RESEARCH PAPER

Clinical Profile, Etiological Spectrum, And Outcomes Of Acute Kidney Injury In Intensive Care Unit Patients: A Prospective Observational Study From Uttar Pradesh, India

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Received: *20th Feb, 2026;* ***Revised:*** *4th Mar, 2026;* ***Accepted:*** *25th Mar, 2026;* ***Available Online:*** *10th Apr, 2026*

Abstract

Background: Acute kidney injury (aki) is a common and serious complication in critically ill patients, associated with significant morbidity and mortality. Regional data from indian intensive care units (icus) remain limited. The present study aimed to evaluate the clinical profile, etiological spectrum, and outcomes of aki patients admitted in icu at a tertiary care hospital in uttar pradesh, india.

Methods: This was prospective observational study which enrolled 100 adult patients with aki admitted to the icu of sharda hospital, greater noida, between april 2024 and november 2025. Aki was defined and staged according to kdigo criteria. Clinical presentation, laboratory parameters, etiological factors, interventions, and outcomes including in-hospital mortality, renal recovery, and 90-day dialysis dependence were assessed. Statistical analysis included chi-square tests, t-tests, anova, and pearson correlations.

Results: The prevalence of aki among icu patients was 10%. Mean age was 57.3 ± 13.5 years with male predominance (63%). Pre-renal causes accounted for 73% of cases, with sepsis-related conditions being the most common etiology (45%). As per kdigo staging of aki, no of patients in stage 1 is 17%, stage 2 62%, and stage 3 21%. Decreased urine output (94%), fever (91%), and fatigue (83%) were the most common presenting features. Mean icu length of stay was 10.8 ± 4.2 days. In-hospital mortality was 6%, and 94% were discharged alive. At 90-day follow-up, 11% remained dialysis-dependent. Kdigo stage 3 was strongly associated with 90-day dialysis dependence ($p < 0.0001$). Lower urine output on days 1–2 and lower admission egfr predicted dialysis dependence ($p < 0.001$).

Conclusions: Pre-renal mainly sepsis-related etiologies predominate in icu-associated aki in this setting. Early urine output trajectories and admission renal function are strong predictors of medium-term renal outcomes. The relatively low mortality observed highlights the importance of timely recognition and management. These findings support early risk stratification using dynamic physiological markers for improved prognostication.

Keywords: Acute Kidney Injury, Intensive Care Unit, Kdigo Staging, Sepsis, Renal Replacement Therapy, Dialysis Dependence, India.

How To Cite This Article: Pinjari Dawood, Ravinder Singh Ahlawat, Deepak Sharma, Bheem Raj Gupta, Monty Bansal, Mayank Chandrakar. Clinical Profile, Etiological Spectrum, And Outcomes Of Acute Kidney Injury In Intensive Care Unit Patients: A Prospective Observational Study From Uttar Pradesh, India. Int J Drug Deliv Technol. 2026;16(25s):1054-1062. Doi: 10.25258/ijddt.16.25s.126

INTRODUCTION

Acute kidney injury (AKI) is a clinical syndrome characterized by a rapid decline in renal function, leading to the accumulation of nitrogenous waste products and disturbances in fluid, electrolyte, and acid-base homeostasis.[1,2] In the intensive care unit (ICU), AKI frequently occurs as part of multi-organ dysfunction syndrome and is associated with substantial morbidity and mortality.[3,4] The presence of AKI in critically ill patients signals a poorer prognosis and significantly increases the complexity of patient management.

The global burden of AKI is substantial, with international studies reporting that 20–50% of ICU admissions develop some degree of AKI during their hospital stay.[5,6] In low- and middle-income countries, the incidence is often higher due to delayed presentation, limited access to early diagnostic tools, and the burden of coexisting infections and comorbidities.[7,8] In India, the problem is compounded by high rates of sepsis, tropical infections, and limited resources for early renal support in peripheral healthcare centers.[9,10]

AKI in ICU settings is associated with increased mortality, prolonged hospitalization, and higher healthcare costs.[11-13] Survivors face long-term consequences, including persistent kidney dysfunction and increased risk of progression to chronic kidney disease (CKD).[14,15] These outcomes place considerable burden on both patients and healthcare systems, making early recognition and appropriate management of AKI crucial.

The etiology of AKI in ICU patients varies widely and is influenced by local epidemiology, patterns of referral, and available healthcare resources. Causes may include sepsis, shock, major surgery, trauma, nephrotoxic drugs, and pre-existing chronic illnesses.[16,17] In many cases, multiple factors contribute to the development of AKI, making identification of the primary cause challenging. Understanding the common etiologies in a specific ICU setting helps customize preventive and therapeutic strategies.[18]

The Kidney Disease: Improving Global Outcomes (KDIGO) criteria have become the reference standard for AKI diagnosis and staging, integrating elements from earlier RIFLE and AKIN classifications.[19-21] KDIGO staging has demonstrated prognostic value, with higher stages corresponding to increased mortality and adverse renal outcomes.[22,23] Application of standardized criteria facilitates comparison across studies and guides clinical decision-making.

In India, there is growing recognition of the need for context-specific data on AKI. Most available literature originates from developed countries, where patient profiles, healthcare delivery systems, and disease patterns differ significantly from those in Indian tertiary care hospitals.[24,25] Regional studies can highlight differences in etiology, severity, and outcomes and may identify modifiable factors that can improve patient care. In tertiary centres catering to diverse patient populations from urban and rural areas, the spectrum of AKI may reflect both community-acquired and hospital-acquired forms of the disease.

The present study aimed to address this knowledge gap by systematically evaluating the clinical profile, etiological spectrum, and outcomes of AKI in ICU patients at a tertiary care hospital in Uttar Pradesh, India. The objectives was to determine the prevalence and etiology of AKI in ICU patients and assess clinical outcomes including mortality, renal recovery, and 90-day dialysis dependence.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted in the Department of General Medicine ICU at Sharda Hospital, School of Medical Sciences and Research (SMS&R), Sharda University, Greater Noida, Uttar Pradesh, India. The duration of study was from April 2024 to November 2025 (20 months).

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee (IEC) of SMS&R, Sharda University, prior to commencement. Written informed consent was obtained from all participants or their legally authorized representatives in both English and Hindi after explaining the purpose, procedure, risks, and benefits of the study. Confidentiality and anonymity of all study participants were strictly maintained throughout the study.

Study Population and Sample Size

The study population comprised adult patients with AKI admitted to the ICU during the study period. Sample size was calculated using Cochran's formula: $n = Z^2 \times P(1 - P) / d^2$, with $Z = 1.96$, anticipated prevalence $P = 0.12$, and margin of error $d = 0.12$, yielding $n \approx 41$. To enhance statistical power and account for potential dropouts, enrollment continued until 100 patients with complete data were included in the final analysis.

Inclusion and Exclusion Criteria

Inclusion criteria were: (1) age ≥18 years, and (2) diagnosis of AKI according to KDIGO criteria.

Exclusion criteria were: (1) age <18 years (3) patients unwilling to participate.

Definition and Staging of AKI

AKI was defined and staged according to KDIGO criteria.[19] Stage 1 was defined as serum creatinine increase ≥0.3 mg/dL within 48 hours or 1.5–1.9 times baseline, or urine output <0.5 mL/kg/h for 6–12 hours. Stage 2 was defined as serum creatinine 2.0–2.9 times baseline or urine output <0.5 mL/kg/h for ≥12 hours. Stage 3 was defined as serum creatinine ≥3.0 times baseline, or increase to ≥4.0 mg/dL, or initiation of renal replacement therapy, or urine output <0.3 mL/kg/h for ≥24 hours or anuria for ≥12 hours.

Data Collection

After enrollment, a structured history was obtained from the patient and attendant, including demographic information, presenting complaints, duration of symptoms, past medical history, comorbidities, and medication exposure. Comprehensive general and systemic examinations (cardiovascular, respiratory, central nervous system, and abdominal) were performed with frequent vital sign monitoring.

Laboratory evaluation included renal function tests (serum creatinine, blood urea, uric acid, estimated glomerular filtration rate [eGFR]), liver function tests (bilirubin, AST, ALT, ALP, albumin, total protein), complete blood count (hemoglobin, packed cell volume, white blood cell count, platelet count, red blood cell count), arterial blood gas analysis (pH, $PaCO^2$, HCO^{3-}, lactate), HBsAg, HIV, HCV serology (card test), and coagulation profile (PT/INR). Urine analysis (cytology,microbiology), electrocardiogram, chest radiograph, and whole-abdomen ultrasonography were obtained for all patients. Urine output was recorded daily during ICU admission.

Outcome Measures

Primary outcomes were in-hospital mortality and renal recovery at discharge. Secondary outcomes included 90-day dialysis dependence, ICU length of stay, requirement for renal replacement therapy (RRT), and mechanical ventilation. Renal recovery was assessed based on improvement in serum creatinine and eGFR at discharge compared to admission values.

Statistical Analysis

Data were entered into a structured proforma and analyzed using SPSS version 22 (IBM Corporation, Armonk, NY, USA). Continuous variables were summarized as mean ± standard deviation (SD) with minimum and maximum values; categorical variables were presented as frequencies and percentages. Group comparisons for continuous outcomes across binary clinical endpoints (discharged alive vs mortality ; dialysis-dependent at 90 days vs dialysis independent) were performed using independent samples t-tests. Associations between categorical variables were assessed using chi- square tests. For multi-level comparisons of continuous measures across ordered or nominal categories (e.g., KDIGO stages, recovery categories), one-way analysis of variance (ANOVA) was applied. Relationships between continuous variables and ICU length of stay were assessed using Pearson correlation coefficients. A two-tailed p-value <0.05 was considered statistically significant.

RESULTS

Prevalence and Demographics

Over the 20-month study period, 1,000 patients were admitted in icu , of whom 100 met criteria for AKI, yielding a prevalence of 10.0% (95% CI: 8.14–11.86%). The baseline characteristics of the study population are presented in Table 1. The mean age was 57.3 ± 13.5 years (range: 18–86 years), with the majority (48%) in the 60–79 years age group. Males comprised 63%(63) of the cohort. Age and sex showed no significant association with discharge status or 90-day dialysis dependence (all p > 0.05).

Regarding comorbidities, diabetes was recorded in 58% of patients with a mean duration of 8.4 ±
4.9 years, and hypertension in 28% with a mean duration of 9.1 ± 7.3 years. Notably, longer duration of diabetes was significantly associated with 90-day dialysis dependence (p = 0.002) and poorer recovery category (p = 0.031).

Table 1. Baseline Characteristics of the Study Population (N = 100)

Characteristic	Value	p-value*
Age (years), mean ± SD	57.3 ± 13.5	-
Range	18 – 86	-
Age groups, n (%)		0.247†
18–39 years	13 (13%)	
40–59 years	35 (35%)	
60–79 years	48 (48%)	
≥80 years	4 (4%)	
Sex, n (%)		0.685†
Male	63 (63%)	
Female	37 (37%)	
Comorbidities, n (%)		
Diabetes mellitus	58 (58%)	0.379†
Duration (years), mean ± SD	8.4 ± 4.9	0.002‡
Hypertension	28 (28%)	0.729†
Duration (years), mean ± SD	9.1 ± 7.3	0.865‡
No known comorbidities	14 (14%)	-
Vital signs at admission, mean ± SD		
Systolic BP (mmHg)	121.7 ± 12.7	0.049§
Diastolic BP (mmHg)	77.8 ± 7.8	0.006§
Pulse rate (beats/min)	91.2 ± 12.0	0.002‡
Respiratory rate (breaths/min)	22.6 ± 2.1	0.412
SpO_2 (%)	96.8 ± 2.1	0.020‡

**p-values for association with discharge status unless otherwise specified; †Chi-square test; ‡t-test for 90-day dialysis dependence; §ANOVA for KDIGO stage. BP, blood pressure; SD, standard deviation; SpO_2, peripheral oxygen saturation.*

Clinical Presentation

The clinical features at presentation are summarized in Table 2. The most frequent presenting symptom was decreased urine output (94%), followed by fever (91%), fatigue (83%), generalized weakness (81%), and shortness of breath (70%) ,altered sensorium (5%). Haematuria was present in 11% of patients and was significantly associated with non-discharge (p = 0.006). Paient who had shortness of breath asspciated with 90 day dialysis dependence (p = 0.015). Altered mental status, present in 5% of patients, was associated with significantly longer ICU length of stay (p < 0.001) and differed by recovery category (p = 0.018).

Table 2. Clinical Features at Presentation (N = 100)

Clinical Feature	n (%)	Discharge p	Dialysis 90d p	ICU LOS p
General/Constitutional				
Fever	91 (91)	1.000	1.000	0.561
Fatigue	83 (83)	0.906	0.948	0.558
Generalized weakness	81 (81)	0.906	0.948	0.612
Urinary				
Decreased urine output	94 (94)	0.493	0.949	0.231
Haematuria	11 (11)	**0.006**	1.000	0.897
Cardiorespiratory				
Shortness of breath	70 (70)	0.674	**0.015**	0.177
Cough with sputum	14 (14)	0.674	0.525	0.697
Neurological				
Altered mental status	5 (5)	0.674	0.525	**<0.001**
Gastrointestinal				
Vomiting	47 (47)	0.230	0.878	0.895
Abdominal pain	44 (44)	0.906	0.934	0.380
Loose stools	17 (17)	0.500	1.000	**0.009**

Bold values indicate statistical significance (p < 0.05). ICU LOS, intensive care unit length of stay.

Etiology of AKI

The etiological distribution of AKI is presented in Table 3. Pre-renal causes were the most common, accounting for 73% of cases, followed by intrinsic renal causes (26%) and post-renal causes (6%). Among the specific conditions, sepsis- related AKI was the most frequent etiology (45%), including pneumonia with sepsis (7%), and sepsis with ischemic acute tubular necrosis (ATN) (9%). Gastrointestinal conditions, primarily acute gastroenteritis with dehydration, accounted for 16%, while cardiac causes including heart failure represented 14%.

Both pre-renal and intrinsic renal etiologies were strongly associated with KDIGO stage (p < 0.001 for both), 90-day dialysis dependence (p < 0.001 for both), and recovery category (p < 0.001 for both). Pre-renal and renal causes were also significantly associated with decreased urine output (p
= 0.011 and p = 0.003, respectively).

Table 3. Etiological Classification of AKI (N = 100)

Etiology Category / Condition	n (%)	KDIGO p	Dial 90d p	Recovery p
Pre-renal	**73 (73)**	**<0.001**	**<0.001**	**<0.001**
Respiratory/soft tissue infection with sepsis	26 (35.6)*			
Cardiac disease (HF/ACS/CHB)	11 (15.1)*			
Acute gastroenteritis/dehydration	9 (12.3)*			
Neurological disease with sepsis	7 (9.6)*			
Post-operative/surgical with sepsis	7 (9.6)*			
Intrinsic Renal	**26 (26)**	**<0.001**	**<0.001**	**<0.001**
Pre-existing kidney disease (CKD/GN/transplant)	8 (30.8)*			
Respiratory infection with sepsis	7 (26.9)*			
Post-renal	**6 (6)**	0.447	1.000	0.161
Obstructive uropathy	3 (50.0)*			
Urosepsis/pyelonephritis	1 (16.7)*			

**Percentage within the respective etiological category. Bold values indicate statistical significance (p < 0.05). ACS, acute coronary syndrome; CHB, complete heart block; CKD, chronic kidney disease; GN, glomerulonephritis; HF, heart failure.*

KDIGO Staging and Laboratory Parameters

The distribution of AKI by KDIGO staging is shown in Table 4 and Figure 1. The majority of patients (62%) were classified as KDIGO Stage 2, followed by Stage 3 (21%) and Stage 1 (17%). KDIGO staging showed no association with discharge status (p = 0.958) but was strongly associated with 90-day dialysis dependence (p < 0.0001), with all dialysis-dependent patients at 90 days belonging to Stage 3. KDIGO stage did not significantly affect ICU length of stay (p = 0.558).

Table 4. KDIGO Staging Distribution and Outcome Associations (N = 100)

KDIGO Stage	n (%)	Discharged n	Dialysis 90d n	ICU LOS (days)
Stage 1	17 (17%)	15 (88.2%)	0 (0%)	10.8 ± 3.8
Stage 2	62 (62%)	53 (85.5%)	0 (0%)	10.6 ± 4.2
Stage 3	21 (21%)	18 (85.7%)	11 (52.4%)	11.4 ± 4.6
p-value		0.958	**<0.0001**	0.558

Bold values indicate statistical significance (p < 0.05). ICU LOS, intensive care unit length of stay.

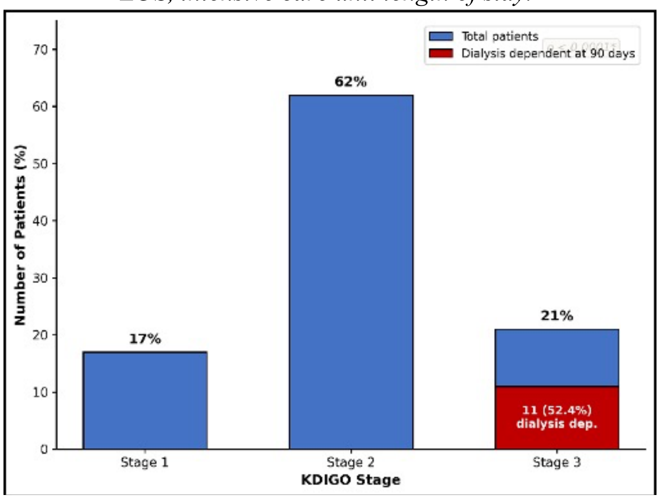

Figure 1: KDIGO Stage Distribution

Laboratory parameters at admission and discharge are presented in Table 5. At admission, the mean serum urea was 100.4 ± 35.5 mg/dL, creatinine 2.05 ± 1.68 mg/dL, and eGFR 27.1 ± 8.5 mL/min/1.73 m². At discharge, eGFR improved significantly to 81.7 ± 31.4 mL/min/1.73 m². Admission creatinine was significantly higher in patients who became dialysis-dependent at 90 days ($p = 0.006$), and admission eGFR was significantly lower in this group ($p < 0.001$). Discharge eGFR remained significantly lower in dialysis-dependent patients ($p < 0.001$).

Urine output trajectories over the first three days showed strong prognostic value (Figure 3). Lower urine output on days 1–3 was associated with higher KDIGO stage (all $p < 0.0001$) and poorer recovery category (all $p < 0.0001$). Day 1 and day 2 urine output were significantly lower in patients who became dialysis-dependent at 90 days ($p < 0.0001$ and $p = 0.002$, respectively).

Figure 2: Urine Output Trajectory

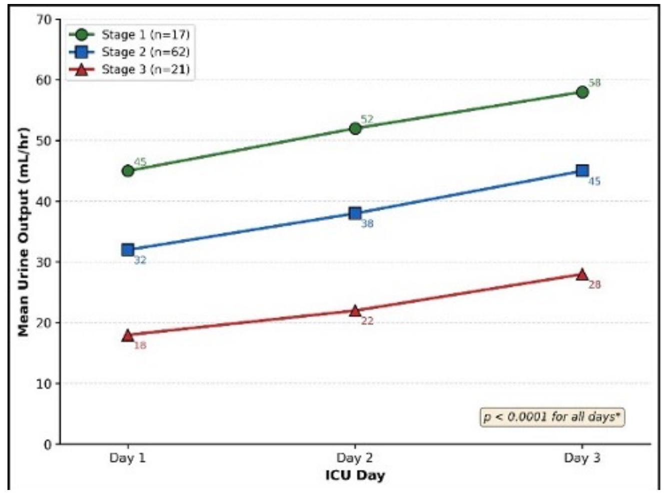

Table 5. Laboratory Parameters at Admission and Discharge (N = 100)

Parameter	Mean ± SD	Range	Discharge p	Dial 90d p
Renal Function (Admission)				
Urea (mg/dL)	100.4 ± 35.5	40–210	0.976	0.316
Creatinine (mg/dL)	2.05 ± 1.68	0.6–9.8	0.105	**0.006**
eGFR (mL/min/1.73 m²)	27.1 ± 8.5	8–45	0.204	**<0.001**
Uric acid (mg/dL)	8.0 ± 2.9	3.2–16	0.423	0.371
Renal Function (Discharge)				
eGFR (mL/min/1.73 m²)	81.7 ± 31.4	15–130	0.860	**<0.001**
Arterial Blood Gas				
HCO_3^- (mEq/L)	16.9 ± 6.1	8–29.7	0.928	0.962
pH	7.32 ± 0.12	6.9–7.5	0.112	0.529
Lactate (mmol/L)	4.1 ± 1.6	1.1–8	0.516	0.583
Hematology				
Hemoglobin (g/dL)	9.96 ± 1.80	5.8–14.2	0.682	0.245
WBC (×10³/µL)	17.9 ± 6.5	4.2–38	0.421	0.318
Platelets (×10³/µL)	167.2 ± 85.3	32–450	0.562	**0.043**

Liver Function				
Total bilirubin (mg/dL)	1.45 ± 1.21	0.2–9.9	0.186	**0.038**
AST (U/L)	132.2 ± 356.3	11–2751	0.342	**0.001**
Albumin (g/dL)	3.14 ± 0.69	1.5–4.7	0.421	0.086

Bold values indicate statistical significance (p < 0.05). AST, aspartate aminotransferase; eGFR, estimated glomerular filtration rate; WBC, white blood cell count.

Outcomes and Interventions

Outcomes and interventions are summarized in Table 6 and Figure 3. In-hospital mortality was 6% (6/100), and 94% of patients were discharged alive. At 90-day follow-up, 11% of survivors (11/94) remained dialysis-dependent. The mean ICU length of stay was 10.8 ± 4.2 days (range: 4– 22 days). ICU length of stay did not differ significantly by discharge status (p = 0.364) or 90-day dialysis dependence (p = 0.701). Renal replacement therapy (RRT) was initiated in 27% of patients, with all receiving intermittent hemodialysis. RRT use was strongly associated with 90-day dialysis dependence (p < 0.0001) and differed by recovery category. Mechanical ventilation was required in 33% of patients and was associated with longer ICU stay (p = 0.020) and poorer recovery category (p = 0.022).

Table 6. Outcomes and Interventions (N = 100)

Outcome/Intervention	Value	Associated Factor (p)
Primary Outcomes		
In-hospital mortality, n (%)	6 (6%)	-
Discharged alive, n (%)	94 (94%)	-
90-day dialysis dependence, n (%)*	11 (11.7%)	KDIGO Stage 3 (p < 0.0001)
Secondary Outcomes		
ICU length of stay (days), mean ± SD	10.8 ± 4.2	Altered sensorium (p < 0.001)
Interventions		
Renal replacement therapy, n (%)	27 (27%)	Dialysis 90d (p < 0.0001)
Intermittent hemodialysis	27 (100%)	
Mechanical ventilation, n (%)	33 (33%)	ICU LOS (p = 0.020)

**Percentage among 94 survivors. ICU, intensive care unit; LOS, length of stay.*

Figure 3: Outcome Distribution

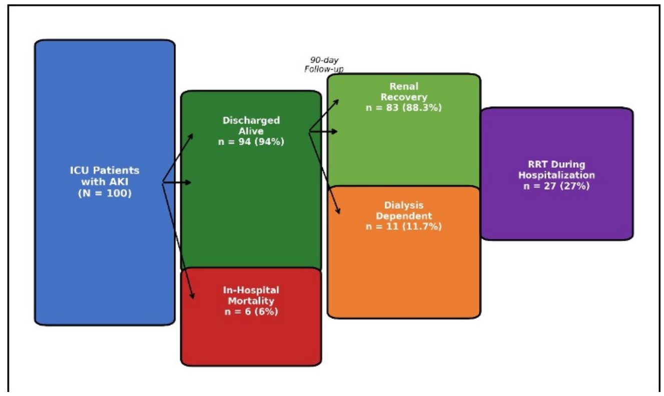

FIGURE LEGENDS

Figure 1. KDIGO stage distribution and association with 90-day dialysis dependence. Bar chart displaying the distribution of AKI severity by KDIGO staging: Stage 1 (17%), Stage 2 (62%), Stage 3 (21%). Overlay shows 90-day dialysis dependence concentrated exclusively in Stage 3 patients (52.4% of Stage 3 vs. 0% in Stages 1–2; p < 0.0001).

Figure 2. Urine output trajectory over first three ICU days stratified by KDIGO stage. Line graph showing mean hourly urine output on days 1, 2, and 3 for each KDIGO stage. Lower urine output was significantly associated with higher KDIGO stage across all three days (p < 0.0001). Day 1–2 urine output was significantly lower in patients who became dialysis-dependent at 90 days.

Figure 3. Outcome distribution of ICU patients with AKI. Flow diagram/stacked bar chart showing patient outcomes: in-hospital survival (94%), mortality (6%), and among survivors, 90-day dialysis dependence (11.7%) versus renal recovery (88.3%). RRT was required in 27% of patients during hospitalization.

DISCUSSION

The present study provides comprehensive data on the clinical profile, etiological spectrum, and outcomes of AKI in ICU patients at a tertiary care center in Uttar Pradesh, India. Our findings reveal a 10% prevalence of AKI among ICU admissions, with pre-renal and sepsis-related etiologies predominating. The relatively low in-hospital mortality (6%) and moderate 90-day dialysis dependence rate (11%) observed in our cohort highlight the importance of early recognition and management. Importantly, early physiological markers, particularly urine output trajectory and admission renal function, emerged as strong predictors of medium-term renal outcomes.

Comparison with Other Studies

The prevalence of AKI in our ICU (10%) was lower than that reported in many international and Indian studies. Hoste et al. (2015) reported AKI prevalence of 57.3% in the multinational AKI- EPI study,[5] while Bhushan et al. (2025) from AIIMS Patna reported that among 77 recruited patients, 72 met inclusion criteria for analysis.[26] The lower prevalence in the present study may reflect differences in case-mix, referral patterns, or the specific exclusion criteria employed.

The demographic profile of our cohort was consistent with other Indian studies. The mean age of
57.3 ± 13.5 years in our study was comparable to that reported by Bhushan et al. (2025) (55.3 ± 16.2 years)[26] and Bhattacharya et al. (2019) (41.1 ± 16.2 years).[27] The male predominance (63%) was also consistent with Pillai et al. (2020), who reported 70% male patients in their Mangalore cohort.[9] Ibrahim et al. (2016) from Ethiopia, studying dialysis-requiring AKI, reported a younger cohort (mean age 36.7 years) with near-equal sex distribution.[28]

Regarding etiology, the predominance of pre-renal causes (73%) and sepsis-related AKI (45%) in our study aligns with regional patterns. Pillai et al. (2020) identified sepsis as the most common etiology (27.1%) in their cohort,[9] while Wotiye et al. (2022) from Ethiopia reported sepsis in 50% of cases.[29] Bhattacharya et al. (2019) similarly found infection-related AKI to be predominant, with sepsis accounting for 26.7% of cases.[27] The high burden of infection-related AKI in low- and middle-income settings reflects the epidemiology of critical illness in these regions, where infectious diseases remain a leading cause of ICU admission.

The KDIGO stage distribution in our study, with the majority (62%) in Stage 2, differs somewhat from other reports. Santos et al. (2019) from Brazil reported a more even distribution across stages,[30] while Hoste et al. (2006) using RIFLE criteria found that 36% of their Dutch cohort developed AKI across all stages.[31] The concentration of cases in Stage 2 in the present study may reflect the timing of ICU admission and the specific patient population studied.

The in-hospital mortality rate of 6% in our study was notably lower than that reported in comparable studies. Bhushan et al. (2025) reported mortality of 68.1% in their AIIMS Patna cohort,[26] while Pillai et al. (2020) observed 47.1% mortality in Mangalore.[9] Ibrahim et al. (2016) reported 29.1% mortality in dialysis-requiring AKI patients.[28] Bhattacharya et al. (2019) observed 24% in-hospital mortality.[27] The lower mortality in the present study may be attributed to several factors: the predominantly Stage 2 disease profile, and potentially earlier presentation and intervention. Additionally, the prospective design with structured follow-up may have enabled more timely interventions.

The 90-day dialysis dependence rate of 11% in our study is consistent with the literature. Jonny et al. (2020) reported that only 35% of AKI patients requiring dialysis achieved complete renal recovery within six months.[32] Hoste et al. (2006) documented a 20% increased risk of CKD following ICU-associated AKI.[31] Bhattacharya et al. (2019) reported excellent short-term recovery, with 92.9% of survivors achieving complete renal recovery at discharge.[27] The present study extends these observations by documenting 90-day outcomes, demonstrating that while most patients recover, a significant minority progress to persistent renal impairment.

Prognostic Markers

A key finding of our study was the strong prognostic value of early urine output trajectories. Lower urine output on days 1–2 was significantly associated with KDIGO stage, recovery category, and 90-day dialysis dependence. This observation aligns with the pathophysiological understanding that oliguria reflects the severity of renal hypoperfusion or parenchymal injury. Luther et al. (2020) similarly emphasized the prognostic importance of oliguric versus non-oliguric AKI.[33] Our findings support the use of quantitative urine output monitoring as a simple, accessible tool for early risk stratification in resource-limited settings.

Admission renal function parameters, particularly eGFR and creatinine, were strong predictors of 90-day dialysis dependence. This is consistent with the findings of Mehta et al. (2018), who demonstrated that the duration and severity of AKI, as reflected in biochemical parameters, correlate with long-term outcomes.[34] The present study adds to this evidence by showing that admission values alone carry significant prognostic information, potentially enabling early identification of high-risk patients.

The association between metabolic acidosis (lower HCO^{3-}) and longer ICU stay observed in our study parallels the findings of Bhattacharya et al. (2019), who reported that severe metabolic acidosis (pH < 7.20) was strongly associated with mortality.[27] Metabolic derangements reflect the severity of systemic illness and multi-organ involvement, providing additional prognostic information beyond renal-specific parameters.

Interestingly, while the presence of diabetes or hypertension did not influence outcomes, longer duration of diabetes was significantly associated with 90-day dialysis dependence and poorer recovery. This suggests that cumulative exposure to metabolic stress, rather than the mere presence of comorbidity, influences renal resilience and recovery capacity. This observation has implications for risk stratification, particularly in populations with high diabetes prevalence.

Clinical Implications

The findings of this study have several clinical implications. First, the predominance of sepsis- related AKI underscores the importance of aggressive management of infection and early hemodynamic optimization in preventing and treating AKI in ICU settings. Second, the strong prognostic value of early urine output suggests that quantitative monitoring over the first 48 hours should be incorporated into routine AKI management protocols. Third, the identification of admission eGFR, creatinine, and KDIGO stage as predictors of 90-day dialysis dependence supports early nephrology consultation and consideration of RRT planning in high-risk patients.

The relatively favorable outcomes observed in our cohort, despite the high burden of pre-renal and sepsis-related AKI, suggest that timely recognition and structured management can improve prognosis. The integration of bedside parameters including urine output trajectory, admission eGFR, acid-base status, and KDIGO staging into clinical decision-making may enable more precise prognostication and resource allocation.

Strengths and Limitations

The strengths of this study include its prospective design, systematic application of KDIGO criteria, comprehensive clinical and laboratory assessment, and follow-up to 90 days enabling evaluation of medium-term renal outcomes. The single-center design allowed for consistent data collection and standardized management protocols.

Several limitations should be acknowledged. First, the single-center design limits generalizability to other settings with different patient populations and healthcare resources. Second, the sample size, while adequate for the primary objectives, may have limited power to detect associations for less common outcomes or subgroups. Third, longer-term follow-up beyond 90 days would provide additional information on progression to CKD and other late outcomes. Finally, biomarkers of tubular injury such as NGAL or KIM-1 were not assessed, which might have provided additional prognostic information.

CONCLUSION

This prospective observational study of 100 ICU patients with AKI at a tertiary care center in Uttar Pradesh, India, demonstrates that pre-renal mainly sepsis-related etiologies predominate in this setting. The relatively low in-hospital mortality (6%) and moderate 90-day dialysis dependence rate (11%) highlight the potential for favorable outcomes with timely recognition and management. Early urine output trajectories, admission renal function, and KDIGO staging emerged as strong predictors of medium-term renal outcomes. The findings support early risk stratification using accessible physiological markers and suggest that dynamic monitoring over the first 48 hours can identify patients at risk of persistent renal impairment. Future multicenter studies with longer follow-up are needed to validate these findings and develop clinical prediction models for AKI outcomes in Indian ICU populations.

DECLARATIONS

Ethics approval and consent to participate: The study was approved by the Institutional Ethics Committee of SMS&R, Sharda University. Written informed consent was obtained from all participants or their legally authorized representatives.

Consent for publication: Not applicable.

Availability of data and materials: The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The author declares no competing interests.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgments: The author thanks the Department of General Medicine and ICU staff at Sharda Hospital for their support in patient recruitment and data collection.

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