International Journal of Research in Medical Sciences
Moral MS et al. Int J Res Med Sci. 2025 Feb;13(2):639-645
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20250230

Original Research Article

Risk factors and prevalence of acute kidney injury among intensive care unit patients: a comprehensive study in a tertiary care setting

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Received: 04 December 2024
Revised: 06 January 2022
Accepted: 07 January 2025

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ABSTRACT

Background: Acute kidney injury (AKI) is a frequent and severe complication among critically ill patients in the intensive care unit (ICU), contributing to increased morbidity, mortality, and extended hospital stays. Identifying risk factors for AKI is crucial for effective prevention and management. Objectives were to determine the prevalence of AKI and identify associated risk factors among ICU patients at Bangabandhu Sheikh Mujib medical university (BSMMU), Dhaka, during a one-year period.
Methods: This cross-sectional study included 122 adult ICU patients admitted between December 2022 and November 2023. Patients with chronic kidney disease (CKD) or prior kidney transplantation were excluded. Data were retrospectively collected from medical records, including demographic details, comorbidities, AKI diagnosis based on kidney disease: improving global outcomes (KDIGO) criteria, treatments, and outcomes. Statistical analyses were performed to evaluate significant risk factors.
Results: AKI occurred in 60 patients (49.2%). Patients with AKI had a higher mean age (65.4 years) than non-AKI patients (58.6 years, p=0.001). Hypertension was more prevalent in the AKI group (50% vs. 29%, p=0.02), and sepsis was identified in 60% of AKI patients compared to 19.4% of non-AKI patients (p=0.001). The AKI group experienced higher mortality (46.7% vs. 16.1%, p=0.001) and longer ICU stays (14.8 vs. 8.9 days, p=0.001).
Conclusions: AKI is highly prevalent among ICU patients, with age, hypertension, and sepsis as significant risk factors. Early detection and tailored interventions are essential to improve outcomes in this high-risk population.

Keywords: AKI, ICU, 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, the patient populations studied, and the 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 the presence of 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 the 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 Bangladesh. The healthcare landscape in Bangladesh is characterized by several unique challenges, including late presentation of diseases, a high burden of infectious diseases, and limited resources within healthcare facilities.[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 Bangladesh, particularly from tertiary care institutions like BSMMU in Dhaka.[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]

Objectives

General objective

General objective was to determine the prevalence of AKI in ICU patients admitted to BSMMU, Dhaka, during the study period.

Specific objectives

Specific objectives were to identify the risk factors associated with the development of AKI in ICU patients, to assess the outcomes of patients with AKI in the ICU, to evaluate the need for renal replacement therapy (RRT) among ICU patients with AKI and to analyze the relationship between AKI and length of ICU stay, mortality rate, and comorbidities.

METHODS

This cross-sectional study was designed to assess the risk factors and prevalence of AKI among patients admitted to the ICU at BSMMU, Dhaka, over a period from 01 December 2022 and 30 November 2023. The study included a total of 122 adult patients who were evaluated at the time of their 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 research enabled a snapshot of the renal function status of critically ill patients at a single point in time. This design facilitated the identification of prevalent risk factors associated with AKI and provided a basis for understanding its impact on patient outcomes, thereby informing clinical practices in managing critically ill patients in the ICU setting.

Sample size calculation the sample size was calculated using the following formula:

$$n= \frac{z^2 \times P \times (1-P)}{d^2}$$

Where:

n=required sample size

Z=Z value (1.96 for 95% confidence level)

P=estimated prevalence of AKI (assumed to be 0.50 for maximum variability)

d=precision (0.05)

$$n=\frac{1.96^2 \times 0.50 \times (1-0.50)}{0.05^2}$$

Since the total study population over the study period was limited to 122 patients, all patients were included in the study, making it a total population study rather than a sample-based study.

Inclusion criteria

The study included adult patients aged 18 years and older who were admitted to the ICU at BSMMU, Dhaka, during the specified study period. To ensure a focused evaluation of AKI, patients with no 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

Conversely, certain exclusion criteria were established to refine the study population and eliminate potential confounding factors. Patients with pre-existing CKD were excluded from the study to ensure that the analysis focused on the incidence of AKI arising from acute conditions rather than chronic renal dysfunction. Additionally, individuals who had undergone kidney transplantation or those receiving RRT prior to ICU admission were also excluded. This decision was crucial to maintain the integrity of the study by 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. This included demographic data such as age, sex, and admission details, as well as clinical characteristics, including relevant comorbidities. The diagnosis of AKI was recorded based on KDIGO guidelines, ensuring a standardized approach to classification. Additionally, data regarding the treatment modalities administered during the ICU stay and the subsequent clinical outcomes observed were meticulously gathered. This thorough data collection process enabled a robust analysis of the prevalence and risk factors associated with AKI in critically ill patients.

Statistical analysis

For the statistical analysis, descriptive statistics were utilized to analyze the prevalence and distribution of AKI within the study population. This approach allowed for a clear understanding of how AKI manifested among the patients admitted to the ICU. Furthermore, both bivariate and multivariate analyses were conducted to identify significant risk factors associated with AKI, enhancing the understanding of its etiology. A p value of less than 0.05 was considered statistically significant, thereby establishing the reliability of the findings. This comprehensive analytical framework aimed to contribute valuable insights into the predictors of AKI, ultimately guiding clinical practices and interventions in the ICU setting.

RESULTS

Table 1 shows. Among the 122 patients studied, 60 developed AKI and 62 did not. Patients with AKI were significantly older, with a mean age of 65.4 years compared to 58.6 years for those without AKI **(**p=0.001). Hypertension was more prevalent in the AKI group (50%) compared to the non-AKI group (29%), showing a significant association **(**p=0.02). However, there were no significant differences between the groups in terms of gender distribution, BMI, or other comorbidities such as diabetes mellitus, heart disease, respiratory disease, and malignancy. These findings suggest that age and hypertension may be key risk factors for AKI in ICU patients.

Table 1: Baseline characteristics of ICU patients.

Variables	Patients with AKI, (n=60) (%)	Patients without AKI, (n=62) (%)	P value
Age (in years) (mean±SD)	65.4±10.2	58.6±12.1	0.001
Male	38 (63.3%)	34 (54.8%)	0.25
Female	22 (36.7%)	28 (45.2%)	0.25
BMI (mean±SD)	28.1±3.2	27.8±4.1	0.72
Hypertension	30 (50%)	18 (29%)	0.02
Diabetes mellitus	24 (40%)	16 (26%)	0.08
Heart disease	16 (26.7%)	10 (16.1%)	0.15
Respiratory disease	10 (16.7%)	6 (9.7%)	0.21
Malignancy	8 (13.3%)	4 (6.5%)	0.22

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

AKI stage	N (%)
Stage 1 (Mild)	24 (40%)
Stage 2 (Moderate)	18 (30%)
Stage 3 (Severe)	18 (30%)

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

Comorbidity	Patients with AKI, (%)	Patients without AKI, (%)	P value
Hypertension	30 (50%)	18 (29%)	0.02
Diabetes mellitus	24 (40%)	16 (26%)	0.08
Heart disease	16 (26.7%)	10 (16.1%)	0.15
Respiratory disease	10 (16.7%)	6 (9.7%)	0.21
Malignancy	8 (13.3%)	4 (6.5%)	0.22

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: Incidence of sepsis, shock, and nephrotoxic drug use in AKI patients.

Risk factor	Patients with AKI, (%)	Patients without AKI, (%)	P value
Sepsis	36 (60%)	12 (19.4%)	0.001
Shock	28 (46.7%)	14 (22.6%)	0.01
Use of nephrotoxic drugs	32 (53.3%)	16 (25.8%)	0.001

Table 4 shows, sepsis was present in 60% of AKI patients versus 19.4% of non-AKI patients **(**p=0.001**)**, while shock was observed in 46.7% of AKI patients compared to 22.6% in the non-AKI group **(**p=0.01). Additionally, the use of nephrotoxic drugs was notably higher in the AKI group (53.3% vs. 25.8%, p=0.001), indicating these factors significantly contribute to the risk of AKI.

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

Risk factor	Odds ratio (95% CI)	P value
Age >60 (in 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	4.5 (2.2-8.9)	0.001
Use of nephrotoxic drugs	3.2 (1.6-5.7)	0.001
Mechanical ventilation	2.1 (1.1-4.0)	0.03

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 6: Multivariate analysis of risk factors for AKI.

Risk factor	Adjusted odds ratio (95% CI)	P value
Age >60 (in years)	1.8 (1.0-3.4)	0.04
Hypertension	2.2 (1.2-4.4)	0.02
Sepsis	3.9 (2.0-7.9)	0.001
Use of nephrotoxic drugs	2.8 (1.5-5.2)	0.001
Mechanical ventilation	1.9 (1.0-3.6)	0.04

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 7: Outcomes in AKI vs non-AKI patients.

Outcome	Patients with AKI, (n=60)	Patients without AKI, (n=62)	P value
Mortality	28 (46.7%)	10 (16.1%)	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 7 shows, the patients with AKI (n=60) experienced significantly worse outcomes compared to those without AKI (n=62), with a mortality rate of 46.7% versus 16.1% (p=0.001).

Additionally, the length of ICU stay was longer for AKI patients (14.8±6.2 days) compared to non-AKI patients (8.9±4.5 days, p=0.001), indicating the severe impact of AKI on patient prognosis.

Table 8: RRT requirement in AKI patients.

Variables	Patients with AKI, (n=60)	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

Table 8 shows, among the patients with AKI (n=60), 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).

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 (46.7%) compared to non-AKI patients (16.1%).

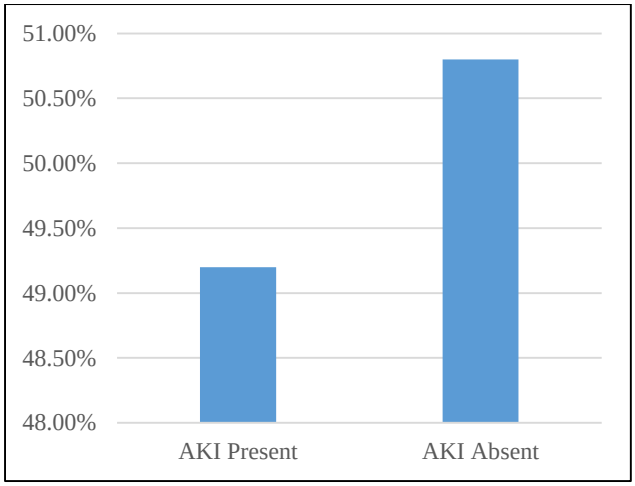

Figure 1: Prevalence of AKI in ICU patients.

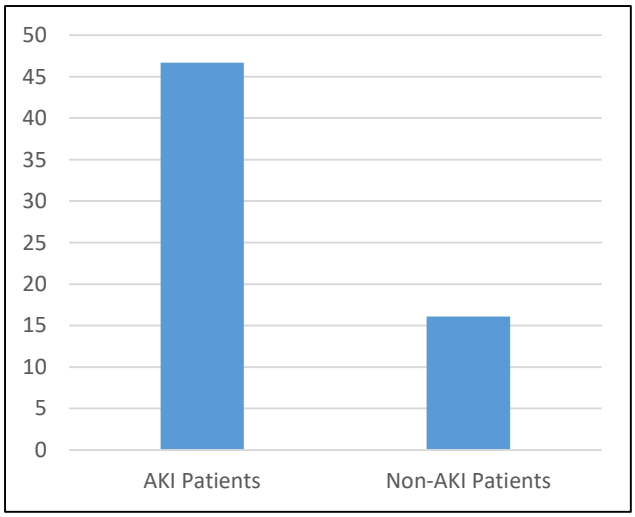

Figure 2: Mortality rate in AKI vs. non-AKI patients.

DISCUSSION

This study highlights the significant prevalence and impact of AKI among ICU patients at BSMMU, Dhaka. In our cohort of 122 patients, 60 (49.2%) developed AKI, indicating a substantial burden of this condition in critically ill populations.[25] This finding is consistent with global reports that suggest AKI affects 20-50% of ICU patients, underscoring the need for effective preventive strategies.[26-27]

Our results indicated that age and hypertension were significant risk factors for AKI. The mean age of patients with AKI was 65.4 years, compared to 58.6 years for those without AKI (p=0.001). This aligns with prior studies that identified older age as a critical risk factor for AKI due to age-related changes in renal function and hemodynamics.[28,29] Additionally, hypertension was significantly more prevalent in the AKI group (50%) compared to the non-AKI group (29%) (p=0.02). This finding is supported by research that suggests hypertension can contribute to renal impairment through mechanisms involving increased glomerular pressure and reduced renal blood flow.[30,31]

While diabetes mellitus and heart disease were more common in the AKI group, these differences did not reach statistical significance, indicating that although these comorbidities may be associated with AKI, they do not exert as strong an influence as age and hypertension in this specific population.[32] Moreover, the presence of sepsis (60% in AKI patients, p=0.001), shock (46.7%, p=0.01), and the use of nephrotoxic drugs (53.3% vs. 25.8%, p=0.001) were identified as significant contributors to AKI risk.[33,34] These findings emphasize the need for vigilance regarding nephrotoxic drug use and careful monitoring of critically ill patients for signs of sepsis.

The adjusted odds ratios further confirmed the increased risk associated with several factors. Patients aged over 60 years had an adjusted odds ratio of 1.8 (95% CI: 1.0-3.4, p=0.04), and those with hypertension had 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) showed strong associations with AKI, highlighting the need for targeted interventions to mitigate these risks in the ICU environment.[35,36]

Outcomes for patients with AKI in our study were notably poor, with a mortality rate of 46.7% compared to 16.1% for those without AKI (p=0.001). This is consistent with previous research indicating that AKI is associated with significantly worse outcomes, including increased mortality and prolonged ICU stays.[37,38] The mean length of ICU stay for AKI patients was 14.8 days, compared to 8.9 days for non-AKI patients (p=0.001), illustrating the severe complications associated with AKI.[39]

Additionally, among patients with AKI, 30% presented with stage 3 AKI, with 66.7% of these requiring RRT. The high mortality rate of 66.7% for patients on RRT further emphasizes the critical nature of advanced AKI stages and their association with increased mortality.[40,41]

In conclusion, our study highlights the high prevalence of AKI in ICU patients at BSMMU, with age, hypertension, sepsis, and nephrotoxic drug exposure identified as significant risk factors. These findings underscore the urgent need for proactive measures to prevent AKI and improve patient outcomes in critically ill populations, particularly in resource-limited settings like Bangladesh. Future research should focus on implementing effective screening and management protocols for AKI to further reduce its impact in the ICU setting.[42,43]

Limitations

This single-center retrospective study relied on medical records, potentially introducing biases from incomplete data. The exclusion of patients with CKD and prior transplants limits generalizability. Additionally, the modest sample size and lack of assessment for factors like

medication use or fluid management constrain the findings. Prospective, multicenter studies are needed to confirm these results.

CONCLUSION

The study demonstrates a high prevalence of AKI among ICU patients at BSMMU, Dhaka, with a significant association between AKI and factors such as sepsis, nephrotoxic medications, and hemodynamic instability. Patients with AKI had worse outcomes, including higher mortality and longer ICU stays. Early identification of high-risk patients and prompt interventions are critical to improving patient outcomes.

Recommendations

Implementation of strict monitoring protocols for high-risk ICU patients to detect early signs of AKI. Avoidance of nephrotoxic medications when possible. Further studies to explore preventive measures and treatment strategies for AKI in resource-limited settings.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Moral MS, Ahmed MS, Alam MH, Siddique ABM, Taher A, Harun-ur-Rashid M. Risk factors and prevalence of acute kidney injury among intensive care unit patients: a comprehensive study in a tertiary care setting. Int J Res Med Sci 2025;13:639-45.