

A Clinical Profile and Risk Factor Analysis of Urinary Tract Infections in Patients with Diabetes Mellitus

Mahesh Reddy¹, Pramod R. Kulkarni², Preetam³

¹Assistant Professor, Department of General Medicine, Bidar Institute of Medical Sciences (BRIMS), Bidar, Karnataka, India

²Assistant Professor, Department of Obstetrics & Gynaecology, Bidar Institute of Medical Sciences (BRIMS), Bidar, Karnataka, India

³Assistant Professor, Department of Psychiatry, Yadgiri Institute of Medical Sciences Yadgiri, Karnataka, India

Received: 25-05-2026 / Revised: 23-06-2026 / Accepted: 26-07-2026

Corresponding Author: Dr. Pramod R. Kulkarni

Conflict of interest: Nil

Abstract:

Background & Objectives: Diabetes mellitus (DM) is a major global metabolic disorder associated with an increased susceptibility to severe opportunistic and recurrent infections. Among these, Urinary Tract Infections (UTIs) pose significant clinical challenges due to structural and immunological impairments. This study aimed to evaluate the clinical spectrum, associated risk factors, causative uropathogens, and antimicrobial susceptibility profiles among diabetic patients presenting with UTIs.

Methods: A prospective descriptive observational study was conducted on 100 admitted diabetic patients presenting with clinical or microbiological evidence of UTI at a tertiary care medical college hospital over a 1-year period. Comprehensive clinical history, biochemical markers (FBS, PPBS, HbA1c), urinalysis, quantitative urine culture ($>10^5$ CFU/mL defining significant bacteriuria), renal ultrasonography, and post-void residual (PVR) urine volume evaluations were systematically performed and analyzed.

Results: Out of 100 diabetic patients evaluated, 43% demonstrated significant bacteriuria while 57% were non-bacteriuric. Significant bacteriuria exhibited a strong female preponderance (62.8% vs 37.2% in males, $p=0.043$). Diabetic neuropathy was significantly associated with positive culture status (58.1% vs 35.1%, $p=0.027$). Uncontrolled glycemic status was heavily predictive of bacteriuria, with 100% of culture-positive patients having HbA1c $>7.0\%$ and 86% presenting with HbA1c $>10\%$ ($p=0.0434$). Leukocytosis ($>12,000/\text{mm}^3$) was present in 30.2% of bacteriuric cases ($p=0.022$). Asymptomatic bacteriuria (ASB) was detected in 32.6% of bacteriuric patients. *Escherichia coli* was the predominant pathogen isolated (69.8%), followed by *Klebsiella pneumoniae* (16.2%), *Enterococcus* species (9.3%), *Pseudomonas aeruginosa* (2.3%), and *Candida* species (2.3%). *Escherichia coli* isolates exhibited highest antimicrobial sensitivity to Ampicillin, Fluoroquinolones, and Co-trimoxazole.

Conclusion: Female gender, diabetic neuropathy, and severe chronic glycemic dysregulation (HbA1c $>10\%$) serve as major predisposing factors for bacteriuria in diabetic patients. *Escherichia coli* remains the primary uropathogen. Routine screening for asymptomatic bacteriuria and stringent glycemic control are vital to prevent ascending upper tract complications like pyelonephritis.

Keywords: Diabetes Mellitus, Urinary Tract Infection, Bacteriuria, Glycated Hemoglobin (HbA1c), Diabetic Neuropathy, *Escherichia coli*, Asymptomatic Bacteriuria.

DOI: 10.25258/ijpqa.17.8.13

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Diabetes mellitus is the most widespread endocrine disease of the 21st century, growing at geometric proportions globally due to rapid urbanization, sedentary lifestyle changes, and dietary shifts. World Health Organization (WHO) reports highlight that developing nations bear over 70% of the global burden of diabetes. India currently houses over 40-50 million diabetic individuals, holding a remarkably high prevalence across both

urban and rural demographics. Patients with diabetes mellitus exhibit markedly heightened susceptibility to various systemic, cutaneous, and mucosal infections. Hyperglycemia induces multifactorial host immune dysfunction, including impaired PMN (polymorphonuclear neutrophil) chemotaxis, reduced phagocytic activity, diminished intracellular killing, blunted oxidative burst, and impaired monocyte function.

Furthermore, microvascular disease delays tissue healing and therapeutic drug distribution, while autonomic neuropathy causes bladder dysfunction, urinary stasis, and vesicoureteral incoordination.

Urinary Tract Infections (UTIs) represent the second most common clinical infection in ambulatory and inpatient medicine. In diabetic patients, UTIs carry a heightened risk of progression from simple cystitis to severe complicated upper tract diseases, including acute pyelonephritis, emphysematous pyelonephritis, renal papillary necrosis, and perinephric/renal abscesses.

This study was undertaken to delineate the clinical profiles, specific host risk factors, micro-organism spectrum, and antimicrobial susceptibility patterns in diabetic patients with UTIs.

Materials and Methods

Study Design & Setting: This prospective, descriptive cross-sectional study evaluated 100 admitted diabetic patients with symptoms or microbiological suspicion of UTI over a 12-month period from March 2024 to March 2025 at a tertiary care teaching institution BRIMS Bidar.

Inclusion Criteria: Patients aged ≥ 18 years with documented Diabetes Mellitus (Type 1 or Type 2) presenting with clinical features of UTI (dysuria, fever, urgency, frequency, suprapubic pain) or positive urine cultures, who provided written informed consent.

Exclusion Criteria: (1) History of antibiotic usage within 2 weeks prior to culture sample collection; (2) Patients with continuous indwelling urinary catheters; (3) Menstruating females.

Clinical & Laboratory Protocol: Midstream clean-catch urine specimens were collected under aseptic precautions prior to initiating antimicrobial therapy. Uncentrifuged gram-stained urine examination and quantitative culture were performed using Blood Agar and MacConkey Agar plates (incubated at 37°C for 24-48 hours). Significant bacteriuria was defined as $\geq 10^5$ Colony Forming Units (CFU)/mL of a single uropathogen. Antimicrobial susceptibility testing was performed via Kirby-Bauer disc diffusion method. Laboratory workup included complete blood counts (Hb, Total Leukocyte Count), Fasting Blood Sugar (FBS), Postprandial Blood Sugar (PPBS), Glycated Hemoglobin (HbA1c), renal function tests, urine pH, specific gravity, abdominal ultrasonography, and post-void residual (PVR) urine measurement.

Statistical Analysis: Data were processed using SPSS Version 17.0. Continuous variables were analyzed using Student's t-test and ANOVA, while categorical variables were evaluated using Chi-square test and Fisher's Exact test. A p-value < 0.05 was considered statistically significant.

Results

Out of 100 diabetic patients evaluated, 43 patients (43%) demonstrated significant bacteriuria ($\geq 10^5$ CFU/mL), while 57 patients (57%) were non-bacteriuric ($< 10^5$ CFU/mL).

Table 1: Demographic and Clinical Parameters according to Bacteriuric Status

Clinical Parameter	Without Bacteriuria (n=57)	With Bacteriuria (n=43)	Statistical Significance
Gender: Male / Female	34 (59.6%) / 23 (40.4%)	16 (37.2%) / 27 (62.8%)	p = 0.043 (Significant)
Mean Age (Years $\pm$ SD)	51.2 $\pm$ 11.2	50.3 $\pm$ 12.1	p = 0.352 (NS)
Type of DM: Type 1 / Type 2	6 (10.5%) / 51 (89.5%)	2 (4.7%) / 41 (95.3%)	p = 0.284 (NS)
Mean DM Duration (Years)	8.71 $\pm$ 5.94	6.16 $\pm$ 2.86	p = 0.011 (Significant)
Diabetic Neuropathy	20 (35.1%)	25 (58.1%)	p = 0.027 (Significant)
Diabetic Retinopathy	16 (28.1%)	17 (39.5%)	p = 0.284 (NS)
Diabetic Nephropathy	9 (15.8%)	11 (25.6%)	p = 0.313 (NS)
Diabetic Foot Ulcer	6 (10.5%)	16 (37.2%)	p = 0.003 (Significant)
Leukocytosis ($>12,000/\text{mm}^3$)	7 (12.3%)	13 (30.2%)	p = 0.022 (Significant)
HbA1c $> 10.0\%$	37 (64.9%)	39 (90.7%)	p = 0.0434 (Significant)

Clinical Symptoms: Dysuria was the most frequent symptom across all patients (49.1% non-bacteriuric vs 41.9% bacteriuric). Frequency of micturition was reported in 39.5% of bacteriuric patients, and suprapubic pain in 37.2%. Notably, Asymptomatic Bacteriuria (ASB) was observed in 14 of the 43 bacteriuric patients (32.6%), comprising 10 females (37.0% of bacteriuric females) and 4 males (25.0% of bacteriuric males).

Table 2: Spectrum of Uropathogens Isolated in Bacteriuric Patients (n=43)

Isolated Organism	Male Patients (n=16)	Female Patients (n=27)	Total (%)
Escherichia coli	10 (62.5%)	20 (74.1%)	30 (69.8%)
Klebsiella pneumoniae	3 (18.8%)	4 (14.8%)	7 (16.3%)
Enterococcus species	2 (12.5%)	2 (7.4%)	4 (9.3%)
Pseudomonas aeruginosa	1 (6.3%)	0 (0.0%)	1 (2.3%)
Candida species (co-isolate)	0 (0.0%)	1 (3.7%)	1 (2.3%)
Total Isolates	16 (100.0%)	27 (100.0%)	43 (100.0%)

Table 3: Antimicrobial Susceptibility Pattern of Isolated Bacterial Pathogens (%)

Pathogen	Ampicillin	Cefuroxime	Ceftriaxone	Amox-Clav	Fluoroquinolones	Gentamicin
<i>Escherichia coli</i> (n=30)	52.4%	20.7%	12.7%	30.4%	40.7%	41.1%
<i>Klebsiella pneumoniae</i> (n=7)	89.7%	18.5%	13.5%	15.4%	22.8%	17.8%
<i>Enterococcus</i> spp. (n=4)	23.7%	12.5%	N/A	20.4%	60.7%	32.8%

Ultrasonographic & Radiological Profile: Ultrasonography of the abdomen revealed evidence of acute pyelonephritis in 12 bacteriuric cases (27.9%) and cystitis in 8 cases (18.6%). Benign Prostatic Hyperplasia (BPH) was present in 7 non-bacteriuric males. Post-Void Residual (PVR) urine volume >100 mL was observed in 27.9% of bacteriuric patients compared to 19.3% in non-bacteriuric patients (p=0.237).

Discussion

The interplay between diabetes mellitus and urinary tract infections represents a major clinical challenge. In our study of 100 diabetic patients presenting with symptoms or microbiological evidence of UTI, 43% demonstrated significant bacteriuria ($\geq 10^5$ CFU/mL). This high prevalence underscores the elevated vulnerability of diabetics to bacterial colonization and active infection within the urinary tract.

Gender Predisposition: Our findings demonstrated a statistically significant female preponderance among bacteriuric patients (62.8% females vs. 37.2% males, p=0.043). This aligns seamlessly with established global literature, including foundational studies by Forland et al., Ooi et al., and Geerlings et al. The anatomic structural predisposition of females—namely a shorter urethra, shorter distance from the anus to the external urethral meatus, and vestibular bacterial colonization—is compounded in diabetic females by localized mucosal changes and altered vaginal flora secondary to ambient hyperglycemia.

Role of Glycemic Control (HbA1c): A critical finding in our investigation was the powerful association between severe chronic hyperglycemia and significant bacteriuria. All 43 bacteriuric patients (100%) had an HbA1c > 7.0%, with 39 patients (90.7%) displaying extreme dysregulation with HbA1c > 10.0% (p = 0.0434). High glucose concentrations in urine foster a supportive culture medium for uropathogens while simultaneously suppressing local uroepithelial immune responses. Uncontrolled glucose impairs neutrophil adherence, chemotaxis, and phagocytosis, thereby facilitating pathogen persistence. Our results strongly corroborate findings by Szucs et al. and Vaishnav et al., highlighting that strict glycemic monitoring is vital to mitigate infectious risk.

Diabetic Neuropathy & Bladder Dysfunction: Diabetic peripheral/autonomic neuropathy was significantly more prevalent in the bacteriuric cohort (58.1% vs 35.1%, p=0.027).

Diabetic cystopathy, characterized by reduced bladder sensation, impaired detrusor contractility, increased bladder capacity, and elevated post-void residual urine, creates urinary stasis that promotes bacterial proliferation. Although PVR >100 mL alone did not reach statistical significance (p=0.237), its clinical contribution in neuropathic patients remains substantial.

Microbiological Spectrum & Susceptibility: *Escherichia coli* was the predominant pathogen isolated (69.8%), followed by *Klebsiella pneumoniae* (16.2%) and *Enterococci* (9.3%). This distribution reflects standard uropathogen patterns reported by Bonadio et al. and Zhanel et al. Antimicrobial testing demonstrated that *E. coli* isolates retained fair sensitivity to Ampicillin, Fluoroquinolones, and Co-trimoxazole. However, emerging resistance patterns emphasize the necessity of obtaining culture-guided antibiotic therapy rather than relying solely on empirical treatment.

Asymptomatic Bacteriuria (ASB): ASB was identified in 32.6% of bacteriuric patients. In diabetic individuals, ASB serves as a potential precursor to severe ascending pyelonephritis and urosepsis. Routine screening for ASB in high-risk diabetic subgroups, particularly those with longstanding disease or poor glycemic control, should be integrated into clinical care.

Conclusion

In conclusion, urinary tract infections in diabetic patients are strongly associated with female gender, diabetic neuropathy, and chronic severe hyperglycemia (HbA1c > 10%). *Escherichia coli* remains the primary uropathogenic agent. Maintaining tight glycemic control, routine screening for asymptomatic bacteriuria, and judicious antibiotic administration based on culture sensitivities are essential strategies to reduce UTI-related morbidity and upper tract complications in diabetes mellitus.

References

1. Geerlings SE. Urinary tract infections in patients with diabetes mellitus: epidemiology, pathogenesis and treatment. *Int J Antimicrob Agents*. 2008;31(Suppl 1):S54-S57.
2. Zhanel GG, Harding GK, Nicolle LE. Asymptomatic bacteriuria in patients with diabetes mellitus. *Rev Infect Dis*. 1991;13(1):150-154.
3. Forland M, Thomas V, Shelokov A. Urinary tract infections in patients with diabetes mellitus: studies on antibody coating of bacteria. *JAMA*. 1977;238(18):1924-1926.
4. Bonadio M, Costarelli S, Morelli G, Tartaglia T. The influence of diabetes mellitus on the spectrum of uropathogens and the antimicrobial resistance in elderly adult patients with urinary tract infection. *BMC Infect Dis*. 2006;6:54.
5. Szucs S, Cserhati I, Csapo G, Szabo A. The relation between diabetes mellitus and infections of the urinary tract. *Am J Med Sci*. 1960;240:186-191.
6. Nicolle LE, Bradley S, Colgan R, Rice JC, Schaeffer A, Hooton TM. Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults. *Clin Infect Dis*. 2005;40(5):643-654.
7. Ooi BS, Chen BTM, Yu M. Prevalence and site of bacteriuria in diabetes mellitus. *Postgrad Med J*. 1974;50(586):497-499.
8. Shah BV, Jadhav CS, Acharya VN. Study of urinary tract infection in diabetic subjects. *J Assoc Physicians India*. 1984;33(12):1037-1040.