ORIGINAL RESEARCH

Exploring Acute Kidney Injury: A Prospective Analysis of Etiology, Clinical Presentation, and Outcome in a Tertiary Care Hospital Setting

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Received date: 22 February, 2024 Acceptance date: 17 March, 2024

ABSTRACT

Background: Acute kidney injury (AKI) is often asymptomatic, diagnosed through biochemical monitoring indicating elevated blood urea and serum creatinine. The study aimed to assess AKI's etiology, clinical aspects, prognosis, and analyze dialysis utilities. **Methods:** Aprospective observational hospital-based study was conducted at King George hospital, Visakhapatnam, India, from January 2017 to September 2018.Patients with AKI exhibitedanincrease in serum creatinineof ≥ 0.3 mg/dL (≥ 26.4 micromole/L) were included in study. **Results:**Of 50 patients, 29 were males and 21 were females.Patient with AKI,oliguria was the predominant presentation in both genders (males 86.20%, females 85.71%). The leading cause of AKI was acute diarrheal diseases (ADD) (32.00%) followed by malaria (24.00%), sepsis-related infections (14.00%) and poisoning (8.00%).In pre-renal AKI patients, ADD (81.25%) emerged as the most common etiology, followed by malaria (66.66%). Pre-renal AKI patients showed a significantly higher prevalence of ADD (81.25%) compared to renal (P=0.02). According to acute kidney injury network (AKIN) criteria, 46.00% patients were in stage 1, 24.00% in stage 2, and 30% in stage 3. Among the AKIN stages, ADD was significantly higher in stage 1 (81.25%, P= 0.0023)and all other etiologies were comparable. Allpatientswere treated conservatively with no mortality in stage 1. In stage 2, 50% patients were treated conservatively, 50% underwent hemodialysis and 16.66% expired. In stage 3, 20% patients were treated conservatively, 80% underwent hemodialysis, and 33% died due to complications. **Conclusion:**The presentation of AKI is predominantly oliguric, with ADDas the leading cause.Despite low mortality, two-thirds were managed conservatively, while one-third required hemodialysisunless contraindicated.

Keywords: Acute diarrheal diseases (ADD), acute kidney injury (AKI), acute kidney injury network (AKIN),hemodialysis (HD),oliguria.

INTRODUCTION

Acute kidney injury (AKI), previously termed acute renal failure, refers to a sudden and frequently reversible decline in kidney function [1]. AKI is a prevalent clinical condition among hospitalized patients, bearing a significant impact on both mortality and morbidity. Annually, over 13 million individuals are affected by AKI, with 85% of these cases occurring in developing nations [2]. AKI occurs in 5–7% of individuals admitted to acute care hospitals and in as many as 30% of those admitted to intensive care units [3].

AKI is a diverse syndrome characterized by a rapid (within hours to days) decrease in the glomerular filtration rate (GFR). This leads to the accumulation of metabolic waste products like urea and creatinine, disrupting the balance of fluids, electrolytes, and acid-base levels within the body [4]. The etiology of AKI is typically classified into three main categories:

prerenal, renal (involving direct intrinsic kidney damage), and postrenal causes [2].

As per Kidney Disease Improving Global Outcomes (KDIGO), AKI is identified by the presence of one or more of the following, 1) A rise in serum creatinine by 0.3 mg/dL or higher (26.5 μmol/L or higher) within 48 hours. 2) An increase in serum creatinine to 1.5 times or more compared to the baseline within the preceding 7 days. 3) Urine output of less than 0.5 mL/kg/hour for a minimum of 6 hours [5].

A major challenge in the investigation and management of AKI is timely recognition of the syndrome.Given the absence of specific pharmacological treatments for AKI, patient care primarily involves supportive management strategies which involves renal replacement therapy (RRT) as the central approach for treatment[6].

The study aims to comprehensively explore AKI by investigating its etiology and clinical profile. It seeks to apply the Acute Kidney Injury Network (AKIN) criteria to patients admitted in medical wards and acute care units to validate its significance in diagnosing AKI. Additionally, the research intends to look into the prognosis and outcomes associated with AKI while analysing the efficacy of dialysis as a treatment option for AKI management.

MATERIALS AND METHODS

Aprospective observational hospital-based study was conducted atKing George hospital, Visakhapatnam, India, over a duration of 20 months, from January 2017 - September 2018. The study design and methodology received approval from the institutional ethics committee and review board (Institutional ethics committee AMC-KGH Vishakhapatnam; 41/IEC AMC-KGH/NOV/2018). Written informed consent was obtained from all patients in their local language prior to their participation in the study.

Patients with AKI exhibited an absolute increase in serum creatinine of ≥ 0.3 mg/dL (≥ 26.4 micromole/L) and a percentage increase in serum creatinine of ≥50% (1.5 times the baseline) were included in the study. Patients with chronic kidney disease, abnormal kidney size and abnormal cortico-medullary differentiation were excluded.

The outcomes of the study wereto evaluate etiology, clinical, prognosis of AKI and analyze the utilities of dialysis in AKI.

A thorough diagnostic evaluation was conducted on patients who met the inclusion criteria, utilizing detailed history reviews, physical examinations, complete urine analyses, renal function tests, renal ultrasounds, malaria smears, serology for diseases like enteric fever and leptospirosis, and other relevant investigations to identify the cause of AKI. After establishing a diagnosis, appropriate treatment was administered, addressing etiological factors whenever possible, and discontinuing any offending agents. The prognosis and outcomes of the patients were studied, and if necessary, renal replacement therapy was initiated.

A comprehensive diagnostic evaluation, encompassing a detailed patient history, thorough physical examination, complete urine analysis, renal function tests, renal ultrasound, smear for malaria, serology for enteric fever, leptospirosis, and other relevant investigations were conductedto find the cause of AKI, and data were collected.

Data were analyzed using SPSS (statistical package for social sciences) version 20. Descriptive analysis was used to present the study outcomes. Categorical variables were described as numbers and percentages. $P< 0.05$ was considered statistically significant.

RESULTS

A total of 50 patients were included, of which 29 were males and 21 were females.The mean age of patients were 42.45 years. Among male patients, the majority (27.58%) were in the age group of 51-60 years and 20.68% were in the age group of 41-50 years. In female patients, the majority (28.57%) were in the age group of 31-40 years and 23.80% were in the age group of 51-60years[Figure 1]. The most common presenting feature of AKI was oliguria in both male (86.20%) and female patients (85.71%), while no-oliguria was observed in 13.79% of the males and 14.28% of thefemales [Figure 2].

The majority (32.00%) of AKI patients were attributed to acute diarrheal diseases (ADD), followed by malaria (24.00%). The etiological profile of AKI was comparable between male and female patients [Table 1].

Among the patients with non-oliguric AKI (n=7), 28.57 % had ADD and sepsis. All of the patients were recovered.In pre-renal AKI patients, ADD (81.25%) emerged as the most common etiology, followed by malaria (66.66%). Pre-renal AKI patients showed a significantly higher prevalence of ADD (81.25%) compared to renal (P=0.02). All other etiologies of AKIwere comparable across pre-renal, renal, and post-renal patients, with renal AKI specifically attributed to snake bite [Table 2].

Based on the acute kidney injury network (AKIN) criteria, 46% of patients were categorized in AKIN stage 1, 24% in AKIN stage 2, and 30% in AKIN stage 3. Among the AKIN stages, ADDwere significantly higher in AKIN stage 1 (81.25%, P= 0.0023). All other etiologies were comparable across all AKIN stages [Table 3].In AKIN stage 1, all patients were treated conservatively and recovered well without any mortality. In AKIN stage 2, out of 12 patients, 50% were treated conservatively, and 50% underwent hemodialysis and 16.66% expired. In AKIN stage 3, 20% of patients were treated conservatively, while 80% underwent hemodialysis, and mortality was reported in 33% of the patients due to complications[Table 4].

Table 1.Etiological profile of AKI in male and female patients

Etiology	No of Patients (N=50)	Male	Female	P value
ADD	16 (32.00)	9 (56.25)	7 (43.75)	0.86
Malaria	12 (24.00)	7 (58.33)	5 (41.66)	0.97
Sepsis	7 (14.00)	4 (57.14)	3 (42.85)	0.96
Poisoning	4 (8.00)	2 (50.00)	2 (50.00)	0.73
Snake bite	3 (6.00)	2 (66.66)	1 (33.33)	0.75
RPGN	3 (6.00)	1 (33.33)	2 (66.66)	0.37
Post renal	3 (6.00)	2 (66.66)	1 (33.33)	0.75
Leptospira	1 (2.00)	1 (100.00)	0	Fisher 0.58
CCF	1 (2.00)	1 (100.00)	0	Fisher 0.58
Data presented as n (%). ADD, acute diarrheal diseases; AKI, acute kidney injury; CCF**,** Congestive cardiac failure; RPGN, rapidly progressive glomerulonephritis.				

Table 2.Etiology of pre-renal, renal, and post renalAKI

Etiology	No of Patients (N=50)	Pre-renal	Renal	Post renal	P value
ADD	16 (32.00)	13 (81.25)	3 (18.75)	0	0.02
Malaria	12 (24.00)	8 (66.66)	4 (33.33)	0	0.57
Sepsis	7 (14.00)	3 (42.85)	4 (57.14)	0	0.64
Poisoning	4 (8.00)	1 (25.00)	3 (75.00)	0	0.45
Snake bite	3 (6.00)	0	3 (100.00)	0	0.148
RPGN	3 (6.00)	0	3 (100.00)	0	0.148
Post renal	3 (6.00)	0	0	3 (100.00)	0
Leptospira	1 (2.00)	1 (100.00)	0	0	0.99
CCF	1 (2.00)	1 (100.00)	0	0	0.99
Data presented as n (%). ADD, acute diarrheal diseases; AKI, acute kidney injury; CCF**,** Congestive cardiac failure; RPGN, rapidly progressive glomerulonephritis.					

Table 3. Etiology based on AKIN criteria

Etiology	No of Patients (N=50)	AKIN stage 1 (N=23)	AKIN stage 2 (N=12)	AKIN stage 3 (N=15)	P value
ADD	16 (32.00)	13 (81.25)	2 (12.50)	1 (6.25)	0.0023
Malaria	12 (24.00)	5 (41.66)	4 (33.33)	3 (25.00)	0.68
Sepsis	7 (14.00)	0	0	7 (100.00)	0
Poisoning	4 (8.00)	1 (25.00)	2 (50.00)	1 (25.00)	0.432
Snake bite	3 (6.00)	2 (66.66)	0	1 (33.33)	0.788
RPGN	3 (6.00)	0	3 (100.00)	0	0.0112
Post renal	3 (6.00)	0	1 (33.33)	2 (66.66)	0.149
Leptospira	1 (2.00)	1 (100.00)	0	0	0.99
CCF	1 (2.00)	1 (100.00)	0	0	0.99
Data presented as n (%). ADD, acute diarrheal diseases; AKI, acute kidney injury; AKIN, acute kidney injury network; CCF**,** Congestive cardiac failure; RPGN, rapidly progressive glomerulonephritis.					

Table 4.Treatment and outcomes according to stages of AKIN

	AKIN stage 1 (N=23)	AKIN stage 2 (N=12)	AKIN stage 3 (N=15)
Treatment			
Conservative	23 (100.00)	6 (50.00)	3 (20.00)
HD	0	6(50.00)	12 (80.00)
Outcome			
Survived	23 (100.00)	10 (83.33)	10 (66.66)
Expired	0	2 (16.66)	5 (33.33)
Data presented as n (%) AKI, acute kidney injury; AKIN, acute kidney injury network; HD, hemodialysis.			

Figure 1: Distribution of patients by age and sex

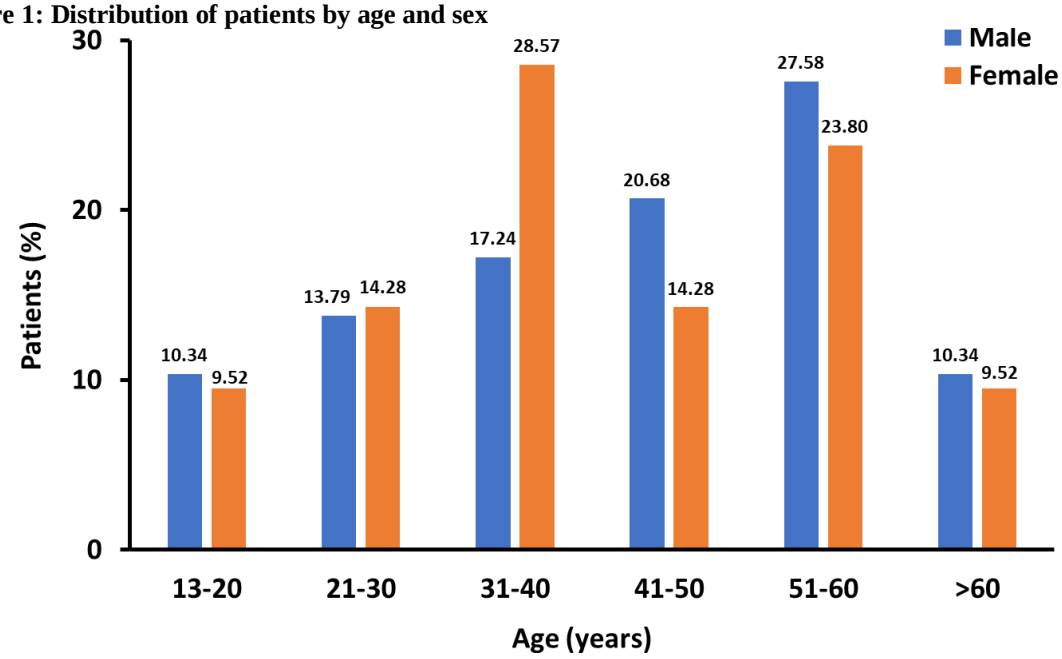
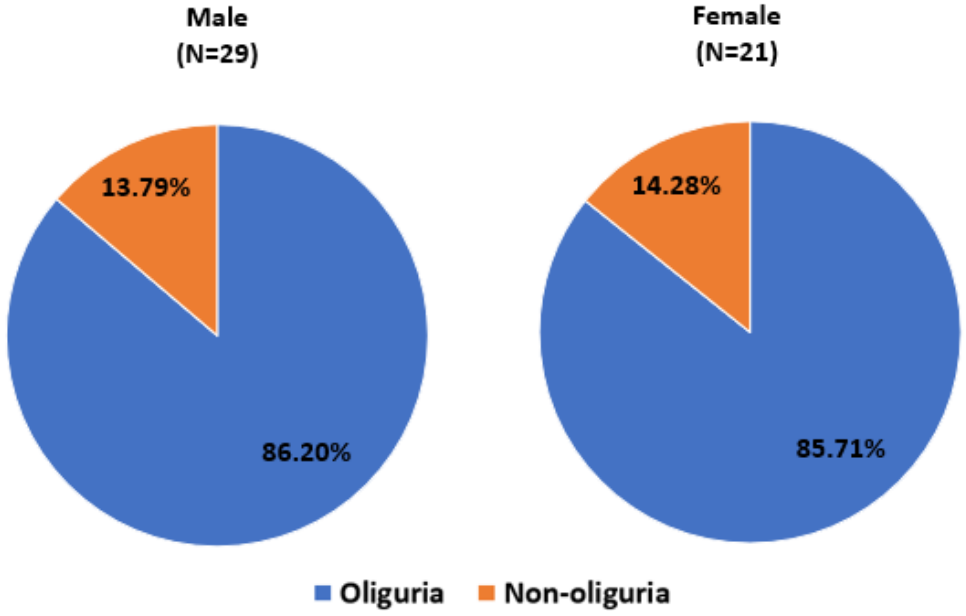


Figure 2: Presenting features of AKI



AKI, acute kidney injury

DISCUSSION

The data collected from this study likely covered a broad spectrum of elements linked to AKI, including potential causes or underlying factors, the wide array of clinical manifestations seen in the patients affected, and the resulting implications for prognosis. Additionally, the study investigated how dialysis functions in the treatment of AKI, assessing its effectiveness in enhancing patient outcomes and potentially impacting the development of the condition.

In the present study, the mean age of the study population was 42.45 years with majority of the male patients belonging to the age group of 51-60 years. Among the female patients with AKI, the majorly affected age group was 31-40 years. Another cross-sectional, prospective study from Ethiopia reported the mean age of patients with AKI was 46.6 years. Notably, approximately 40% of the patients fell within the age range of 30 to 50 years [7]. A study from Northeastern India reported similar findings to the present study. In this study the mean age of the patients was 46.16 years and majority of the female patients belonged to the age group 31-40 years[8].

Low urine output, known as oliguria, is a strong indicator or predictor for AKI[1].In the present study oliguria was the most common presenting feature of AKI among the study population. A study by Mehta et al. reported oliguria as a predominant presenting feature among 70.4 % of the patients with AKI [9].

Around 40% of AKI cases in India are attributed to various factors including acute diarrheal disease, malaria, leptospirosis, snakebites, insect stings, intravascular hemolysis due to septicaemia as well as conditions related to pregnancy[10,11].AKI frequently occurs and holds significant importance among individuals hospitalized due to diarrheal illnesses[12].Data from a study on a cohort from National Inpatient Sample in USA concluded that ten percent of adults admitted to the hospital due to diarrhoea suffered from AKI, the condition more commonly observed in older individuals[12].In the present study ADD accounted for the majority of AKI incidence among patients, followed by malaria, infections leading to sepsis, snake bite and poisoning. This aligns with results from a study by Jayakumar et al. [13] where ADD was the most common among medical causes of acute renal failure. A study by Mehta et al., malaria was identified as the leading cause, affecting 28.3% of the patient population[9].

Out of the seven patients who had non-oliguric AKI, 28.57% experienced both ADD and sepsis. No mortality was reported. Similar to the present study, Choi et al. also reported sepsis as a leading cause of non-oliguric AKI [14].

Diarrhea leads to substantial fluid loss, causing dehydration. Reduced fluid volume results in decreased blood flow to the kidneys, contributing to pre-renal azotemia, a common cause of pre-renal AKI[1]. In the present study ADD emerged as most common cause for pre- renal AKI. Acute kidney injury in the context of snake bites is distinctly linked to the venom's direct impact on renal function. Venom from snake bite induces pathological alterations in the kidneys which encompasses tubular necrosis, cortical necrosis, interstitial nephritis, glomerulonephritis, and vasculitis. The emergence of nephropathy is predominantly attributed to hemodynamic shifts induced by vasoactive mediators and cytokines, alongside substantial nephrotoxic effects[15].In this study AKI of renal origin specifically linked to snake bite.

As per the criteria established by the AKIN, 46% of patients were placed in AKIN Stage 1, 24% in AKIN Stage 2, and 30% in AKIN Stage 3.These results are consistent with findings from the previous study by Bhattacharya, et al. where over half of the AKI patients (54.67%) were in Stage 1, with 16% in Stage 2 and 29.33% in Stage 3[8].Also, similar results were reported from a retrospective cohort study conducted across seven American ICUs, involving 14,524 patients with Acute Kidney Injury (AKI), the findings revealed that AKI Stage 1 was the most prevalent at 38.5%, followed by AKI Stage 2 at 14.1%, and AKI Stage 3 at 4.3% [16].

Diarrheal illnesses can lead to hemodynamic changes, affecting blood pressure and perfusion to the kidneys. Reduced blood supply can compromise renal function, leading to AKI[12].Similarly, in the present study among the AKIN stages, the prevalence of ADD was notably elevated in individuals classified under AKIN stage 1.Out of 50 cases, 36% of the patients underwent hemodialysis, and the rest were managed conservatively. A study by Bhattacharya, et al. reported that 24% of the patients necessitated hemodialysis, while other research conducted in India demonstrated a range in the need for hemodialysis in AKI from 28% to 51.6%[17,18].

In the present study,among AKIN stage 1, all patients received conservative treatment and recovered without mortality. In AKIN stage 2, among 12 patients, 16.66% experienced mortality. In AKIN stage 3, 33% faced mortality due to complications.The mortality rate for Stage 3 AKI is significantly higher when compared to Stage 1. Studies consistently report an increased risk of mortality as AKI severity progresses. For instance, a study showed a greater in-hospital mortality rate of 21% in Stage 3 compared to 9% in Stage 1 AKI cases [19]. Another investigation revealed a mortality rate of 44% for high AKI burden, 35% for medium, and 27% for low AKI burden [20]. These findings underscore the critical importance of recognizing and managing AKI promptly, particularly at later stages, to mitigate the associated higher mortality risk.

The study has limitations, including a small sample size, a short follow-up period, and an inability of AKIN staging to consistently predict outcomes due to instances where mortality resulted from multisystem failure rather than the specified renal criteria.

CONCLUSION

The study highlights the predominance of oliguric presentation in AKI but emphasizes the importance of considering non-oliguric cases. Acute diarrheal disease remains a leading cause of AKI, with remarkably low mortality compared to previous studies. Early rehydration and prompt referral contribute to the reduced mortality. Infections, including malaria and leptospirosis, significantly contribute to AKI. Aggressive management of sepsis is crucial to prevent or treat multi-organ failure and reduce associated higher mortality**.**

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