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# ASSOCIATION OF AKI WITH UTI AND ITS PROGNOSTIC SIGNIFICANCE

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**Abstract**

**Background:** Urinary tract infections (UTIs) are among the most frequent types of bacterial infections. Acute kidney injury (AKI) is also commonly experienced by hospitalized patients. There is a critical connection between UTIs and AKI. To determine the association of AKI with UTI, and its prognostic significance with the risk factors for developing AKI in hospitalized patients with UTI.

**Methods:** This is a prospective cohort study conducted at Isra University Hospital from March 2025 to August 2025. Patients aged >18 years, admitted to the hospital with a diagnosis of UTI and diagnosed with AKI during hospitalization were included in the study. Data was collected and analyzed using SPSS. Continuous variables were demonstrated as mean ± standard deviation (SD), while, categorical variables were shown as frequencies and percentages. Chi-square test and Independent t-test was used to determine associations between categorical variables vs AKI and between continuous variables vs. AKI, respectively.

**Results:** The total participants included in the study were 270. The mean age of the participants was 51 ± 20.01 years. Among them, 125 (46.3%) participants were male while, 145 (53.7%) were female. AKI was diagnosed in 100 (37%) of the patients who completed the study. Patients who developed AKI experienced higher average serum creatinine levels (1.87 ± 0.48) and serum urea concentrations (55.18 ± 13.90) compared to participants who did not develop AKI ($p < 0.001$). Compared to patients without AKI, patients with AKI had significantly longer lengths of hospital stays (13.83 ± 3.79 days vs. 8.11 ± 3.19 days, $p < 0.001$). Diabetes was more prevalent in AKI patients (60%) compared to non-diabetic patients (28.2%) and was significantly associated with AKI ($p < 0.001$).

**Conclusion:** The occurrence of AKI was associated with a variety of clinical outcomes such as longer hospital stays, greater chance of admission to ICU, and increased mortality. Certain comorbid conditions, especially diabetes, hypertension, and sepsis were recognized as significant contributors to AKI among hospitalized patients with UTI.

## INTRODUCTION

Urinary tract infections (UTIs) are among the most frequent types of bacterial infections seen in clinical settings and are considered an important cause of morbidity (1,2). A large number of hospital admissions are due to UTIs, and a large portion of healthcare resource usage in the adult population is due to UTIs (3). The clinical presentation of a UTI varies from uncomplicated cystitis to more complicated forms such as pyelonephritis and urosepsis; all of which can lead to significant systemic complications (4). Because UTIs can progress rapidly, and have higher rates of antimicrobial resistance, as well as presenting a greater risk for adverse outcomes, this is of particular concern in hospitalized patients (5).

Acute kidney injury (AKI) is also commonly experienced by hospitalized patients and is characterized by an abrupt decrease in renal function. There is an increased mortality rate for patients with AKI compared with patients without renal impairment; therefore, patients who have AKI are likely to have lengthened hospital stays, increased costs to the healthcare system, and a more significant likelihood of developing chronic kidney disease (CKD) (6,7). Additionally, even mild degrees of renal impairment can adversely affect patient prognosis; AKI is of primary concern to acutely ill patients, and early detection and management are essential due to the clinical and economic implications associated with AKI (8).

There is a critical connection between UTIs and AKI. There are several reasons that lead to kidney injury in patients who have UTIs: urinary obstruction through an infection or another means leading to decreased renal blood flow (hypoperfusion) and/or systemic inflammation causing an increase in the inflammatory mediators (cytokines, chemokines, etc.) present in the body (9). The presence of complicated urinary tract infections, such as those associated with bacteria in the bloodstream (bacteremia), can set off a chain reaction in the body which includes decreased blood volume (hypovolemia), hypotension (low blood pressure) (10), and increased inflammation leading to hemodynamic (blood flow) instability as well as a cascade of inflammatory reactions that lead to kidney damage. In addition to these factors, pre-existing conditions such as diabetes mellitus, hypertension, and chronic kidney disease make patients more susceptible to developing AKI when they present with a UTI (11).

Detecting AKI in patients with UTI may help health care providers immediately treat their patients to improve their outcomes and reduce the anticipated increased length of stay, therapy cost, and mortality rates. AKI can negatively affect the course of treatment; timely recognition and treatment of patients with UTI who are at high risk for developing AKI is a critical prevention strategy that may help improve outcomes in patients presenting to an emergency room with an UTI (12). This link, however, is not clearly defined in research literature with estimates of AKI in UTI patients varying dramatically by report; previously published studies demonstrate that there are few studies on UTI-related AKI in resource-limited countries.

The amount of published data on the prevalence of AKI in hospitalized patients with UTI in Pakistan is relatively small, as are the studies that profile the characteristics of local risk factors for patients that develop AKI due to UTI. Closing this gap is critically important for improving the quality of care and making better clinical decisions.

This study aims to determine how often patients with UTI develop AKI, examine the prognostic value of AKI for UTI-related clinical outcomes, and identify UTI patients' risk factors that predispose them to the development of AKI.

## MATERIALS AND METHODS

This is a prospective cohort study conducted at Isra University Hospital from March 2025 to August 2025. Ethical approval was obtained from Research Ethics Committee of Isra University (Approval no. IU/CP.REC(FCS)/2025/418 on March 11, 2025). Written informed consent was taken from the participants. Participant confidentiality was ensured by assigning unique identification codes in place of personal information. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The sampling technique was purposive nonprobability sampling.

Patients aged >18 years, admitted to the hospital and had a diagnosis of UTIs during hospitalization were included in the study. Patients with a diagnosis of end-stage renal disease (ESRD) with or without dialysis and having UTI along with other susceptible infections like RTI were not included I the study. Patients who were already on diuretics were also excluded from the study.

A 30 ml midstream urine sample was collected in a plastic container labeled with the name of the patient and date. A urine sample was analyzed with a visual exam, dipstick test, and a microscopic exam. A blood sample was collected for urea and creatinine by using a 5cc syringe and serum urea and creatinine was measured by using the principal photometric method and the Jaffe method respectively. Then patients with UTI were followed during a hospital stay of more than 48 hours. Data regarding age, gender, comorbidities like hypertension, diabetes, CKD, sepsis and dehydration were collected. Laboratory parameters like baseline creatinine, serum creatinine and serum urea were also collected. AKI was defined according to KDIGO criteria as an increase in serum creatinine $\geq$0.3 mg/dL within 48 hours or $\geq$1.5 times baseline.

Data was analyzed using SPSS. Continuous variables were demonstrated as mean ± standard deviation (SD), while, categorical variables were shown as frequencies and percentages. Chi-square test was used to determine

associations between categorical variables vs AKI. Independent t-test / Mann-Whitney U test was used to determine association between continuous variables among AKI and non-AKI patients. Multivariate logistic regression was used to determine independent predictors of AKI. p-value < 0.05 was considered statistically significant.

## RESULTS

This study recruited 270 patients that were hospitalized for UTIs. The mean age of participants was 51 ± 20.01 years. A majority of participants (145, or 53.7%) in the study were female, whereas 125 (46.3%) participants were male. The mean creatinine level at baseline was found to be 1.03 ± 0.30 mg/dL at the time of admission to the hospital, and the average serum creatinine upon discharge from the hospital was found to be 1.35 ± 0.58 mg/dL. The mean serum urea level among all participants was equal to 39.28 ± 16.8 mg/dL.

Diabetes was present in 108 (40%), hypertension in 114 (42.2%), CKD in 50 (18.5%), sepsis in 81 (30%), and dehydration in 88 (32.6%) participants. AKI occurred in 100 (37%) participants. The mean hospital stay was 10.23 ± 4.4 days. 50 (18.5%) were admitted in ICU and 19 (7%) participants died.

AKI was diagnosed in 100 (37%) of the patients who completed the study. Patients who developed AKI experienced higher average serum creatinine levels (1.87 ± 0.48) compared with patients who did not develop AKI (1.03 ± 0.37, $p < 0.001$) and patients who developed AKI had higher serum urea concentrations (55.18 ± 13.90) compared to participants who did not develop AKI (29.93 ± 9.93, $p < 0.001$). No differences could be observed between baseline serum creatinine levels between patients who developed, or did not develop AKI ($p = 0.908$). Age ($p = 0.113$) was found to not be significantly different between AKI vs. non-AKI patients.

Compared to patients without AKI, patients with AKI had significantly longer lengths of hospital stays (13.83 ± 3.79 days vs. 8.11 ± 3.19 days, $p < 0.001$). In addition, the diagnosis of AKI was significantly associated with a higher frequency of ICU admissions and higher in-hospital mortality ($p < 0.001$) (Table 1).

**Table 1: Comparison of different variables among AKI and non-AKI patients.**

| Variable | AKI Absent (n = 170) | AKI Present (n = 100) | P-value |
|---|---|---|---|
| Age (years), Mean ± SD | 49.52 ± 19.84 | 53.53 ± 20.36 | 0.113 |
| Baseline Creatinine (mg/dL), Mean ± SD | 1.03 ± 0.29 | 1.02 ± 0.30 | 0.908 |
| Serum Creatinine (mg/dL), Mean ± SD | 1.03 ± 0.37 | 1.87 ± 0.48 | < 0.001 |
| Serum Urea (mg/dL), Mean ± SD | 29.93 ± 9.93 | 55.18 ± 13.90 | < 0.001 |
| Length of Hospital Stay (days), Mean ± SD | 8.11 ± 3.19 | 13.83 ± 3.79 | < 0.001 |

In terms of comorbid conditions, diabetes was more prevalent in AKI patients (60%) compared to non-diabetic patients (28.2%) and was significantly associated with AKI ($p < 0.001$). Similarly, hypertension was more prevalent in AKI patients (53%) compared to non-AKI patients (35.9%) ($p = 0.006$). The presence of CKD (25%) was also significantly associated with AKI ($p = 0.035$). Sepsis was also significantly associated with AKI ($p < 0.001$). However, dehydration was not significantly associated with AKI ($p = 0.52$).

Diabetes, hypertension, and sepsis were identified as independent predictors of AKI in a multi-variable logistic regression analysis. The odds of developing AKI were 3.54 times higher in diabetic patients (OR = 3.541; $p < 0.001$) and 2.113 times higher in hypertension patients (OR = 2.113; $p = 0.010$). There was an increased risk of developing AKI in the presence of sepsis (OR = 3.079; $p < 0.001$). There was no statistically significant association between CKD and AKI ($p = 0.061$). Age, dehydration, and baseline creatinine level were not significant independent predictors of AKI.

## DISCUSSION

The aim of this study is to investigate the incidence of AKI in people admitted to hospital with a UTI and the subsequent impact of this on the outcome of their hospital stay. Our results show that among our cohort of patients with UTIs, 37% of these patients are diagnosed as having AKI while hospitalized. This finding indicates that the development of a significant renal complication such as AKI occurs relatively frequently for this patient population. Additionally, patients diagnosed as having AKI had worse outcomes than non-AKI patients, including longer lengths of stay, a higher likelihood of admission into an ICU, and a greater likelihood of dying prior to discharge. These results highlight that AKI is an important complication associated with UTIs and, therefore, contributes greatly to the overall burden of disease among patients who are hospitalized.

Our group of patients developed AKI at rates consistent with previous literature describing the incidence of this complication among patients hospitalized due to severe or complicated UTIs. Research has shown that AKI may be diagnosed in approximately 15-40% of patients hospitalized for UTI when the infection can also be classified as being associated with a systemic inflammatory response or sepsis (10,13). Given that our study included a population consisting of only hospitalized patients, and many of whom had significant comorbidities or systemic

complications such as sepsis, it is reasonable to expect that we would find an increased rate of AKI among our study population than has been previously reported in the literature. It is likely that both the aforementioned conditions contributed to the susceptibility of our patients due to developing an acute kidney injury during their hospitalization as a result of the UTI.

The pathophysiological connection linking AKI and UTI is multifactorial. Severe urinary infections/pyelonephritis cause systemic inflammatory responses which, when associated with poor renal perfusion, can lead to acute tubular injury (14). Toxins derived from the bacteria infecting the urinary tract and those inflammatory mediators released during a UTI may cause acute kidney injury through indirect means such as by causing renal microvascular and endothelial dysfunction (15). Additionally, hemodynamic instability/hypotension and dehydration associated with a serious UTI may also contribute to poor renal blood flow, thus precipitating acute kidney injury. These mechanisms interact to render patients with complicated UTIs particularly susceptible to AKI (16).

A number of comorbid conditions were found to independently correlate with AKI among the UTI population studied. Diabetes, hypertension, and sepsis were determined to be independent predictors of AKI in multivariate analysis. The presence of diabetes places UTI patients at risk for kidney injury due to chronic microvascular disease and decreased renal reserve (17). Likewise, hypertension is a chronic change resulting in a greater susceptibility to acute insults of and to the kidneys (18). Conversely, sepsis is a defined cause of AKI due to systemic inflammatory activation, endothelial dysfunction, and alteration of renal hemodynamics (19). These results reinforce the need for identifying patients at high risk for AKI among those presenting with UTIs.

In this study, one of the key findings was that patients who developed AKI had an increased length of stay in the hospital compared to those who did not have renal injury; furthermore, AKI was also associated with increased ICU admission rates and mortality rates. The results of this study are consistent with previous studies showing that AKI not only reflects the severity of the underlying illness but also contributes to worsening clinical status and deterioration (12). Renal dysfunction causes fluid and electrolyte imbalances, builds-up of metabolic waste products in the body, and leads to increased risk of other complications, thus prolonging hospitalization and increasing health care utilization (20).

Interestingly, we noted no significant differences in baseline creatinine levels and age between patients with AKI and patients without AKI. This suggests that AKI can occur in patients without obvious pre-existing renal dysfunction. Therefore, solely relying on baseline renal function to determine risk for AKI may not be adequate. Thus, continuous monitoring of renal function parameters is very important during hospitalization, especially for patients with severe infections or multiple comorbidities.

This study has a number of strengths. The prospective nature of the study facilitated systematic and comparable data collections for both AKI and non-AKI patients. Also, the use of clinical outcomes such as ICU admission, death and length of stay in the hospital adds a level of clinical relevance to this research project. Finally, an additional benefit of the research design is that the investigation of numerous co-morbidities provides insight into possible risk factors that may predispose UTI patients to renal complications.

However there are several limitations to the study. The first limitation is that the study occurred at a single institution, thus limiting the generalizability of the results to other populations/healthcare settings. Second, the study did not assess patient UTIs according to severity or by the microbiological etiology or anatomical classification of their UTI infection, all of which may affect a patient's risk for developing AKI. Finally, long-term renal outcomes after discharge from the hospital were not evaluated; therefore it was not possible to assess the extent to which AKI caused the development of ongoing kidney dysfunction or if and how patients' renal function improved with time.

## CONCLUSION

The incidence of AKI in hospitalized patients with UTI is substantial, with over 1/3rd developing AKI during hospitalization. This indicates a sizable burden of renal complications among these patients. The occurrence of AKI was associated with a variety of clinical outcomes such as longer hospital stays, greater chance of admission to ICU, and increased mortality. Certain comorbid conditions, especially diabetes, hypertension, and sepsis were recognized as significant contributors to AKI among hospitalized patients with UTI. Based on these findings, it appears that patients with UTI who also have comorbidities require close monitoring of their renal function while hospitalized. Additionally, the prompt recognition of patients at risk for AKI (due to either infection or comorbidities) and the prompt treatment of their infection and its associated risk factors may prevent AKI from occurring or progressing and may subsequently improve patient outcomes. Further multi-centered studies involving larger cohorts, with prolonged follow-up, are warranted to identify the pathways that connect UTI and AKI and develop effective measures to prevent these complications.

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