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INCIDENCE AND MEDICATION BASED OUTCOMES OF ACUTE KIDNEY INJURY IN PEDIATRIC GASTROENTERITIS: A RIFLE-BASED RETROSPECTIVE STUDY

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Abstract

Objective: *To establish the incidence, severity, and short-term consequences of AKI in pediatric patients with acute gastroenteritis by applying the pediatric-adapted RIFLE criteria and to identify related electrolyte abnormalities and urine output patterns.*

Methods: *The retrospective (observational) study was performed between February 2025 and June 2025 in emergency department of Jinnah Sindh Medical College, Karachi, Pakistan. This study was conducted on 305 children aged 12 months to 12 years with acute gastroenteritis who presented to a tertiary emergency department from Feb 2025 to June 2025. Clinical, biochemical, and urine output data were collected. AKI was defined as those meeting the "Failure" category of the RIFLE classification. Outcomes included incidence of AKI, electrolyte disturbances, urine output patterns, and renal recovery over a 3–6 month follow-up.*

Results: *AKI was diagnosed in 109 children (35.7%), anuria and oliguria were seen in 3.9% and 17.7% of the patients, respectively. There was elevated BUN (>100 mg/dL) in 18 patients and creatinine levels between 0.9 and 5.4 mg/dl. Electrolyte imbalances were hyponatremia (n=8), hypernatremia (n=5), and hypokalemia (n=8). Younger children who had oral rehydration solution (ORS) at home tended to have less severe AKI. All patients successfully recovered with normalized renal function within 3–6 months, and none progressed to chronic kidney disease.*

Conclusion: *AKI was a frequent and serious complication of pediatric gastroenteritis, occurring in 35.7% of children in the RIFLE "Failure" category. Early detection, fluid resuscitation, and supportive therapy allowed complete renal recovery.*

Keywords: *Acute kidney injury, Dehydration; Electrolyte imbalance, Oral rehydration solution, Pediatric gastroenteritis, RIFLE criteria*

INTRODUCTION

Acute gastroenteritis remains one of the leading causes of morbidity and mortality among children in low- and middle-income countries, accounting for significant hospital admissions worldwide. Excessive fluid and electrolyte losses through diarrhea and vomiting predispose children to dehydration and hypovolemia, which are the principal mechanisms leading to acute kidney injury (AKI). Pediatric patients are particularly susceptible due to immature renal auto regulatory mechanisms, higher extracellular fluid losses, and limited physiological reserves. Untreated dehydration-related AKI may result in serious short-term complications and potential long-term renal sequelae (1-3).

AKI in children with gastroenteritis is frequently underdiagnosed, especially in resource-limited settings where laboratory monitoring and urine output assessment are inconsistent. Reported incidence rates range from 10% to 40%, with higher rates observed in younger children and those presenting late to healthcare facilities (4-6). Early recognition of AKI is essential, as timely fluid resuscitation can reverse prerenal injury and prevent progression to intrinsic renal damage. The RIFLE (Risk, Injury, Failure, Loss,

End-stage kidney disease) criteria provide a standardized framework for classifying AKI severity based on changes in serum creatinine and urine output (7, 8).

Electrolyte abnormalities such as hyponatremia, hypernatremia, and hypokalemia frequently coexist with dehydration and may exacerbate renal dysfunction. Additionally, the inappropriate use of nephrotoxic medications during diarrheal illness can further increase the risk of AKI (9, 10).

This study aimed to determine the incidence, severity, and short-term outcomes of AKI in children with acute gastroenteritis using the RIFLE criteria, while evaluating associated electrolyte disturbances and renal recovery.

METHODOLOGY

This observational study was conducted in the Emergency Department of a Tertiary Care Teaching Hospital. The study took place between February 2025 and June 2025. Ethical clearance (JSMU/ERC-PGC/2025/13) was provided by the Jinnah Sindh Medical University, Karachi before data retrieval and analysis.

Researchers randomly selected a total of 305 pediatric patients aged between 12 months and 12 years, who presented to the emergency department with a primary diagnosis of acute gastroenteritis, for inclusion in the study. Patients were included if they had clinical features of dehydration and available laboratory data, including serum creatinine, blood urea nitrogen (BUN), electrolyte levels, and urine output records at the time of presentation.

INCLUSION AND EXCLUSION CRITERIA

Children aged 12 months to 12 years with a clinical diagnosis of acute gastroenteritis (defined as three or more loose stools per day, with or without vomiting) and evidence of dehydration at presentation were included, provided that renal function tests (serum creatinine and BUN) and documented urine output records were available. Exclusion criteria comprised known chronic kidney disease or congenital renal anomalies, gastroenteritis complicated by sepsis or shock requiring inotropic support, a history of nephrotic syndrome or obstructive uropathy, incomplete medical records, or the use of chronic nephrotoxic medications.

DATA COLLECTION

Data were extracted from electronic medical records using a structured data collection form, capturing demographic information (age and sex), clinical presentation features (vomiting, diarrhea, and level of dehydration), laboratory measures (serum creatinine, BUN, sodium, and potassium), and urine output categorized for the pediatric population as anuria (<0.5 mL/kg/hr for 12 hours), oliguria (0.5–1 mL/kg/hr), or polyuria (>2.5–3 cc/kg/min after fluid resuscitation). Additionally, we recorded the use of oral rehydration solution (ORS) at home prior to hospital visit, management information (IV fluids and electrolyte correction), and monitored renal function and discharge status for 3 to 6 months after discharge.

DEFINITION OF AKI AND SEVERITY CLASSIFICATION

Acute kidney injury (AKI) was defined and classified according to the pediatric-adapted RIFLE criteria, which categorizes patients into five groups: Risk (R) defined as a 1.5-fold increase in serum creatinine or urine output <0.5 mL/kg/hr for 8 hours; Injury (I) defined as a 2-fold increase in serum creatinine or urine output <0.5 mL/kg/hr for 16 hours; Failure (F) defined as a 3-fold rise in serum creatinine, serum creatinine ≥4 mg/dL, or anuria for 12 hours; and Loss (L) and End-stage (E), which were not applicable due to the study's short follow-up period [7,8]. In the current study, only patients meeting criteria for "failure" were classified as having AKI.

OUTCOME MEASURES

The primary outcome was the incidence of acute kidney injury (AKI) in children with gastroenteritis according to the pediatric-adapted RIFLE criteria. Secondary outcomes included the prevalence of

electrolyte derangements (hyponatremia, hypernatremia, and hypokalemia), urine output patterns (anuria, oliguria, and polyuria), and follow-up recovery of renal function at 3 and 6 months.

STATISTICAL ANALYSIS

Descriptive statistics were used to summarize baseline characteristics. Continuous variables were presented as mean with standard deviation or median with range, as appropriate, while categorical variables were expressed as frequencies and percentages. Associations between categorical variables were assessed using the chi-square test, and comparisons of continuous variables were performed using the t-test or Mann-Whitney U test, as applicable. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were conducted using SPSS version 22.0.

RESULTS

A total of 305 pediatric patients diagnosed with acute gastroenteritis were included in this retrospective analysis. The median age of the cohort was 2.5 years (range: 12 months to 12 years), and 56.9% were female (Fig. 1). Using the RIFLE classification, 109 children were found to have acute kidney injury (AKI) in the "Failure" category, which means 35.7% of the patients had this condition.

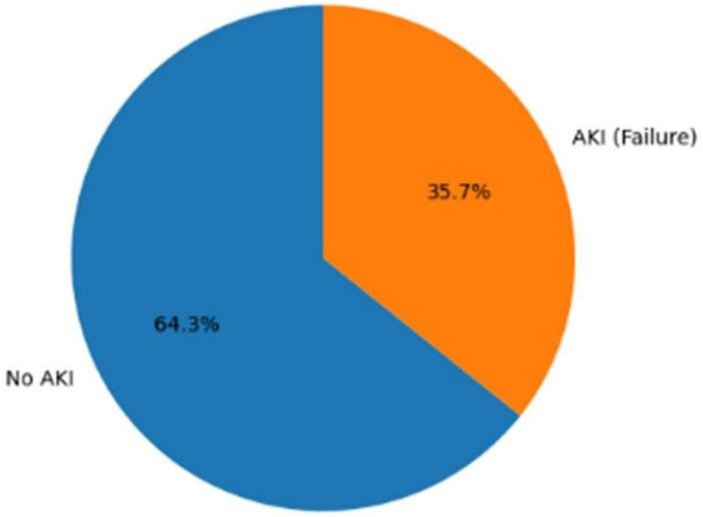

Fig. 1. Distribution of AKI (n=109)

At presentation to the emergency department, 46 children had blood urea nitrogen (BUN) concentrations from 30 to 164 mg/dL. Of these, 18 children had >100 mg/dL critically elevated BUN values. Serum creatinine concentrations varied between 0.9 and 5.4 mg/dL. Oliguria was noted in 54 patients and anuria in 12 patients. After proper fluid resuscitation, 30 children developed polyuria, with a mean urinary output of 6.4 cc/kg/min (range: 4–9 cc/kg/min) (Table I).

Table I. Biochemical parameters and urine output (n=109)

Parameter	Number of Patients
Serum BUN 30-164 mg/dL	46
Serum BUN >100 mg/dL	18
Creatinine range	0.9 - 5.4 mg/dL
Anuria	12
Oliguria	54
Polyuria (after fluid therapy)	30
Polyuria rate (cc/kg/min)	6.4 (range 4–9)

Electrolyte derangements were observed in a limited number of patients. Hyponatremia was observed in 8 children, and hypernatremia occurred in 5 children. Eight children also had hypokalemia (Fig. 2). The derangements were transient and corrected with a dehydration correction and supportive treatment.

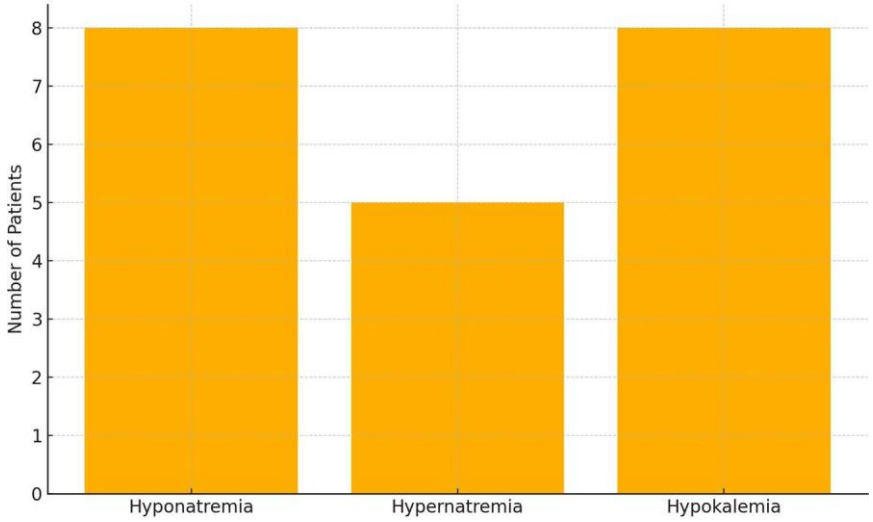

Fig. 2. Electrolyte abnormalities (n=109)

Amongst the drugs examined, NSAIDs and aminoglycosides had the greatest renal risk. Interestingly, NSAIDs were utilized in more than 80% of our population, with concern in the context of hypovolemia. Although certain drugs such as PPIs and antiemetics are only indirectly harmful, their potential to conceal the severity of dehydration or induce idiosyncratic damage should prompt clinical vigilance. These data implicate the importance of drug review and dose reduction in children at risk of AKI.

Table II. Medication-associated AKI Risk inp gastroenteritis (n=109)

	Drug/Class	No. of patients (%±S.D)	Potential renal risk	Expected mechanism of AKI	Recommendations
1.	NSAIDs (e.g., Ibuprofen)	83.5±1.33	High	↓ Renal perfusion via prostaglandin inhibition	Avoid in dehydrated or hypovolemic children
2.	Aminoglycosides	11.6±0.36	High	Direct tubular toxicity	Requires renal dosing adjustment
3.	Proton Pump Inhibitors (e.g., Omeprazole)	27.17	Low to moderate (rare AIN)	Rare acute interstitial nephritis (idiosyncratic)	Monitor if used long term
4	Antiemetics (Metoclopramide/ Ondansetron)	33.52	Low	Indirect— masking severity of fluid loss	Monitor hydration status
5	IV Fluids (NS, RL)	100	Low	Overhydration can cause fluid overload if AKI already exists	Use with caution in oliguric AKI
6	Antibiotics (Ciprofloxacin, Ceftriaxone, Amoxicillin + Clarithromycin)	98.6	Moderate	Rare crystal nephropathy or immune AIN	Monitor if prolonged use

The total of cohort, 196 children were treated and discharged directly from the emergency department after rehydration and stabilization. Notably, all the patients, even those with AKI, were assessed at 3 to 6 months of follow-up. At follow-up, all the children had normal glomerular filtration rates (GFR) and no recurring electrolyte disturbances. None of them developed chronic kidney disease or other long-term renal dysfunction.

Initial evidence indicated that children who had been given oral rehydration solution (ORS) at home before presentation were less likely to have severe AKI, though exact quantitative data on ORS administration were not recorded.

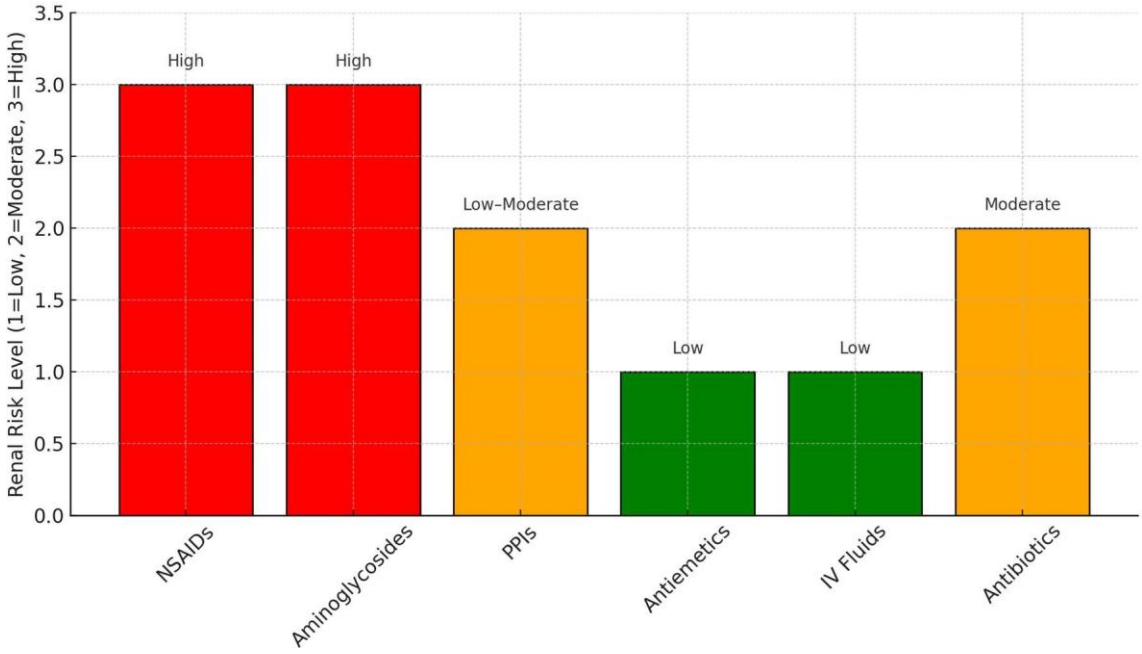

Fig. 3. Renal risk of medications used in pediatric gastroenteritis (n=109)

DISCUSSION

This study identified a high prevalence (35.7%) of acute kidney injury (AKI) among children presenting with acute gastroenteritis, all classified within the RIFLE "Failure" category. Since selected emergency ward is the center of pediatric treatment ,therefore, patients with different ethnic groups are usually recommended to this center represent good picture of correlation of acute kidney injury to diarrheal complications which is agree to the result of another study showing 20%–40% having the same issues.(6,11) One more study reflecting AKI in children upto 31%, further supports the comparability of our findings.(12) Marzuillo *et al.* showed correlation of AKI in 24.6% in patients under 12 years with gastroenteritis (13).

RIFLE has been validated as a clinically meaningful tool in pediatric nephrology, with increasing severity correlating with adverse outcomes (14). Focusing on the "Failure" category allowed targeted assessment of children at highest risk of complications, consistent with evidence demonstrating prolonged hospitalization and increased intensive care requirements in this group (15). Compared with KDIGO criteria, RIFLE remains simpler and more feasible for use in emergency and resource-limited settings, relying on readily available clinical and laboratory parameters (16).

Urine output abnormalities were prominent in this cohort, with anuria observed in 3.9% and oliguria in 17.7% of patients at presentation. Reduced urine output is recognized as an early and sensitive indicator of AKI severity and is strongly associated with poorer outcomes compared with serum creatinine alone (16). Following fluid resuscitation, a subset of patients developed polyuria, reflecting the recovery phase of prerenal AKI, as described previously (17). However, this phase requires careful monitoring to prevent secondary dehydration.

Laboratory reports present high BUN and creatinine levels which usually indicates hyperfusion (18). These abnormalities may further compromise renal perfusion and tubular function if not promptly corrected. Comparable electrolyte patterns have been reported in pediatric diarrheal cohorts from the region (19). In addition to dehydration, medication exposure emerged as an important contributory factor. The frequent use of potentially nephrotoxic agents, particularly nonsteroidal anti-inflammatory drugs and certain antibiotics may exacerbate renal injury in hypovolemic children. NSAIDs, in particular, impair renal prostaglandin-mediated autoregulation and are well-established causes of AKI in pediatric populations (20-

21). Rational prescribing and avoidance of nephrotoxic medications during acute diarrheal illness are therefore essential preventive strategies.

A notable and encouraging finding was complete renal recovery in all patients within 3–6 months, with no progression to chronic kidney disease. This supports existing evidence that prerenal AKI in children is largely reversible when promptly recognized and managed (22). Differences from studies reporting residual renal impairment may be explained by early fluid resuscitation and structured follow-up in our settingAdditionally, children who reportedly received oral rehydration solution at home appeared to have less severe AKI (23).

CONCLUSION

The current study shows that gastritis or diarrhea which are still one of the most life threatening condition in pediatric population in a country with less and expensive medical support can impact the mortality/mobility rate in children under risk of dehydration followed by kidney injury (mostly temporary). Although, this condition cannot be neglected but cheap medication/ fluid management and timely admission to ward in case of severity to compensate body fluid and infection can help the patients to get through it. Community awareness program particularly for females at field levels or via social media can be helpful in this regard.

Limitations of the study:

The study is limited to the single center and categorized only taking RIFLE as creteria. Moreover, supportive domestic therapy such as taking ORS or other minerals or food which is usually use to cure diarrhea ws not recorded. Furthermore, recurrent of the condition was not on record.

List of abbreviations:

Abbreviation	Full form
AKI	Acute Kidney Injury
ORS	Oral Rehydration Solution
BUN	Blood Urea Nitrogen
GFR	Glomerular Filtration Rate
RIFLE	Risk, Injury, Failure, Loss, End-stage kidney disease
NS	Normal Saline
RL	Ringer's Lactate
AIN	Acute Interstitial Nephritis
SPSS	Statistical Package for the Social Sciences
PAQSJIMS	Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences

Conflict of interest:

Authors declared no conflict of interest.

Authors' contribution:

SM **C**onceptualized the study, supervised data analysis, and contributed to manuscript editing; KR Collected data, performed the statistical analysis and drafted the initial manuscript; MW Drafted the initial manuscript; MM Helped interpret the pharmacological data; AM Revised the manuscript critically; SI Helped interpret the pharmacological data; AP & HU Data collection.

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