



Research Article

## Clinical Profile and Outcomes of Acute Kidney Injury in a tertiary care Medical ICU: A Retrospective Observational Study

Dr. Jayakrishna Murthy<sup>1\*</sup> Dr. B. shaheed Abdul Ansar<sup>2</sup> Dr. Uppara Ravi Kumar<sup>3</sup>, Dr. Shamsheer Khan. P<sup>4</sup> Dr. Pilimgodu Ravali yadav<sup>5</sup> Dr. Sura Maheswar Reddy<sup>6</sup>

<sup>1</sup>ORCID ID - 0000-0003-2706-1324, Assistant Professor, Department of Nephrology, Viswabharathi Medical College, Kurnool, Andhra Pradesh

<sup>2</sup> Associate Professor, Department of General Medicine, Viswabharathi Medical College, Kurnool, Andhra Pradesh

<sup>3</sup> Assistant Professor, Department of General Medicine, Viswabharathi Medical College, Kurnool, Andhra Pradesh

<sup>4</sup> Associate Professor, Department of General Medicine, Viswabharathi Medical College, Kurnool, Andhra Pradesh

<sup>5,6</sup> Final Year PG, Department of General Medicine, Viswabharathi Medical College, Kurnool, Andhra Pradesh.

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### ABSTRACT

#### Corresponding Author:

**Dr. Jayakrishna Murthy,**  
Assistant Professor,  
Department of Nephrology,  
Viswabharathi Medical College,  
Kurnool, Andhra Pradesh,  
Phone: 9493870740,  
Mail-id:  
[jaya122678@gmail.com](mailto:jaya122678@gmail.com)

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**Background:** Acute kidney injury (AKI) is a common complication among critically ill patients and is associated with significant morbidity and mortality. Early identification of risk factors and severity patterns may improve outcomes in ICU settings.

**Objective:** To evaluate the clinical profile, etiological spectrum, severity distribution based on KDIGO criteria, and outcomes of AKI in a tertiary care Medical Intensive Care Unit (MICU).

**Materials and Methods:** This retrospective observational study was conducted in the MICU under the Departments of General Medicine and Nephrology of a tertiary care teaching hospital. Medical records of 100 adult patients diagnosed with AKI during the study period were analyzed. AKI was classified according to KDIGO criteria. Demographic details, comorbidities, etiology, need for organ support, renal replacement therapy (RRT), and in-hospital outcomes were recorded. Statistical analysis was performed using SPSS software, and  $p < 0.05$  was considered statistically significant.

**Results:** The incidence of AKI among ICU admissions was 20.6%. The mean age was  $54.6 \pm 15.2$  years, with a male predominance (62%). Sepsis was the leading cause of AKI (56%). KDIGO Stage 1, Stage 2, and Stage 3 were observed in 36%, 28%, and 36% of patients, respectively. Overall ICU mortality was 28%, with significantly higher mortality in Stage 3 AKI (44%;  $p = 0.01$ ). Mechanical ventilation and severe AKI independently predicted mortality. Renal replacement therapy was required in 20% of patients. Among survivors, 72% achieved complete renal recovery, while 13% remained dialysis-dependent at discharge.

**Conclusion:** AKI is a frequent and severe complication in critically ill patients, predominantly associated with sepsis. Increasing AKI severity and requirement of organ support significantly worsen outcomes. Early identification and aggressive management of high-risk patients may improve survival and renal recovery.

**Keywords:** Acute kidney injury; Intensive care unit; KDIGO; Sepsis; Renal replacement therapy; Mortality.

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### INTRODUCTION

Acute kidney injury (AKI) is a frequent and serious complication in critically ill patients, characterized by an abrupt decline in renal function that leads to the accumulation of metabolic wastes, electrolyte imbalances, and fluid dysregulation. The KDIGO guidelines define AKI based on changes in serum creatinine and urine output, providing a standardized framework for diagnosis and staging.<sup>1</sup> Recent global estimates suggest that AKI affects an increasingly large proportion of hospitalized patients, and the incidence in intensive care units exceeds that in general wards due to multiple concurrent organ dysfunctions and systemic insults.<sup>1,2,3</sup>

Critically ill patients, particularly those with sepsis, are highly susceptible to AKI. Sepsis-associated AKI (SA-AKI) now accounts for up to 25–75% of AKI cases in ICU settings, reflecting the profound inflammatory and microvascular changes that characterise septic critical illness.<sup>4,5</sup> Persistent inflammation, endothelial injury, and haemodynamic instability contribute to renal hypoperfusion and tubular injury in sepsis, making early recognition essential for targeted support.<sup>4,6</sup> Moreover, ICU patients are commonly exposed to additional insults such as nephrotoxic drugs, hypotension, hypovolaemia, and mechanical ventilation, all of which further increase AKI risk.<sup>3,7</sup>

AKI has significant clinical implications beyond the acute phase. It is strongly associated with increased in-hospital mortality, prolonged length of stay, and greater resource utilisation. Recent ICU studies continue to confirm that more severe AKI stages (especially KDIGO Stage 3) and the requirement for renal replacement therapy (RRT) are robust predictors of poor outcomes.<sup>2,8</sup> Longitudinal data also indicate that AKI contributes to long-term adverse consequences, including chronic kidney disease progression, recurrent AKI episodes, and elevated cardiovascular risk.<sup>9</sup>

Emerging evidence from low- and middle-income countries highlights an even heavier AKI burden, with higher incidence and worse outcomes compared with high-income settings.<sup>7,10</sup> Furthermore, recent analyses suggest that AKI remains under-detected in routine clinical practice, potentially delaying intervention and worsening prognosis.<sup>11</sup> Despite these insights, data specifically focusing on tertiary care medical ICUs in India remain limited.

Understanding the clinical profile, precipitating factors, severity patterns, and outcomes of AKI in critically ill patients is crucial for improving patient care and resource allocation. Therefore, this retrospective observational study was undertaken to characterize AKI among patients admitted to a tertiary care medical ICU, examining its etiologies, severity, requirement for RRT, and impact on ICU outcomes.

## MATERIAL AND METHODS

### Study Design and setting

This retrospective observational study was conducted in the **Medical Intensive Care Unit (MICU), Department of General Medicine, in collaboration with the Department of Nephrology at a tertiary care teaching hospital**, during the study period

The MICU functions under the Department of General Medicine and provides comprehensive critical care services, including mechanical ventilation, vasopressor support, and advanced hemodynamic monitoring. The management of acute kidney injury, including renal replacement therapy, was carried out in coordination with the Department of Nephrology.

### Study Period

Medical records of patients admitted during a **defined study period January 2022 to December 2023** were reviewed. This duration ensured adequate sample size and representation of seasonal variations in ICU admissions.

### Study Population

During the study period, 620 patients were admitted to the MICU. Among them, **128 patients (20.6%) developed AKI**. After applying exclusion criteria, **100 patients** were included in the final analysis.

### Inclusion Criteria

- Age  $\geq 18$  years
- Admission to the MICU during the study period
- Diagnosis of AKI as per **KDIGO criteria**
- ICU stay of  $\geq 24$  hours

### Exclusion Criteria

- Known chronic kidney disease stage 4 or 5
- Patients on maintenance dialysis
- Renal transplant recipients
- Obstructive uropathy as primary diagnosis
- Incomplete or missing medical records
- ICU stay  $< 24$  hours

These exclusions were applied to avoid confounding due to pre-existing advanced renal dysfunction and incomplete outcome assessment.

### Definition and Classification of AKI

AKI was defined and staged according to the **KDIGO (Kidney Disease: Improving Global Outcomes) guidelines**, based on serum creatinine and/or urine output criteria:

- **Stage 1:** Increase in serum creatinine  $\geq 0.3$  mg/dL within 48 hours or 1.5–1.9 times baseline
- **Stage 2:** Increase in serum creatinine 2.0–2.9 times baseline

- **Stage 3:** Increase in serum creatinine  $\geq 3$  times baseline, serum creatinine  $\geq 4.0$  mg/dL, or initiation of renal replacement therapy

The **highest KDIGO stage** reached during ICU stay was considered for analysis.

### Baseline Renal Function

Baseline serum creatinine was defined as:

- The most recent documented serum creatinine value within **3 months prior to hospital admission**, or
- In the absence of prior values, the **lowest serum creatinine recorded during hospitalization** was considered baseline.

### Data Collection

Data were extracted retrospectively from electronic medical records and ICU case files using a **pre-designed structured proforma**.

### Demographic Variables

- Age
- Sex

### Clinical Variables

- Primary diagnosis at ICU admission
- Comorbidities (hypertension, diabetes mellitus, coronary artery disease, chronic liver disease, etc.)
- Presence of sepsis or septic shock
- Requirement for mechanical ventilation
- Use of vasopressors or inotropes
- Duration of ICU stay

### Laboratory Parameters

- Serum creatinine (baseline and peak)
- Blood urea nitrogen
- Serum electrolytes
- Hemoglobin
- Arterial blood gas parameters

### Etiological Classification of AKI

Based on clinical evaluation, laboratory data, imaging, and treating physician documentation, AKI was classified into the following etiological categories:

- Sepsis-associated AKI
- Hypovolemia-related AKI
- Cardiorenal syndrome
- Drug-induced nephrotoxicity
- Multifactorial AKI

When multiple contributing factors were present, AKI was categorized as **multifactorial**.

### Renal Replacement Therapy

The requirement for **renal replacement therapy (RRT)** was recorded. Indications for initiation of RRT included:

- Refractory hyperkalemia
- Severe metabolic acidosis
- Fluid overload unresponsive to medical management
- Uremic complications (encephalopathy, pericardi)

### Statistical Analysis

Data were entered into Microsoft Excel and analyzed using **Statistical Package for the Social Sciences (SPSS) version 19.0**. Continuous variables were expressed as **mean  $\pm$  standard deviation (SD)**. Categorical variables were presented as **frequencies and percentages**. Independent *t*-test or Mann–Whitney U test was used for comparison of continuous variables. Chi-square test or Fisher's exact test was applied for categorical variables. One-way ANOVA was used to compare outcomes across KDIGO stages. A **p-value  $< 0.05$**  was considered statistically significant.

### Ethical Considerations

The study was approved by the **Institutional Ethics Committee**.

## RESULTS

A total of **100 patients** with AKI admitted to the MICU were included in the final analysis. The incidence of AKI among ICU admissions was **20.6%**. The mean age of the study population was **54.6 ± 15.2 years**. Elderly patients (>60 years) constituted 38% of cases. There was a male predominance (62%), as shown in Table 1.

**Table 1. Baseline Demographic Characteristics (N = 100)**

Variable	Frequency (n)	Percentage (%)
<b>Age Group (years)</b>		
< 40	24	24
40–60	38	38
> 60	38	38
<b>Gender</b>		
Male	62	62
Female	38	38
<b>Mean Age (years)</b>	54.6 ± 15.2	—

Hypertension (55%) and diabetes mellitus (42%) were the most common comorbid conditions among AKI patients.

**Table 2. Distribution of Comorbidities (N = 100)**

Comorbidity	Frequency (n)	Percentage (%)
Hypertension	55	55
Diabetes Mellitus	42	42
Coronary Artery Disease	18	18
Chronic Liver Disease	8	8

Sepsis was the leading cause of AKI, accounting for 56% of cases, followed by hypovolemia and cardiogenic shock (table 3)

**Table 3. Etiological Spectrum of AKI (N = 100)**

Etiology	Frequency (n)	Percentage (%)
Sepsis-associated AKI	56	56
Hypovolemia	14	14
Cardiogenic Shock	10	10
Drug-induced	8	8
Multifactorial	12	12

KDIGO Stage 1 and Stage 3 were equally represented (36% each), while Stage 2 accounted for 28% of cases. (table 4)

**Table 4. KDIGO Staging of AKI (N = 100)**

KDIGO Stage	Frequency (n)	Percentage (%)
Stage 1	36	36
Stage 2	28	28
Stage 3	36	36

Half of the patients required mechanical ventilation. Renal replacement therapy was required in 20% of cases. (table 5)

**Table 5. Organ Support Requirement (N = 100)**

Intervention	Frequency (n)	Percentage (%)
Mechanical Ventilation	50	50
Vasopressor Support	46	46
Renal Replacement Therapy	20	20

Overall ICU mortality was 28%. Mortality increased progressively with AKI severity (table 6)

**Table 6. ICU Mortality by KDIGO Stage**

KDIGO Stage	Survivors n (%)	Non-survivors n (%)	Mortality (%)	p-value
Stage 1 (n=36)	32 (89%)	4 (11%)	11	0.01
Stage 2 (n=28)	20 (71%)	8 (29%)	29	
Stage 3 (n=36)	20 (56%)	16 (44%)	44	

Non-survivors had significantly higher rates of Stage 3 AKI and mechanical ventilation (table 7)

**Table 7. Comparison of Clinical Variables**

Variable	Survivors (n=72)	Non-survivors (n=28)	p-value
Age (years)	52.1 ± 14.3	60.8 ± 16.1	0.03
Sepsis-associated AKI	36 (50%)	20 (71%)	0.04
KDIGO Stage 3	20 (28%)	16 (57%)	0.01
Mechanical Ventilation	26 (36%)	24 (86%)	<0.001
RRT Requirement	10 (14%)	10 (36%)	0.02

Among survivors, 72% achieved complete renal recovery, while 13% remained dialysis-dependent at discharge (table 8)

**Table 8. Renal Recovery Among Survivors (n = 72)**

Renal Outcome	Frequency (n)	Percentage (%)
Complete Recovery	52	72
Partial Recovery	11	15
Dialysis-dependent	9	13

On logistic regression analysis, KDIGO Stage 3 and mechanical ventilation remained independent predictors of mortality. (table 9)

**Table 9. Multivariate Logistic Regression Analysis**

Variable	Adjusted OR	95% CI	p-value
KDIGO Stage 3	2.4	1.0 – 5.8	0.04
Mechanical Ventilation	3.1	1.5 – 6.7	0.002

## DISCUSSION

In this retrospective observational study conducted in a tertiary care medical ICU, we evaluated the clinical profile, severity patterns, and outcomes of acute kidney injury (AKI) among critically ill patients.

### Incidence of AKI in the Medical ICU

In the present study, the incidence of AKI among MICU admissions was 20.6%. This falls within the range reported in previous ICU-based studies, where AKI incidence varies from 20% to 50% depending on patient characteristics and diagnostic criteria used.<sup>12,13</sup> The adoption of KDIGO classification in our study ensured standardized staging and comparability with international data.

### Etiological Spectrum: Predominance of Sepsis

Sepsis was identified as the leading cause of AKI, accounting for 56% of cases. This observation is consistent with prior multicenter studies that have reported sepsis as the most frequent precipitating factor for AKI in critically ill patients.<sup>14,15</sup> Sepsis-associated AKI results from complex mechanisms including systemic inflammation, endothelial dysfunction, altered renal microcirculation, and mitochondrial injury rather than solely reduced renal perfusion.<sup>15</sup> The high prevalence of sepsis in our cohort underscores the need for early infection control and hemodynamic optimization in preventing AKI progression.

### Severity of AKI and Stage-Dependent Mortality

Approximately 36% of patients developed KDIGO Stage 3 AKI. Mortality increased progressively with increasing AKI severity, demonstrating a clear stage-dependent relationship. This pattern mirrors findings from multinational ICU studies, which consistently report higher mortality with advanced AKI stages.<sup>13,16</sup>

In multivariate analysis, KDIGO Stage 3 remained an independent predictor of ICU mortality. This reinforces the prognostic utility of KDIGO staging in critically ill patients and highlights the importance of early identification and intervention in high-risk individuals.

### Organ Support and Multi-Organ Dysfunction

Mechanical ventilation and vasopressor requirement were significantly associated with mortality. Respiratory failure emerged as a strong independent predictor of adverse outcome. Similar associations have been documented in prior ICU studies, where the need for mechanical ventilation reflects the presence of severe systemic illness and multi-organ dysfunction.<sup>17,18</sup>

The interaction between lung injury and kidney injury—often referred to as organ cross-talk—may explain the worsened prognosis observed in these patients.<sup>19</sup> Hypoxemia, inflammatory mediators, and hemodynamic instability contribute to both pulmonary and renal dysfunction.

### Renal Replacement Therapy and Outcomes

Renal replacement therapy was required in 20% of patients. Although RRT was associated with mortality on univariate analysis, it did not remain independently significant after adjustment. This likely reflects the fact that RRT serves as a marker of severe systemic illness rather than a direct cause of mortality.<sup>20</sup>

These findings are consistent with previous studies suggesting that mortality in dialysis-requiring AKI is driven primarily by underlying disease severity and multi-organ failure.

### Renal Recovery and Long-Term Implications

Among survivors, 72% achieved complete renal recovery, while 13% remained dialysis-dependent at discharge. This aligns with published literature demonstrating that a subset of ICU-AKI survivors experience incomplete renal recovery and remain at risk for progression to chronic kidney disease.<sup>21</sup>

Early nephrology follow-up and structured post-discharge monitoring may therefore be essential in improving long-term renal outcomes.

## CONCLUSION

Acute kidney injury is a frequent and serious complication among critically ill patients in the medical ICU. Sepsis was the predominant etiological factor, and increasing KDIGO stage was strongly associated with higher mortality. Severe AKI (Stage 3) and the need for mechanical ventilation independently predicted poor outcomes.

Although the majority of survivors achieved renal recovery, a proportion remained dialysis-dependent at discharge, highlighting the potential long-term consequences of AKI. Early recognition, timely management of sepsis, and careful monitoring of organ dysfunction are essential to improve clinical outcomes in this high-risk population.

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