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Predictors of Severity, and Outcomes of Acute Kidney Injury in the Intensive Care Unit Patients a Tertiary Care Teaching Hospital

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ABSTRACT

Objectives: To analyze the predictors of severity, and outcomes of Acute Kidney Injury in the Intensive Care Unit patients a tertiary care teaching hospital.
Methodology: This retrospective, record-based observational study analyzed 200 adult AKI patients medical records (2024-25) admitted to the ICU of a tertiary care teaching hospital. AKI was defined and staged according to the Kidney Disease Improving Global Outcomes (KDIGO) 2012.
Results: The mean age of AKI patients was 58 years. Males comprised 59% of them. Sepsis/septic shock observed in 22% of patients were the leading cause of AKI besides hepatorenal syndrome (17%), pneumonia (15%), malaria (12%) and dengue (10%). Hypertension was present in 47% of patients, while 38% had diabetes mellitus. Chronic liver disease was observed in 13%, and coronary heart disease in 10%. KDIGO Stage 3 emerged as the strongest independent predictor of mortality, besides sepsis/septic shock / chronic liver disease.
Conclusion: The mean age of AKI patients was 58 years. Sepsis/septic shock, hepatorenal syndrome, pneumonia, malaria, and dengue were the leading cause of AKI. Hypertension was present in 47% of patients, while 38% had diabetes mellitus. KDIGO Stage 3 was the strongest independent predictor of mortality, besides sepsis/septic shock / chronic liver disease.

Keywords: Acute Kidney Injury, Intensive Care Unit, KDIGO, Sepsis.

INTRODUCTION

In critically sick patients admitted to the Intensive Care Unit (ICU), Acute Kidney Injury (AKI) is a frequent complication.[1] AKI, an abrupt decrease in kidney function, is a major global public health concern affecting millions of people. Up to 16–60% ICU patients develop AKI despite medical advancements.[2-5]

In patients admitted to ICU, AKI development / high incidence is associated with increases duration of hospital stay, reduced survival and poor outcome, adding to the healthcare burden. AKI involves abrupt kidney function loss with adverse clinical outcomes.[6,7] It has high mortality, morbidity, leading to massive healthcare costs. For better AKI outcomes, proper management is critical after early detection.

Sepsis, hypotension, nephrotoxic interventions, and systemic illnesses are the common causes (multifactorial aetiology).
AKI challenge encompasses hypovolaemia, nephrotoxic exposure, and sepsis.[8] In AKI patients admitted to the ICU, renal stress is often exacerbated by its dynamic environment, treatment-related factors and systemic illnesses, sepsis, hypotension, mechanical ventilation / vasoactive drugs (as a part of therapeutic interventions).For improving outcomes of such patients, it is imperative to identify, recognize, and promptly address these factors at an early stage to reduce the AKI progression risk and reducing mortality rates. Identification of high-risk patients is vital for preventing AKI in ICU.[7,9]
Given the significant burden of AKI in critically ill patients and the variability in outcomes across different settings, there is a need for region-specific data to better understand its epidemiology and determinants.

Objectives: To analyze the predictors of severity, and outcomes of Acute Kidney Injury in the Intensive Care Unit patients a tertiary care teaching hospital.

MATERIALS & METHODS

Study Design and Setting: This retrospective, record-based observational study was conducted in the Intensive Care Unit (ICU) of a tertiary care teaching hospital. The study analyzed medical records of patients admitted over a two-year period from January 2024 to December 2025.

Study Population: All adult patients (≥18 years) admitted to the ICU during the study period who were diagnosed with AKI were eligible for inclusion. AKI was defined and staged according to the kidney disease: Improving Global Outcomes (KDIGO) 2012 criteria, based on serum creatinine levels and urine output.

Inclusion Criteria
Age ≥ 18 years
Diagnosis of AKI during ICU stays as per KDIGO criteria
Complete medical records with documented laboratory and clinical data

Exclusion Criteria
Patients with pre-existing end-stage renal disease on maintenance dialysis
Renal transplant recipients
Incomplete or missing clinical records

Sample size estimation
The sample size was calculated based on previously published data reporting a 30-day mortality rate of 52.5% among critically ill patients with acute kidney injury.
For prevalence/mortality estimation: $n=Z^2\times p\times(1-p)/d^2$ where Z = 1.96 (for 95% confidence level), p = expected prevalence (0.5254), d = 0.07 allowable absolute error (precision). Therefore, the minimum required sample size was calculated to be 196 patients. The final study included 200 patients, which was considered adequate to estimate mortality and evaluate associations between KDIGO severity and clinical outcomes.

Data Collection: Data were extracted retrospectively from hospital medical records using a structured data collection proforma. Information collected included demographic details such as age and sex; clinical characteristics including primary diagnosis, etiology of acute kidney injury (AKI), and associated comorbidities such as diabetes mellitus, hypertension, chronic liver disease, and coronary artery disease. ICU-related variables, including the presence of sepsis or septic shock, requirement of mechanical ventilation, and use of vaso active drugs, were also recorded. Relevant laboratory parameters, particularly serum creatinine levels and urine output, were obtained to classify AKI according to kidney disease: Improving Global Outcomes (KDIGO) staging criteria (Stage 1, 2, and 3). Additionally, details

regarding therapeutic interventions, especially the requirement of renal replacement therapy (RRT), were documented. All data were collected systematically to evaluate predictors of severity and clinical outcomes among ICU patients with AKI.

Statistical Analysis

Data were entered into Microsoft Excel 2019 and analyzed using SPSS software (version 27). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were summarized as frequencies and percentages. The association between categorical variables, including KDIGO stage and in-hospital mortality, was assessed using the Fisher exact test. Multivariate logistic regression analysis was performed to identify independent predictors of in-hospital mortality, and adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated.[10] Model performance was evaluated using Nagelkerke R^2. A p-value of less than 0.05 was considered statistically significant.

Ethical Consideration: Ethical approval for this study was obtained from the Institutional Ethics Committee of Shri Ram Murti Smarak Institute of Medical Sciences (SRMS-IMS), Bareilly (Ref. No.: SRMSIMS/ECC/2024/45; dated 07 June 2024).

RESULT

A total of 200 patients with acute kidney injury (AKI) admitted to the intensive care unit (ICU) were included in the study. The mean age was 58.2 ± 12.4 years. Males comprised 59% of the cohort, while females accounted for 41% (Table 1).

Table 1: Baseline Demographic Characteristics of Study Population (n = 200)

Sex	Frequency (n)	Percentage (%)
Male	118	59
Female	82	41
Mean Age ± SD	58.2 ± 12.4 years	

Sepsis/septic shock were the leading cause of AKI, observed in 22% of patients. Hepatorenal syndrome (17%) and pneumonia (15%) were the next most common etiologies. Tropical infectious diseases including malaria (12%) and dengue (10%) were also significant contributors. Other causes included acute gastroenteritis (10%), obstructive nephropathy (5%), acute pancreatitis (4%), and rare causes such as malignancy, chemotherapy-induced AKI, scrub typhus, and upper gastrointestinal bleeding (each 1%) (Figure 1).

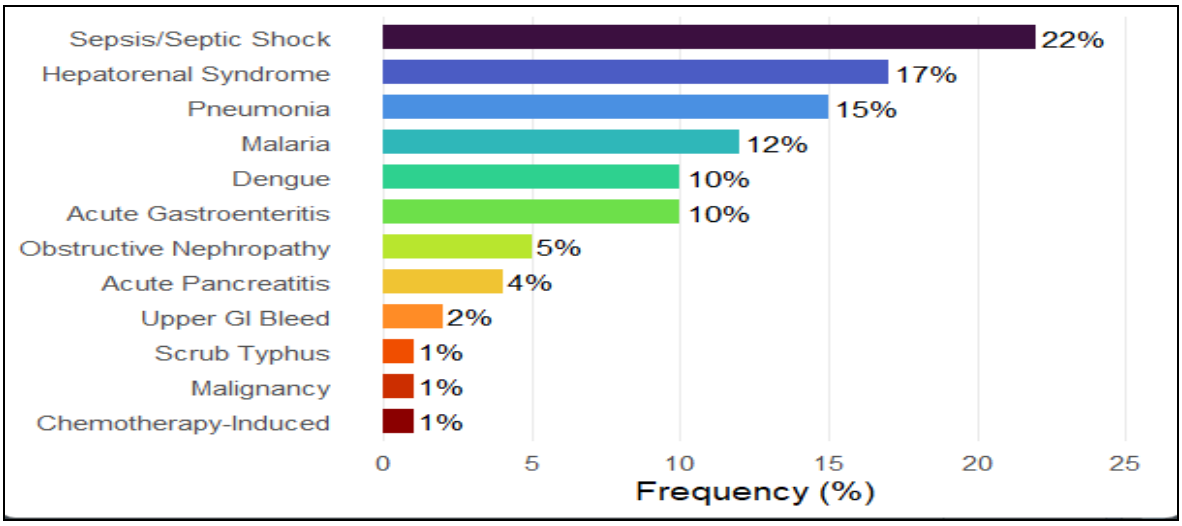

Figure 1: Etiology of Acute Kidney Injury in ICU Patients (n = 200)

Hypertension was present in 47% of patients, while 38% had diabetes mellitus. Chronic liver disease was observed in 13%, and coronary heart disease in 10%. Thyroid disorders (14%), COPD (8%), malignancy (6%), and cerebrovascular accidents (3%) were less frequent (Figure 2).

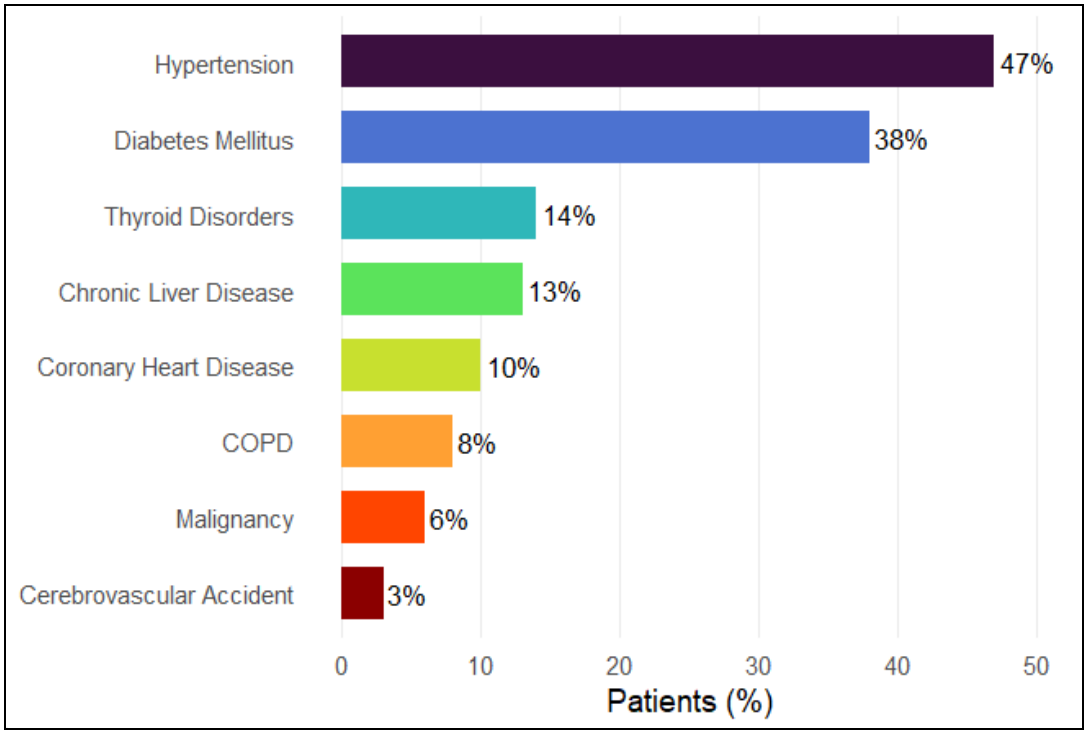

Figure 2: Distribution of Comorbidities among AKI Patients (n = 200)

Table 2 shows a statistically significant association was observed between KDIGO stage and in-hospital mortality among ICU patients with acute kidney injury ($p<0.05$). Mortality increased progressively with advancing AKI severity. No deaths were recorded among patients in Stage 1 (0/20), while Stage 2 was associated with a mortality rate of 2.9% (1/35). The highest mortality was observed in Stage 3, where 8 out of 45 patients (17.8%) succumbed during hospitalization.

Table 2: Association between KDIGO Stage and In-Hospital Mortality among ICU Patients with AKI (n = 200)

KDIGO Stage	Total	Death	Survival	p value*
Stage 1	40	0	40	**0.019**
Stage 2	70	2	68	
Stage 3	90	16	74	
Total	200	18	182	

Fisher exact test.

Table 3 shows multivariate logistic regression analysis was performed to identify independent predictors of in-hospital mortality among ICU patients with acute kidney injury. After adjustment for potential confounders, KDIGO Stage 3 emerged as the strongest independent predictor of mortality (AOR 5.10; 95% CI: 1.85–14.05; p = 0.002), indicating that patients with severe AKI had more than fivefold higher odds of death compared to those in Stages 1–2. Sepsis/septic shock was also independently associated with increased mortality (AOR 3.29; 95% CI: 1.32–8.20; p = 0.011), as was chronic liver disease (AOR 2.86; 95% CI: 1.05–7.79; p = 0.039). Additionally, age > 60 years was significantly associated with higher

mortality risk (AOR 2.49; 95% CI: 1.09–5.69; p = 0.03).

Male sex, diabetes mellitus, hypertension, and requirement of renal replacement therapy did not independently predict mortality after adjustment. The model demonstrated good explanatory power, with a Nagelkerke R^2 of 0.42, indicating that approximately 42% of the variability in mortality was explained by the included variables.

Table 3: Multivariate Logistic Regression Analysis for Predictors of In-Hospital Mortality among ICU Patients with AKI (n = 200)

Variable	Reference Category	AOR	95% CI	Standard Error	p value
Age > 60 years	≤ 60 years	2.49	1.09–5.69	0.42	0.03
Male Sex	Female	1.2	0.47–3.05	0.48	0.71
Diabetes Mellitus	No DM	1.89	0.77–4.63	0.46	0.16
Hypertension	No Hypertension	1.63	0.69–3.88	0.44	0.26
Chronic Liver Disease	No CLD	2.86	1.05–7.79	0.51	0.039
Sepsis/Septic Shock	Other Etiology	3.29	1.32–8.20	0.47	0.011
KDIGO Stage 3	Stage 1–2	5.1	1.85–14.05	0.52	0.002
Required RRT	No RRT	2.41	0.92–6.28	0.49	0.074
Constant				0.89	<0.001
Nagelkerke R^2	0.42				

Note: "Dependent Variable: In-hospital Mortality (Yes = 1, No = 0), Adjusted odds ratios (AOR) with 95% confidence intervals (CI) are reported. Statistical significance was defined as $p < 0.05$."

DISCUSSION

Due to age-related decline in renal reserve, AKI prevalence is higher among elderly, (> 60 yrs) as they are at a higher risk. In ICU patients, AKI is a serious complication with high mortality (30–80%) / morbidity, with multi-organ dysfunction / severe illness, indicated by High APACHE II or SOFA scores being the strong predictors. Conditions like hypertension, cardiovascular diseases, and diabetes mellitus are the usual risk factors, predisposing and making the patients more susceptible to endothelial dysfunction, nephrotoxic insults, and haemodynamic instability.[7] In the present study, males comprised 59% of AKI patients with a mean age of 58.2 ± 12.4 years. As per other studies, AKI was mainly seen in older males Bhattacharjee et al, e.g., a varying range of gender distribution and mean age in AKI patients was reported - 42 yrs (53% females)[3]; 65 yrs[11], 59.5 yrs (41% women)[12]; 60 yrs (84% male)[9]; 76 yr[4]54%males[13]. In this study, sepsis and septic shock, observed in 22% of patients, were the leading cause of AKI besides hepatorenal syndrome (17%), pneumonia (15%), malaria (12%) and dengue (10%). In other studies, also, among ICU patients with AKI the range of reported sepsis varied28%[13,]76%[6]; 47%[15] 39%;71%[1], Khambhala et al found sepsis as the commonest cause of AKI, besides malaria.[7] In this study, 47% of patients had hypertension, while 38% had diabetes mellitus. Chronic liver disease was observed in 13%, and coronary heart disease in 10%. Thyroid disorders (14%), COPD (8%), malignancy (6%), and cerebrovascular accidents (3%) were less frequent. In Saini and Bhattacharjee study also, 48% ICU patients with AKI had diabetes and 52% had hypertension.[9] In Khambhala et al study, co-morbidities included diabetes mellitus and hypertension.[7]In other studies, the range of AKI comorbidities included coronary artery disease (37%), diabetes mellitus (29%), chronic kidney disease (30%), and chronic liver disease (21%); 64% required dialysis[12]. In Korula et al study, 71% had metabolic acidosis, 57% required mechanical ventilation, 39% required RRT and 48% patients had shock.[6] In a cross-sectional descriptive observational study in Dhaka during 2015 Mahmood et al on 271 AKI patients admitted to ICU assessed the risk factors, incidence, and outcome. Among 59 eligible patients 54% were males. Etiology

included hepato-renal syndrome (17%), malignancy (12%), sepsis (10%), pneumonia (10%), diabetes mellitus with complication (19%), intra-uterine death (9%) etc. Gender, age, or comorbidities did not influence the AKI incidence in ICU patients. In this study, 18% patients succumbed during hospitalization. In other studies, different range of mortality was reported7.8%[6].36.4%[5] 32.5%[15]; 37-50%[12].

In this study, age (> 60 years) was significantly associated with higher mortality risk among ICU patients with AKI. Sepsis/septic shock were also independently associated with increased mortality, as was chronic liver disease. However, male sex, diabetes mellitus, hypertension did not independently predict mortality after adjustment. KDIGO Stage 3 emerged as the strongest independent predictor of mortality, indicating that patients with severe AKI had more than fivefold higher odds of death compared to those in Stages 1–2. Hoste et al also found that mortality was associated with severity of AKI.[8] Sah & Prakash reported that the mortality was not associated with RIFLE classification, while, the etiology was significantly associated with RIFLE classification.[1] Khambhala et al reported that the need for initiating renal replacement therapy (RRT) in severe metabolic disturbance / fluid overload cases is associated with high 50–60% mortality rates at 3 months.[7] Bhattacharjee et al reported that RRT was needed in 35% patients.[15] In this study, requirement of RRT did not independently predict mortality after adjustment. Saini and Bhattacharjee mean hospital stay 9 ± 4 days, non-recovery was seen in 51%, with complete remission at 3 months in 63% and progression to CKD in 28%.[9]

Melo et al assessed the AKI epidemiology in the 3 ICUs of Brazilian Amazon area. The AKI incidence was 53%, with predictors like higher APACHE II scores, nonsurgical patients, and higher age. A higher AKI mortality was predicted by sepsis at admission, age, nonsurgical patients, use of vasoactive drugs/ mechanical ventilation, and presence of shock.[16]

The cross-sectional study by Mathew et al**.** identified AKI patterns, etiologic factors, and outcome in 150 patients admitted in ICU of Kottayam. Leptospirosis (22%) / undifferentiated fever (21%) / sepsis (17%) were the commonest diagnoses, with dialysis needed 79% in leptospirosis and 81% undifferentiated in febrile illness cases. In majority (65%), AKI stage 3 was the commonest in with patients requiring dialysis (45%), RRT (24%), hemodialysis (76%). Of them 41% died.

More mortality was seen in, leptospirosis patients (36%), those who underwent dialysis (48.5%), and undifferentiated acute febrile illness (44%). Independent predictors of mortality requirement of inotropic supports and ventilator support. But dialysis requirement / diagnosis did not affect mortality.[17] Eswarappa et al**.** conducted a retrospective records-based study on AKI etiology, clinical characteristics, epidemiology, and outcomes of in 500 adult ICU patients. Most common comorbidities encountered were coronary artery disease, hypertension, and diabetes. AKI was mainly seen in older males. The commonest cause of AKI was sepsis (39%). RRT was needed in 37% patients. Case fatality rate was 38% with about 60% had complete renal function recovery.[18] The multivariate logistic regression model developed by the authors in this study, demonstrated good explanatory power, with approximately 42% of the variability in mortality explained by the included variables.

CONCLUSION

Acute kidney injury in critically ill ICU patients predominantly affects older individuals, with a mean age of 58 years, and is commonly associated with multifactorial etiologies. Sepsis/septic shock, hepatorenal syndrome, pneumonia, malaria, and dengue were the leading cause of AKI. Hypertension was present in 47%

of patients, while 38% had diabetes mellitus. KDIGO Stage 3 was the strongest independent predictor of mortality, besides sepsis/septic shock / chronic liver disease. These findings indicate the critical importance of early identification of high-risk patients, prompt management of sepsis, and careful monitoring of renal function to prevent progression to severe AKI and reduce mortality in ICU settings.

Declaration by Authors

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