FREQUENCY OF ACUTE KIDNEY INJURY IN CRITICALLY ILL CHILDREN ADMITTED IN ICU OF A TERTIARY CARE HOSPITAL

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Abstract:

Objective: The aim of this research is to assess acute kidney injury (AKI) prevalence and severity in hospitalized patients.

Methods: This research, which was done in a tertiary care facility in Lahore, Pakistan, is prospective observational. The research was conducted between September 2022 and March 2023. The study included all paediatric inpatients admitted to hospitals throughout the study period, whose ages ranged from 1 month to 18 years. All eligible patients who were hospitalized throughout the research period were included. For each patient, baseline demographic information such as age, gender, and diagnosis were gathered. Serum creatinine levels were checked at check-in and then every day until check-out. AKI was identified using the AKI Network's serum creatinine criterion.

Results: From September 2022 to March 2023, 486 people were enrolled in the trial, which was undertaken. The remaining 378 individuals were not severely sick, leaving 108 of these patients who were. A significant difference between critically ill patients (36.1%) and non-critically ill (9.0%) patients was found in the incidence of AKI, with a P-value of less than 0.001. The incidence densities were, respectively, 45.1 and 11.7 cases per 1000 patient days. Stage 1 AKI was the most severe stage among individuals who acquired it, occurring in 65.8% of cases, stage 2 in 17.8%, and stage 3 in 16.4% of cases. 15.1% of patients needed dialysis. According to the study, individuals with AKI had higher fatality rates (37% vs. 8.7%, hazard ratio 2.73, 95% CI 1.64 to 4.54), as well as significantly longer hospital stays i.e., 9 days vs. 7 days with the P-value less than 0.01.As independent risk factors for AKI, it was also highlighted that being young, shock, infection, and needing mechanical ventilation. AKI stage 2 and stage 3 patients died at higher rates than AKI-free patients. The independent risk factor for death identified as shock is shock.

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Conclusions: Children who are severely unwell often develop AKI, particularly young kids who have septicemia and shock, which lengthens hospital stays and increases death.

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Introduction:

Acute kidney damage (AKI) is a serious illness that affects hospitalized patients and is linked to poor short- and long-term prognoses [1]. Children with AKI who are severely ill have significant mortality rates, which range from 9% to 67% [2], and these percentages increase if multiorgan dysfunction, organ transplantation, or syndrome of acute respiratory distress are taken into account [3]. ATN, which is caused by hypovolemic shock, infection, or the intake of nephrotoxic medicines, affects the majority of individuals with incident AKI [4].

Several studies have emphasized how different definitions of AKI have led to significant differences in incidence and outcomes that have been documented [5]. Recent efforts have been made to standardize the diagnosis and staging of AKI, using the RIFLE classification developed by the Acute Dialysis Quality Action Committee [6] and the one advised by the Acute Kidney Injury Network (AKIN) [7]. It has been shown that these categories are helpful in defining AKI after being tested in both adults as well as kids getting hospital treatment [8].

Figure 1: Acute Kidney Injury (AKI)

The majority of paediatric research on the prevalence of AKI are restricted to industrialized nations [10,11] and based on retrospective record analysis [12]. Given that the spectrum of AKI differs in underdeveloped nations and that it may be difficult to diagnose AKI after the fact, we sought to prospectively evaluate the frequency and severity of AKI in children admitted to a tertiary care hospital in Lahore, Pakistan.

Methods:

Study Design: Between September 2022 and March 2023, Mayo Hospital Lahore, Pakistan, accepted paediatric patients to its paediatric inpatient and paediatric intensive care unit (PICU). The following people were excluded: those with stage 5 chronic renal disease, bilirubin levels above 5 mg/dL, hospital stays under 24 hours, patients who had AKI that was recognized at the time of admission, had serum creatinine levels that were higher than 1.5 mg/dL, and whose serum creatinine assessments had not been completed at the

time of their admission or within 48 hours. The stay in hospital, comorbidities, and diagnosis were noted after obtaining parental consent and the Institute Ethics Committee's clearance for the study.

Based on the AKIN criteria, AKI was described as a sudden decline in kidney function accompanied by a rise in creatinine level. All patients had their serum creatinine levels measured at the time of admission and then every 24±6 hours for three days in a row following that. These levels were checked every 48±6 hours till the patient was discharged in individuals who weren't severely sick but had risk factors. Patients were categorized as critically ill if they needed mechanical ventilation or vasopressor support, were admitted to the PICU, or did not fulfil these requirements.

When the cause, progression, and need for dialysis were determined, patients were followed until they were released. Signs of complete recovery were normal urinalyses, serum creatinine, and blood pressure for age. Hypertension, unusual urinalysis, or high serum creatinine were signs of partial recovery. Dialysis dependent patients are those who need maintenance dialysis.

The Pediatric Index of Mortality score version 2 (PIM2) was calculated for children admitted to the PICU, and the research assessed the outcome in connection to the maximum stage of AKI. The patients were also assessed to determine the cause, course, and need for dialysis of AKI. ATN was characterized as renal impairment without active urinary sediment in the presence of diarrhea and dehydration, cardiac dysfunction, burns, blood loss, sepsis, or use of nephrotoxic drugs. Leukocyturia and suspicious renal histology were taken into consideration in individuals who had acute interstitial nephritis.

Statistical Analysis: AKI affects children in around 5% of non-critically sick patients and 30% of critically ill patients [16,23]. Using a 95% confidence interval and a reliability of 2.5% for the non-critically ill and 9% for the critically ill, 304 and 104 samples, respectively, were required to estimate these prevalence rate. The outcomes were examined using STATA version 17. Categorical variables were represented as a percentage (%), and continuous data as the median (interquartile range, IQR). The number of occurrences was indicated by the incidence density (95% CI: cases per 1000 patient days). The Fisher exact test or the Wilcoxon rank-sum test were used to evaluate patient characteristics across groups. Patients who had and did not have AKI were compared for mortality using the log rank test. A hazard ratio was utilized to show the findings of the Cox proportional hazard analysis, which was used to look into the risk factors for AKI and mortality.

Results:

127 of the 613 patients who underwent screening were disqualified (Figure 2), including 28 patients who had been hospitalized with AKI due to dehydration (7), hemolytic uremic syndrome (7), or septicemia (5), and glomerulonephritis (9). 108 (22.2%) of the 486 patients were in critical condition, whereas 378 (71.8%) were not (Table 1). Upon admission, the PIM2 scores for severely sick individuals were 10.7. (5.4-21.6). At the time of admission, the most frequent diagnoses were bronchitis or asthma (22.6%), cancer (16.7%), neurological disorders (14.6%), and kidney illnesses (9.5%). 39 individuals (or 15.0%) with severe illness and 73 (15.0%) other patients had AKI at a median (IQR) of 2 (2–3) days. AKI occurred in 36.1% of critically ill patients compared to 9.0% of non-critically unwell patients (P-value < 0.001). AKI incidence density per one thousand patient days was 19.4 with 95% confidence interval of 15.42 to 24.39, instances overall. In comparison to patients who were not critically sick (11.7; with 95% confidence interval of 8.37 to 16.4 cases per 1000 patient days), critically ill patients had a higher incidence density (45.1; with 95% confidence interval of 3.3 to 61.78 cases per 1000 patient days). ATN (n=70, 95.9%), which was present in both non-seriously ill (31) and critically sick (39) patients, was thought to

be the most frequent cause of AKI. Acute interstitial nephritis (2) and bladder outlet blockage (1) were other reasons. Sepsis (42), (60%) and shock (38), (54.3%) were the primary risk factors for ATN; other risk factors were nephrotoxic medications (14), congestive heart failure (n=7), diarrheal dehydration (n=6), and blood loss (3).

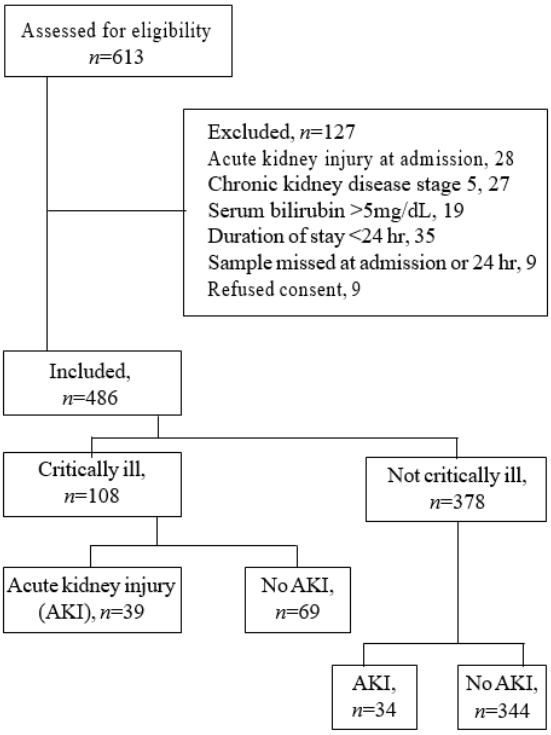

Figure 2: A flowchart outlining the information about the research participants is shown.

Table 1: Primary Medical and Biochemical Attributes

Characteristics	Non-Critical			Critical		
	no	%	Range	no	%	Range
Age (Months)	48		12-96	43		9-72
Girls	132	34.9		43	39.8	
Blood creatinine	0.5		0.4-0.6	0.5		0.4-0.6
Admission time diagnosis						
Dengue	7	1.9		4	3.7	
Malaria	6	1.6		1	0.9	
Immunodeficiency	10	2.6		1	0.9	
Connective tissue disease	13	3.4		1	0.9	
Gastroenteritis	12	3.2		4	3.7	
Liver	25	6.6		4	3.7	
Renal	45	11.9		1	0.9	
Heart	9	2.4		10	9.3	
Neurological illness	48	12.7		23	21.3	
Malignancy	62	16.4		19	17.6	
Pneumonia, asthma	79	20.9		31	28.7	

Others	62	16.4		9	8.3	

Table 2: Patients' characteristics, both those who have acute kidney injury and those who don't

Characteristic	**No AKI**			**AKI**		
	n	**%**	**Range**	**n**	**%**	**Range**
Age (Months)	48		12.5-96	24		7-60
Girls	145	35.1		30	41.1	
Admission Time Diagnosis						
Mortality	36	8.7		27	37	
PIM2 score (in PICU)	9.1		4.9-16.7	13.1		7.9-25.2
Vasopressor support	62	15		29	39.8	
Sepsis	124	30		42	57.5	
Shock	98	23.7		38	52.1	
Mechanical ventilation	58	14		35	48	
Renal	39	9.4		7	9.6	
Heart	15	3.6		4	5.5	
Neurological illness	61	14.8		10	13.7	
Malignancy	70	17		11	15.1	
Pneumonia asthma	82	19.9		21	28.8	

Patient age differences between those with and without AKI are seen in Table 2 (P-value=0.002). Moreover, they had considerably greater rates of shock, sepsis, and the requirement for mechanical breathing and vasopressor assistance. Patients who were critically unwell and had AKI often had higher PIM2 scores than those who did not have AKI (P-value=0.08). Sixty patients had AKI stage 1, eleven had stage 2, and two had stage 3. Three patients advanced from stage 2 to stage 3, compared to five and seven patients who had stage 1 AKI and went on to stages 2 and 3, respectively. 48 people had stage 1 AKI, 13 had stage 2, and 12 had stage 3. AKI stage 3 required hemodialysis or peritoneal dialysis for 11 (91.7%) of the patients, starting 3 to 20 days after hospital admission. Patients with AKI spent an average of 9 (6–13) days in the hospital, compared to patients without AKI who stayed an average of 7 (5–10) days (P=0.02). After an average of 8 days (with a range of 2-49), 63 individuals passed away. Those who were seriously sick died at a greater rate than those who were not (60 of 108; 55.5% vs. 3 of 378; 0.8%). Death rates were 37.0% and 8.7%, respectively, for individuals with and without AKI. As compared to patients with AKI stages 2 and 3, stage 1 patients had a reduced death rate (n=7; 14.6% vs. 11; 84.6% vs. 9; 75%) (P-value<0.001).

Among the 41 survivors who had AKI stage 1, 22 had fully recovered. 11 of the 19 patients with incomplete kidney restoration had aberrant urinalyses, and 5 of them had increased serum creatinine and blood pressure. One of the two patients with stage 2 AKI at discharge had both full and partial renal improvement. One patient had stage 3 AKI, one had partial and full renal restoration, and one was reliant on dialysis.

Table 3: Acute kidney injury (AKI) risk factors

		Age (Months)	Gender (Female)	Mechanical ventilation	Sepsis	Shock
Adjusted (HR Ratio)	HR Ratio	0.89	1.16	2.18	3.64	2.65
	CI Range	0.83, 0.95	0.72, 1.87	1.12, 4.26	2.20, 6.01	1.32, 5.31
Unadjusted (HR Ratio)	HR Ratio	0.91	1.23	4.12	2.75	2.85
	CI Range	0.81, 0.97	0.80, 2.02	2.60, 6.52	1.73, 4.37	1.80, 4.52

According to Cox regression analysis, sepsis, shock, and the requirement for mechanical ventilation were all separate risk factors for AKI (P-value < 0.001). (Table 3). In univariate analysis, shock and the presence of AKI were risk factors for death (HR 11.93; P-value< 0.001) and shock (HR 2.73; P-value < 0.001). AKI stages 2 and 3 had greater mortality risks compared to those without AKI (HR 5.18; P0.001) and stage 1 (HR 1.23; P0.62), while stages 1 did not (HR 1.23; P-value<0.001). According to the Cox model, shock was the only independent risk factor for mortality (HR 10.7, P-value 0.001).

Discussions:

This study found that for every 1000 patient days, there were 19.4 cases of AKI among hospitalized patients. Those who were critically sick had a 4-fold greater incidence than those who were not critically ill. Although though the great majority of patients were initially in stage 1 of the disease, there was a gradual kidney impairment, and 15.1% of patients required renal replacement therapy.AKI rates were greater in patients who were younger, experienced shock, sepsis, or needed mechanical ventilation. Particularly within individuals with AKI stages 2 and 3, the presence of AKI caused a lengthier stay in hospital and a four-fold greater fatality rate.

The AKIN and RIFLE criteria, two newly suggested categories, have been shown to be effective prognostic and diagnostic aids in severely sick elderly patients suffering AKI [13]. The incidence of AKI ranges from 10% to 58% in studies utilizing the RIFLE [14] or its paediatric variant, the pRIFLE [15], in critically ill children. 339 of 3396 (10%) patients hospitalized to a PICU in Los Angeles developed AKI, according to a study [16]. Three recent studies on kids [13–15] have employed the AKIN criterion. According to another research, 20% of hospitalized children receiving aminoglycoside treatment had AKI by the AKIN diagnosis and 33% had it under the pRIFLE definition [14]. While additional studies [14,15] employed similar criteria, neither research provided information on its prevalence. We discovered that more than one-third of all severely sick patients had incident AKI using comparable criteria. AKI in hospitalized, non-critically sick patients is a topic on which little is known [17,18], although the current research found a 9% incidence. According to recent and earlier studies [19,20], AKI was independently risked by young age, hypotension, infection, and the necessity for mechanical ventilation.

In industrialized and underdeveloped nations, AKI in children has different aetiologies. AKI occurs after major operations, complications from cancer, and the use of nephrotoxic medications in the former [1,6]. Important causes in underdeveloped nations include hemolytic uremic syndrome, acute bacteremia, postinfectious nephropathy, and diarrheal dehydration [7, 14]. As the present study's objective was to assess the prevalence of AKI in hospitalised children, we excluded patients who were already diagnosed with AKI at the time of their admission.

AKI may have serious consequences, including severe short- and long-term morbidity and death [1,2]. The current investigation

demonstrated that renal replacement treatment is necessary in around 6–45% of critically ill patients with acute AKI [5,11,13,15]. The diverse definitional criteria, as well as the range and intensity of the underlying disease, all affect the chance of death. Mortality was 37% in the current research, compared to rates between 9 and 67% in previous publications [3,4,11-13,15]. Additionally, we discovered that individuals with AKI stages 2 and 3 had a greater mortality risk than those who had not had renal damage. While evidence from several research suggests that AKI is an independent risk factor for death [5,11,13,15], the current analysis did not support these conclusions. We hypothesize that these individuals' severe underlying illnesses and the presence of hypotension were stronger predictors of mortality than acute AKI. About half of the stage 1 AKI patients had a full recovery, while the other survivors had only partial recovery when they were discharged. Minor degrees of renal damage may have less consequences than more major alterations in renal function, even if the current research lacked the ability to investigate outcomes in various grades of AKI.

Conclusions:

Information on the prevalence of AKI in hospitalized children is provided by this prospective research. It stresses how often AKI occurs in critically ill patients, particularly small kids with sepsis, shock, and those who need mechanical ventilation. AKI led to a lengthier hospital stay and a higher death rate. The effect of AKI on renal outcome in the short- and medium-term has to be investigated further.

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