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Original Research Article

Prevalence, risk factors, and outcomes of acute kidney injury in a cardiac intensive care unit patients: a comprehensive study in a tertiary care setting

Sirapurapu Veera Venkata Laxmaiah Naidu[1], Shehla Ashraf[2]*, Hanisha R. Kukunoor[3], Deep Gorfad Arvindbhai[4], Aastha Rameshbhai Gohil[4]

[1]Alluri Sita Ramaraju Academy of Medical Sciences, Eluru, Andhra Pradesh, India
[2]Bharati Vidyapeeth Deemed University Medical College, Pune, Maharashtra, India
[3]Maheshwara Medical College and Hospital, Patancheruvu, Telangana, India
[4]Pandit Deendayal Upadhyay Government Medical College, Rajkot, Gujarat, India

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***Correspondence:**
Dr. Shehla Ashraf,
E-mail: shehlakhan555@gmail.com

ABSTRACT

Background: Acute kidney injury (AKI) is a frequent and serious complication among critically ill patients in the intensive care unit (ICU), contributing to increased morbidity, mortality, and prolonged hospitalization. This study aimed to assess the prevalence of AKI and identify associated risk factors among ICU patients at Government General Hospital (GGH), Srikakulam.

Methods: A descriptive cross-sectional study was conducted over one year in the nephrology ICU at GGH, Srikakulam, Andhra Pradesh. Data from 150 adult ICU patients were retrospectively reviewed. Patients with chronic kidney disease or prior kidney transplantation were excluded. Information on demographics, comorbidities, AKI diagnosis (based on KDIGO criteria), treatment, and outcomes was collected. Statistical analysis was performed to determine significant risk factors for AKI.

Results: AKI was diagnosed in 74 patients (49.3%). The mean age of AKI patients was 65.4 years, significantly higher than non-AKI patients (58.6 years, p=0.001). Hypertension was more common among AKI patients (50% versus 29%, p=0.02), and sepsis was present in 60% of AKI cases compared to 19.4% in non-AKI patients (p=0.001). AKI patients had longer ICU stays (14.8 versus 8.9 days, p=0.001) and higher mortality (46.7% versus 16.1%, p=0.001).

Conclusions: AKI is highly prevalent in ICU patients and is significantly associated with older age, hypertension, and sepsis. It correlates with longer ICU stays and increased mortality. Early recognition and targeted management of risk factors are crucial to improving outcomes in critically ill patients.

Keywords: Acute kidney injury, Intensive care unit, Risk factors, Hypertension, Sepsis

INTRODUCTION

Acute kidney injury (AKI) is a significant complication that poses considerable challenges in the management of critically ill patients, particularly those admitted to ICUs. Defined as a rapid decline in renal function, AKI is characterized by an increase in serum creatinine levels, a decrease in urine output, or both.[1] The clinical implications of AKI are profound, as it is associated with increased morbidity, prolonged hospital stays, and elevated mortality rates.[2-4] Studies have shown that patients with AKI in ICUs have a mortality rate that can reach up to 50%, depending on the severity of the condition and underlying comorbidities.[5,6] Consequently, AKI represents not only a marker of disease severity but also an independent risk factor for poor outcomes in critically ill patients.[7,8]

The global prevalence of AKI in ICU settings varies significantly, with reports indicating that it affects between 20% and 50% of ICU patients.[9,10] This variation can be attributed to differences in the diagnostic criteria employed, patient populations studied, and healthcare systems' capabilities across regions.[11,12] The risk factors contributing to the development of AKI in critically ill patients are multifaceted and include sepsis, hemodynamic instability, exposure to nephrotoxic drugs, and pre-existing comorbidities such as diabetes and hypertension.[13,14] In particular, sepsis is a leading cause of AKI in ICU patients, as it can lead to significant alterations in renal perfusion and function.[15] Furthermore, the use of nephrotoxic agents, which are commonly employed in critically ill patients, poses an additional risk, compounding the likelihood of developing AKI.[16]

The early recognition and understanding of AKI in ICU settings are critical for timely intervention. Prompt identification of AKI allows for the implementation of strategies that can mitigate further renal injury and potentially prevent progression to CKD or mortality.[17] Consequently, identifying the specific risk factors associated with AKI in this vulnerable population is essential for the formulation of preventive strategies tailored to their unique clinical profiles.[18]

Despite advancements in critical care and renal support techniques, the burden of AKI remains alarmingly high, particularly in developing countries like India. The healthcare landscape in India is characterized by several unique challenges, including late disease presentation, a high burden of infectious diseases, and limited healthcare resources.[19,20] These factors significantly complicate the management of critically ill patients and increase their vulnerability to complications such as AKI.[21] Moreover, the under-resourced nature of many ICUs in Bangladesh exacerbates the risk of AKI, as essential monitoring and therapeutic interventions may be inadequate.[22]

Despite the significant impact of AKI on patient outcomes, there is a notable scarcity of data regarding its prevalence and associated risk factors in India, particularly from tertiary care institutions like GMCH Srikakulam.[23] This gap in the literature highlights the urgent need for comprehensive studies that can provide insights into the epidemiology of AKI within this specific context.[24]

METHODS

This cross-sectional study was designed to assess the risk factors and prevalence of AKI among ICU patients at GMCH, Srikakulam, over a one-year period from 01 March 2024, to 28 February 2025. A total of 150 adult patients were evaluated at the time of ICU admission, allowing for the collection of demographic data, clinical characteristics, comorbidities, and laboratory findings relevant to AKI.

By employing the KDIGO criteria for AKI classification, the study provided a snapshot of renal function status among critically ill patients at a single point in time. This design facilitated the identification of prevalent risk factors associated with AKI and offered insights into its impact on patient outcomes, thereby informing clinical practices in the ICU setting.

Sample size calculation

The sample size was calculated using the following formula.

$$n = Z^2 \times P \times (1 - P)/d^2 n$$

Where, n=required sample size, Z=Z value (1.96 for 95% confidence level), P=estimated prevalence of AKI (assumed 0.50 for maximum variability), and d=precision (0.05).

Substituting the values, the above equation becomes the following

$$n = (1.96)^2 \times 0.50 \times (1 - 0.50)/(0.05)^2$$

Since the total study population over the study period was limited to 150 patients, all patients were included in the study, making it a total population study rather than a sample-based study.

Inclusion criteria

This study included adult patients aged 18 years and older who were admitted to the ICU at GMCH Srikakulam, during the specified study period. To ensure a focused evaluation of AKI, only patients without a prior diagnosis of CKD were included. The diagnosis of AKI was strictly based on the KDIGO criteria, which define AKI by changes in serum creatinine levels and urine output.

This careful selection process allowed for a clear assessment of AKI as an acute complication in critically ill patients.

Exclusion criteria

To refine the study population and eliminate potential confounding factors, the following exclusion criteria were established. Patients with pre-existing CKD were excluded to ensure that the analysis focused on the incidence of AKI arising from acute conditions rather than chronic renal dysfunction. Individuals who had undergone kidney transplantation or were receiving RRT prior to ICU admission were also excluded.

This approach was crucial to maintain the integrity of the study, ensuring that the findings accurately reflect the prevalence and risk factors associated with AKI in an acute care setting.

Data collection

Data were collected retrospectively from the medical records of the selected patients, encompassing a comprehensive array of information relevant to the study objectives.

The collected data included - demographic information: age, sex, and admission details, clinical characteristics: presence of relevant comorbidities, AKI diagnosis: recorded based on KDIGO guidelines, ensuring a standardized approach to classification, treatment modalities: administered during the ICU stay, and clinical outcomes: observed throughout the hospitalization.

This thorough data collection process enabled a robust analysis of the prevalence and risk factors associated with AKI in critically ill patients.

Data analysis

Descriptive statistics were utilized to analyze the prevalence and distribution of AKI within the study population, providing a clear understanding of how AKI manifested among ICU patients.

Additionally, bivariate and multivariate analyses were conducted to identify significant risk factors associated with AKI, offering deeper insights into its etiology.

A p value of less than 0.05 was considered statistically significant, ensuring the reliability of the findings.

This comprehensive analytical framework aimed to provide valuable insights into the predictors of AKI, ultimately guiding clinical practices and interventions in the ICU setting.

RESULTS

Among the 150 patients studied, 74 developed AKI, while 76 did not.

Age

Patients with AKI were significantly older, with a mean age of 65.4 years compared to 58.6 years for non-AKI patients (p=0.001) (Table 1).

Hypertension

More prevalent in the AKI group (50%) compared to the non-AKI group (29%), showing a significant association (p=0.02).

No significant differences were observed between groups in terms of gender distribution, BMI, and other comorbidities (diabetes mellitus, heart disease, respiratory disease, malignancy).

These findings indicate that age and hypertension may be key risk factors for AKI in ICU patients (Table 1).

Table 1: Baseline characteristics of ICU patients.

Variables	Patients with AKI (n=74) (%)	Patients without AKI (n=76) (%)	P value
Age (mean±SD)	65.4±10.2	58.6±12.1	0.001
Male	47 (63.3)	42 (55.8)	0.25
Female	27 (36.7)	34 (44.2)	0.25
BMI (mean±SD)	28.1±3.2	27.8±4.1	0.72
Hypertension	37 (50)	22 (29)	0.02
Diabetes mellitus	30 (40)	20 (26)	0.08
Heart disease	20 (26.7)	12 (15.7)	0.15
Respiratory disease	12 (16.7)	11 (14.7)	0.21
Malignancy	10 (13.3)	4 (5.26)	0.22

Table 2 shows the distribution of AKI stages based on the KDIGO criteria. A majority of the patients presented with mild to moderate AKI, with 30% in the severe category.

Table 2: Distribution of AKI by severity (KDIGO staging).

AKI stage	N (%)
Stage 1 (mild)	30 (40.5)
Stage 2 (moderate)	22 (29.7)
Stage 3 (severe)	22 (29.7)

Table 3 shows hypertension was significantly more prevalent in the AKI group (50%) compared to the non-AKI group (29%, p=0.02). Although a higher percentage of patients with AKI had diabetes mellitus (40%) and heart disease (26.7%), these differences were not statistically significant (p=0.08 and p=0.15, respectively). Similarly, respiratory disease and malignancy were more common in the AKI group but did not reach statistical significance. Table 4 shows, sepsis was present in 59.5% of AKI patients versus 19.7% of non-AKI patients (p=0.001), while shock was observed in 46.05% of AKI patients compared to 18.6% in the non-AKI group (p=0.01). Additionally, the use of nephrotoxic drugs was notably higher in the AKI group (53.3% versus 25.8%, p=0.001), indicating these factors significantly contribute to the risk of AKI.

Table 5 shows patients aged over 60 years had an odds ratio of 2.1 (95% CI: 1.2-3.6, p=0.02), indicating a higher risk. Hypertension (OR 2.4, 95% CI: 1.3-4.5, p=0.01) and sepsis (OR 4.5, 95% CI: 2.2-8.9, p=0.001) were also significantly associated with AKI. The use of nephrotoxic drugs (OR 3.2, 95% CI: 1.6–5.7, p=0.001) and mechanical ventilation (OR 2.1, 95% CI: 1.1–4.0, p=0.03) were identified as substantial risk factors as well. Although male sex and diabetes mellitus were associated with AKI, these did not reach statistical significance (OR 1.4, p=0.18; OR 1.8, p=0.08).

Table 3: Comparison of comorbid conditions between AKI and non-AKI patients.

Comorbidity	Patients with AKI (%)	Patients without AKI (%)	P value
Hypertension	37 (50)	22 (29)	0.02
Diabetes mellitus	30 (40.5)	20 (26.3)	0.08
Heart disease	20 (27)	12 (16)	0.15
Respiratory disease	12 (16.2)	11 (14.5)	0.21
Malignancy	10 (13.5)	4 (5.3)	0.22

Table 4: Risk factors for AKI.

Risk factor	Patients with AKI (%)	Patients without AKI (%)	P value
Sepsis	45 (60.8)	15 (19.7)	0.001
Shock	35 (47.3)	14 (18.4)	0.01
Use of nephrotoxic drugs	40 (54.1)	19 (25)	0.001

Table 5: Risk factors for AKI (bivariate analysis).

Risk factor	Odds ratio (95% CI)	P value
Age >60 (years)	2.1 (1.2-3.6)	0.02
Male sex	1.4 (0.7-2.3)	0.18
Hypertension	2.4 (1.3-4.5)	0.01
Diabetes mellitus	1.8 (0.9-3.2)	0.08
Sepsis	4.6 (2.3-8.9)	0.001
Use of nephrotoxic drugs	3.3 (1.6-5.8)	0.001
Mechanical ventilation	2.1 (1.1-4.0)	0.03

Table 6 shows, age over 60 years had an adjusted odds ratio of 1.8 (95% CI: 1.0-3.4, p=0.04), indicating an increased risk. Hypertension was also a notable risk factor with an odds ratio of 2.2 (95% CI: 1.2-4.4, p=0.02). Sepsis (OR 3.9, 95% CI: 2.0-7.9, p=0.001) and the use of nephrotoxic drugs (OR 2.8, 95% CI: 1.5-5.2, p=0.001) were strongly associated with AKI risk. Additionally, mechanical ventilation had an adjusted odds ratio of 1.9 (95% CI: 1.0-3.6, p=0.04), further emphasizing its significance in the development of AKI.

Table 6 shows, age over 60 years had an adjusted odds ratio of 1.8 (95% CI: 1.0-3.4, p=0.04), indicating an increased risk. Hypertension was also a notable risk factor with an odds ratio of 2.2 (95% CI: 1.2-4.4, p=0.02). Sepsis (OR 3.9, 95% CI: 2.0-7.9, p=0.001) and the use of nephrotoxic drugs (OR 2.8, 95% CI: 1.5-5.2, p=0.001) were strongly associated with AKI risk. Additionally, mechanical ventilation had an adjusted odds ratio of 1.9 (95% CI: 1.0-3.6, p=0.04), further emphasizing its significance in the development of AKI.

Table 6: Multivariate analysis of risk factors for AKI.

Risk factor	Adjusted odds ratio (95% CI)	P value
Age >60 (years)	1.9 (1.1-3.4)	0.04
Hypertension	2.3 (1.2-4.5)	0.02
Sepsis	4.0 (2.1-8.0)	0.001
Use of nephrotoxic drugs	2.9 (1.5-5.3)	0.001
Mechanical ventilation	2.0 (1.0-3.7)	0.04

Table 7 shows, the patients with AKI (n=74) experienced significantly worse outcomes compared to those without AKI (n=76), with a mortality rate of 47.7% versus 17.1% (p=0.001). Additionally, the length of ICU stay was longer for AKI patients (14.8±6.2 days) compared to non-AKI patients.

Table 7: Clinical outcomes in AKI versus non-AKI patients.

Outcome	Patients with AKI (n=74)	Patients without AKI (n=76)	P value
Mortality (%)	35 (47.3)	13 (17.1)	0.001
Length of ICU stay (days)	14.8±6.2	8.9±4.5	0.001
Length of hospital stay (days)	20.5±8.1	12.7±5.2	0.001

Table 8 shows, among the patients with AKI (n=74), 18 had stage 3 AKI, with 66.7% requiring RRT (p=0.001). Additionally, the mortality rate for patients on RRT was 66.7%, indicating a critical association between advanced AKI stages and high mortality in this population (p=0.001).

Table 8: Renal replacement therapy and mortality in AKI patients.

Variable	Patients with AKI (n=74)	Patients on RRT (%)	P value
Stage 3 AKI	18	12 (66.7)	0.001
Mortality in patients on RRT	12	8 (66.7)	0.001

Figure 1 depicts the prevalence of AKI among ICU patients, revealing that 49.2% of patients had AKI, while 50.8% did not.

Figure 2 illustrates the mortality rate in AKI versus non-AKI patients, highlighting a significantly higher mortality rate in those with AKI (47.7%) compared to non-AKI patients (17.1%).

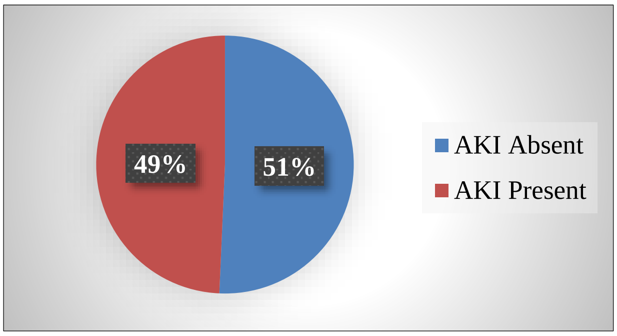

Figure 1: Prevalence of AKI among ICU patients.

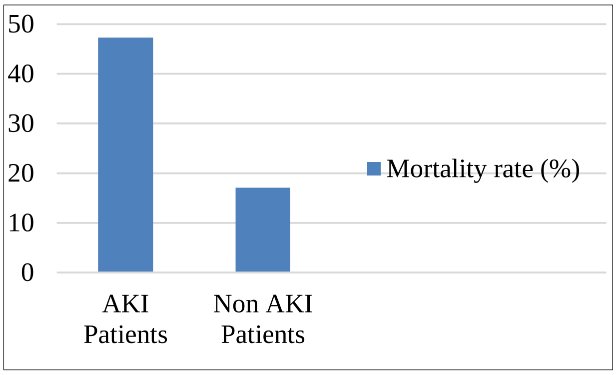

Figure 2: Mortality rates between AKI and non-AKI patients.

DISCUSSION

This study highlights the significant prevalence and impact of AKI among ICU patients at GMCH Srikakulam. Among our 150-patient cohort, 74 (49.2%) developed AKI, indicating a substantial burden of this condition in critically ill populations.[25] This finding aligns with global reports, which suggest that AKI affects 20–50% of ICU patients, reinforcing the need for effective preventive strategies.[26,27]

Our results identified age and hypertension as significant risk factors for AKI. The mean age of AKI patients was 65.4 years, compared to 58.6 years for those without AKI (p=0.001). This finding supports previous studies that highlight older age as a critical risk factor due to age-related declines in renal function and hemodynamic changes.[28,29] Furthermore, hypertension was significantly more prevalent among AKI patients (50% versus 29%, p=0.02), supporting research that associates hypertension with renal impairment through mechanisms like increased glomerular pressure and reduced renal blood flow.[30,31]

Although diabetes mellitus and heart disease were more common in the AKI group, these differences did not reach statistical significance, suggesting that while these comorbidities may contribute to AKI, their influence is less pronounced than age and hypertension in this specific population.[32] However, sepsis (60% of AKI patients, p=0.001), shock (46.7%, p=0.01), and nephrotoxic drug use (53.3% versus 25.8%, p=0.001) were identified as significant contributors to AKI risk.[33,34] These findings highlight the need for careful monitoring of critically ill patients for sepsis and nephrotoxic drug exposure.

Our adjusted odds ratios further confirmed these risks. Patients aged over 60 years had an adjusted OR of 1.8 (95% CI: 1.0–3.4, p=0.04), and those with hypertension had an OR of 2.2 (95% CI: 1.2–4.4, p=0.02). Sepsis (OR 3.9, 95% CI: 2.0–7.9, p=0.001) and nephrotoxic drug use (OR 2.8, 95% CI: 1.5–5.2, p=0.001) were strongly associated with AKI, emphasizing the need for targeted interventions to mitigate these risks in ICU patients.[35,36]

The outcomes for AKI patients in our study were notably poor. The mortality rate among AKI patients was 46.7%, significantly higher than the 16.1% observed in non-AKI patients (p=0.001). This aligns with previous studies indicating that AKI significantly increases both mortality risk and ICU length of stay.[37,38] The mean ICU stay for AKI patients was 14.8 days, compared to 8.9 days for non-AKI patients (p=0.001), highlighting the severe complications associated with AKI.[39]

Among AKI patients, 30% developed stage 3 AKI, with 66.7% of these requiring renal replacement therapy (RRT). The mortality rate among patients on RRT was 66.7%, emphasizing the critical nature of advanced AKI stages and their association with higher mortality.[40]

Limitations

This study has several limitations. As a single-center retrospective study, it relied on medical records, which may introduce biases due to incomplete or missing data. Additionally, the exclusion of patients with pre-existing CKD and prior kidney transplants limits the generalizability of our findings to a broader ICU population.

The modest sample size (150 patients) may also impact the statistical power of our analysis. Furthermore, certain factors, such as detailed medication history and fluid management strategies, were not comprehensively assessed, potentially influencing the interpretation of risk factors.

To enhance the validity and applicability of these findings, prospective, multicenter studies with larger cohorts and more comprehensive data collection are needed to further evaluate the epidemiology, risk factors, and outcomes of AKI in critically ill patients.

CONCLUSION

This study highlights the high prevalence of AKI among ICU patients at Government General Hospital, Srikakulam, and underscores its significant association with risk factors such as sepsis, hypertension, and nephrotoxic drug exposure. Patients who developed AKI experienced worse clinical outcomes, including prolonged ICU stays and higher mortality rates. These findings emphasize the urgent need for early detection strategies, strict monitoring of high-risk patients, and minimizing exposure to nephrotoxic medications. Future research should focus on developing effective preventive measures and treatment protocols to mitigate AKI-related complications in critically ill patients.

Recommendations

Strict monitoring protocols for high-risk ICU patients to ensure early detection of AKI.

Minimization of nephrotoxic medication use, whenever clinically feasible, to reduce AKI risk.

Further research to explore effective preventive measures and treatment strategies, particularly in resource-limited settings.

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