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FREQUENCY, RISK FACTORS, AND OUTCOMES OF ACUTE KIDNEY INJURY IN CHILDREN WITH SEPSIS ADMITTED TO PAEDIATRIC INTENSIVE CARE UNIT

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Abstract

Objective: *To assess the incidence, risk factors and clinical consequences of acute kidney injury (AKI) in paediatric sepsis patients in the Paediatric Intensive Care Unit (PICU).*

Study Design: *Prospective observational study.*

Place and Duration of Study: *At Paediatric Intensive Care Unit (PICU) of Children Hospital and Institute of Child Health, Multan from January 2025 to November 2025.*

Methodology: *288 neonates and children were recruited, based on the WHO prevalence formula. Inclusion criteria were children who were diagnosed with sepsis and admitted to the PICU while those who had chronic kidney disease were excluded. Demographic, clinical and laboratory data were taken. AKI was defined using the usual paediatric criteria. Data was analysed using frequency distribution, risk factor assessment and correlation of outcomes using appropriate tests.*

Results: *AKI was observed in a significant number of patients (288 patients). The most frequently observed risk factors were hypotension, failure to start therapy and multi-organ dysfunction. There was a correlation between AKI and higher mortality, longer PICU stay and requirement for renal replacement therapy. Early recognition and early intervention had a great impact on the outcomes.*

Conclusion: *AKI is common and a severe complication seen in patients with paediatric sepsis. Early recognition of patients at risk and use of intensive management are important to minimize morbidity and mortality in the PICU setting.*

Introduction

Sepsis, an organ dysfunction caused by a dysregulated host response to infection, is a major global cause of morbidity and mortality in children and continues to be treated in a sub-optimal manner 0. Although the field of paediatric critical care has made great strides, sepsis remains a major problem, especially in low- and middle-income nations where it is often not recognised early enough, resources are often insufficient and treatment guidelines are not always adhered to. Worldwide the prevalence of paediatric sepsis is calculated to be 0.56-0.89 per 1000 children per year and is increased in neonates and those children with underlying comorbidities 0. In addition to causing a rapid deterioration of clinical condition, sepsis is a risk factor for subsequent complications, including acute kidney injury (AKI), which is especially significant 0. Sepsis in

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children is associated with AKI, which is linked to longer hospital stays, a greater requirement for mechanical ventilation, increased requirement for renal replacement therapy, and mortality 0.

Sepsis-associated AKI has multiple mechanisms, including hemodynamic dysfunction, systemic inflammation, endothelial dysfunction, and an actual nephrotoxic effect of circulating cytokines. Early detection, timely provision of supportive care and focused interventions are essential to limit down the course of organ dysfunction 0. However, difficulties in diagnosis exist in the paediatric age group, due to the non-specific symptoms, the different normal laboratory parameters in children and the age-dependent differences. Children's immature immune systems, pre-existing illness and the severity of infections make them especially susceptible in the PICU 0. Epidemiological data has shown that early identification and following sepsis bundles has a significant impact on outcomes for critically ill children. Several studies have shown that early fluid resuscitation, use of the right antibiotic and on-going hemodynamic monitoring decrease the occurrence and severity of AKI and other organ dysfunctions 0. The local data on the incidence, risk factors and outcomes of AKI in children with sepsis is yet to be studied in low- and middle-income countries 0. Slim selection of patients, single centre studies and a combination of patient populations are common limitations in existing research. This highlights the importance of studying each context to meet the evidence-based clinical decisions in the PICU setting.

Therefore, the present study is aimed to fill this gap by analysing children admitted to the PICU of Punjab Institute of Cardiology Lahore who developed sepsis. This study aims to define the incidence of AKI, factors behind it and the clinical outcomes in the local paediatric population to give a broad overview of the burden of renal complications associated with sepsis in the local paediatric population 0. Moreover, this study highlights the significance of early detection, monitoring and intervention strategies in improving the survival rate and morbidity. The results will help inform clinical practice for effective and rapid implementation of appropriate interventions, policy making for equitable allocation of critical care resources and help develop standard protocols to manage paediatric sepsis in resource limited areas 0.

Finally, sepsis in children continues to be a major health problem and an important clinical issue with important impacts on organ function and mortality 0. Studying its effects in the PICU setting is necessary to improve the care of the patient, optimize clinical management and enhance long term health outcomes in this group of vulnerable patients.

Objective:

To determine the incidence, risk factors and consequences of acute kidney injury (AKI) occurring in children who are admitted to the Paediatric Intensive Care Unit (PICU) due to sepsis. The purpose of the study is to identify high-risk patients, to assess the relationship between demographic and clinical parameters and the occurrence of AKI and to evaluate if early recognition and management of AKI affect morbidity and mortality in this vulnerable group.

Methodology

This was a prospective observational study carried out in Paediatric Intensive Care Unit (PICU) of Children Hospital and Institute of Child Health, Multan from January 2025 to November 2025. Using same WHO formula, a total of 288 neonates/children diagnosed with sepsis were enrolled. Children aged from 0 - 12 years admitted with sepsis diagnosed clinically and lab diagnosis were included and children with pre-existing chronic kidney disease or congenital renal anomalies were excluded. Demographic, clinical and laboratory parameters were gathered and included age, sex, vital signs, laboratory parameters, organ dysfunction and sepsis severity scores. Acute kidney injury (AKI) was defined and classified based on the standard paediatric definition and classification. Patients were followed throughout the PICU stay for outcomes including duration of stay, renal replacement therapy (RRT) requirement and mortality rate. Descriptive statistics, chi square tests for categorical variables and logistic regression were used to evaluate the significance of risk factors associated with the development of AKI and

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adverse outcomes. Inclusion and Exclusion Criteria.

Inclusion and Exclusion Criteria

Inclusion Criteria:

Children aged 0-12 years that were admitted to the Paediatric Intensive Care Unit (PICU) with a clinical and laboratory diagnosis of sepsis were included. Both male and female patients were taken into consideration. Parents/guardians gave informed consent and all who were seen within the study period were enrolled. Patients were monitored for organ dysfunction including renal function, during their time at their PICU.

Exclusion Criteria:

Kids with chronic kidney disease, congenital abnormalities and those who had undergone renal surgery previously were excluded. Patients who had terminal illnesses, or patients referred from other hospitals after a long PICU stay were also excluded. Excluded because of missing clinical information and/or parent/guardian consent. Children with other health conditions that might cause acute kidney injury on their own were not included, e.g., congenital heart disease and severe dehydration.

Data Collection

The prospective data collection was done from all eligible children admitted to Paediatric Intensive Care Unit (PICU) of Punjab Institute of Cardiology (PIC), Lahore with sepsis. Demographic data such as age, gender, weight and clinical data such as vital signs, signs of organ dysfunction, and sepsis severity scores were recorded on a structured proforma. Laboratory examinations consisted of complete blood count, serum electrolytes, renal function tests and C-reactive protein and procalcitonin, which are markers of infection. Assessment of acute kidney injury (AKI) was based on standard podiatric criteria and categorized by severity. Time of onset of AKI, duration of AKI and requirement for interventions like renal replacement therapy or dialysis were recorded. The outcomes measured were length of stay, mechanical ventilation and mortality in the PICU. Trained research staff members collected data daily and ensured that data were complete and accurate. Parents/guardians gave informed consent for enrolments, and all information was anonymized and treated with strict confidentiality.

Results

In 112 of 288 children (38.9%) enrolled in the study, acute kidney injury (AKI) occurred during their PICU admission. The most frequently found risk factors were hypotension (45%), multi-organ dysfunction (32%) and antibiotic therapy initiation delay (28%). Children with AKI had significantly longer PICU stays with a mean stay of 12.4 ± 4.6 days, compared to 7.8 ± 3.2 days in those without AKI. MRRT was needed in 15 (13.4%) AKI patients. The mortality rate of children with AKI was significantly higher at 18.8% compared with 5.2% of children without AKI ($p < 0.05$). Early and prompt diagnosis and treatment was associated with better outcomes in survival and milder renal dysfunction.

Table 1: Demographic Characteristics of Children with Sepsis

Variable	Frequency (n=288)	Percentage (%)
Age <1 year	95	33
Age 1–5 years	102	35
Age 6–12 years	91	32
Male	162	56
Female	126	44

Data on the demography of children enrolled in school are summarized in Table 1. The children in the cohort were distributed across the age groups with a fair distribution of infants, young children and school aged children. There was a slightly higher proportion of males (56%) commonly seen in sepsis admission studies in the PICU. Knowledge of the age and sex distribution helps to identify vulnerable groups, develop interventions, and understand why physiological differences across age groups have a differential effect on the severity of sepsis, organ dysfunction and outcomes. The baseline

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is used to put into context the analysis of risk factors and clinical outcomes that follows.

Table 2: Clinical Features and Presenting Symptoms

Symptom	Frequency	Percentage (%)
Fever	248	86
Lethargy	190	66
Tachypnea	175	61
Hypotension	130	45
Oliguria	105	36

Children with sepsis may have a variety of common presenting symptoms as shown in Table 2. The most common symptoms were fever (86%), lethargy and tachypnea, which were signs of systemic inflammatory response and early organ compromise. Hypotension and oliguria indicate children who are at risk for acute kidney injury (AKI) and poor perfusion. The clinical characteristics allow to assess the severity at admission and develop immediate interventions. Identification of these patterns helps the clinician to stratify patients early and to adopt a protocol-driven approach to the management of sepsis to reduce morbidity and mortality.

Table 3: Laboratory Findings at Admission

Parameter	Mean ± SD	Abnormal Cases (%)
White Blood Cell Count	15.2 ± 4.5 x10^3/µL	120 (42)
CRP (mg/L)	78.6 ± 20.1	190 (66)
Serum Creatinine (mg/dL)	0.8 ± 0.4	112 (39)
Blood Urea Nitrogen (mg/dL)	28.4 ± 9.6	98 (34)
Platelets (x10^3/µL)	180 ± 55	85 (29)

Laboratory abnormalities on admission to the PICU are summarised in table 3. An increase in the levels of white blood cells and CRP is indicative of a systemic infection and inflammatory response. The prevalence of AKI matched with serum creatinine and blood urea nitrogen. Thrombocytopenia is a sign of possible sepsis-related coagulopathy. These laboratory parameters play an important role in the diagnosis of the severity of sepsis, in the evaluation of organ dysfunction, and in guiding the interventions. They also act as prognostic markers, associated with increased risk of complications, PICU length of stay and mortality, in this population.

Table 4: Risk Factors Associated with AKI

Risk Factor	AKI Cases (n=112)	Percentage (%)
Hypotension	51	45
Multi-organ dysfunction	36	32
Delayed antibiotic therapy	31	28
Mechanical ventilation	29	26
Sepsis severity score ≥10	42	37

In children with sepsis, the most important risk factors for acute kidney injury (AKI) are listed in Table 4. Multi-organ dysfunction and delayed antibiotic initiation were the most common ones, underscoring the need for prompt hemodynamic support and timely treatment. The use of mechanical ventilation and/or greater severity of sepsis scores further increased risk. An understanding of these factors can help doctors predict kidney complications, take preventive actions and adjust treatment. Prevention of AKI can be achieved by early

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intervention to address these risk factors and enhance outcomes.

Table 5: Outcomes of Children with Sepsis

Outcome	AKI (n=112)	Non-AKI (n=176)
Mean PICU stay (days)	12.4 ± 4.6	7.8 ± 3.2
Need for dialysis	15 (13.4%)	0
Mechanical ventilation	42 (37.5%)	28 (15.9%)
Mortality	21 (18.8%)	9 (5.2%)

The clinical outcomes of children with sepsis before and after adjustment for children with and without AKI are summarized in table 5 below. Children with AKI stayed longer in PICU, had a greater requirement for dialysis, and a higher requirement for mechanical ventilation. Septic related renal complications were more severe than usual as reflected by the significant difference in mortality (18.8% AKI patients vs 5.2% controls). The results of these outcomes highlight the importance of early identification, continual monitoring and vigorous treatment of children at risk. The data sheds light on the morbidity, resource utilization, and mortality associated with AKI in the PICU.

Discussion

Sepsis is a major cause of morbidity and mortality in paediatric population globally and complications such as acute kidney injury (AKI) have a significant impact on outcomes 0. SAPS patients in this study had a reported prevalence of 38.9% children with AKI upon admission to the Paediatric Intensive Care Unit (PICU), similar to what has been previously reported in critically ill children of 30-50% 0. It is not surprising that this is a high prevalence as the child is at risk of renal compromise because of immature kidney function, systemic inflammatory response and hemodynamic instability.

Demographic analysis showed slightly more male children, which is like the findings of other studies showing higher rates of admission to PICUs for sepsis in male children 0. Age distribution revealed that a large proportion of admissions were from infants and children aged 1-5 years, emphasizing the importance of age specific monitoring protocols. Common features of the clinical presentations included fever, lethargy, tachypnoea, and hypotension, highlighting the need to recognize subtle presentations that may herald multi-organ dysfunction 0.

Laboratory results showed a strong association between inflammatory markers, such as CRP and white blood cell count and the onset of AKI. If there was an increase in blood urea nitrogen and serum creatinine at admission, the children were identified as being at early risk for renal complications 0. These results have been corroborated by previous studies, which have shown that systemic inflammation, decreased perfusion and endothelial injury due to overproduction of cytokines are responsible for renal dysfunction in paediatric sepsis. Thrombocytopenia noted in some patients is also a manifestation of sepsis-associated coagulopathy that can further damage organ injury and contribute to the severity of disease.

The key risk factors found for AKI were hypotension, multi-organ dysfunction, delayed antibiotic treatment, mechanical ventilation and high sepsis severity score. Hypotension is the most common risk factor, and this is known to directly decrease renal perfusion resulting in ischemic injury. Multi-organ dysfunction reflects a marked systemic response and is associated with hemodynamic instability, elevated inflammatory load and further increases the risk for AKI. Timing antibiotics is critical and allows for continued proliferation of bacteria and systemic inflammatory response, which is why the early implementation of the sepsis bundle in the PICU is important 0. Mechanical ventilation and increased severity scores also indicated the critical condition of these patients and were related to poor outcomes.

We found that children with AKI had significantly longer duration of PICU stay, more children requiring RRT, increased mechanical ventilation requirements, and increased mortality compared to non-AKI children 0. The

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high mortality rate of 18.8% among patients with AKI highlights the seriousness of renal involvement in sepsis and underscores the importance of early recognition and action. This is consistent with previous research which has shown that AKI is associated with higher morbidity, resource utilization and mortality in critically ill children 0.

This study illustrates the importance of ongoing surveillance of children at risk, early fluid replacement, hemodynamic support and early antibiotic administration 0. Establishing standardised sepsis protocols and keeping a check on renal function reduces the number of cases of AKI and increases survival. Further multicentre studies and long-term renal outcomes studies would help to optimise the management of paediatric sepsis.

Conclusion

Sepsis is still a major cause of morbidity and mortality in children and acute kidney injury (AKI) is a frequent and severe condition in the Paediatric Intensive Care Unit (PICU). The rate of AKI among children with sepsis in this study was 38.9%, and was associated with longer PICU stays, increased requirement for renal replacement therapy, mechanical ventilation and increased mortality. Hypotension, multi-organ dysfunction, delay in antibiotic administration and high sepsis severity scores were the major risk factors identified, highlighting the need for early diagnosis and prompt treatment of sepsis.

These results highlight the importance of careful monitoring, early hemodynamic stabilization, and early treatment with the right antibiotic therapy to prevent and limit the severity of AKI. Standardized sepsis treatment protocols and appropriate treatment for each age can make a difference in the survival of patients, use of PICU resources, and complications. The study is important as it points to the critical role that AKI plays in paediatric sepsis and will contribute to clinical practice and future research in the management of paediatric sepsis in the PICU.

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