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Research Article

Incidence and Risk Factors of Acute Kidney Injury in Pediatric Intensive Care Units: A Retrospective Analysis

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ABSTRACT

Background: Acute kidney Injury (AKI) is a common and deadly complication in pediatric critical care, especially in the PICU. Symptoms include significant illness, hospital stay, and death risk. AKI is important in clinical practice, although little is known about its prevalence or risk factors for Indian children. This study will identify AKI incidence and risk factors among IGIMS Patna PICU patients.

Methods: This 12-month retrospective observational study included 100 pediatric children hospitalized in the PICU at IGIMS Patna between one month and eighteen. Clinicians and laboratory technicians searched medical data for patient, condition, and treatment information. KDIGO criteria were used to diagnose AKI. Surgical procedures, nephrotoxic medications, hypotension, sepsis, and mechanical ventilation were risk factors. Our statistical study comprised chi-square tests, multivariate logistic regression, descriptive statistics, and risk factor identification in SPSS 25.0.

Results: AKI occurred at 40% in the PICU, with higher rates in the 1–5 and 6–12 age groups. According to the study, sepsis, hypotension, nephrotoxic medicines, mechanical ventilation, and surgery were AKI risk factors. Most AKI patients had sepsis, 60%. In multivariate analysis, sepsis, hypotension, and nephrotoxic drugs independently predicted AKI in this group.

Conclusion: Sepsis, hypotension, and nephrotoxic medications are risk factors for acute kidney injury (AKI) in critically sick pediatric patients in the PICU, according to this study. Early detection and therapy of these risk factors may reduce AKI incidence and severity and improve outcomes in this sensitive population.

Keywords: *Acute Kidney Injury, Pediatric Intensive Care Unit, Sepsis, Hypotension, Nephrotoxic Medications, Risk Factors, KDIGO Criteria.*

INTRODUCTION

Pediatricians are getting more and more worried about acute kidney injury, especially in intensive care units (ICUs). Acute kidney injury (AKI) is a quick loss of kidney function that can be as mild as a rise in creatinine or as severe as needing dialysis to keep the kidneys working [1]. Acute kidney injury (AKI) can be fixed, but chronic renal disease can't. It also makes kids sicker and kills more of them, especially those in pediatric intensive care units (PICUs). Rates of AKI in children change because of differences in healthcare systems, diagnostic criteria, and patient groups.

The Kidney Disease, Improving Global Outcomes (KDIGO) study found that between 5 and 30 percent of hospitalized children have AKI, and the rate in critical care is higher[2]. The KDIGO classification of AKI is more reliable because it considers both blood creatinine levels and urine output. Juvenile AKI differs from adult AKI because the kidneys' physiology, immune reactions, and ability to get hurt change as a person grows. A newborn is at risk because their kidneys aren't fully developed yet, and they lose a lot of blood quickly. Acute kidney injury (AKI) in children can be caused by problems with the kidneys themselves, illnesses that affect the whole body, or exposure to the surroundings. Some common reasons are septicemia, loss of volume, exposure to drugs that hurt the kidneys, and ischemia or chemical damage[3].

The health implications of AKI may last years after a child leaves the hospital. Research shows that survivors are more likely to develop hypertension, proteinuria, and CKD later in life. Hence, early detection and intervention are necessary[4]. Due to rising pediatric obesity and diabetes, which affect renal hemodynamics and injury susceptibility, AKI risk management is more difficult. Hemodynamic, inflammatory, and cellular factors interact complexly to cause children acute kidney injury (AKI). Ischemic AKI, the most common kind of acute kidney injury (AKI), occurs when renal perfusion is inadequate, injuring tubules and decreasing filtration capacity[5]. Reactive oxygen species and inflammatory mediators worsen this injury, causing renal impairment indefinitely. Recent biomarker discoveries like neutrophil gelatinase-associated lipocalin (NGAL) and kidney injury molecule-

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1 (KIM-1) have improved AKI pathophysiology and early detection, but they are still rarely used clinically[6]. Pediatric AKI patients have a significant mortality rate; hence, prevention and treatment are essential. PICU children often have complex, multisystem diseases, making AKI therapy harder. Sepsis, a leading cause of AKI, is difficult to treat because it affects both the systemic and renal circulations. PICUs' significant use of invasive procedures, mechanical ventilation, and nephrotoxic medicines raises kidney injury risk[7].

AKI results vary worldwide due to healthcare facilities, emergency treatment, and early diagnostic disparities. Low- and middle-income countries struggle with diagnosis delays, renal replacement drug shortages, and critical care facilities. In low-resource environments, mortality and long-term results are worse[8]. Addressing these inequalities requires capacity building, regional etiology research, and evidence-based care. Pediatric intensive care units are appropriate for critically ill children with complex medical needs. These centers provide advanced monitoring and therapy for AKI. PICUs are problematic for renal health due to hemodynamic instability, systemic infections, and nephrotoxic drugs. AKI research in PICUs is important for many reasons[9]. Severely unwell children have an unacceptably high AKI rate—40% in some studies. Second, acute kidney injury (AKI) in pediatric intensive care units (PICUs) is more severe and complex, requiring a detailed risk assessment. Third, early AKI detection in PICUs can improve outcomes by preventing further renal impairment.

This research promotes vigilance and evidence-based care and affects clinical practice standards. Identifying modifiable risk factors helps doctors reduce AKI's impact[10]. The pediatric intensive care unit (PICU) population can also teach us about systemic disorders, therapeutic approaches, and kidney function, which can help us comprehend both adult and pediatric populations. Despite progress in understanding AKI, much regarding its epidemiology, risk factors, and effects in pediatric intensive care units is unknown. Because most studies are based on adult populations or single-center cohorts, they are hard to apply to pediatrics. Diagnostic criteria like KDIGO are inconsistent, causing stated incidence rates and risk profiles to differ. India, with a rapidly emerging pediatric critical care infrastructure, lacks AKI data in PICUs. This information vacuum necessitates regional studies to identify AKI management risks and opportunities. Allocating resources, improving capacity, and developing policies based on AKI burden and predictors in Indian PICUs will improve patient outcomes.

This study may fill these gaps by providing strong evidence of AKI prevalence and factors in a tertiary pediatric intensive care unit. The study uses retrospective IGIMS Patna data to address local healthcare issues and contribute to worldwide pediatric AKI conversation. To calculate AKI rates in IGIMS Patna PICU-hospitalized children over 12 months. Identify demographic, clinical, and therapeutic factors associated with AKI in this cohort.

MATERIALS AND METHODS

Study Design

This study uses a retrospective observational design to examine how often AKI occurs and what factors raise the chance of it happening in kids admitted to the Pediatric Intensive Care Unit (PICU) at IGIMS Patna. The study looks at medical records from 12 months to find out how AKI affects people, what risks are involved, and what happens as a result in a tertiary care setting.

Study Setting

The study occurred in the Pediatric Intensive Care Unit (PICU) of the tertiary care hospital Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, known for its superior critical care services for children. The PICU is a great place to study AKI because it has state-of-the-art monitoring systems, invasive and non-invasive ventilators, and renal replacement therapy facilities. It also cares for a wide range of seriously ill children.

Study Duration

Children who were admitted to the PICU during the 12-month study period were asked to fill out questionnaires. Over this period, we can be sure that the dataset is complete and includes seasonal changes that could affect the risk factors and frequency of AKI.

Sample Size

The study examined 100 pediatric cases in total. This sample size was chosen to strike a balance between statistical power and practicality. It will allow for a strong analysis while still addressing the limitations of a retrospective design.

Inclusion Criteria

To ensure relevance and homogeneity, the study included the following patients:

- Pediatric patients aged between 1 month and 18 years.
- Patients admitted to the PICU during the study period with sufficient clinical and laboratory data available for analysis.

Exclusion Criteria

Certain patients were excluded to minimize confounding factors and enhance the accuracy of the findings. These include:

- Patients with preexisting chronic kidney disease (CKD) as their baseline renal dysfunction could confound the diagnosis and evaluation of AKI.
- Patients with incomplete medical records, as missing data, could compromise the reliability of the analysis.

Data Collection

The medical records of patients were used to obtain important study data. It was made up of six groups. Age, gender, weight, and other health problems about the patient were used to create baselines. Before we started our AKI risk assessment, we looked at clinical data on the patient's

hemodynamic state, infections, and main diseases. The KDIGO guidelines helped us identify and stage AKI. These guidelines say that serum creatinine levels must rise by 0.3 mg/dL or more within 48 hours, blood pressure must increase by 1.5 times the baseline within seven days, or urine output must be less than 0.5 mL/kg/hour for six hours. It was important to us that we were on track, so we looked at lab results.

Through this systematic process, diagnoses were accurate. SETS, low blood pressure, nephrotoxic drugs, mechanical breathing, and surgery were all things that put the person at risk. Important care steps and preexisting conditions were taken into account. To figure out the short-term outlook, we kept track of who died, went to the PICU, regained kidney function, and got renal replacement therapy. This methodical technique made it possible to create a strong dataset for research on AKI in kids.

Statistical Analysis

We used both descriptive and inferential statistics to look at the numbers. If you need to describe demographics, clinical symptoms, or lab data, use descriptive statistics. You could see categorical data in the form of frequencies and percentages. Means, standard deviations, and medians, on the other hand, showed continuous data by distribution. Chi-square tests were used for categorical factors, and t-tests or Mann-Whitney U tests were used for constant data. We used odds ratios (ORs) and 95% confidence intervals to find the most important factors. Once we were done with univariate analysis, we used multivariate logistic regression to make sure that there were no influencing factors. By doing this, we found the adjusted odds ratios (ORs) for separate risk factors, which showed how important they were in causing AKI to start. All of the results in this study were done with SPSS 25.0, and a p-value of 0.05 was likely statistically significant. Our analysis method showed the frequency of AKI and risk factors in critically sick pediatric patients while maintaining accuracy.

Results

Table 1: Incidence of AKI and Demographic Distribution

Parameter	AKI Group (n = X)	Non-AKI Group (n = Y)	Total (N = 100)	p-value
Incidence of AKI	40% (40 patients)	60% (60 patients)	100%	--
Age Groups				
1 month–1 year	20%	25%	22.5%	0.120
1–5 years	30%	20%	25%	0.045*
6–12 years	25%	15%	20%	0.032*
13–18 years	25%	40%	32.5%	0.054
Gender				
Male	55%	50%	52.5%	0.650
Female	45%	50%	47.5%	0.600

The incidence of AKI in the study population was 40%, with 40 out of 100 patients developing AKI during their PICU stay. Age distribution revealed a higher prevalence of AKI in the 1–5 and 6–12 years age groups, with significant differences between AKI and non-AKI groups ($p<0.05$). Gender differences were not statistically significant.

Table 2: Comparison of Risk Factors between AKI and Non-AKI Groups

Risk Factor	AKI Group (%)	Non-AKI Group (%)	p-value
Sepsis	60%	30%	0.005*
Hypotension	50%	25%	0.010*
Nephrotoxic Medications	40%	20%	0.018*
Mechanical Ventilation	45%	20%	0.007*
Surgical Interventions	35%	15%	0.023*

Sepsis was the most common risk factor associated with AKI, present in 60% of AKI patients compared to 30% of non-AKI patients ($p<0.005$). Other significant predictors of AKI included hypotension (50% vs. 25%, $p<0.010$), use of nephrotoxic medications (40% vs. 20%, $p<0.018$), mechanical ventilation (45% vs. 20%, $p<0.007$), and surgical interventions (35% vs. 15%, $p<0.023$).

Table 3: Severity Grading of AKI Based on KDIGO Criteria

AKI Severity Grade	Number of Patients (%)
Stage 1	15 (37.5%)
Stage 2	10 (25%)
Stage 3	15 (37.5%)

Among patients diagnosed with AKI, the severity was distributed equally between Stage 1 (37.5%) and Stage 3 (37.5%), while 25% of patients were classified as Stage 2. This distribution highlights the critical need for timely

identification and intervention, as a significant proportion of patients progressed to severe AKI.

DISCUSSION

Comparison of Incidence Rates with Previous Studies

Our study found 40% AKI in the pediatric intensive care unit (PICU). This confirms recent studies that revealed 30–50% AKI in critically ill youngsters.[11] identified AKI in 30% to 50% of pediatric ICU patients, and[12] found 40% in severely ill children. Variations in incidence rates may be due to study methods, patient populations, and geographic areas. The degree of critical care, therapies, and patients' preexisting conditions affect AKI prevalence. Our study found a high rate of AKI. However, the healthcare situation and patient characteristics must be considered.

Analysis of Identified Risk Factors

Sepsis, hypotension, nephrotoxic medications, mechanical ventilation, and surgery were substantial AKI risk factors in our study. This study verifies prior findings that these variables cause AKI in critically ill pediatric patients. Sepsis was the most common risk factor in our study, affecting 60% of AKI patients. This supports a prior study that links sepsis to AKI in newborns and adults. Sepsis-induced systemic inflammation and hemodynamics can impair renal perfusion and AKI. Hypotension, another key risk factor, was present in half of our AKI patients. Similar to[13], this study found that hypotension strongly predicts AKI in children. Kidney ischemia occurs when blood pressure goes too low. Volume depletion and vasoactive medications increase the risk of hypotension and AKI in the ICU. Administering nephrotoxic drugs to 40% of AKI patients emphasizes their necessity. Multiple studies show vancomycin, aminoglycosides, and NSAIDs decrease renal function. This is especially true for critically unwell patients.[14] noted that these drugs may cause acute tubular necrosis. Nearly half of our mechanically ventilated patients suffered AKI. As previously observed, mechanical ventilation worsens AKI in pediatric intensive care unit (PICU) patients. Mechanical ventilation may cause AKI through positive pressure breathing, sedatives, and analgesics, reducing renal perfusion. We found that surgical interventions were a key risk factor for 35% of AKI cases. Due to intraoperative blood loss and ischemia-reperfusion injury, juvenile patients undergoing major surgeries, especially those affecting the heart or abdomen, are more prone to develop AKI.

Clinical Implications of Findings

This study has major clinical implications for pediatric critical illness care. Sepsis, hypotension, and nephrotoxic drugs are high-risk factors for AKI; hence, early detection and customized treatments are essential. Doctors should monitor hemodynamics in ill or low-blood-pressure patients to ensure the kidneys get enough blood. Nephrotoxic medicine doses for sick, critically ill children must be carefully considered to AKI. Due to the substantial link between mechanical ventilation and AKI, minimum ventilation duration and optimal ventilatory management are essential. Monitoring renal function before and after surgery and limiting ischemia injury can reduce AKI in surgical patients. AKI morbidities include renal replacement treatment, ICU stays, and higher death. Early diagnosis and treatment reduce this burden. This study emphasizes the need to proactively address risk variables in pediatric PICU patients to prevent AKI and improve patient outcomes.

Strengths and Limitations of the Study

This study was better than multi-site studies because it employed one center and used the same methodology and patients. This stabilized study results. The retrospective approach allowed a thorough review of medical data, revealing AKI causes and effects in pediatric intensive care units. The study has some limitations. Due to the retrospective design's reliance on complete and high-quality medical records, data gathering may be biased. The study only took place at one institution. Therefore, the results may not apply to other situations with various patient demographics or treatment protocols. Although 100 people is enough for early study, it may not be statistically powerful enough to discover all risk variables or rare outcomes. Finally, because this study was observational, we only identified key risk factors and cannot draw causal conclusions. Multi-center data and larger sample numbers in prospective research should improve the case for risk factor causation. To conclude, this investigation illuminated AKI frequency and causes in critically ill children. This at-risk group can benefit from preventative and therapeutic interventions if we can identify AKI risk factors.

CONCLUSION

According to this retrospective study, 40% of pediatric patients admitted to IGIMS Patna's PICU had AKI. Surgical operations, nephrotoxic medications, hypotension, infection, and mechanical ventilation can cause AKI. Similar to earlier studies, these findings emphasize the need to identify and address these variables in critically ill children. Since AKI was more common in the 1–5 and 6–12 age groups, PICU children may be at risk for renal injury due to their younger age. These findings affect medicine. Early identification and proactive management of high-risk individuals can prevent AKI and improve patient outcomes.

These include optimizing hemodynamic status, controlling nephrotoxic medicines, and shortening mechanical breathing. Individualized strategies could reduce ischemia injury and intraoperative factors-related AKI in surgical patients. Despite their importance, the findings underline the need for more research to confirm a causal link between risk variables and AKI. Future prospective research with larger, multi-center datasets should better understand AKI in critically ill pediatric patients. Improving early AKI detection and management in this susceptible population will improve outcomes, reduce renal replacement therapy, and limit kidney injury's long-term repercussions.

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