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A Retrospective Study of Outcomes of Acute Kidney Injury In the Medical Intensive Care Unit

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Abstract

***Background:** Acute Kidney Injury (AKI) is a serious complication in ICU patients, linked to high morbidity and mortality. Common causes include systemic illnesses, sepsis, hypotension, and nephrotoxic interventions. Early detection and management are critical for better outcomes. This study examines AKI incidence, risk factors, and outcomes in South Gujarat, emphasizing co-morbidities, causes, and the impact of interventions like dialysis.*

***Methods:** A retrospective observational study was conducted on 100 patients admitted to the ICU of a tertiary care hospital from July 2022 to September 2023. All patients were diagnosed with AKI based on the KDIGO criteria. Data on demographics, co-morbidities, aetiologies, and outcomes were collected using pre-formed case record forms. Statistical analysis was performed using IBM SPSS software to evaluate the influence of various factors on patient outcomes.*

***Results:** Sepsis was the leading cause of AKI, and infections such as malaria contributed significantly, with a mortality rate of 62.5% for malaria-related AKI. The most common co-morbidities were hypertension and diabetes mellitus. Patients receiving dialysis had significantly better recovery rates (97.3%) compared to those who did not receive dialysis (68%). Overall, 64% of patients recovered, 12% progressed to chronic kidney disease (CKD), and 24% succumbed to the condition.*

***Conclusions:** This study underscores the high incidence of AKI in ICU settings, with infections as the primary aetiology. Timely dialysis and effective management of underlying conditions significantly enhance the patient outcomes.*

***Key words:** Acute Kidney Injury, Intensive Care Unit, sepsis, dialysis.*

Introduction

Acute Kidney Injury (AKI) is a commonly prevalent complication in critically ill patients admitted to the intensive care units (ICUs). Defined by an abrupt loss of kidney function, AKI adversely impacts the clinical outcomes, increasing morbidity, mortality, and healthcare costs. Global data suggests that AKI affects up to 50% of ICU patients, with variation in incidence depending upon the patient population and healthcare setting[1]. Despite advancements in intensive care medicine, AKI remains a formidable challenge due to its multifactorial aetiology, encompassing conditions like sepsis, hypovolaemia, and nephrotoxic exposure.

In the ICU, AKI is often an interplay of systemic illnesses and treatment-related factors. Conditions such as sepsis and hypotension contribute to a hypo perfused state, while therapeutic interventions, including vasoactive drugs and mechanical ventilation, may further exacerbate renal stress[2]. The dynamic environment of the ICU makes it imperative to recognise and address these factors promptly to mitigate AKI progression. Studies indicate that early identification and targeted interventions are pivotal in improving patient outcomes, reducing the risk of transitioning to chronic kidney disease (CKD), and decreasing mortality rates[3].

The burden of AKI is not uniformly distributed but varies by demographic, geographic, and institutional characteristics. South Gujarat, as a region with diverse socio-economic and health determinants, provides a unique context for studying AKI. Limited data are available from this region regarding the demographic profiles, co-morbidities, and risk factors of ICU patients developing AKI. Understanding these aspects can guide the development of region-specific management protocols, improving outcomes for this vulnerable population.

Co-morbidities like diabetes mellitus, hypertension, and cardiovascular diseases are well-established risk factors for AKI. These conditions predispose individuals to haemodynamic instability, endothelial dysfunction, and increased susceptibility to nephrotoxic insults. Furthermore, the prevalence of AKI is higher among elderly patients, likely due to age-related decline in renal reserve and higher burden of comorbidities[4]. Identifying such high-risk groups is essential for devising preventive strategies, including optimizing fluid management and avoiding unnecessary

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nephrotoxic interventions.

Outcomes of AKI in the ICU are multifaceted, ranging from complete recovery of renal function to progression to CKD or end-stage renal disease (ESRD). Mortality rates among ICU patients with AKI remain alarmingly high, with estimates ranging between 30 - 50% depending on severity and underlying aetiology. Recovery trajectories are influenced by several factors, including the timeliness of AKI recognition, severity at onset, and adequacy of supportive care. Renal replacement therapy (RRT) is often employed in severe cases; however, its use carries inherent risks and resource implications. Emerging evidence underscores the importance of individualised decision-making regarding RRT initiation to balance benefits against potential harms[5].

Another critical area of exploration is the identification of modifiable variables that can improve AKI outcomes. Strategies such as early goal-directed therapy, judicious use of potential nephrotoxic agents, and implementation of AKI care bundles have shown promise in reducing incidence and improving recovery rates. Moreover, advancements in biomarkers for early AKI detection, including neutrophil gelatinase-associated lipocalin (NGAL) and kidney injury molecule-1 (KIM-1), hold potential for transforming the diagnostic landscape, enabling preemptive intervention[6].

The present study seeks to address these gaps in knowledge by providing a comprehensive evaluation of AKI outcomes in a tertiary care medical ICU in South Gujarat. Specifically, aiming to analyse the incidence, prevalence, and demographic characteristics of AKI, identify associated risk factors and co-morbidities, and assess short- and long-term patient outcomes. The findings will contribute valuable insights for optimising AKI management and informing clinical decision-making in similar settings.

By focusing on a geographically distinct population, this study adds to the growing body of evidence on AKI, bridging the gap between global research and local healthcare practices. The results are anticipated to drive quality improvement initiatives, ultimately enhancing the care of critically ill patients in the ICUs.

Material and Methods

Study Setting

This study was conducted in the Medical ICU of a tertiary care hospital in South Gujarat, India.

Study Design

A retrospective observational study.

Study Subjects

All patients diagnosed with AKI and admitted to the Medical ICU during the study period.

Inclusion Criteria

- Patients >18 years with decreased urine output.
- AKI diagnosis based on KDIGO criteria:
  - Serum creatinine increases ≥0.3 mg/dL within 48 hours or ≥1.5 times baseline within 7 days.
  - Urine output <0.5 mL/kg/h for 6 hours.
- Baseline serum creatinine of 1.3 mg/dL considered normal.

Exclusion Criteria

- Age <18 or >90 years.
- Pregnant women.
- Chronic kidney disease (CKD) patients.

Sample Size

Using hypothesis testing, the required sample size was 80, based on a 30% prevalence and 10% margin of error. Data from 100 patients was analysed.

Study Period

Data was collected from July 2022 to September 2023 (15 months), with 5 additional months for analysis.

Sampling Technique

Purposive sampling was employed.

Study Tools

Data was recorded using a pre-formed case record form (CRF).

Data Collection

Following Institutional Ethics Committee (IEC) approval, demographic and clinical data were collected, including age, sex, symptoms, co-morbidities, and outcomes.

Investigations

Complete blood counts, renal function tests, serum electrolytes, calcium, phosphate, urine analysis, bicarbonate, eGFR, creatinine clearance, and abdominal ultrasound were included during initial investigations.

Outcome Measures

1. **Recovery:** Kidney function restored to baseline.

2. **Progression to CKD:** Persistent dysfunction post-AKI.
3. **Death:** AKI-related mortality.

Statistical Analysis

Data were entered into Microsoft Excel and analysed by appropriate statistical tests using IBM SPSS.

Results

The study enrolled 100 participants, out of which 60 were male and 40 were female.

Fig. 1 shows the age distribution of the study participants, with the majority being in the younger age groups. The highest percentage (37%) of participants were aged 18 -

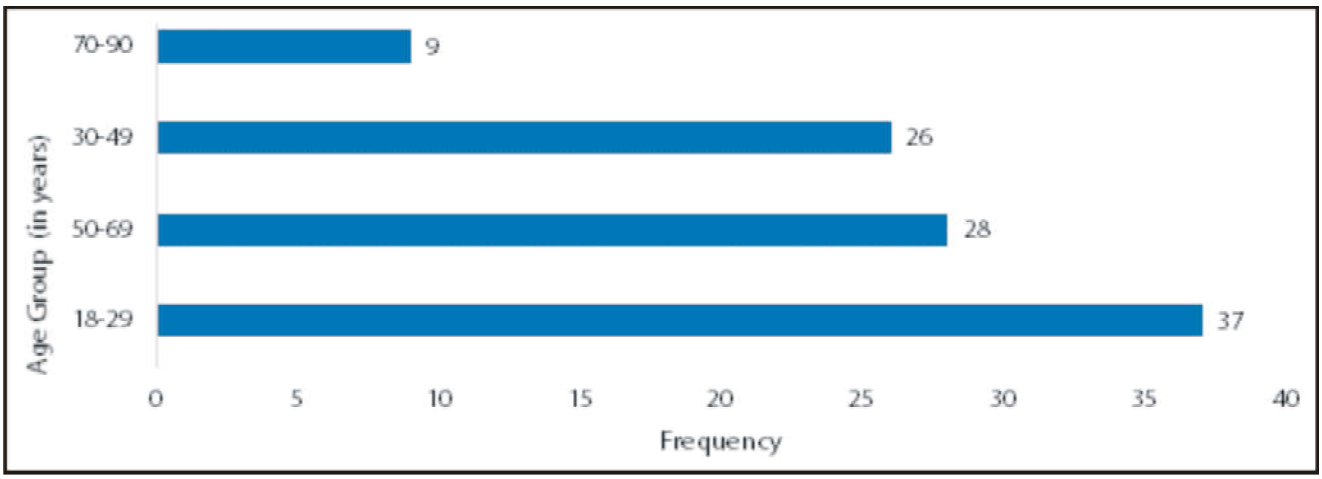

Fig. 1: *Distribution of study participants according to age: (N = 100) (Mean ± SD = 42.83 ±18.60).*

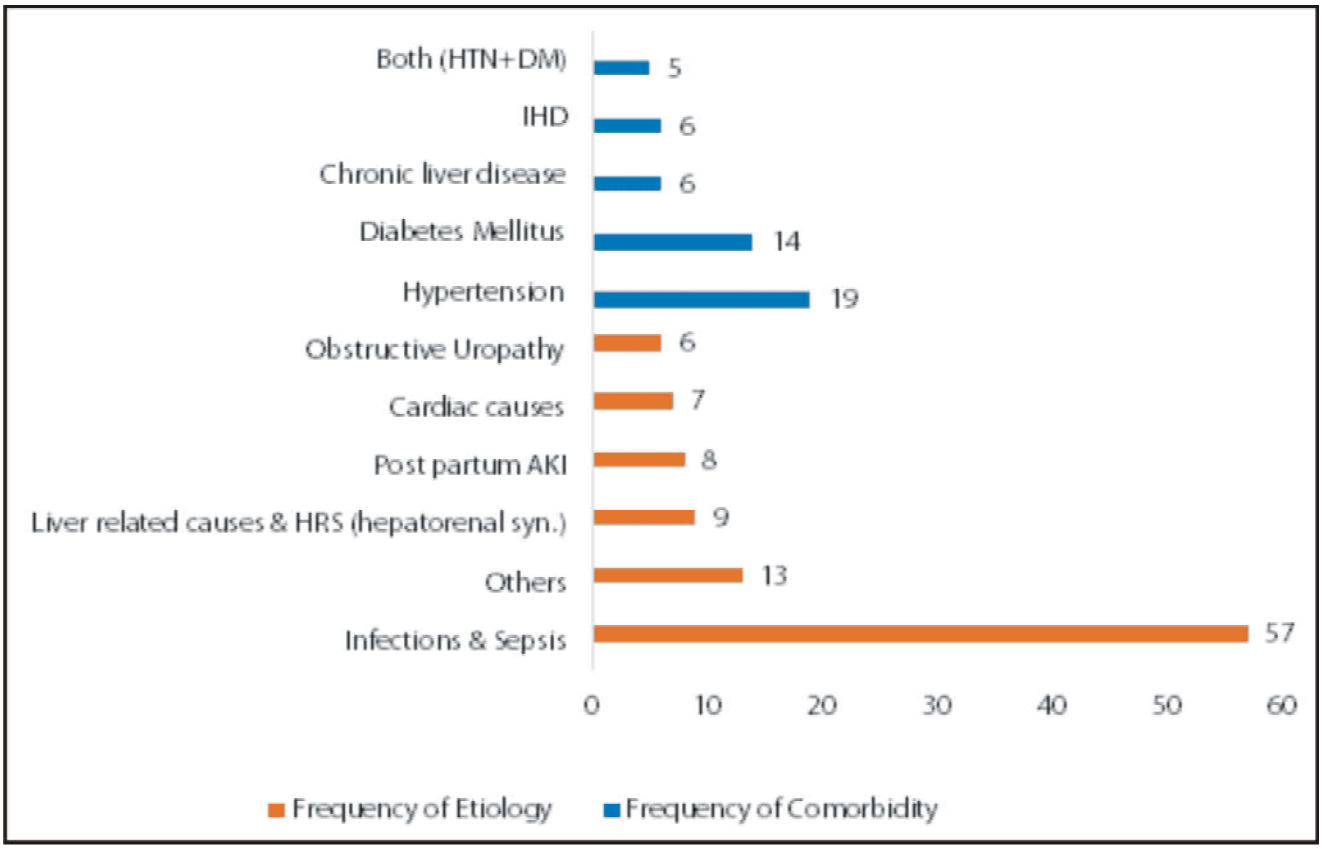

Fig. 2: *Distribution of co-morbidities and aetiologies.*

29 years, followed by 26% in the 30 - 49 age range. The mean age was 42.83 years (SD = 18.60).

Fig. 2 illustrates the distribution of co-morbidities and aetiologies associated with acute kidney injury (AKI) among the study participants. Co-morbidities were dominated by hypertension (19 cases) and diabetes mellitus (14 cases), followed by chronic liver disease and ischaemic heart disease (6 cases each), and a combination of hypertension and diabetes mellitus (5 cases).

In contrast, aetiologies were primarily linked to infections and sepsis, which accounted for the majority of cases (57), followed by other aetiologies (13), liver-related causes including hepatorenal syndrome (9), post-partum AKI (8), cardiac causes (7), and obstructive uropathy (6).

Table I: Association between different co-morbidity and outcome of acute kidney injury: (N = 100)

	Outcome			
Co-morbidity	**Recovered**	**Death**	**P value**	**95% CI**
Diabetes mellitus	8 (57.14%)	6 (42.8%)	0.076	0.1085 - 0.3529
Hypertension	14 (73.68%)	5 (26.3%)	0.793	0.273 - 0.85
Chronic liver disease	6 (100%)	0	0.1578	-
Ischaemic heart disease	6 (100%)	0	0.1578	-
Both DM+HTN	3 (60%)	2 (40%)	0.392	0.071 - 0.452

Table I shows the association between co-morbidities and AKI outcomes. While diabetes mellitus had a higher mortality rate (42.8%), the result was not statistically significant. Hypertension also did not significantly affect outcomes, and chronic liver disease and ischaemic heart disease had no recorded mortality.

Table II: Association between specific aetiology and outcome of acute kidney injury: (N = 100)

	Outcome			
Ethology	**Recovered**	**Death**	**P value**	**95% CI**
Infection and sepsis	40 (70.17%)	17 (29.8%)	0.1182	0.1702 - 0.4575
Post-partum AKI	6 (75%)	2 (25%)	0.945	0.1774 - 0.942
Obstructive Uropathy	6 (100%)	0	0.1578	-
Cardiac cause	7 (100%)	0	0.125	-
Liver-related cause	7 (77.7%)	2 (22.2%)	0.896	0.215 - 1.115
Others	10 (76.9%)	3 (23%)	0.933	0.266 - 1.060
Total	76	24		

Table II summarises the association between specific aetiologies and AKI outcomes. Infections and sepsis had the highest mortality rate (29.8%), but this was not statistically significant. Notably, patients with obstructive uropathy and cardiac-related AKI had no recorded mortality and showed favourable outcomes.

Table III: Association between infection and sepsis-related aetiology and outcome of acute kidney injury: (N = 57)

	Outcome			
Infection and sepsis	**Recovered**	**Death**	**P value**	**95% CI**
Malaria	3 (37.5%)	5 (62.5%)	0.0082	0.034 - 0.1562
Viral etiology	6 (66.6%)	3 (33.3%)	0.494	0.138 - 0.6
AGE	5 (83.3%)	1 (16.6%)	0.666	0.1798 - 1.619
LRTI	11 (78.5%)	3 (21.4%)	0.809	0.3016 - 1.184
UTI	7 (70%)	3 (30%)	0.641	0.168 - 0.710
Others	8 (80%)	2 (20%)	0.756	0.255 - 1294
Total	40	17		

Table III focuses on infection and sepsis-related aetiology, showing that malaria had the highest mortality (62.5%) among the infection subgroups, with a statistically significant p-value of 0.0082. Other infections, such as viral aetiology and urinary tract infections, showed varying outcomes, but differences were not statistically significant.

Patients who received dialysis had a significantly higher recovery rate (97.3%) compared to those who did not (68%). The mortality rate was markedly lower in the dialysis group (2.7% versus 32%), with a highly significant p-value of 0.0001 (95% CI: 2.803 - 21.8 for recovery with dialysis and 0.0059 - 0.0458 without dialysis).

Patients exposed to nephrotoxic drugs had a higher risk of developing chronic kidney disease (CKD), with 37.5% progressing to CKD compared to only 10% in the non-exposed group. Recovery rates were similar between the two groups (62.5% versus 64%). However, the association was not statistically significant (p = 0.07, 95% CI: 0.051–0.254).

Discussion

Our study found that most of the acute kidney injury (AKI) cases occurred in individuals under 60 years of age, comprising 83% of the participants, with a mean age of 42.83 years. This contrasts with studies by Nash *et al* (2002)[7] and Hsu *et al* (2007)[8], which found that AKI predominantly affected individuals over 60 years. The younger age group in our study may indicate that environmental or occupational factors, along with lifestyle choices, contribute to renal injury in this demographic population.

In present study, 60% of participants were male, while 40% were female. These findings are consistent with the study

by Prakash *et al* (2013)[9], which reported 57% males and 43% females in their cohort, with higher environmental and occupational exposures in males. The greater prevalence of AKI in males may be attributed to increased exposure to occupational risk factors and lifestyle-related kidney stressors.

Hypertension (19%) and diabetes mellitus (14%) were the most common co-morbidities among AKI patients, followed by 6% with ischaemic heart disease (IHD) and 6% with chronic liver disease. These findings are consistent with those reported by Wang *et al* (2024)[10]. The high prevalence of hypertension and diabetes highlights how chronic conditions contribute significantly to the risk of developing AKI.

Our study identified infection and sepsis (57%) as the leading causes of acute kidney injury (AKI), followed by post-partum AKI (8%), cardiac causes (7%), and liver-related causes (9%). These findings are consistent with studies by Wang *et al* (2024)[10] and Prakash *et al* (2013)[9], which similarly highlighted infections as the predominant cause of AKI, accounting for 53% and 50%, respectively, with post-partum AKI contributing 7% - 9%, cardiac causes 5% - 6%, and liver-related causes 10% - 11%. Infections, particularly in resource-limited regions, remain a major driver of AKI, underscoring the importance of timely healthcare access. Notably, respiratory tract infections (24.5%) and malaria (14%) were the most common infections in our study, which aligns with the findings of Kute *et al* (2012)[11]. Malaria and respiratory infections are thus leading causes of AKI in endemic areas.

Regarding cardiac causes, 71% of patients had ischaemic heart disease (IHD), and 29% had dilated cardiomyopathy (DCM). These findings are consistent with those of Lassnigg *et al* (2004)[12], who reported IHD in 71% of AKI patients and DCM in 31%. The link between heart disease and kidney injury, commonly referred to as cardiorenal syndrome, highlights the bidirectional nature of these conditions, where heart failure can exacerbate kidney damage.

Our study also found that disseminated intravascular coagulation (DIC) was the most frequent cause of post-partum AKI (62.5%), followed by post-partum haemorrhage (PPH) (25%). These results are similar to those of Prakash *et al* (2010)[13], who reported DIC as the leading cause of post-partum AKI in 60% of cases and PPH in 28%.

In terms of liver-related causes, hepatorenal syndrome (HRS) was the most frequent cause of AKI (44.4%), followed by acute hepatitis (22.2%). These findings are in agreement with Ginès *et al* (2009)[14], who found that HRS and acute hepatitis accounted for 45% and 20% of liver-related AKI cases, respectively. HRS is a severe complication of liver failure and often leads to kidney damage, emphasizing the need for early intervention in these cases.

Renal stones (83.3%) were the most common cause of obstructive uropathy leading to AKI, followed by neurogenic bladder (16.7%). These findings are consistent with those of Ginès *et al* (2009)[14], who reported that renal stones accounted for 75% of obstructive uropathy cases, with neurogenic bladder contributing to 25%. Timely intervention in cases of obstructive uropathy, particularly for renal stones, can prevent irreversible kidney damage and improve patient outcomes.

Our study found that 64% of patients with acute kidney injury (AKI) recovered, while 12% progressed to chronic kidney disease (CKD), and 24% died. This mortality rate is within the expected range for AKI, particularly among critically ill patients. Coca *et al* (2009)[15] reported similar findings, with 56% recovery, 15% progression to CKD, and 29% mortality in AKI patients.

When analysing recovery rates by co-morbidities, our study found that 57.14% of diabetic patients recovered, compared to 73.68% of hypertensive patients. These findings align with those of Wang *et al* (2024)[10].

Infection and sepsis-related AKI had a mortality rate of 29.8% in our study. This is similar to Bagshaw *et al* (2008)[16], who also reported a high mortality rate (35%) in sepsis-related AKI cases. Early intervention in sepsis-related AKI has been shown to reduce mortality rates, a trend confirmed by several studies.

Regarding post-partum AKI, our study found a recovery rate of 75%. Prakash *et al* (2010)[13] also reported a recovery rate of approximately 70%, reinforcing the finding that post-partum AKI generally has a favourable recovery prognosis, though a quarter of cases still result in mortality.

Malaria-related AKI had the highest mortality rate (62.5%) among infection-related aetiologies in our study, with a statistically significant p-value of 0.0082. Kute *et al* (2012)[11] found similar results, highlighting the severe impact of malaria on kidney function, especially in endemic areas.

Our research also found that mortality was significantly higher in non-dialysis patients (32%) compared to dialysis patients (2.7%), with a strong statistical correlation (p-value = 0.00001). Palevsky *et al* (2008)[17] reported that early dialysis in AKI patients significantly reduces mortality (4%), while patients without dialysis had a 30% mortality rate, a finding consistent with our results. Timely dialysis thus plays a crucial role in improving outcomes in AKI patients.

Patients exposed to potentially nephrotoxic drugs had a recovery rate of 62.5%, with 37.5% progressing to CKD. This aligns with findings by Palevsky *et al* (2008)[17], who also noted that nephrotoxic drug exposure was associated with poorer long-term kidney function, with 32% of patients developing CKD and 64% recovering. Nephrotoxic drug

exposure appears to increase the risk of CKD progression, underlining the importance of careful drug monitoring in AKI patients to prevent long-term kidney damage.

Limitations

This study being a single-centre, retrospective analysis with a focus on short-term outcomes, which may not reflect broader settings. It also lacks follow-up and causal insights, limiting generalisation and understanding of AKI's full impact.

Conclusion

This study highlights regional patterns, with younger males being predominantly affected and infections, hypertension, and diabetes as key contributors. While most recovered, diabetes increased mortality risk, and early dialysis improved survival but raised CKD incidence. Timely treatment and effective management of co-morbidities remain critical for better outcomes.

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