Indian Journal of Pharmacy Practice., 2026; 19(4):525-530.
https://www.ijopp.org

Original Article

Assessment of Risk Factors, Microbiological Pattern and Management of Urinary Tract Infection in Diabetic Patients

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ABSTRACT

Background and Aim: Urinary Tract Infection (UTI) refers to an infection affecting any part of the urinary tract that can be bacterial, fungal or viral. Due to the higher incidence of glucosuria and impaired immune function, diabetic people are more vulnerable. This study aims to assess the risk factors, microbiological pattern and management of urinary tract infections in diabetic patients. **Materials and Methods:** An ambispective observational single-centre study was conducted at the General Medicine department of a tertiary care hospital. Retrospective data were obtained from November 2023-November 2024 and prospective data from December 2024-May 2025. Data were extracted from the Mediware System and records using a structured form. **Results:** Uncontrolled diabetes mellitus, duration of diabetes, female gender, age, prior UTI history, and postmenopausal emerged as the most frequent risk factors. Urosepsis and pyelonephritis were the principal complications observed. *Escherichia coli* and *Klebsiella pneumoniae* predominated among the isolates. Cephalosporins and carbapenems were commonly used, with notable variation in antimicrobial sensitivity patterns depending on the uropathogen. **Conclusion:** Urinary tract infections are common in diabetic patients, with gram-negative pathogens predominating and urosepsis as a key complication. Sensitivity patterns support the role of aminoglycosides, carbapenems, and cephalosporins in guiding appropriate therapy.

Keywords: Antibiogram, Diabetes Mellitus, Microbiological Pattern, Risk Factors and Complications, Urinary Tract Infection.

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Received: 27-03-2026;
Revised: 12-05-2026;
Accepted: 03-07-2026.

INTRODUCTION

Diabetes mellitus is a major global health concern associated with significant morbidity and mortality. In 2021, the World Health Organization identified diabetes mellitus as the eighth leading cause of death worldwide. The rising prevalence of diabetes, particularly in developing nations, has led to an increase in infection-related complications, among which Urinary Tract Infection (UTI) remains one of the most common and clinically significant. According to the International Diabetes Federation (2019), the countries with the highest number of diabetic patients are China, India, and the United States, and this trend is expected to increase substantially by 2030 (Tan and Chlebicki, 2016).

Several risk factors contribute to the increased susceptibility to UTIs and their associated complications in diabetic patients (Reenu *et al*., 2022). Timely recognition and appropriate management of these risk factors are essential to prevent disease progression and reduce complications. Moreover, the emergence of antimicrobial resistance among uropathogens has become a major global therapeutic challenge. Empirical and inappropriate use of antibiotics without knowledge of local microbial patterns and susceptibility trends can result in treatment failure, prolonged illness, increased healthcare costs, and the development of multidrug-resistant organisms.

Studies from the 2000s reported that the predominant uropathogens included *Escherichia coli, Staphylococcus* spp., *Proteus* spp., *Klebsiella* spp., *Enterococcus* spp., *Pseudomonas aeruginosa*, and *Enterobacter* spp (Dogru *et al*., 2013). In the 2010s, a similar pattern was observed, with *E. coli* remaining the most common pathogen, followed by *Enterococcus* spp., *Klebsiella* spp., and *Pseudomonas* spp (Linhares *et al*., 2013). However, the spectrum of uropathogens and their antibiotic sensitivity profiles may vary across time and healthcare settings, highlighting the need for continuous surveillance (Nath *et al*., 2021).

Although several studies have explored UTIs in diabetic patients, limited data are available from South India. Additionally, antimicrobial sensitivity patterns continue to evolve over time. Therefore, this study aims to evaluate the risk factors, microbiological patterns, and management strategies of urinary tract infections in patients with diabetes mellitus.

DOI: 10.5530/ijopp.20260881

MATERIALS AND METHODS

Study Design

An ambispective, single-centre, observational study was conducted in six months (December 2024 - May 2025) in a tertiary care hospital where the study population was based on the diabetic in-patients diagnosed with urinary tract infection. The retrospective data were collected from the period between November 2023 to November 2024 using the Electronic Medical Records (EMR) and the prospective data were collected from December 2024 to May 2025 patient medical records.

Subject Selection

All diabetic patients diagnosed with UTI admitted under the General Medicine department of a tertiary care hospital, Kochi, Kerala, India. This study had a total of 160 patients. These patients were in congruence with the inclusion and exclusion criteria. The inclusion criteria included patients ≥ 18 years of both genders and diabetic patients diagnosed with urinary tract infection. Patients diagnosed with any type of malignancy conditions were excluded.

Diagnostic Criteria for UTI

Patients were considered to have urinary tract infection based on the diagnosis documented by the treating physician in the medical records. Diagnosis was established using a combination of clinical symptoms, laboratory findings, urine routine examination, and urine culture reports when available. Common symptoms included dysuria, increased urinary frequency, urgency, suprapubic discomfort, flank pain, fever, and other signs suggestive of urinary tract infection.

A positive urine culture was defined as significant microbial growth (≥ 10^5 CFU/mL) as reported according to the criteria of hospital microbiology laboratory. Pyelonephritis was identified based on documented diagnosis with associated clinical findings such as fever, flank pain, and/or renal involvement. Urosepsis was defined as sepsis secondary to a urinary tract source as documented in the patient's medical records.

Data Collection Methods

The data for this study was collected from patient files and Electronic Medical Records (EMR) using a standardised pre-structured data collection form. The data collection form included demographics of the patient, past medical and medication histories, signs and symptoms, risk factors, complications, comorbidities, culture sensitivity reports, urine routine examinations, lab investigations (FBS, RBS, GRBS, HbA_{1C}), antibiotic treatment medications (empirical and definitive) and discharge medication.

Statistical Analysis

Descriptive statistics were performed using Microsoft Excel. Categorical variables were expressed as frequencies and percentages, whereas continuous variables were expressed as mean ± standard deviation. Data collected were tabulated, analysed and compared with relevant studies.

Ethical Consideration

The Institutional Ethics Committee of Lourdes Hospital, Post-Graduate Institute of Medical Science and Research, Kochi approved the study titled "Assessment of risk factors, microbiological pattern and management of urinary tract infection in diabetic patients" vide letter no. LH/EC/2024-37 on 20th November 2024.

RESULTS

A total of 160 diabetic patients with confirmed Urinary Tract Infection (UTI) were included in this ambispective observational study, out of which 98 (61%) were women and 62 (39%) were men. The highest proportion of patients belonged to the 65-75 year age group, accounting for 30% of the total population. The mean age of the study population was 67.02±12.28 years, with a predominance of elderly individuals (>60 years). Females constituted 61.25% of cases, and a substantial proportion of them (87.75%) were post-menopausal.

Uncontrolled diabetes mellitus emerged as the most significant risk factor, observed in 71.87% of patients. Additional risk factors include female gender (61.25%), prior history of UTI (56.25%), prolonged duration of diabetes, and catheterization (8.12%) (Table 1). The majority of the patients had Type 2 diabetes mellitus. A prolonged duration of diabetes was commonly observed, 105 (65.62%) had diabetes mellitus for more than 10 years, while 55 (34.37%) had a disease duration of less than 10 years.

Multiple comorbidities were frequently documented among the study population. Hypertension was the most common comorbidity, accounting for 86 (33.20%) of the total documented comorbidities, followed by kidney dysfunction 49 (18.91%), dyslipidemia 41 (15.83%), coronary artery disease 41 (15.83%), hypothyroidism 28 (10.81%), and stroke 14 (5.40%). Furthermore, more than one-third of patients (55, 34.37%) had more than three comorbidities, while 46 (28.75%), 39 (24.37%), and 20 (12.50%) patients had three, two, and one comorbidity, respectively.

Out of 160 patients, complications were observed in 57 patients (35.62%). Urosepsis is the most common complication (57.9%), followed by pyelonephritis (24.56%). The remaining cases represent combinations of complications (Table 2).

A total of 109 urine cultures were done, among them 77 were found to have positive cultures, from which 93.5% of isolated uropathogens were found to be gram-negative organisms, followed by gram-positive organisms and others. This relatively

Table 1: Risk factors of urinary tract infection in the study population.

Sl. No.	Risk factors	Number (*n*=160)	Percentage
1.	Uncontrolled DM	115	71.87%
2.	Duration of diabetes (>10 years)	105	65.62%
3.	Sex (Female)	98	61.25%
4.	Age (above 65 yrs)	93	58.12%
5.	Previous UTI history	90	56.25%
6.	Post- Menopausal	86	53.75%
7.	Prostate abnormalities	28	17.5%
8.	Catheter induced	13	8.12%
9.	Calculi	7	4.4%

Table 2: Complications found in the study population.

Complications		
Types	**Number (*n*=160)**	**Percentage**
Urosepsis	33	20.62%
Pyelonephritis	14	8.75%
Cystitis	2	1.25%
Urosepsis, Pyelonephritis	6	3.75%
Urosepsis, Pyelonephritis, Cystitis	1	0.62%
Pyelonephritis, Cystitis	1	0.62%
Total	57	

Table 3: Microbiological pattern of uropathogens.

Organism Isolated	Number of positive cultures (*n*=77)	Percentage
Gram-positive		
Enterococcus faecalis	1	1.30%
Enterococcus faecium	2	2.60%
Gram-negative		
Escherichia coli	43	55.80%
Klebsiella pneumoniae	17	22.10%
Pseudomonas aeruginosa	7	9.10%
Klebsiella oxytoca	1	1.30%
Enterobacter cloacae	1	1.30%
Enterobacter aerogenes	1	1.30%
Acinetobacter baumannii	1	1.30%
Morganella morganii	1	1.30%

low culture positivity rate may be attributed to prior antibiotic exposure before sample collection and low bacterial counts. Among the 72 gram-negative organisms, 59.72% are *Escherichia coli*, followed by *Klebsiella pneumoniae* (23.61%). Apart from bacteria, fungal pathogens were also identified. These include fungi such as *Candida krusei* and non-*albicans Candida*, which account for approximately 1.30% (Table 3). Patients with negative or unavailable culture reports were diagnosed based on clinical presentation, urine routine examination findings, and physician documentation.

Empirical therapy most commonly involves third-generation cephalosporins and carbapenems. Culture-guided definitive therapy predominantly includes carbapenems, aminoglycosides, and cephalosporins (Table 4).

The sensitivity pattern (antibiogram) of *Escherichia coli* and *Klebsiella pneumoniae* to various antibiotics is evaluated. The obtained information shows that *E. coli* is highly sensitive to imipenem, meropenem, nitrofurantoin, fosfomycin, amikacin, cefoperazone, and ertapenem. In contrast, *K. pneumoniae* does not show high sensitivity to any antibiotic but demonstrates moderate sensitivity to amikacin, amoxicillin-clavulanic acid, cefoperazone, and gentamicin (Table 5).

DISCUSSION

The present study evaluated the clinical profile, microbiological spectrum, treatment outcomes, and associated risk factors of Urinary Tract Infections (UTIs) among patients with diabetes mellitus. Diabetes is a well-established predisposing factor for UTIs due to multifactorial pathophysiological mechanisms, including persistent hyperglycemia, glucosuria, impaired immune response, autonomic neuropathy, and microvascular complications. Immune dysfunction in diabetic individuals particularly defects in neutrophil chemotaxis, phagocytosis, and intracellular killing significantly increases susceptibility to infections (Garcia *et al.*, 2025). Additionally, hyperglycemia promotes bacterial adherence to uroepithelial cells, thereby facilitating colonization and recurrent infections.

In the present study, a higher proportion of UTIs was observed among female diabetic patients. This finding is consistent with epidemiological evidence demonstrating that female sex is an independent risk factor for UTIs, particularly in diabetic

Table 4: Empirical and definitive antibiotic therapy used in the treatment.

Drug Class of Antibiotic	Number of empirical antibiotics used	Percentage	Number of definitive antibiotics used	Percentage
Cephalosporins	123	71.09%	4	13.79%
Aminoglycosides	2	1.15%	2	6.89%
Penicillins	11	6.35%	1	3.44%
Nitrofurantoin	1	0.57%	1	3.44%
Fluoroquinolones	2	1.15%	2	6.89%
Carbapenem	25	14.45%	11	37.93%
Macrolides	2	1.15%	1	3.44%
Tetracyclines	2	1.15%	2	6.89%
Fosfomycin	-	-	1	3.44%
Teicoplanin	1	0.57%	-	-
Antiprotozoals	4	2.31%	3	10.34%
TMP/SMX	-	-	1	3.44%
TOTAL	173		29	

Table 5: Antibiogram of uropathogens.

Drugs	*Escherichia coli* (*n*=43)	*Klebsiella pneumoniae* (*n*=17)
Amikacin	95.34%	70.58%
Amoxicillin-clavulanic acid	81.39%	64.70%
Cefepime	37.20%	35.29%
Cefoperazone	93.02%	64.70%
Ceftazidime	-	58.82%
Cefuroxime	25.58%	23.52%
Ceftriaxone	69.76%	35.29%
Gentamicin	86.04%	64.70%
Imipenem	100%	47.05%
Meropenem	100%	52.94%
Ertapenem	93.02%	58.82%
Ciprofloxacin	37.20%	23.52%
Nitrofurantoin	100%	-
Piperacillin	83.72%	58.82%
Colistin	-	29.41%
Fosfomycin	97.67%	58.82%

populations (Janifer *et al.*, 2009). Anatomical predisposition, shorter urethral length, and hormonal influences, combined with glycosuria, create a favorable environment for bacterial proliferation. Postmenopausal status may further increase susceptibility due to reduced estrogen-mediated mucosal protection.

Glycemic control emerged as a significant determinant of infection frequency and severity. Patients with elevated HbA_{1C} levels experienced more recurrent and complicated UTIs. Similar findings have been reported, demonstrating a direct association between poor glycemic control and increased incidence of UTIs in patients with type 2 diabetes (Wang *et al.*, 2023). Chronic hyperglycemia not only enhances microbial growth through glucosuria but also impairs cytokine production and cellular immunity, leading to prolonged infection and delayed recovery. Association between risk factors (age above 65, female sex, uncontrolled diabetes (HbA_{1C}>8%), postmenopausal women, previous UTI, catheter, prostate abnormalities and renal calculi) and UTI occurrence/complications were evaluated descriptively.

Microbiological analysis in the present study revealed *Escherichia coli* as the predominant pathogen, followed by *Klebsiella pneumoniae* and other Gram-negative organisms. This pattern aligns with findings reported by Nicolle, who identified Gram-negative bacilli as the most common causative agents in diabetic UTIs (as cited in Farajnia *et al.*, 2009). However, a notable observation in the present study was the increased prevalence of antimicrobial resistance among isolated organisms. Recurrent antibiotic exposure, frequent hospital visits, and empirical therapy without culture confirmation may contribute to resistance development. Current guidelines emphasize the importance of urine culture and sensitivity testing to guide targeted therapy and prevent treatment failure.

Complicated UTIs, including pyelonephritis and recurrent infections, were more frequently observed among patients with a longer duration of diabetes and associated complications such as diabetic nephropathy and autonomic neuropathy. Autonomic neuropathy may result in impaired bladder emptying and urinary stasis, thereby increasing the risk of bacterial persistence and ascending infections. This finding is consistent with previous

studies highlighting the role of diabetic complications in increasing UTI risk (Wang *et al*., 2023).

Antimicrobial management primarily involved cephalosporins and carbapenems in both empirical and definitive therapy. Carbapenems were empirically used in patients presenting with severe or complicated infections, such as urosepsis, recurrent UTI and prior antibiotic exposure. However, antimicrobial stewardship principles support culture-guided de-escalation whenever feasible to minimize emergence of antimicrobial resistance.

Furthermore, the clinical and economic burden of UTIs in diabetic patients was evident through increased hospitalization rates and longer duration of stay among individuals with uncontrolled diabetes. Previous research has demonstrated that diabetes is associated with greater healthcare utilization and higher treatment costs in infection-related admissions (Nath *et al*., 2021). Effective glycemic management and early detection of infections may therefore reduce morbidity and overall healthcare burden.

A major strength of the study is that, although several studies on UTI in diabetic patients have been conducted worldwide, relatively very few have been reported from India. Also, the inclusion of both retrospective and prospective data provides a comprehensive assessment of real-world clinical practice and antimicrobial utilization patterns.

Limitations of the study

The present study has several limitations. First, it was a single-centre study with a relatively small sample size, which may limit the generalizability of the findings. Second, the limited number of complications and risk factor events restricted the ability to perform statistical analyses of associations between risk factors and clinical outcomes. Therefore, the findings are presented descriptively. Third, only a proportion of patients had culture-confirmed infections, limiting microbiological validation. In addition, incomplete documentation of prior antibiotic exposure and patient history may have introduced information bias. Future multicentre studies with larger sample sizes and comprehensive microbiological data can help validate these findings.

CONCLUSION

UTIs are common in diabetic patients, with commonly observed risk factors including age over 65, female sex, poor glycemic control, postmenopausal status, prior UTIs, catheter use, prostate issues, and urinary stones. Urosepsis was the most common complication, followed by pyelonephritis and cystitis. Predominant pathogens were gram-negative bacteria (*Escherichia coli*, *Klebsiella pneumoniae*), along with gram-positive species (*Enterococcus faecalis*, *Enterococcus faecium*). Empirical and definitive antibiotic therapies were guided by clinical findings and microbiological investigations, mainly using cephalosporins and carbapenems. An antibiogram was created on *Escherichia coli* and *Klebsiella pneumoniae* showing maximum sensitivity to aminoglycosides, carbapenems and cephalosporins.

ACKNOWLEDGEMENT

We extend our sincere thanks to the Principal of St. Joseph's College of Pharmacy and the faculty team of Pharmacy Practice along with the management of Lourdes Hospital, Post Graduate Institute of Medical Science & Research, Kochi, who provided us with their whole hearted support which led to the successful completion of this work.

ABBREVIATIONS

UTI: Urinary Tract Infection; **DM:** Diabetes Mellitus; **EMR:** Electronic Medical Records; **FBS:** Fasting Blood Sugar; **RBS:** Random Blood Sugar; **GRBS:** Glucometer-measured Random Blood Sugar; **HbA_{1C}:** Glycated Hemoglobin; **TMP/SMX:** Trimethoprim/Sulfamethoxazole.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

Alena Riya Sajan, Megha Anna Joy, and Neenu George contributed to data collection, data analysis, literature review, and manuscript drafting. Lakshmi Ramachandran conceptualized and supervised the study, critically revised the manuscript, and approved the final version. Romia Rodrigues facilitated clinical support, provided expert guidance, and reviewed the manuscript. All authors read and approved the final manuscript.

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Cite this article: Sajan AR, Joy MA, George N, Ramachandran L, Rodrigues R. Assessment of Risk Factors, Microbiological Pattern and Management of Urinary Tract Infection in Diabetic Patients. Indian J Pharmacy Practice. 2026;19(4):525-30.