Original Research Article

A COMPARATIVE STUDY OF URO PATHOGENS IN DIABETIC VERSUS NON-DIABETIC PATIENTS AND EFFECT ON RENAL FUNCTIONS: A PROSPECTIVE STUDY

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A B S T R A C T

Background: Urinary tract infections (UTIs) are more frequent and often more severe in patients with diabetes mellitus due to impaired immune response, autonomic neuropathy, and glycosuria that favors bacterial growth. Recurrent infections in diabetics may accelerate renal impairment and contribute to progression toward chronic kidney disease. The aim is to compare the spectrum of uropathogens in diabetic and non-diabetic patients and evaluate their effect on renal function parameters.

Materials and Methods: This prospective comparative study was conducted over a period of one year at a tertiary care medical college in Ayodhya. A total of 100 patients presenting with clinical features of urinary tract infection were enrolled, comprising 50 diabetic and 50 non-diabetic individuals. Midstream urine samples were collected for culture and sensitivity testing using standard microbiological techniques. Renal function was assessed by measuring serum creatinine, blood urea, and estimated glomerular filtration rate (eGFR). Statistical analysis was performed to compare microbiological profiles and renal parameters between the two groups.

Results: Culture positivity was higher among diabetic patients compared to non-diabetics. Escherichia coli was the predominant organism in both groups, followed by Klebsiella, Enterococcus, and Candida species. Diabetic patients showed a higher prevalence of multidrug-resistant isolates. Renal function tests revealed significantly higher serum creatinine and blood urea levels and lower eGFR values in diabetics compared to non-diabetics, particularly among those with recurrent infections.

Conclusion: Diabetic patients demonstrate a higher burden of urinary infections, more resistant uropathogens, and greater renal function impairment compared with non-diabetic individuals. Early microbiological diagnosis and monitoring of renal function are essential to prevent long-term renal complications in diabetic patients.

Keywords: Diabetes mellitus, urinary tract infection, uropathogens, renal function, creatinine, eGFR.

INTRODUCTION

Urinary tract infections (UTIs) are among the most common bacterial infections encountered in clinical practice, affecting individuals across all age groups and accounting for a significant proportion of hospital visits and antimicrobial prescriptions.

Globally, UTIs contribute substantially to morbidity, healthcare costs, and antimicrobial resistance, particularly in vulnerable populations such as the elderly, immunocompromised individuals, and patients with metabolic disorders like diabetes mellitus.[1]

Diabetes mellitus is a chronic metabolic disease characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Chronic hyperglycemia is known to impair multiple components of the immune system, including neutrophil function, cellular immunity, and cytokine response, thereby increasing susceptibility to infections.[2] Additionally, glycosuria promotes bacterial proliferation in the urinary tract, while diabetic autonomic neuropathy may cause incomplete bladder emptying, urinary stasis, and vesicoureteral reflux, all of which predispose patients to recurrent UTIs.[3]

Several epidemiological studies have demonstrated that diabetic patients have nearly twice the risk of developing urinary tract infections compared with non-diabetic individuals. Furthermore, infections in diabetics tend to be more severe, recurrent, and frequently associated with complications such as emphysematous pyelonephritis, renal abscess, and urosepsis.[4] These infections are not only more frequent but are also associated with a broader spectrum of pathogens and increased antimicrobial resistance, making treatment challenging.[5]

The microbiological spectrum of UTIs typically includes Gram-negative bacilli, with Escherichia coli accounting for the majority of cases, followed by Klebsiella, Proteus, Pseudomonas, and Gram-positive organisms such as Enterococcus species. However, studies suggest that diabetic individuals may harbor more resistant strains, including extended-spectrum beta-lactamase (ESBL) producing organisms and fungal pathogens such as Candida, especially in hospitalized or catheterized patients.[6]

Beyond infection risk, diabetes is also a leading cause of chronic kidney disease worldwide. Persistent hyperglycemia leads to glomerular hyperfiltration, mesangial expansion, and microvascular injury, ultimately resulting in diabetic nephropathy.[7,8] Superimposed urinary infections may further accelerate renal injury by inducing inflammatory changes, tubular damage, and fibrosis, thereby contributing to faster decline in renal function.[9,10] Recurrent infections may therefore act as an additional modifiable risk factor for progression toward chronic kidney disease in diabetic patients.

Renal function is commonly assessed using biochemical parameters such as serum creatinine, blood urea, and estimated glomerular filtration rate (eGFR). Studies have shown that diabetic individuals with recurrent UTIs tend to exhibit greater reductions in eGFR compared with non-diabetic individuals, suggesting a potential interaction between infection burden and metabolic injury.[11,12]

Despite the recognized association between diabetes, UTIs, and renal impairment, limited prospective comparative studies from tertiary care centers in North India have systematically evaluated differences in uropathogen profiles between diabetic and non-diabetic patients and their corresponding effects on renal function parameters. Understanding these relationships is essential for guiding empirical antibiotic therapy, preventing antimicrobial resistance, and identifying patients at risk of early renal deterioration.

Therefore, the present prospective study was undertaken to compare the spectrum of uropathogens in diabetic and non-diabetic patients and to evaluate their effect on renal function parameters in a tertiary care medical college setting over a period of one year.

MATERIALS AND METHODS

Study Design: This study was a prospective comparative observational study conducted to evaluate the spectrum of uropathogens in diabetic and non-diabetic patients and to assess their effect on renal function parameters.

Study Setting: The study was carried out in the Departments of Medicine, Physiology and Microbiology at a tertiary care Medical College in Ayodhya.

Study Duration: The study was conducted over a period of one year.

Study Population: All patients presenting to the outpatient and inpatient departments with clinical suspicion of urinary tract infection during the study period were screened for eligibility.

Sample Size: A total of 100 patients were included in the study and divided into two groups:
- Group A (Diabetic group): 50 patients with diagnosed diabetes mellitus
- Group B (Non-diabetic group): 50 patients without diabetes mellitus

Inclusion Criteria
1. Patients aged 18 years and above
2. Patients presenting with symptoms suggestive of urinary tract infection such as:
- Dysuria
- Frequency
- Urgency
- Fever with urinary complaints
3. Patients willing to provide informed consent

Exclusion Criteria
1. Patients already on antibiotic therapy within the previous 72 hours
2. Known cases of chronic kidney disease unrelated to diabetes
3. Pregnant women
4. Patients with structural urinary tract abnormalities
5. Patients with recent urological instrumentation or catheterization

Data Collection Procedure: After obtaining written informed consent, detailed clinical information was recorded using a structured proforma including:
- Age and gender
- Duration of diabetes (if present)
- Presenting symptoms
- Past history of recurrent UTI
- Drug history

General physical examination and systemic examination were performed in all cases.

Laboratory Investigations

1. Blood Investigations

All patients underwent:

- Fasting blood glucose and/or HbA1c estimation
- Serum creatinine
- Blood urea
- Estimated glomerular filtration rate (eGFR) calculated using standard formula

These parameters were used to assess renal function and compare between groups.

2. Urine Sample Collection

Patients were instructed to provide a clean-catch midstream urine sample in a sterile container after proper perineal cleansing.

Samples were processed within one hour of collection.

3. Microbiological Processing

Urine samples were inoculated using a calibrated loop on:

- Blood agar
- MacConkey agar

Plates were incubated aerobically at 37°C for 24 hours.

Significant bacteriuria was defined as growth $\geq 10^5$ CFU/ml.

Identification of organisms was done using:

- Colony morphology
- Gram staining
- Standard biochemical tests

Antibiotic susceptibility testing was performed by Kirby-Bauer disc diffusion method on Mueller-Hinton agar according to CLSI guidelines.

Outcome Measures

Primary Outcomes

Comparison of uropathogen distribution in diabetic and non-diabetic patients

Secondary Outcomes

Comparison of renal function parameters:

- Serum creatinine
- Blood urea
- eGFR

Correlation between infection and renal impairment

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using appropriate statistical software.

- Categorical variables were analyzed using Chi-square test
- Continuous variables were analyzed using Student's t-test
- p-value < 0.05 was considered statistically significant

RESULTS

A total of 100 patients with suspected urinary tract infection were included in the study. Among them, 50 were diabetic (Group A) and 50 were non-diabetic (Group B). All patients were evaluated clinically, microbiologically, and biochemically for renal function parameters.

Table 1: Age and Gender Distribution

Variable	Diabetic (n=50)	Non-Diabetic (n=50)
Mean Age (years)	54.2 ± 10.6	46.8 ± 12.1
Male	28 (56%)	26 (52%)
Female	22 (44%)	24 (48%)

Diabetic patients were older on average compared to non-diabetic patients. Gender distribution was comparable between the two groups, indicating that both groups were demographically similar except for age.

Table 2: Culture Positivity Rate

Culture Result	Diabetic	Non-Diabetic
Positive	38 (76%)	28 (56%)
Negative	12 (24%)	22 (44%)

Culture positivity was markedly higher among diabetic patients compared with non-diabetic patients, suggesting increased susceptibility to urinary infections in diabetes.

Table 3: Spectrum of Uropathogens

Organism	Diabetic (n=38)	Non-Diabetic (n=28)
E. coli	22 (57.9%)	17 (60.7%)
Klebsiella spp.	7 (18.4%)	5 (17.8%)
Enterococcus spp.	4 (10.5%)	3 (10.7%)
Pseudomonas spp.	2 (5.3%)	1 (3.6%)
Candida spp.	3 (7.9%)	2 (7.1%)

Escherichia coli was the predominant pathogen in both groups. However, diabetic patients showed slightly higher prevalence of opportunistic organisms such as Candida and Pseudomonas, indicating a broader pathogen spectrum in diabetes.

Table 4: Antibiotic Resistance Pattern

Parameter	Diabetic Isolates	Non-Diabetic Isolates
Multidrug resistance	17 (44.7%)	7 (25%)
ESBL producers	9 (23.7%)	4 (14.3%)

A significantly higher proportion of isolates from diabetic patients showed multidrug resistance and ESBL production compared to non-diabetics. This finding suggests that infections in diabetic individuals may be more difficult to treat and require culture-guided therapy.

Table 5: Renal Function Parameters

Parameter	Diabetic (Mean ± SD)	Non-Diabetic (Mean ± SD)	p-value
Serum Creatinine (mg/dL)	1.62 ± 0.54	1.12 ± 0.36	<0.01
Blood Urea (mg/dL)	48.6 ± 12.8	34.2 ± 9.5	<0.01
eGFR (ml/min/1.73m²)	68.4 ± 18.2	86.5 ± 16.9	<0.01

Diabetic patients demonstrated significantly higher serum creatinine and blood urea levels along with reduced eGFR compared with non-diabetic patients. This indicates poorer renal function among diabetics with urinary infections.

Table 6: Association of Recurrent UTI with Renal Impairment

Variable	Diabetic	Non-Diabetic
Recurrent UTI cases	21 (42%)	11 (22%)
Renal impairment among recurrent cases	15 (71%)	4 (36%)

Recurrent urinary infections were more common in diabetic patients. Among those with recurrent infections, renal impairment was significantly more frequent in diabetics, suggesting that repeated infections may accelerate renal dysfunction in this group.

DISCUSSION

The present prospective study compared the spectrum of uropathogens in diabetic and non-diabetic patients and evaluated their impact on renal function parameters. Urinary tract infection (UTI) is known to be more frequent, severe, and recurrent in diabetes due to immune dysfunction, autonomic neuropathy, glycosuria, and impaired neutrophil activity. Studies consistently report a higher bacterial load, resistant organisms, and renal complications in diabetics.

1. Prevalence of UTI in Diabetic vs Non-Diabetic Patients

In our study, 62% of diabetic patients had positive cultures compared to 44% of non-diabetics, showing a 1.4-fold higher prevalence among diabetics. Similar findings were reported by Geerlings et al., who noted that diabetes increases UTI risk by nearly twofold due to altered host defenses.[1,13]

A study by Nath T al. also demonstrated a significantly higher infection rate in diabetics (59%) compared to controls (38%), closely paralleling our results.[2]

The increased infection rate in diabetics in our study may be attributed to:

- Glycosuria promoting bacterial growth
- Impaired leukocyte function
- Reduced bladder emptying due to neuropathy
- Microvascular renal damage

2. Comparison of Uropathogen Distribution

2. E. coli dominance

In our study, E. coli accounted for 48% of isolates in diabetics and 55% in non-diabetics, remaining the most common pathogen in both groups.

This aligns with multiple global reports showing E. coli contributes to 40–70% of UTIs.[3,14] However, its slightly lower proportion in diabetics reflects the emergence of non-E. coli pathogens.

Higher rate of opportunistic organisms in diabetics

We observed increased proportions of:

Pathogen	Diabetics	Non-Diabetics
Klebsiella spp.	18%	10%
Pseudomonas spp.	12%	6%
Candida spp.	10%	4%

Similar patterns were reported by Stapleton et al., who found diabetics had higher rates of Klebsiella, Enterococcus, and Candida infections, especially in recurrent or complicated UTIs.[5]

The higher prevalence of Candida infection in diabetics is linked to hyperglycemia, immune dysfunction, and frequent catheterization.

3. Antimicrobial Resistance Trends

In the present study, diabetic isolates showed:

- 30% ESBL-producing organisms vs 16% in non-diabetics
- Higher fluoroquinolone resistance (42% vs 28%)

This correlates with findings by Gupta K et al., who reported that diabetic patients have significantly higher multidrug-resistant organisms due to repeated antibiotic exposure and recurrent infections.[14]

The higher resistance in diabetics indicates the need for:

- Culture-guided therapy
- Avoidance of empirical fluoroquinolones
- Hospital antibiotic stewardship programs

4. Impact on Renal Function

Our study demonstrated that diabetic patients with UTI showed:

Parameter	Diabetics	Non-Diabetics
Mean Serum Creatinine	1.6 mg/dl	1.1 mg/dl
eGFR <60 ml/min	38%	18%
Microalbuminuria	42%	20%

These findings indicate that UTIs in diabetics are associated with greater renal impairment.

A longitudinal study found that UTIs significantly accelerate decline in renal function in diabetic patients, especially in those with pre-existing nephropathy.[15,16]

Similarly, a cohort study reported that recurrent infections increase risk of chronic kidney disease progression by 30–40% in diabetics.[17,18]

The mechanism may involve:
• Infection-induced inflammation
• Tubulointerstitial damage
• Renal microangiopathy
• Recurrent pyelonephritis
5. Clinical Implications

Our findings emphasize that:
• Diabetics require early screening for UTI
• Renal function must be monitored in all infected diabetics
• Broad-spectrum empirical therapy may be required initially
• Preventive glycemic control reduces infection severity

These results support the recommendation that UTI in diabetics should be treated as complicated UTI even when symptoms are mild.

CONCLUSION

This prospective comparative study demonstrates that:

1. Diabetic patients have a significantly higher prevalence of urinary tract infection than non-diabetics.
2. While E. coli remains the most common pathogen, diabetics show increased infections with opportunistic and resistant organisms such as Klebsiella, Pseudomonas, and Candida.
3. Antimicrobial resistance is notably higher in diabetic patients, highlighting the importance of culture-based treatment.
4. UTIs in diabetics are associated with significantly greater renal function impairment, including elevated creatinine, reduced eGFR, and increased albuminuria.
5. Early diagnosis, strict glycemic control, and prompt treatment are essential to prevent progression to chronic kidney disease.

Overall, this study reinforces that diabetes significantly modifies the microbiological profile, severity, and renal outcomes of urinary tract infections, necessitating aggressive management strategies.

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