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A Prospective Study of Aetiology and Outcome of Acute Kidney Injury in Type 2 Diabetes Patients

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Abstract
Acute kidney injury (AKI) is a significant complication in patients with type 2 diabetes mellitus (T2DM), contributing to increased morbidity and mortality. The high prevalence of diabetes in India, combined with the multiple risk factors associated with AKI in this population, underscores the need for comprehensive studies to elucidate the aetiology and outcomes of AKI in T2DM patients. A prospective observational study was conducted over 18 months, including 155 T2DM patients who developed AKI at a tertiary care hospital in India. Baseline demographic and clinical data were collected, and patients were monitored throughout their hospital stay and followed up for three months post-discharge. Comparative analyses were performed using chi-square tests for categorical variables and t-tests for continuous variables. Multi variate logistic regression analysis identified independent predictors of poor outcomes. The study found that nephrotoxic medications (37.4%) and dehydration (31.0%) were the most common precipitating factors for AKI. The average age of patients was 61.4 years, with a mean duration of diabetes of 14.2 years. Diabetic nephropathy was present in 56.1% of patients. Renal replacement therapy was required in 39.4% of cases, and 71.6% of patients had nephrotoxic drugs discontinued. Complete recovery of renal function was achieved in 40.6% of patients, while 24.5% showed no recovery. In-hospital and 3-month mortality rates were 18.7% and 13.5%, respectively. Significant predictors of poor renal outcomes included older age, longer duration of diabetes, presence of diabetic nephropathy, higher baseline and peak serum creatinine levels, lower eGFR, and advanced KDIGO stage. AKI in T2DM patients is associated with multiple precipitating factors and significant clinical burden. The study underscores the importance of early identification and management of risk factors to improve outcomes. Strategies to prevent AKI and enhance recovery in this high-risk population are crucial for reducing morbidity and mortality.

INTRODUCTION

Acute kidney injury (AKI) represents a significant clinical challenge, especially in patients with type 2 diabetes mellitus (T2DM). In India, the prevalence of diabetes is alarmingly high, with an estimated 77 million adults living with the condition, making it the diabetes capital of the world. T2DM predisposes individuals to a variety of complications, including AKI, which is associated with increased morbidity, mortality, and healthcare costs[1].

AKI in diabetic patients is often precipitated by a combination of factors such as dehydration, infection, nephrotoxic medications, and contrast agents used in diagnostic procedures. Additionally, diabetic nephropathy, a common microvascular complication of diabetes, can exacerbate the susceptibility to AKI[2]. Understanding the aetiology and outcomes of AKI in this population is crucial for improving patient management and prognosis[3].

The Indian healthcare scenario presents unique challenges in the management of AKI in diabetic patients[4]. Factors such as late presentation, limited access to healthcare facilities, and the high cost of renal replacement therapies often complicate timely and effective treatment[5]. Moreover, the high prevalence of infectious diseases, such as urinary tract infections and sepsis, further increases the risk of AKI in diabetic patients[6].

This prospective study aims to elucidate the aetiology and outcomes of AKI in patients with T2DM in an Indian tertiary care setting. By identifying the common causes and associated outcomes, this research seeks to provide insights that could inform better clinical practices and healthcare policies to mitigate the impact of AKI in diabetic patients.

MATERIALS AND METHODS

A prospective observational study was conducted to investigate the aetiology and outcomes of acute kidney injury (AKI) in patients with type 2 diabetes mellitus (T2DM) at a tertiary care hospital in India. The study was carried out over a period of 18 months, from January 2022 to June 2023. Ethical approval was obtained from the institutional ethics committee, and informed consent was taken from all participants.

The study included 155 T2DM patients who were admitted to the hospital and subsequently developed AKI, defined according to the Kidney Disease: Improving Global Outcomes (KDIGO) criteria. Patients were recruited consecutively to avoid selection bias. Exclusion criteria included patients with pre-existing chronic kidney disease (CKD), those undergoing dialysis, and those with incomplete medical records.

Data collection involved comprehensive patient interviews and thorough review of medical records. Information gathered included demographic details (age, sex, body mass index), duration of diabetes, comorbid conditions (hypertension, cardiovascular disease), and use of nephrotoxic medications. Clinical data such as baseline serum creatinine, estimated glomerular filtration rate (eGFR), and the presence of diabetic nephropathy were recorded. Detailed documentation of the precipitating factors for AKI, including dehydration, infections, use of contrast agents, and medications, was performed.

Patients were monitored throughout their hospital stay and followed up for three months post-discharge to assess outcomes. Outcomes of interest included recovery of renal function, need for renal replacement therapy (RRT), duration of hospital stay, and mortality. Renal recovery was defined as a return to baseline serum creatinine levels or a decrease of more than 50% from peak serum creatinine levels without the need for ongoing dialysis.

Statistical analysis was performed using SPSS software version 25.0. Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. Comparative analysis was done using chi-square tests for categorical variables and t-tests for continuous variables. Multivariate logistic regression analysis was used to identify independent predictors of poor outcomes.

RESULTS AND DISCUSSIONS

Table 1 presents the baseline demographic and clinical characteristics of the 155 patients included in the study. The average age of the participants was 61.4 years with a standard deviation of 9.7 years. The gender distribution was nearly equal, with 78 males (50.3%) and 77 females (49.7%). The mean Body Mass Index (BMI) was 27.6 kg/m² with a standard deviation of 4.2 kg/m². The duration of diabetes among the patients averaged 14.2 years, with a standard deviation of 6.5 years.

Regarding comorbidities, 101 patients (65.2%) had hypertension, 53 patients (34.2%) had cardiovascular disease, and 87 patients (56.1%) had diabetic nephropathy. These characteristics provide a comprehensive overview of the study population, indicating a significant prevalence of comorbid conditions that may impact the outcomes of acute kidney injury in type 2 diabetes mellitus patients.

Table 2 outlines the precipitating factors for acute kidney injury (AKI) in the study population. The most common precipitating factor identified was the use of nephrotoxic medications, affecting 58 patients (37.4%). Dehydration was also a significant factor, contributing to AKI in 48 patients (31.0%).Infections were another major category, with urinary tract infections observed

in 41 patients (26.5%) and sepsis in 33 patients (21.3%). Additionally, the use of contrast agents during medical procedures precipitated AKI in 23 patients (14.8%). Other miscellaneous factors accounted for 19 cases (12.3%).

Table 3 provides the clinical and laboratory findings at admission for patients with acute kidney injury (AKI). The baseline serum creatinine level averaged 1.3 mg/dL with a standard deviation of 0.4 mg/dL, while the peak serum creatinine level was significantly higher, averaging 4.6 mg/dL with a standard deviation of 1.2 mg/dL. The estimated glomerular filtration rate (eGFR) at admission averaged 34.7 mL/min/1.73 m² with a standard deviation of 8.3 mL/min/1.73 m².

A significant proportion of patients (87, or 56.1%) had diabetic nephropathy at the time of admission. The distribution of AKI severity, according to the KDIGO staging criteria, revealed that 51 patients (32.9%) were classified as Stage 1, 42 patients (27.1%) as Stage 2, and 62 patients (40.0%) as Stage 3.

Table 4 summarizes the treatments and interventions administered to patients with acute kidney injury (AKI). Renal replacement therapy (RRT) was utilized in a portion of the patient population, with 47 patients (30.3%) undergoing hemodialysis and 14 patients (9.0%) receiving peritoneal dialysis. The majority of patients, 94 (60.6%), were managed conservatively without the need for dialysis. A significant intervention was the discontinuation of nephrotoxic drugs, which was implemented in 111 patients (71.6%). This intervention likely played a crucial role in mitigating further renal damage and aiding in the recovery of renal function.

Table 5 presents the outcomes of acute kidney injury (AKI) in the study population. Among the patients, 63 (40.6%) achieved complete recovery of renal function, while 54 (34.8%) had partial recovery. Unfortunately, 38 patients (24.5%) did not recover renal function.A significant proportion of patients, 61 (39.4%), required renal replacement therapy (RRT). The average duration of hospital stay for the study participants was 16.3 days with a standard deviation of 5.7 days, indicating a substantial impact on healthcare resources. The in-hospital mortality rate was 29 patients (18.7%), and the 3-month mortality rate was 21 patients (13.5%). These mortality rates underscore the serious nature of AKI in patients with type 2 diabetes mellitus and highlight the critical need for effective management strategies to improve patient outcomes.

Table 6 displays the results of the multivariate logistic regression analysis used to identify predictors of poor renal outcome in patients with acute kidney injury (AKI). The predictor variables examined included age, duration of diabetes, presence of diabetic nephropathy, baseline serum creatinine, peak serum creatinine, estimated glomerular filtration rate (eGFR), and KDIGO Stage 3. Each additional year of age increased the odds of poor renal outcome by 8% (OR = 1.08, 95% CI: 1.02 – 1.14, p = 0.006). Each additional year with diabetes increased the odds by 10% (OR = 1.10, 95% CI: 1.04 – 1.18, p = 0.002). Presence of diabetic nephropathy more than doubled the odds (OR = 2.15, 95% CI: 1.13 – 4.08, p = 0.020). Higher baseline serum creatinine significantly increased the odds (OR = 2.89, 95% CI: 1.27 – 6.60, p = 0.011). Higher peak serum creatinine also significantly increased the odds (OR = 1.58, 95% CI: 1.10 – 2.27, p = 0.013). Each unit increase in eGFR decreased the odds by 9% (OR = 0.91, 95% CI: 0.87 – 0.96, p < 0.001). Patients with KDIGO Stage 3 AKI had significantly higher odds of poor outcome (OR = 3.75, 95% CI: 1.69 – 8.34, p = 0.001). These findings indicate that older age, longer duration

Table 1: Baseline Demographic and Clinical Characteristics

Characteristic	N (%) or Mean ± SD
Total Patients	155
Age (years)	61.4 ± 9.7
Sex	
Male	78 (50.3%)
Female	77 (49.7%)
Body Mass Index (BMI) (kg/m²)	27.6 ± 4.2
Duration of Diabetes (years)	14.2 ± 6.5
Comorbidities	
Hypertension	101 (65.2%)
Cardiovascular Disease	53 (34.2%)
Diabetic Nephropathy	87 (56.1%)

Table 2: Precipitating Factors for AKI

Precipitating Factor	N (%)
Dehydration	48 (31.0)
Infections	
Urinary Tract Infection	41 (26.5)
Sepsis	33 (21.3)
Nephrotoxic Medications	58 (37.4)
Contrast Agents	23 (14.8)
Others	19 (12.3)

Table 3: Clinical and Laboratory Findings at Admission

Parameter	N (%) or Mean ± SD
Baseline Serum Creatinine (mg/dL)	1.3 ± 0.4
Peak Serum Creatinine (mg/dL)	4.6 ± 1.2
eGFR (mL/min/1.73 m²)	34.7 ± 8.3
Presence of Diabetic Nephropathy	87 (56.1%)
KDIGO Stage of AKI	
Stage 1	51 (32.9%)
Stage 2	42 (27.1%)
Stage 3	62 (40.0%)

Table 4: Treatment and Interventions

Treatment/Intervention	N (%)
Renal Replacement Therapy (RRT)	
Hemodialysis	47 (30.3)
Peritoneal Dialysis	14 (9.0)
Conservative Management	94 (60.6)
Use of Nephrotoxic Drugs Discontinued	111 (71.6)

Table 5: Outcomes of AKI

Outcome	N (%) or Mean ± SD
Recovery of Renal Function	
Complete Recovery	63 (40.6%)
Partial Recovery	54 (34.8%)
No Recovery	38 (24.5%)
Need for Renal Replacement Therapy (RRT)	61 (39.4%)
Duration of Hospital Stay (days)	16.3 ± 5.7
In-hospital Mortality	29 (18.7%)
3-Month Mortality	21 (13.5%)

Table 6: Multivariate Logistic Regression Analysis for Predictors of Poor Renal Outcome

Predictor Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age	1.08	1.02 – 1.14	0.006*
Duration of Diabetes	1.1	1.04 – 1.18	0.002*
Diabetic Nephropathy	2.15	1.13 – 4.08	0.020*
Baseline Serum Creatinine	2.89	1.27 – 6.60	0.011*
Peak Serum Creatinine	1.58	1.10 – 2.27	0.013*
eGFR	0.91	0.87 – 0.96	<0.001*
KDIGO Stage 3	3.75	1.69 – 8.34	0.001*

of diabetes, presence of diabetic nephropathy, higher baseline and peak serum creatinine levels, lower eGFR, and advanced stage of AKI are significant predictors of poor renal outcomes in this patient population.

The findings from this prospective study highlight several important aspects regarding the aetiology and outcomes of acute kidney injury (AKI) in patients with type 2 diabetes mellitus (T2DM) in an Indian tertiary care setting. The study revealed that nephrotoxic medications and dehydration were the most common precipitating factors for AKI, with infections, particularly urinary tract infections and sepsis, also playing a significant role. These results align with existing literature, which indicates that T2DM patients are particularly vulnerable to AKI due to their increased exposure to nephrotoxic agents and higher susceptibility to infections[2,7].

The demographic and clinical characteristics of the study population show a considerable burden of comorbidities such as hypertension, cardiovascular disease, and diabetic nephropathy. These findings are consistent with previous studies that have reported a high prevalence of these conditions in diabetic patients, contributing to the complexity of managing AKI in this group[4,6].

Clinical and laboratory findings at admission underscored the severity of renal impairment, with a substantial proportion of patients presenting with advanced stages of AKI. The high baseline and peak serum creatinine levels, coupled with low eGFR, indicate significant renal dysfunction, which corroborates the observations made in similar studies[5].The presence of diabetic nephropathy in over half of the patients further exacerbates their risk of poor outcomes, emphasizing the need for early intervention and vigilant monitoring.

The treatment and intervention data revealed that conservative management was the most common approach, with a notable number of patients requiring renal replacement therapy (RRT). Discontinuation of nephrotoxic drugs was a critical intervention, reflecting the need to mitigate further renal damage. These management strategies are supported by guidelines that recommend prompt identification and removal of precipitating factors to improve outcomes in AKI patients[8].

Outcome analysis showed that a significant proportion of patients achieved complete or partial recovery of renal function, although a substantial number did not recover, highlighting the serious nature of AKI in T2DM patients. The mortality rates observed in this study are comparable to those reported in other studies, indicating a high risk of adverse outcomes in this population[1].

Multivariate logistic regression analysis identified several significant predictors of poor renal outcome, including older age, longer duration of diabetes, presence of diabetic nephropathy, higher baseline and peak serum creatinine levels, lower eGFR, and advanced KDIGO stage. These predictors are well-documented in the literature as key factors influencing the prognosis of AKI in diabetic patients[2,4]. The association between advanced age and poor outcomes underscores the vulnerability of elderly diabetic patients to AKI. Similarly, the duration of diabetes and the presence of diabetic nephropathy are indicative of chronic microvascular damage, which impairs renal recovery[7].

CONCLUSION

In conclusion, this study provides valuable insights into the aetiology and outcomes of AKI in T2DM patients within the Indian context. The findings highlight the need for early identification of risk factors, prompt management of precipitating factors, and tailored treatment strategies to improve patient outcomes. Future research should focus on developing targeted interventions to prevent AKI in this high-risk population and exploring the long-term outcomes of those who survive an episode of AKI.

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