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Original Research Article

Clinical Profile of Post-Diarrheal Acute Kidney Injury During the Monsoon Season in Karwar: A Cross-Sectional Study

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Abstract

Background: Acute kidney injury (AKI) is a recognized complication of acute diarrheal diseases, particularly in tropical and monsoon-affected regions. However, evidence regarding the clinical profile and outcomes of post-diarrheal AKI (PD-AKI) remains limited, especially from coastal regions of India. This study aimed to evaluate the clinicodemographic profile, laboratory parameters, and outcomes of patients admitted with PD-AKI during the monsoon season at a tertiary care hospital in Karwar, Karnataka.

Methods: A hospital-based cross-sectional observational study was conducted at the Department of Medicine, KRIMS, Karwar. Thirty adult patients (≥18 years) presenting with acute diarrhoea followed by AKI, as defined by the Kidney Disease: Improving Global Outcomes (KDIGO) criteria, were enrolled. Patients with pre-existing chronic kidney disease, obstructive uropathy, or drug-induced AKI unrelated to diarrhoea were excluded. Demographic data, clinical features, laboratory parameters, etiological profiles, KDIGO staging, management details, and outcomes were recorded and analysed using descriptive statistics.

Results: The mean age was 40.87 years, with male predominance (73.3%). Most admissions occurred during July and August (80%). Acute gastroenteritis was the most common aetiology (63.3%), followed by Vibrio cholerae infection (20%). Moderate dehydration was present in 50% of patients. Oliguria was observed in 86.7% and anuria in 13.3%. The median peak serum creatinine was 1.15 mg/dL. Four patients (13.3%) required haemodialysis. Kidney function recovery was observed in 93.3%, with zero mortality and a median hospital stay of 5 days.

Conclusion: Post-diarrheal AKI during the monsoon season in a coastal Indian setting predominantly affects middle-aged males engaged in fishing-related occupations. Early recognition, prompt fluid resuscitation, and appropriate supportive care lead to excellent renal recovery and favourable outcomes.

Keywords: Acute Kidney Injury, Diarrhoea, Monsoon, Dehydration, KDIGO, Gastroenteritis, Coastal India.

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Introduction

Acute kidney injury (AKI) is a clinical syndrome characterized by an abrupt decline in kidney function, reflected by a reduction in glomerular filtration rate (GFR), impaired excretion of nitrogenous waste products, and disturbances in fluid, electrolyte, and acid–base homeostasis [1]. The Kidney Disease: Improving Global Outcomes (KDIGO) clinical practice guidelines define AKI as an increase in serum creatinine by ≥0.3 mg/dL within 48 hours, an increase in serum creatinine to ≥1.5 times the baseline value within seven days, or a urine output of less than 0.5 mL/kg/h for at least six hours [1].

AKI is associated with substantial morbidity and mortality worldwide. In critically ill patients with severe acute tubular necrosis requiring dialytic support, hospital mortality rates range between 40% and 70% [2]. The understanding of AKI has undergone considerable evolution over the past several decades. Previously regarded as a singular clinical entity, AKI is now recognized as a complex, multifactorial syndrome encompassing diverse etiologies and variable prognoses. Before the establishment of standardized definitions, more than 50 terminologies and diagnostic criteria for AKI—then referred to as "acute renal failure"—were in use, contributing to inconsistent reporting of incidence and outcomes across studies [3].

The introduction of the Risk, Injury, Failure, Loss, and End-stage kidney disease (RIFLE) criteria in 2004 marked a significant step toward standardization [4]. This was followed by the Acute

Kidney Injury Network (AKIN) criteria in 2007 and subsequently by the KDIGO criteria in 2012, which harmonized these earlier classification systems and enabled more uniform reporting and enhanced understanding of AKI epidemiology [1,5].

Globally, AKI poses an enormous public health challenge. An estimated 13.3 million episodes of AKI occur annually worldwide, with approximately 85% of these events occurring in low- and lower-middle-income countries (LMICs) [6]. The epidemiological pattern of AKI differs significantly between high-income countries and LMICs. In high-income countries, AKI predominantly occurs in hospitalized elderly patients and is commonly associated with sepsis, nephrotoxic drugs, and invasive procedures. In contrast, AKI in LMICs frequently affects younger individuals and is primarily driven by infections, volume depletion, and obstetric complications—conditions that are often preventable with timely intervention [6,7].

Acute gastroenteritis is one of the most common clinical syndromes encountered worldwide, involving inflammation of the gastrointestinal tract and characterized by abdominal pain, vomiting, nausea, and diarrhoea. It is typically self-limiting and may be caused by a range of pathogens including viruses, bacteria, protozoa, and parasites. Transmission occurs primarily through contaminated water or food, although pathogens with low infectious doses may also spread via person-to-person contact [8]. Diarrheal diseases remain a major global health burden. According to the Global Burden of Disease Study 2021, diarrheal diseases caused an estimated 1.17 million deaths globally in 2021, although this represented a 60.3% decrease from approximately 2.93 million deaths in 1990 [9]. Despite this decline in mortality, the incidence of diarrheal illness remains alarmingly high, particularly in tropical and subtropical regions where unsafe water, poor sanitation, and inadequate hygiene infrastructure persist.

Acute diarrheal disease is a well-recognized precipitant of AKI. The pathophysiology of diarrhoea-associated AKI is primarily driven by volume depletion leading to prerenal azotaemia. When fluid losses are not promptly corrected, sustained renal hypoperfusion may progress to ischemic acute tubular necrosis (ATN). In addition to prerenal injury and ATN, diarrheal illness may also give rise to acute tubulointerstitial nephritis, haemolytic uremic syndrome, infection-related glomerulonephritis, and acute cortical necrosis [10,11].

The constellation of electrolyte derangements, metabolic acidosis, and hemodynamic instability accompanying severe diarrhoea further compounds the risk of renal injury. The epidemiological significance of diarrhoea-associated AKI has been well documented in the Indian subcontinent. A landmark study from eastern India spanning 26 years (1983–2008) reported that diarrheal diseases constituted the single most common cause of community-acquired AKI, although their proportion decreased from 36.83% in the earlier period (1983–1995) to 19% in the later period (1996–2008), reflecting improvements in public health infrastructure [12]. Similarly, data from South India identified acute diarrheal disease as the most common cause of acute renal failure over a decade-long study period [13]. A study from Mumbai examining AKI of infectious aetiology during the monsoon season reported an overall incidence of 13.21%, with acute gastroenteritis accounting for 23% of all cases, predominantly affecting males (79.5%) with a mean age of approximately 41 years [14].

Seasonal outbreaks of diarrheal disease are particularly common during the monsoon months in India, when heavy rainfall increases the risk of waterborne contamination, flooding, and disruption of sanitation systems. Coastal regions are especially vulnerable owing to the confluence of occupational exposure to contaminated water bodies, high ambient humidity, and the proliferation of waterborne pathogens. Despite the recognized seasonal surge in diarrheal illnesses during the monsoon, data on post-diarrheal AKI (PD-AKI) remain surprisingly sparse. A recent retrospective study from a tertiary care hospital examining PD-AKI during a monsoon epidemic observed that this condition disproportionately affected younger adults, with a predominance of severe AKI stages and a significant need for renal replacement therapy [15]. The present study was conducted during a diarrheal illness epidemic in the monsoon season of 2024 at Karwar, a coastal town in the Uttara Kannada district of Karnataka, India. Karwar's geography as a coastal fishing hub, combined with its monsoon vulnerability, creates a unique epidemiological setting for studying PD-AKI. This cross-sectional observational study aimed to evaluate the burden of PD-AKI and analyse the clinical profile, laboratory parameters, management strategies, and outcomes of patients admitted with post-diarrheal AKI during this period.

Aims and Objectives

The primary objectives of this study were: To evaluate the clinicodemographic profile of patients presenting with post-diarrheal acute kidney injury during the monsoon season at a tertiary care hospital in Karwar. To determine the etiological spectrum, KDIGO staging distribution, and laboratory parameters associated with PD-AKI. To assess the clinical outcomes including renal

recovery, need for dialysis, duration of hospital stay, and mortality in patients with PD-AKI.

Materials and Methods

Study Design: This was a hospital-based cross-sectional observational study conducted at the Department of Medicine, Karwar Institute of Medical Sciences (KRIMS), Karwar, Karnataka, India.

Study Setting and Duration: The Retrospective observational study was carried out during the monsoon season of 2024. KRIMS is a tertiary care referral hospital catering to the coastal Uttara Kannada district of Karnataka, serving a predominantly fishing and agrarian population.

Study Population: The study population comprised adult patients (aged ≥18 years) who presented to the hospital with acute diarrheal illness followed by the development of AKI during the monsoon months.

Sample Size: A total of 30 consecutive patients meeting the inclusion criteria were enrolled in the study during the study period.

Inclusion Criteria: Patients were included if they met all of the following criteria: age ≥18 years, presence of acute diarrhoea preceding the onset of kidney injury, and AKI as defined by the KDIGO criteria (an increase in serum creatinine of ≥0.3 mg/dL within 48 hours, an increase to ≥1.5 times the baseline within seven days, or a urine output of less than 0.5 mL/kg/h for at least six hours) [1].

Exclusion Criteria: Patients were excluded if they had pre-existing chronic kidney disease (as determined by prior medical records or ultrasonographic evidence of chronicity), obstructive uropathy, or drug-induced AKI unrelated to the diarrheal illness.

Data Collection: A detailed history and clinical examination were performed for each enrolled patient. The following data were systematically collected: demographic characteristics (age, sex, occupation, and geographic location), clinical features of the diarrheal illness (duration of diarrhoea, stool frequency, presence of fever, vomiting, and abdominal pain), assessment of dehydration status (graded as mild, moderate, or severe based on World Health Organization criteria), vital signs including systolic and diastolic blood pressure, and assessment of urine output (oliguria or anuria). Laboratory investigations included complete blood count, serum creatinine, blood urea, serum electrolytes (sodium and potassium), serum bicarbonate, and arterial blood gas analysis. Etiological evaluation included stool culture, serological testing where applicable, and clinical assessment. The KDIGO staging system was applied to classify the severity of AKI. Management details including the nature of fluid resuscitation, use of antibiotics, and requirement for renal replacement therapy (haemodialysis) were recorded. Outcomes assessed included recovery of kidney function (defined as normalization of serum creatinine at discharge), requirement for dialysis at discharge, duration of hospital stay, and in-hospital mortality.

Statistical Analysis: Data were entered in Microsoft Excel and analysed using descriptive statistics. Continuous variables were expressed as mean ± standard deviation or median with range, as appropriate based on the distribution of data. Categorical variables were expressed as frequencies and percentages.

Ethical Considerations: The study was approved by the Institutional Ethics Committee. Informed consent was obtained from all participants prior to enrolment. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

Demographic Profile: A total of 30 patients with post-diarrheal AKI were included in the study. The mean age of the study cohort was 40.87 years (median: 34.5 years), with a wide age range from 18 to 79 years. There was a marked male predominance, with 22 out of 30 patients (73.3%) being male and 8 (26.7%) being female.

Seasonal Distribution of Admissions: The study confirmed a strong monsoon-season predilection for PD-AKI. The monthly distribution of admissions is presented in Table 1.

The vast majority of admissions (28 out of 30; 93.3%) occurred during the peak monsoon months of June through August, with July accounting for the highest proportion (43.3%), followed by August (36.7%). Only two patients (6.7%) were admitted in September.

Table 1: Monthly Distribution of Admissions

Month of Admission	Count (n)	Percentage (%)
June	4	13.3
July	13	43.3
August	11	36.7
September	2	6.7
Total	30	100.0

Etiological Profile: The aetiology was predominantly infectious gastroenteritis. Acute gastroenteritis (GE) was the most common diagnosis, identified in 19 patients (63.3%), followed by Vibrio cholerae infection in 6 patients (20.0%), dengue fever-associated diarrhoea in 4 patients (13.3%), and leptospirosis in 1 patient (3.3%).

Occupational Distribution: The occupational profile revealed a notable concentration of specific groups. Fishermen constituted the largest occupational category (12 patients; 40.0%), followed by homemakers (11 patients; 36.7%). Students, farmers, labourers, and shopkeepers comprised the remaining 23.3%. The occupational distribution is shown in Table 2.

Table 2: Occupational Distribution of Patients

Occupation	Count (n)	Percentage (%)
Fisherman	12	40.0
Homemaker	11	36.7
Student	3	10.0
Farmer	2	6.7
Labourer	1	3.3
Shopkeeper	1	3.3
Total	30	100.0

Geographic Distribution: The geographic distribution demonstrated a clustering of cases around the coastal region of Karwar. Karwar town itself accounted for 50% of cases (15 patients), followed by Baithkol—a prominent fishing harbor—contributing 23.3% (7 patients). Together, Karwar and Baithkol accounted for nearly 75% of all patients. The remaining patients were from Ankola, Chendia, Majali, Kumta, and Yellapura, as detailed in Table 3.

Table 3: Geographic Distribution of Patients

Address / Taluk	Count (n)	Percentage (%)
Karwar	26	86.66
Ankola	2	6.7
Kumta	1	3.3
Yellapura	1	3.3
Total	30	100.0

Clinical Presentation and Diarrheal Profile: The median duration of diarrhoea prior to hospital admission was 3 days (range: 1–6 days), and the median stool frequency was 10 episodes per day (range: 5–19 per day). Among associated symptoms, fever was present in 76.7% of patients, vomiting in 70.0%, and abdominal pain in 53.3%. Regarding the severity of dehydration, half of the patients (50.0%) presented with moderate dehydration, followed by mild dehydration in 33.3% and severe dehydration in 16.7%. Hemodynamic assessment revealed a median systolic blood pressure of 102 mmHg (range: 80–138 mmHg) and a median diastolic blood pressure of 78 mmHg (range: 60–89 mmHg).

AKI Profile and Urine Output: A very high proportion of patients presented with decreased urine output. Oliguria was documented in 86.7% (26 patients) and anuria in 13.3% (4 patients). Among the patients for whom KDIGO staging data were available (n = 12; 40%), the distribution was as follows: Stage 1 in 5 patients (16.7% of total cohort), Stage 2 in 3 patients (10.0%), and Stage 3 in 4 patients (13.3%). Four patients (13.3%) required haemodialysis during their hospital stay.

Laboratory Parameters: The key laboratory findings are summarized in Table 4. The median peak serum creatinine was 1.15 mg/dL (range: 0.46–7.38 mg/dL), indicating high variability in the severity of renal involvement. The median serum urea was 43.65 mg/dL (range: 7.30–98.70 mg/dL), which was elevated above normal limits.

Serum bicarbonate had a median value of 18.00 mEq/L (range: 6.00–22.00 mEq/L), suggesting mild metabolic acidosis. The median serum sodium was 136.00 mEq/L (range: 100.00–148.00 mEq/L), with some patients demonstrating severe hyponatremia. The median serum potassium was 3.40 mEq/L (range: 1.90–5.40 mEq/L), indicating a tendency toward hypokalemia rather than hyperkalemia.

Table 4: Key Laboratory Parameters

Parameter	Median	Minimum	Maximum	Interpretation
Peak Serum Creatinine (mg/dL)	1.15	0.46	7.38	High variability; peak 7.38 mg/dL
Serum Urea (mg/dL)	43.65	7.30	98.70	Elevated above normal
Bicarbonate (mEq/L)	18.00	6.00	22.00	Mild metabolic acidosis
Serum Sodium (mEq/L)	136.00	100.00	148.00	Some severe hyponatremia
Serum Potassium (mEq/L)	3.40	1.90	5.40	Tendency toward hypokalemia

Outcomes: The overall outcomes for this cohort were remarkably favourable despite the severity of AKI in some patients. The results are summarized in Table 5. The median duration of hospital stay was 5 days (range: 3–10 days). No mortality was observed in the study cohort (0% mortality). Kidney function recovery was achieved in 28 out of 30 patients (93.3%), with a median serum creatinine at discharge of 0.97 mg/dL.

Two patients (6.7%) remained dialysis-dependent at the time of discharge.

Table 5: Clinical Outcomes

Outcome Parameter	Value
Median Hospital Stay (days)	5 (Range: 3–10)
In-Hospital Mortality	0 (0%)
Full Kidney Function Recovery	28 (93.3%)
Median Creatinine at Discharge (mg/dL)	0.97
Dialysis-Dependent at Discharge	2 (6.7%)

Discussion

This cross-sectional observational study provides valuable insights into the clinical profile and outcomes of post-diarrheal acute kidney injury during the monsoon season in the coastal town of Karwar. The findings confirm that PD-AKI is a clinically significant complication of diarrheal illness, particularly during monsoon-related outbreaks, and that early recognition and management can yield favourable outcomes even in a resource-limited setting.

The mean age of the study population was 40.87 years, which is consistent with the findings of Mehta et al. [14], who reported a mean age of 40.95 ± 16.55 years in their prospective study of AKI of infectious etiology during the monsoon season from a tertiary care hospital in Mumbai. Similarly, Haridas et al. [15] reported a mean age of 41.4 years in their retrospective analysis of 93 patients with PD-AKI during a monsoon epidemic. The predilection for middle-aged adults may reflect this age group's greater occupational exposure to contaminated water sources, particularly in coastal and agrarian settings. The marked male predominance observed in our study (73.3%) is in agreement with the broader literature on AKI in tropical settings. Mehta et al. [14] reported 79.5% male patients in their monsoon AKI cohort, while Prakash et al. [12] observed a male preponderance (57.2%) in their 26-year analysis of community-acquired AKI in eastern India. The study by Eswarappa et al. [13] from South India also noted a male predominance (60.1%) among patients with acute renal failure. The higher proportion of males likely reflects occupational exposure patterns, as men in coastal regions are predominantly engaged in outdoor occupations such as fishing that predispose them to waterborne infections.

The occupational profile of our cohort is particularly noteworthy. Fishermen constituted the single largest occupational group (40.0%), followed by homemakers (36.7%). The high representation of fishermen is a distinctive finding that likely reflects the unique epidemiological context of Karwar as a coastal fishing hub. Fishermen have frequent and prolonged contact with seawater and estuarine environments, which may harbor Vibrio species and other enteropathogenic organisms. This occupational link is further supported by the geographic clustering of cases in Karwar and Baithkol—the latter being a prominent fishing harbor—which together accounted for nearly 75% of the study cohort.

Regarding the seasonal distribution, 93.3% of admissions occurred during the peak monsoon months of June through August, with July alone accounting for 43.3% of cases. This finding is consistent with the well-established association between monsoon rainfall and outbreaks of diarrheal disease [14,15]. Monsoon-related flooding, contamination of water supplies, and disruption of sanitation infrastructure create conditions conducive to the spread of waterborne pathogens. Mehta et al. [14] similarly observed a peak incidence of monsoon-associated AKI during the months of July through September.

Acute gastroenteritis was the most common etiology (63.3%) in our study, followed by Vibrio cholerae infection (20.0%), dengue-associated diarrhea (13.3%), and leptospirosis (3.3%). This etiological distribution is broadly consistent with

the pattern described by Mehta et al. [14], where acute gastroenteritis accounted for 23% and leptospirosis for 13% of all monsoon-associated AKI cases. The relatively high proportion of cholera in our cohort (20%) is notable and may reflect the vulnerability of coastal communities to Vibrio contamination of water sources, particularly during monsoon flooding. A Saudi Arabian study by Alghamdi et al. [8] examining AGE-related AKI in a tertiary care setting found that dehydration, particularly even mild dehydration, was a primary mechanism leading to AKI, reinforcing the importance of early fluid management.

The clinical presentation in our study was characterized by a median diarrheal duration of 3 days prior to admission, with a median stool frequency of 10 episodes per day. Fever was present in 76.7% and vomiting in 70.0% of patients. Half of the patients (50.0%) presented with moderate dehydration, 33.3% with mild dehydration, and 16.7% with severe dehydration. Alghamdi et al. [8] similarly found that mild dehydration was the most common category among AGE patients who developed AKI (48.7%), demonstrating that even moderate fluid losses can precipitate renal injury when not promptly corrected.

The high prevalence of oliguria (86.7%) and anuria (13.3%) in our cohort underscores the severity of prerenal injury resulting from volume depletion. These findings are consistent with the pathophysiology of diarrhoea-associated AKI, where sustained renal hypoperfusion leads to reduced urine output as a physiological compensatory mechanism. Among the patients for whom KDIGO staging was available (n = 12), the majority were classified as Stage 1 (41.7%) or Stage 2 (25.0%), reflecting early clinical detection, while Stage 3 was observed in 33.3% of staged patients. In contrast, Haridas et al. [15] reported a higher proportion of severe AKI (KDIGO Stage 3 in 61.3%) in their cohort, which may reflect differences in the timing of presentation and the referral pattern of their tertiary care centre. The laboratory parameters in our study revealed a median peak serum creatinine of 1.15 mg/dL with a wide range (0.46–7.38 mg/dL), indicating significant heterogeneity in the severity of renal impairment. The elevated median serum urea (43.65 mg/dL), low bicarbonate levels (median 18.00 mEq/L), tendency toward hyponatremia (range extending to 100.00 mEq/L), and hypokalemia (median 3.40 mEq/L) are consistent with the metabolic consequences of severe diarrheal illness, including fluid loss, acid-base disturbance, and electrolyte depletion. These findings parallel the observations of Rao et al. [11], who emphasized that electrolyte derangements and metabolic acidosis are hallmarks of diarrhea-associated AKI that require prompt correction alongside volume resuscitation.

Only 4 patients (13.3%) in our study required hemodialysis, which is substantially lower than the 44.78% reported by Mehta et al. [14] in their monsoon AKI cohort and the 50% reported by some case series of AGE-induced AKI [11]. This difference likely reflects the predominance of milder AKI stages in our cohort and the earlier initiation of fluid resuscitation. The Gupta et al. [11] case series highlighted that 3 out of 6 patients with AGE-induced AKI remained dialysis-dependent at one month, emphasizing the potential for progression to chronic kidney disease when renal replacement is required.

The most striking finding of our study was the favourable outcome profile. Kidney function recovery was achieved in 93.3% of patients, with a median creatinine of 0.97 mg/dL at discharge. The zero mortality rate observed in our cohort is particularly encouraging when compared with the 12.17% mortality reported by Mehta et al. [14] in their monsoon AKI study and the 19.2% overall mortality observed by Prakash et al. [12] in their eastern India cohort. The national-level data from Patel et al. [2] indicate that AKI complicated approximately 1 in 10 hospitalizations for diarrheal illness and was associated with a five-fold increase in mortality in the affected population. The favorable outcomes in our study may be attributed to the relatively younger age of the cohort, absence of significant comorbidities, predominantly prerenal etiology of AKI, and timely initiation of fluid resuscitation. The median hospital stay of 5 days further reflects the typically reversible nature of prerenal AKI when managed appropriately.

The current study has several limitations that should be acknowledged. First, the sample size of 30 patients is relatively small, which limits the statistical power and generalizability of the findings. Second, KDIGO staging data were available for only 40% of the cohort, which may have led to underestimation of the severity distribution of AKI. Third, the absence of stool testing for viral pathogens may have resulted in the underdiagnosis of viral etiologies. Fourth, the cross-sectional design precludes assessment of long-term renal outcomes and the potential transition to chronic kidney disease. Finally, being a single-center study from a coastal region, the findings may not be directly applicable to inland or urban populations.

Despite these limitations, this study contributes meaningful data to the sparse literature on PD-AKI in the Indian context and highlights the unique epidemiological characteristics of this condition in a coastal monsoon-affected region.

Conclusion

This study demonstrates that post-diarrheal acute kidney injury during the monsoon season in the coastal region of Karwar predominantly affects middle-aged males, particularly those engaged in fishing occupations, and is primarily caused by acute gastroenteritis and Vibrio cholerae infection. The majority of patients present with moderate-severe dehydration and oliguria, and the disease follows a favourable clinical course when recognized early and managed with prompt fluid resuscitation and supportive care. Kidney function recovery was observed in over 93% of patients, and no mortality was recorded in the cohort.

These findings underscore the importance of heightened clinical vigilance for AKI in patients presenting with diarrheal illness during the monsoon season, particularly in coastal communities. Early assessment of renal function, timely correction of volume depletion and electrolyte derangements, and appropriate referral for dialysis when indicated are key determinants of favourable outcomes.

At the public health level, preventive measures including improved sanitation infrastructure, access to safe drinking water, community health education, and targeted occupational health interventions for fishing communities are essential to reduce the burden of diarrheal illness and its renal complications during the monsoon season. Larger multicentreprospective studies with longer follow-up are recommended to further characterize the epidemiology, risk factors, and long-term renal outcomes of post-diarrheal AKI in monsoon-affected regions of India.

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