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Frequency of Acute Kidney Injury in Patients Presenting with Acute Pyelonephritis at Tertiary Care Hospital, Karachi

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ABSTRACT

Objective: To determine the frequency of acute kidney injury in patients presenting with acute pyelonephritis at Tertiary Care Hospital, Karachi. **Methods:** A total of 141 patients were included in this hospital-based cross-sectional study. Baseline characteristics such as age, gender, diabetes mellitus, hypertension, dyslipidemia, and smoking status were recorded. The presence of AKI was determined, and its association with these factors was analyzed. **Results:** AKI was diagnosed in 58.2% of participants, while 41.8% did not develop the condition. The majority of patients (68.1%) were between 46 and 75 years old, and the gender distribution was nearly equal (49.6% male, 50.4% female). Diabetes mellitus was present in 19.9%, hypertension in 28.4%, dyslipidemia in 8.5%, and 36.2% of participants were smokers. However, none of these factors showed a statistically significant association with AKI development ($p > 0.05$ for all variables). **Conclusion:** More than half of the patients with acute pyelonephritis developed AKI, yet no specific risk factor emerged as a significant predictor. This suggests that AKI in this population is likely influenced by a combination of factors rather than any single underlying condition. Further research with larger, multi-center cohorts and long-term follow-up is needed to better understand the risk factors and improve early detection and management strategies.

INTRODUCTION

Acute pyelonephritis (APN) is a prevalent bacterial infection that affects the upper urinary tract, specifically targeting the renal parenchyma and pelvis.[1] The diagnosis of acute pyelonephritis (APN) relies primarily on a thorough clinical history and physical examination. Patients commonly present with lower urinary tract symptoms, including increased frequency, urgency, and painful urination, along with systemic manifestations such as fever, flank pain, headache, and upper gastrointestinal symptoms. [2] Flank pain is a hallmark symptom of acute pyelonephritis (APN), and its absence may indicate an alternative diagnosis that warrants further evaluation with additional diagnostic tests. Urine cultures yield positive results in approximately 90% of APN cases and should be obtained before initiating antibiotic treatment. Blood cultures, however, are recommended only for patients with an unclear diagnosis. [3] Potential complications of acute pyelonephritis include renal abscess formation, septic shock, and varying degrees of renal dysfunction, including acute kidney failure. (ARF). [4]

Acute kidney injury (AKI) is widely recognized as a prevalent, serious, and often overlooked condition. It can develop in diverse clinical scenarios and serves as a key indicator of both short-term and long-term adverse outcomes. [5] Globally, an estimated 13.3 million people experience acute kidney injury (AKI), with approximately 1.7 million succumbing to the condition, primarily in low-income and lower-middle-income countries (LMIC). [6] Acute kidney injury (AKI) is a significant concern in patients with infectious diseases. Depending on the diagnostic criteria used, its occurrence in individuals with sepsis varies widely, ranging from 5% to 51%.[7] AKI is also recognized as an independent predictor of poor outcomes in sepsis. Research has identified multiple contributing factors that influence both the development and progression of AKI in septic patients. [8] The connection between acute pyelonephritis (APN) and acute renal failure (ARF), as well as severe forms of acute kidney injury (AKI), has been documented primarily in isolated case series or within a single aspect of APN's clinical presentation. [9-10] In 2004, the Acute Dialysis Quality

Initiative (ADQI) group established a standardized definition of acute kidney injury (AKI) by introducing the Risk, Injury, Failure, Loss, and End-Stage Renal Disease (RIFLE) classification. This classification has been validated as an effective tool for assessing the incidence of AKI. [11-12] A study done by Jeon et al found the prevalence of AKI to be 62.8% in patients presenting with acute pyelonephritis. [13]

The development of AKI in patients having acute pyelonephritis is a critical prognostic factor for survival. Literature review on this subject showed paucity of local literature. Data from this study would help in addressing this knowledge gap on the basis of which effective management plan will be developed by physicians involved in the care of patients presenting with acute pyelonephritis. Furthermore, socioeconomic, demographic and lifestyle varies from other countries. Such knowledge could direct more attention to prevention of pyelonephritis and associated AKI in those with reduced kidney function to prevent further decline of kidney function.

MATERIAL AND METHODS

This descriptive cross-sectional study was conducted at the Department of Medicine, JPMC, Karachi, over a period of six months following approval of the synopsis from 2 October 2024 to 2 April 2025. The study aims to assess the frequency of acute kidney injury (AKI) in patients diagnosed with acute pyelonephritis (APN). A total of 141 patients were enrolled based on a calculated sample size, using a frequency of AKI in APN patients of 62.8%, an 8% margin of error, and a 95% confidence level. The sampling technique employed was non-probability consecutive sampling.

Patients aged 20 to 70 years of either gender with a confirmed diagnosis of APN, as defined by the presence of at least two of the following criteria, were included: (a) axillary temperature ≥38.3°C or chills, (b) flank pain, costovertebral angle tenderness, or pain on bimanual palpation of the kidney, and (c) urethral syndrome, including two or more of the following symptoms—dysuria, frequency ≥5 times/day, suprapubic pain, or urgency ≥5 times/day—along with pyuria (positive nitrite or leukocyte esterase result, >10 leukocytes/mL in uncentrifuged urine, or >5 leukocytes per high-power field in centrifuged sediment) or a positive urine culture. Patients with a history of chronic renal failure on hemodialysis, concomitant hepatitis B, C, HIV, malaria, typhoid, asthma, COPD, myocardial infarction, congestive cardiac failure, stroke, contrast-induced nephropathy, malignancy, or renal stones were excluded.

Following institutional ethical review committee approval, the study protocol was submitted to the College of Physicians and Surgeons Pakistan. Informed written consent was obtained from each participant after explaining the study's purpose, risks, and benefits. Confidentiality was maintained throughout the study period. Demographic and clinical data was collected at admission. Blood samples for serum creatinine analysis will be obtained under aseptic conditions and sent to the hospital laboratory. Urine output was monitored every two hours and measured in a calibrated flask. Patients were followed during hospitalization to assess the development of AKI, defined as any of the following: an increase in serum creatinine of >0.3 mg/dL within 48 hours, an increase in serum creatinine of >50% from baseline within the past seven days, or a urine output reduction to <0.5 mL/kg/hour for at least six hours.

Data was recorded in a structured proforma, including quantitative variables such as age and categorical variables such as gender, residence status, diabetes mellitus type II, hypertension, dyslipidemia, smoking status, and AKI occurrence. Data was analyzed using SPSS Version 22. Continuous variables will be expressed as mean ± standard deviation if normally distributed (Kolmogorov–Smirnov test) and as median (IQR) if non-normally distributed. Categorical variables was presented as frequencies and percentages. Stratification will be conducted for age, gender, residence status, diabetes mellitus, hypertension, dyslipidemia, and smoking status to assess their impact on AKI occurrence. Post-stratification, a chi-square or Fisher's exact test was applied, with a p-value of ≤0.05 considered statistically significant.

RESULTS

The study included 141 participants, most of whom (68.1%) were between 46 and 75 years old, while 31.9% were 20 to 45 years old. The gender distribution was nearly equal, with 49.6% males and 50.4% females. Diabetes mellitus was present in 19.9% of participants, while 80.1% did not have the condition. Hypertension affected 28.4% of individuals, whereas 71.6% were non-hypertensive. Only 8.5% had dyslipidemia, while the majority (91.5%) had normal lipid levels. Smoking was reported by 36.2% of participants, while 63.8% were non-smokers. Acute kidney injury (AKI) was diagnosed in 58.2% of cases, while 41.8% did not develop the condition. When comparing those with and without AKI, there were no significant differences in baseline characteristics. Among AKI patients, 55.6% were 20 to 45 years old, while 59.4% were in the older age group (p = 0.66). Males and females had similar AKI rates, at 57.1% and 59.2%, respectively (p = 0.80). Diabetes was slightly more common in the AKI group (64.3% vs. 56.6%), though the difference was not significant (p = 0.46). Similarly, 62.5% of hypertensive patients and 56.4% of non-hypertensive patients developed AKI (p = 0.51). Dyslipidemia was present in 75% of AKI cases compared to 56.6% in the non-AKI group, but the difference remained statistically insignificant (p = 0.21). Smoking showed a similar pattern, with AKI affecting 60.8% of smokers and 56.7% of non-smokers (p = 0.63).

Table 1

Distribution of Baseline Characteristics among the Study Participants.

Variables		n (%)
Age	20 to 45 years	45 (31.9)
	46 to 75 years	96 (68.1)
Gender	Male	70 (49.6)
	Female	71 (50.4)
Diabetes Mellitus	Yes	28 (19.9)
	No	113 (801)
Hypertension	Yes	40 (28.4)
	No	101 (71.6)

Dyslipidemia	Yes No	12 (8.5) 129 (91.5)
Smoking status	Yes No	51 (36.2) 90 (63.8)
Acute Kidney Injury	Yes No	82 (58.2) 59 (41.8)
Total		141 (100)

Table 2
Distribution of Patient Characteristics according to the Acute Kidney Injury Groups.

Variables		Acute kidney injury (Yes) n(%)	Acute kidney injury (No) n(%)	P value
Age	20 to 45 years 46 to 75 years	25 (55.6) 57 (59.4)	20 (44.4) 39 (40.6)	0.66
Gender	Male Female	40 (57.1) 42 (59.2)	30 (42.9) 29 (40.8)	0.80
Diabetes Mellitus	Yes No	18 (64.3) 64 (56.6)	10 (35.7) 49 (43.4)	0.46
Hypertension	Yes No	25 (62.5) 57 (56.4)	15 (37.5) 44 (43.6)	0.51
Dyslipidemia	Yes No	09 (75) 73 (56.6)	03 (25) 56 (43.4)	0.21
Smoking status	Yes No	31 (60.8) 51 (56.7)	20 (39.2) 39 (43.3)	0.63

DISCUSSION

Acute kidney injury (AKI) affected 58.2% of participants in this study, yet no single risk factor stood out as a significant contributor. While conditions like diabetes, hypertension, dyslipidemia, and smoking were slightly more common among AKI patients, the differences lacked statistical significance. This suggests that AKI development is likely influenced by multiple overlapping factors rather than any one condition alone.

Age and gender showed no clear link to AKI. Both younger (20–45 years) and older (46–75 years) participants had similar AKI rates (p = 0.66), contradicting the common assumption that older adults face a higher risk due to declining kidney function and increased comorbidities.[14-15] Likewise, males and females had similar AKI frequencies (p = 0.80), reinforcing the idea that gender alone does not determine AKI susceptibility. [16-17]

Diabetes and hypertension, known contributors to kidney damage, were slightly more frequent in AKI patients but did not reach statistical significance. 64.3% of diabetics developed AKI compared to 56.6% of non-diabetics (p = 0.46). Previous studies suggest that poor glycemic control and nephrotoxic drug use raise AKI risk in diabetics, which may not have been prominent factors here. [18-19] Similarly, 62.5% of hypertensive individuals developed AKI compared to 56.4% of non-hypertensives (p = 0.51), aligning with research that hypertension alone is not a strong AKI predictor unless combined with other risk factors. [20-21]

Dyslipidemia has been linked to endothelial dysfunction and oxidative stress, both of which can impair kidney function. [22-23] In this study, 75% of those with dyslipidemia developed AKI compared to 56.6% without it (p = 0.21). While the trend suggests a possible link, it was not statistically significant, indicating that dyslipidemia alone may not drive AKI risk. [24-25]

Smoking, another suspected risk factor, followed a similar pattern. 60.8% of smokers developed AKI versus 56.7% of non-smokers (p = 0.63). Studies show that smoking contributes to renal vasoconstriction and inflammation, but its role in AKI remains inconsistent, often depending on pre-existing conditions or critical illness. [26-27]

These findings highlight the complex nature of AKI, where no single factor acts independently. Instead, a combination of comorbidities, medication use, dehydration, and infections likely contribute to its development. [18-29] Future research should explore biomarkers, medication effects, and lifestyle influences in more depth to better predict and prevent AKI.

Limitations

This study has several limitations that should be considered. The small sample size of 141 participants may not provide enough statistical power to detect significant associations between AKI and its risk factors. A larger, more diverse study population would strengthen the findings. Since this was a single-center study conducted in a tertiary care hospital, the results may not reflect broader populations, particularly those in rural or community settings where healthcare access and risk factors differ.

Another limitation is the lack of follow-up data, making it unclear whether AKI cases resolved, progressed to chronic kidney disease (CKD), or led to other complications. The study also did not account for key clinical factors, such as infection status, nephrotoxic drug use, hydration levels, and ICU admissions, all of which could have influenced AKI development. Additionally, selection bias may be present, as only hospitalized patients were included, possibly over representing severe cases while missing milder or community-acquired AKI.

The absence of biomarkers like Cystatin C, NGAL, or KIM-1, which provide early detection and prognosis insights, limits the ability to assess kidney injury severity. The study also did not fully adjust for confounders, such as medication use, lifestyle habits, and baseline kidney function, which could affect the results. Moreover, its cross-sectional design captures only a single point in time, making it difficult to establish cause-and-effect relationships between risk factors and AKI.

Future studies should include larger, multi-center cohorts, track patients over time to assess long-term kidney function, and incorporate biomarkers for better risk assessment. Research should also explore modifiable factors, such as hydration, nephrotoxin exposure, and medication use, to develop better prevention strategies. Despite these limitations, this study provides valuable insights into AKI prevalence and potential risk factors, serving as a foundation for further research in this field.

CONCLUSION

AKI affected more than half of the participants, but no specific risk factor emerged as a strong predictor. While diabetes, hypertension, dyslipidemia, and smoking were slightly more common in AKI cases, none showed a statistically significant impact. These results reinforce the need for early detection, close monitoring, and preventive measures in at-risk individuals. Future studies should focus on larger datasets, detailed medication tracking, and long-term patient follow-up to better understand AKI risk factors and improve patient outcomes.

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