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ORIGINAL ARTICLE

Frequency and outcomes of acute kidney injury in pediatric intensive care unit.

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ABSTRACT... Objective: To ascertain the prevalence of acute kidney damage (AKI) in pediatric patients who are hospitalized to the critical care unit at Fatima Memorial Hospital in Lahore. **Study Design:** Cross-sectional Descriptive study. **Setting:** Pediatric Intensive Care Unit, Fatima Memorial Hospital, Lahore. **Period:** Jan 10, 2023 to July 10, 2023. **Methods:** 100 PICU children had urine output and serum creatinine measured. Patients received the proper pRIFLE categorization (Table II). Duration and mortality in the PICU were recorded. **Results:** For this research, we included 100 children from the Pediatric Intensive Care Unit (PICU) with an average age of 8.17 ± 3.81 years. There were an equal number of men and females, with each gender comprising 50% of the total population. The male-to-female ratio was 1:1. Upon admission, the average creatinine level was 1.04 ± 0.39 mg/dl, however it considerably rose to 1.44 ± 0.81 mg/dl throughout the patient's stay ($p<0.05$). The RIFLE criteria revealed that 50% of the children were at risk, 14% had injury, 8% had failure, 16% suffered loss, and 12% reached the end-stage. AKI was seen in 36% of the children. **Conclusion:** The risk of AKI is high in children admitted to PICU.

Key words: Acute Kidney Injury, Pediatric Intensive Care Unit, RIFLE Criteria, Serum Creatinine.

INTRODUCTION

Acute kidney injury (AKI) is characterized by a fast decline in kidney function, leading to the buildup of nitrogenous wastes and the kidney's failure to maintain the balance of fluids and electrolytes. Historically, the absence of clear and unbiased diagnostic criteria has led to a significant range of terminology being used to describe this illness.[1] Acute kidney injury (AKI) is a sudden and reversible increase in the levels of serum creatinine (SCr), which may or may not be accompanied by a decrease in urine production to low levels or absence of urine. AKI is recognized as an intricate condition, with clinical symptoms that may vary from little harm to total kidney failure.[2] Worldwide, about 13.3 million instances of Acute Kidney Injury (AKI) are documented, with 85% of these cases originating from poor countries.[3,4] The primary cause of cases among children in developed countries is a severe illness associated with intensive care settings and hemolytic uremic syndrome. In contrast, infection-related causes such as gastroenteritis and post-streptococcal glomerulonephritis are more frequently observed in developing countries.[5]

Recent studies highlight the discrepancies in the definition of AKI, which have led to significant differences in the reported occurrence and consequences. The RIFLE classification, presented by the acute Dialysis Quality Initiative group, and the classification provided by the Acute Kidney Injury Network (AKIN), have recently standardised the definition and staging of AKI. The use of these categories in characterizing AKI has been assessed in both hospitalized adults and children. The majority of pediatric research examining the occurrence of acute kidney injury (AKI) is restricted to industrialized nations and relies on retrospective examination of medical data.[6,7] The incidence and impact of AKI in underdeveloped nations may vary from those in industrialized nations.[8] In recent years, there have been only a limited number of retrospective

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studies undertaken to ascertain the occurrence and characteristics of acute kidney injury (AKI) among critically unwell children from poor countries. Identifying the occurrence rate, causes, and results of AKI is crucial for implementing measures to prevent and treat the condition.[9]

To address the increase in creatinine levels caused by AKI and minimize the negative health outcomes in children, it is necessary to focus on prevention strategies in Lahore. The incidence of Acute Kidney Injury (AKI) is increasing in Pakistan, however, there is less evidence available about the outcomes of AKI in our local population. This research aims to gain insight into the issue and thereafter classify drug mistakes, providing suggestions for their reduction.

OBJECTIVES

The objective of this study is to ascertain the prevalence of acute kidney damage (AKI) in pediatric patients who are hospitalized to the critical care unit at Fatima Memorial Hospital in Lahore.

METHODS

This Cross-sectional descriptive study was conducted at Pediatric Intensive Care Unit, Fatima Memorial Hospital, Lahore from Jan 10, 2023 to July 10, 2023.

A sample of size 89≈100 was estimated using a 5% level of significance, 95% confidence interval, and 12.9%[9] anticipated proportion of acute kidney injury with a 7% margin of error, with Non-probability, convenient Sampling Technique.

Inclusion Criteria

All patients admitted to PICU aged 01 months to 14 years, both genders were enrolled in the study from the pediatric intensive care unit.

Exclusion Criteria

All patients with preexisting end-stage renal disease were excluded from the study.

This study was approved from ethical committee [(IRB No. FMH-25/10/2022-IRB-1140)18-01-2023].

Data Collection Procedure

AKI diagnosis was characterized using pRIFLE criteria after face-to-face interviews and medical records reviews. Socio-demographic characteristics were noted. For the first 14 days of PICU hospitalization, demographic, laboratory, and clinical data, including urine output and serum creatinine, were obtained daily. Table-I shows the Schwartz formula for estimated creatinine clearance (eel). For baseline eCCl, the patient was presumed to have normal renal function and given 120 mL/min/1.73 m2. If urine output or serum creatinine criteria were met, patients were classified by pRIFLE (Table-II). Duration and mortality in the PICU were recorded. The main outcome was death, while the secondary was PICU stay.

Name	Formula
2009-Schwartz	eGFR=k * height/PCr K=36.5
Schwartz-Lyon	eGFR=k * height/PCr k=36.5 in males aged >13 years K=32.5 in others
Height is expressed in cm. PCr=Plasma creatinine, expressed in μmol/L.	

Table-I. Schwartz formula to estimate creatinine clearance

Category	Estimated Creatinine Clearance*	Urine Output
Risk (R)	Decrease by 25%	< 0.5 ml/kg/ hr for 8 h
Injury (I)	Decrease by 50%	< 0.5 ml/kg/ hr for 16 h
Failure (F)	Decrease by 75%	< 0.3 ml/kg/ hr for 24 hr or anuric for 12 h
Loss (L)	Loss of renal function > 4 weeks	
End-Stage (E)	End Stage Renal Disease	

Table-II. pRIFLE classification

Data Analysis

Data was entered and analyzed in SPSS version 25. A Chi-square test/ independent t-test was used to see the association between a socio-demographic variable and acute kidney injury. A

P-value less than or equal to 0.05 was considered significant.

RESULTS

In this study, we enrolled 100 children from PICU with a mean age of 8.17 ± 3.81 years. There were 50 (50%) males and 50 (50%) females with male to female ratio of 1:1. Out of 100 children, 31 (31%) were admitted with sepsis or infection, 30 (30%) children had pneumonia, 16 (16%) were diagnosed with tuberculosis meningitis, 12 (12%) children had pulmonary tuberculosis, 6 (6%) children had typhoid / enteric fever while 5 (5%) children were admitted after surgery. The mean duration of admission until enrollment in the study was 6.29 ± 2.87 days. Table-III

From the medical record, it was observed that at the time of admission in the study, the mean creatinine level was 1.04 ± 0.39 mg/dl which was significantly increased to 1.44 ± 0.81 mg/dl during the stay ($p<0.05$). During PICU stay, the nephrotoxic drug was used in 32 (32%) children, mechanical ventilation was done in 49 (49%) children and vasoactive drug was used in 38 (38%) children. On RIFLE criteria, Risk was observed in 50 (50%) children, Injury in 30 (30%), Failure in 20 (20%). Table-IV

Out of 100 children, AKI was developed in 36 (36%) children. Figure-1

The frequency of AKI was compared with different effect modifiers. It has been observed that the chances of AKI were equal in any pediatric age group ($p>0.05$) and no significant effect of gender, diagnosis, and duration of admission in PICU was noticed ($p>0.05$), however, the frequency of AKI was high in pneumonia, sepsis, and tuberculosis meningitis. The use of the nephrotoxic drug had a significant effect on the occurrence of AKI i.e. 61.1% vs. 15.6%, $P<0.001$. However mechanical ventilation and vasoactive drug use had no impact ($p>0.05$). The mean hospital stay of AKI children was significantly longer (11.00 ± 2.62 days) than children without AKI (5.19 ± 1.85, $p<0.001$). There is also a higher risk of death in children with AKI (30.6%) than non-AKI children (3.1%). Table V

	F (%), mean ± SD
Age (years)	8.17 ± 3.81
Gender	
Male	50 (50%)
Female	50 (50%)
Diagnosis	
Sepsis/infection	31 (31%)
Pneumonia	30 (30%)
Tuberculosis meningitis	16 (16%)
Pulmonary tuberculosis	12 (12%)
Typhoid / enteric fever	6 (6%)
Post-surgical patients	5 (5%)
Duration of admission (days)	6.29 ± 2.87

Table-III. Baseline information of children enrolled in the study (n=100)

	F (%), mean ± SD
Serum creatinine at baseline	1.04 ± 0.39
Serum creatinine after 3 days	1.44 ± 0.81*
Use of nephrotoxic drug	32 (32%)
Mechanical ventilation	49 (49%)
Vasoactive drug used	38 (38%)
RIFLE	
Risk	50 (50%)
Injury	30 (30%)
Failure	20 (20%)

Table-IV. Outcome of patients
*** = P-value <0.001**

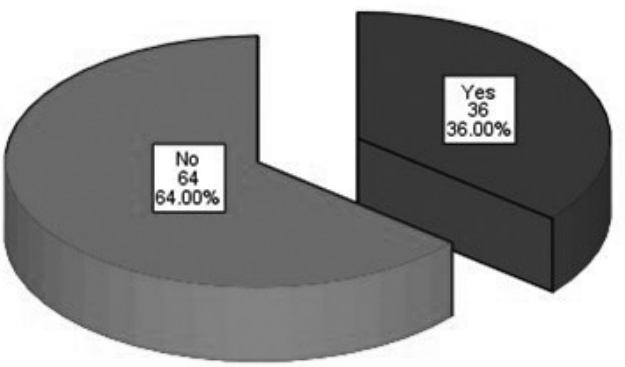

Figure-1. AKI observed during PICU admissions

	AKI Present	AKI Absent	P-Value
Age (years)			
1-5	11 (30.6%)	16 (25%)	0.827
6-10	15 (41.7%)	28(43.8%)	
> 10	10 (27.8%)	20 (31.3%)	
Gender			
Male	17 (47.2%)	33 (51.6%)	0.677
Female	19 (52.9%)	31 (48.4%)	
Diagnosis			
Sepsis/infection	10 (27.8%)	21 (32.8%)	0.108
Pneumonia	12 (33.3%)	18 (28.1%)	
Tuberculosis meningitis	7 (19.4%)	9 (14.1%)	
Pulmonary			
tuberculosis	1 (2.8%)	11 (17.2%)	
Typhoid enteric fever	2 (5.6%)	4 (6.3%)	
Postsurgical cases	4 (11.1%)	1 (1.6%)	
Duration of admission			
≤5 days	15 (41.7%)	25 (39.1%)	0.799
>5 days	21 (58.3%)	39 (60.9%)	
Nephrotoxic drug used	2 (61.1%)	10 (15.6%)	0.000
Mechanical ventilation	19 (52.8%	30 (46.9%)	0.571
Vasoactive drug used	14 (38.9%)	24 (37.5%)	0.891
Hospital stay (days)	11.00 ± 2.62	5.19 ± 1.85	0.000
Outcome			
Transferred / LAMA	14 (38.9%)	11 (17.2%)	0.000
Discharged home	11 (30.6%)	51 (79.7%)	
Death	11 (30.6%)	2 (3.1%)	

Table-V. Comparison of AKI in different groups

DISCUSSION

In the PICU, acute kidney injury (AKI) is common. PICU patients may develop AKI at the beginning or throughout their stay. Regardless of other considerations, AKI is strongly connected to poor outcomes. Western literature provides most AKI clinical progression data. Our national news is scarce.[10,11] Acute kidney damage (AKI) affects 25% of severely ill children and 33% of infants. In advanced acute kidney injury (AKI), outcomes are worse. Acute Kidney Injury (AKI) is directly connected to mortality, hence early detection and treatment are essential.[12]

In this research, we observed that at admission, the average creatinine level of children was 1.04 ± 0.39 mg/dl. However, throughout their stay in the Paediatric Intensive Care Unit (PICU), this level considerably rose to 1.44 ± 0.81 mg/dl ($p<0.05$). According to the RIFLE criteria, a risk was seen in 50 (50%) of the children, an injury in 30 (30%), a failure in 20 (20%). AKI was seen in 36% of the children. Research conducted by Akansha Parikh and Milind Tullu in 2020 revealed that out of the 220 children included in the study, 161 of them, accounting for 73.2%, experienced Acute Kidney Injury (AKI). The average duration of hospitalization was 14.7±16.2 days, and in 52.8% of cases, the stay in the Paediatric Intensive Care Unit (PICU) exceeded 5 days.[13] Gonesh (2020) conducted research that revealed a 6.9% occurrence of Acute Kidney Injury (AKI) among infants hospitalized in the pediatric Intensive Care Unit (ICU). The average blood creatinine level and duration of hospitalization for AKI patients were 2.91±2.48 and 9.98±7.27 days, respectively.[1]

Cibelle and Alexandre (2021) observed that 12.9% (146) of 1131 children hospitalized in the Paediatric Intensive Care Unit (PICU) had Acute Kidney Injury. The research found that these children were hospitalized for 6 days on

average, ranging from 3 to 13 days.[14] Multiple Indian and international research have shown incidence rates from 25.1% to 82%. Different inclusion criteria and PICU patient characteristics affect these rates.[11,15] In the paediatric critical care unit, Mehta et al. found 38.1% acute kidney damage (AKI). Krishnamurthy et al. and Soler et al. reported 25.1% and 27.4% occurrences, respectively, lower than ours.[11,15,16] Both Plötz and Akcan-Arikan found high incidence rates of 58% and 82%.[17,18] AKI rates vary between research due to study demographic and/or PICU setting.

We found that 50% of children had Risk, 30% Injury, 20% Failure, according to the RIFLE criteria. Acute kidney injury (AKI) severity was evaluated using pRIFLE criteria in this study. The findings showed that 49.1% of patients were "R" type, 29.5% "I" type, and 21.3% "F" type. Mehta et al. found that 65.8% of acute kidney injury (AKI) patients were Stage 1, 17.8% Stage 2, and 16.4% Stage 3.[11] AkcanArikan et al. found 48.8%, 26%, and 25.2% AKI severity levels. For the same severity levels, Plötz et al. reported 52%, 37%, and 11%.[17,18] A recent research by Naik et al. indicated that 37.9% of patients had a risk, 35.9% had harm, and 26.2% had failure.[19]

Our study revealed that nephrotoxic drugs increased acute kidney injury (AKI) by 61.1% compared to 15.6% in the control group. The difference was substantial ($P<0.001$). According to Bajracharya et al., 21 children with acute kidney damage (AKI) and 3 without AKI were exposed to nephrotoxic medicines.[20]

Acute Kidney Injury (AKI) is common in children admitted to the Paediatric Intensive Care Unit (PICU) and is connected to longer ICU and hospital stays and higher mortality rates.[21] Children with AKI had a significantly higher average hospitalisation time (11.00 ± 2.62 days) compared to those without AKI (5.19 ± 1.85, $p<0.001$). Bajracharya et al. also found that children with acute kidney damage (AKI) spent 9.86 days in the paediatric intensive care unit (PICU), whereas those without AKI spent 6.23 days.[20]

Children with AKI had a substantially longer average hospitalisation time (11.00 ± 2.62 days) compared to those without AKI (5.19 ± 1.85, $p<0.001$). Bajracharya et al. found that children with acute kidney injury (AKI) spent 9.86 days in the paediatric intensive care unit (PICU), whereas those without AKI spent 6.23 days.[22] Bajracharya et al. found that 47.36% of 18 AKI children and 21.38% of 36 non-AKI children died.[20]

CONCLUSION

AKI risk is increased in PICU children. In the future, preventative and therapeutic techniques should reduce AKI risk in PICU patients.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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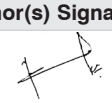
AUTHORSHIP AND CONTRIBUTION DECLARATION

No.	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Yummnah Lone	Study design, Data collection, Interpretation.	
2	Abid Rafiq Chaudhry	Study concept, Topic selection, Data interpretation, Review.	
3	Rashid Ayub	Review of article.	