	2
Death	10	10
Total	**100**	**100**

Observation: Renal recovery occurred in 82% of patients, while mortality was observed in 10% of cases.

Table 12: Factors Associated with Mortality Among AKI Patients (n=100)

Factor	Survivors (n=90)	Deaths (n=10)	p-value
Sepsis	52 (57.8%)	10 (100%)	<0.05
Shock	38 (42.2%)	10 (100%)	<0.05
Mechanical ventilation	26 (28.9%)	8 (80%)	<0.05
MODS	20 (22.2%)	8 (80%)	<0.05
Stage 3 AKI	16 (17.8%)	8 (80%)	<0.05

Observation: Sepsis, shock, mechanical ventilation, MODS, and Stage 3 AKI were significantly associated with increased mortality.

DISCUSSION

Acute kidney injury is a common and serious complication among critically ill pediatric patients and contributes significantly to increased morbidity, prolonged intensive care stay, and mortality. The present prospective observational study evaluated 100 children with AKI admitted to the PICU and assessed demographic characteristics, clinical spectrum, risk factors, disease severity, treatment requirements, and outcomes.

In the present study, children aged 1–5 years constituted the largest proportion of AKI cases (32%), followed by children aged 6–10 years (28%). Similar age distributions have been reported in pediatric intensive care studies, where younger children are more vulnerable due to higher susceptibility to infections, dehydration, and hemodynamic instability.[1–2] Male predominance was observed in our study, with males accounting for 61% of cases. Male predominance in pediatric AKI has also been reported in previous studies, although gender differences are not consistently associated with outcome.[8]

Sepsis and septic shock were the most common underlying causes of AKI in our study, accounting for 38% of cases. Sepsis was also identified as the most frequent risk factor (62%). This finding is consistent with previous reports showing sepsis as the leading contributor to AKI in critically ill children. Septic AKI results from complex interactions between inflammation, immune dysregulation, altered renal blood flow, endothelial injury, and mitochondrial dysfunction rather than isolated renal ischemia alone.[4]

Oliguria was observed in 64% of patients, while fever and respiratory distress were common presenting symptoms. Clinical manifestations of AKI in children are often nonspecific and may be masked by the primary illness, emphasizing the importance of regular monitoring of urine output and renal function parameters in critically ill patients.[9]

According to KDIGO classification, Stage 1 AKI was observed in 42% of children, Stage 2 in 34%, and Stage 3 in 24%. Similar studies have demonstrated that increasing AKI severity is associated with progressively worse clinical outcomes. KDIGO staging provides valuable prognostic information and helps identify children who may require intensive monitoring and early renal support.[3]

The present study identified sepsis, shock, nephrotoxic drug exposure, mechanical ventilation, dehydration, and MODS as important risk factors associated with AKI. Critically ill children frequently receive medications such as aminoglycosides, vancomycin, and other nephrotoxic agents, which may contribute to renal injury, especially in the presence of systemic inflammation and reduced renal perfusion.[10]

Metabolic acidosis (46%) and electrolyte abnormalities (38%) were the most common complications observed. These complications are commonly reported in pediatric AKI and may contribute to increased morbidity if not promptly corrected. Fluid overload was observed in 22% of patients, a finding associated with worse outcomes in critically ill children due to impaired oxygenation and delayed recovery.[11]

Renal replacement therapy was required in 12% of children, with the highest requirement among Stage 3 AKI patients (33.3%). Previous studies have similarly reported increased RRT requirement among children with severe AKI, particularly those with persistent oliguria, fluid overload, severe electrolyte disturbances, and metabolic abnormalities.[12]

In the current study, complete renal recovery occurred in 68% of patients, partial recovery in 14%, and mortality was observed in 10%. Mortality was significantly associated with sepsis, shock, mechanical ventilation, MODS, and Stage 3 AKI. These findings are consistent with previous literature demonstrating that AKI severity and associated organ dysfunction are strong predictors of mortality in critically ill pediatric populations.[7]

The relationship between AKI and long-term renal outcomes is increasingly recognized. Survivors of severe AKI may remain at risk for CKD, hypertension, and reduced glomerular filtration rate. Therefore, follow-up of children recovering from AKI is essential for early detection of chronic renal impairment.[6]

The findings of this study highlight the importance of early diagnosis, regular monitoring of renal parameters, prevention of nephrotoxic exposure, prompt treatment of sepsis, and timely initiation of renal support when indicated. Implementation of AKI prevention strategies and standardized monitoring protocols in PICUs may improve outcomes among critically ill children.

CONCLUSION

Acute kidney injury is a significant complication among critically ill pediatric patients and is associated with increased morbidity and mortality. In the present study, sepsis and septic shock were the most common causes and risk factors associated with AKI. Higher AKI severity, particularly KDIGO Stage 3, was associated with increased requirement for renal replacement therapy and poorer outcomes. Sepsis, shock, mechanical ventilation, multiorgan dysfunction syndrome, and severe AKI stage were important predictors of mortality.

Early identification of high-risk children, regular monitoring of renal function, prevention of nephrotoxic exposure, prompt management of infections and hemodynamic instability, and timely initiation of renal support can improve clinical outcomes. Long-term follow-up of children recovering from AKI is recommended to detect possible progression to chronic kidney disease.

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