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"Demographic and Microbiological Patterns of Urinary Tract Infections in Adult Type 2 Diabetic Patients: A Cross-Sectional Study"

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Abstract

This study analyzed the microbial profile of urinary tract infections in patients with type 2 diabetes admitted to a tertiary care hospital in western India. Demographic, microbiological, and antibiotic data were collected from 105 adult patients with type 2 diabetes and urinary tract infections using a prospective cross-sectional approach. Escherichia coli appeared to be the predominant micro organism with varying resistance patterns. There was a significant relationship between high HbA1c levels and the prevalence of infection. Given the high burden of multidrug-resistant pathogens, timely and cautious empirical treatment is imperative.

Keywords: Extended-Spectrum Beta-Lactamase (ESBL) and carbapenem-resistant Enterobacteriaceae (CRE), pyelonephritis, Type 2 diabetes mellitus, UTI.

Introduction

Diabetes refers to a heterogeneous group of metabolic disorders characterized by hyperglycemia due to defects in insulin action,

insulin secretion, or both. The increasing prevalence of diabetes worldwide has led to more complex and severe forms of infection, including urinary tract infections, which are particularly

common in patients with diabetes. Study presents the microbiological profile and antibiotic resistance patterns of UTIs among diabetic patients at a tertiary care hospital in UTI among diabetics can manifest as more complicated infections because it often combines with factors such as glycosuria, decreased immune response, and frequent infections with multi-drug resistant organisms (MDROs). This western India, where information is scarce regarding the same.

Objective: This study describes the demographic patterns, microbiological causes, and antibiotic resistance/susceptibility of urinary tract infections in adult patients with type 2 diabetes admitted to a tertiary care hospital. Our aim was to establish the relationship between antibiotic sensitivity patterns and duration, severity, and control of diabetes. In addition, they aimed to correlate morphological and radiographic changes in the urinary system with antibiotic susceptibility.

Methods

This was a prospective cross-sectional study conducted in a tertiary care center. The study included 105 adult patients with type 2 diabetes who presented with signs of urinary tract infection and had positive urine culture. Inclusion criteria were all adult men and women aged 30 years and above, with a diagnosis of type 2 diabetes, who were voluntarily admitted to a general ward or intensive care unit, and who agreed to sign an informed consent.

Exclusion criteria were all outpatients, pregnant women, patients with type 1 diabetes, congenital urinary tract malformations, or patients with a history of antibiotic-treated urinary tract infection within the last 3 months. Data collected included demographics, symptoms, diabetes treatment, and history of urinary tract infection. Urine samples were collected according to standard culture and susceptibility testing techniques. Statistical analysis was performed using SPSS software.

Results

Urinary tract infections in diabetic patients can present as more complicated infections as they are often associated with factors such as glycosuria, reduced immune response, and frequent infection with multidrug-resistant organisms (MROs). This study presents the microbiological characteristics and antibiotic resistance patterns of UTIs in diabetic patients in a tertiary care hospital in western India where information is scarce.

The mean age of the study population was 70.42 years, ranging from 46 to 92 years, with the majority of age groups being 71-80 years (32.38%) and 61-70 years (30.47%). Of the 105 participants, 54.28% were males and 45.71% were females. The mean BMI was 24.35 kg/m², varying between 20 and 30. Most patients had comorbidities, with hypertension being the most common (68.57%), followed by ischemic heart disease (24.76%) and chronic kidney disease (19.04%).

In terms of diabetes control, only 6.67% of participants had a fasting blood sugar level below 100 mg/dL, and 75.23% had a history of UTI. *E. coli* was the most frequently isolated organism (37.14%), followed by *Klebsiella pneumoniae* (27.62%).

Imaging results showed that 63.8% of patients had normal ultrasound findings, while 15.23% exhibited cystitis. Severe complications included acute kidney injury, observed in 8.57% of cases, and encephalopathy in 5.71%. Acute pyelonephritis was observed in 10 cases (9.52%), while emphysematous pyelonephritis was noted in approximately 1.9% of cases.

Among these severe cases, *E. coli* and *Klebsiella pneumoniae* were the organisms most frequently implicated. The study also recorded three mortalities, all in patients with high-risk profiles and multiple complications. Most of the patients were treated with meropenem empirically.

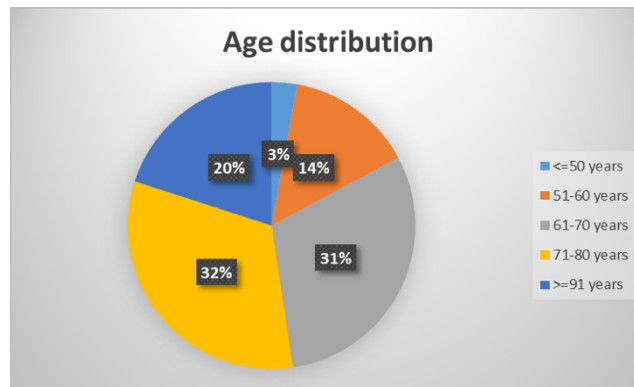


Figure 1: Age distribution

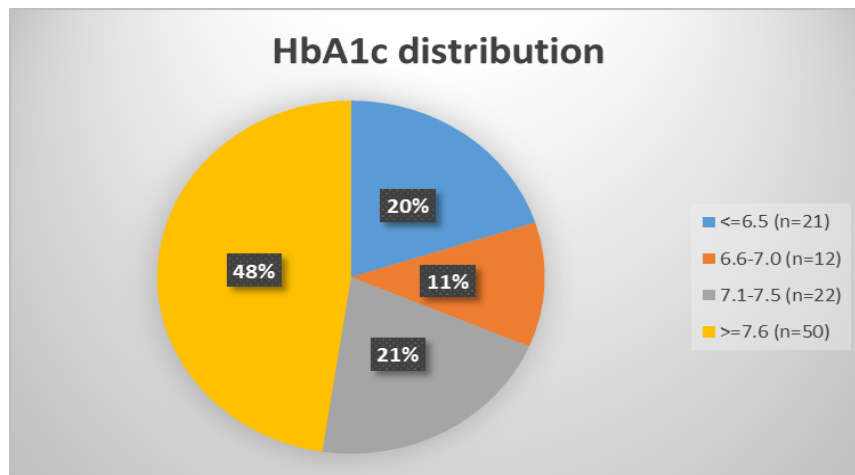


Figure 2:HbA1c distribution

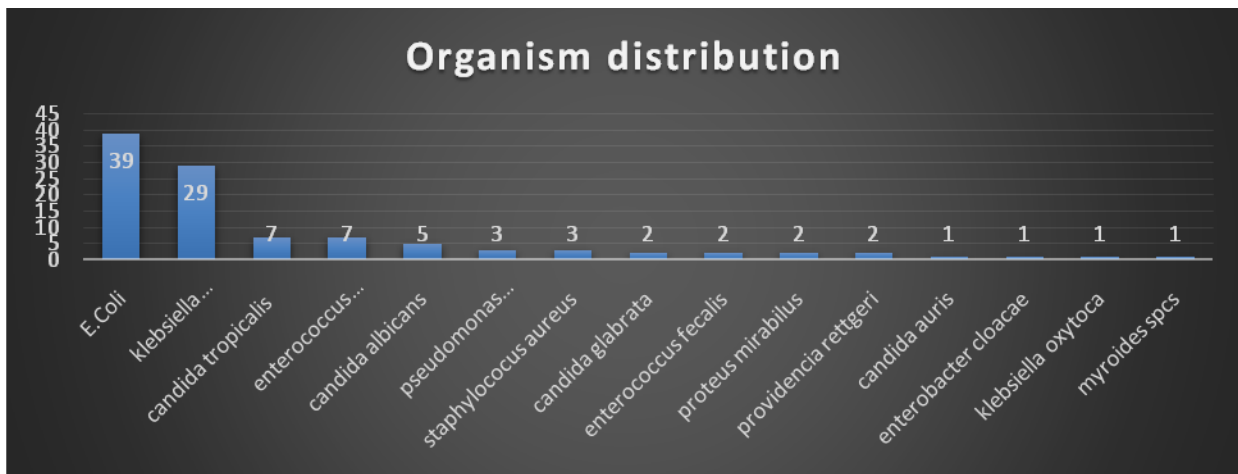


Figure 3: Organism wise distribution

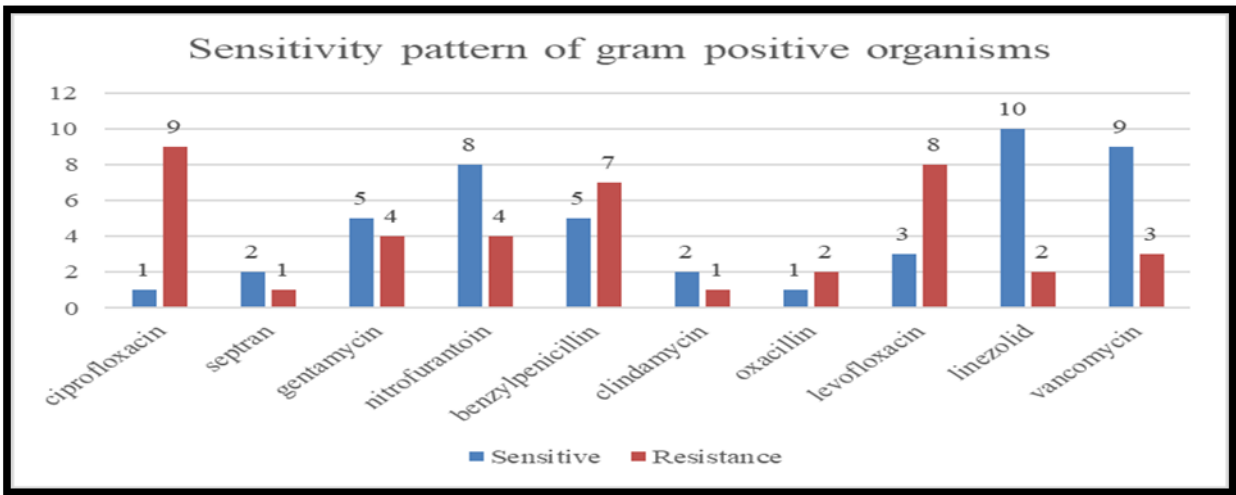


Figure 4: Sensitivity pattern of Gram-Positive organisms

Linezolid>vancomycin>nitrofurantoin>gentamycin=benzylpenicillin>levofloxacin>Trimethoprim-sulfamethoxazole =clindamycin> ciprofloxacin

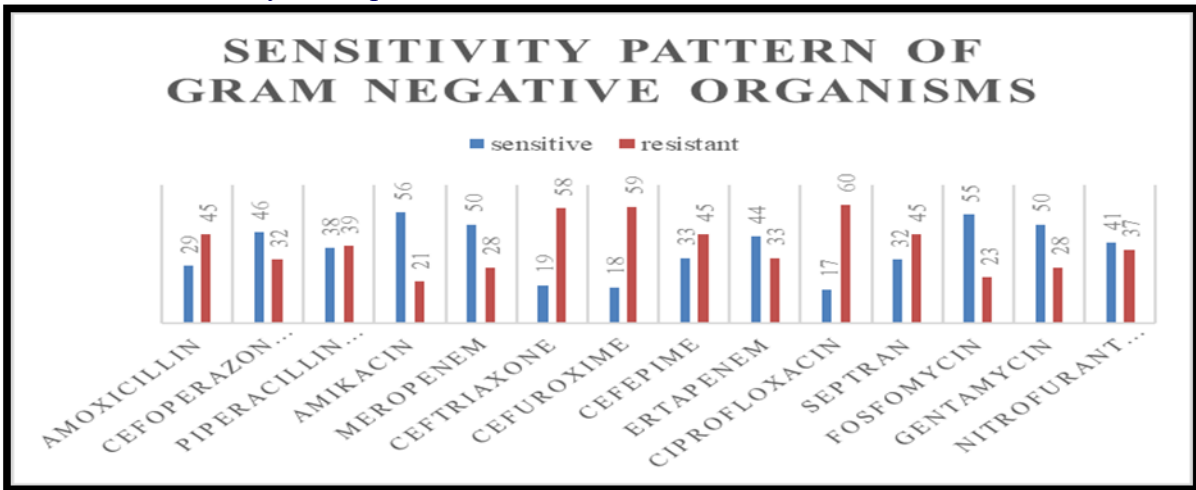


Figure 5: Sensitivity pattern of Gram-Negative organisms

Amikacin >Fosfomycin>meropenem = gentamycin >cefoperazonesulbactam>ertapenem> nitrofurantoin > piperacillin tazobactam>cefepime> Trimethoprim-sulfamethoxazole > amoxicillin>ceftriaxone > cefuroxime > ciprofloxacin.

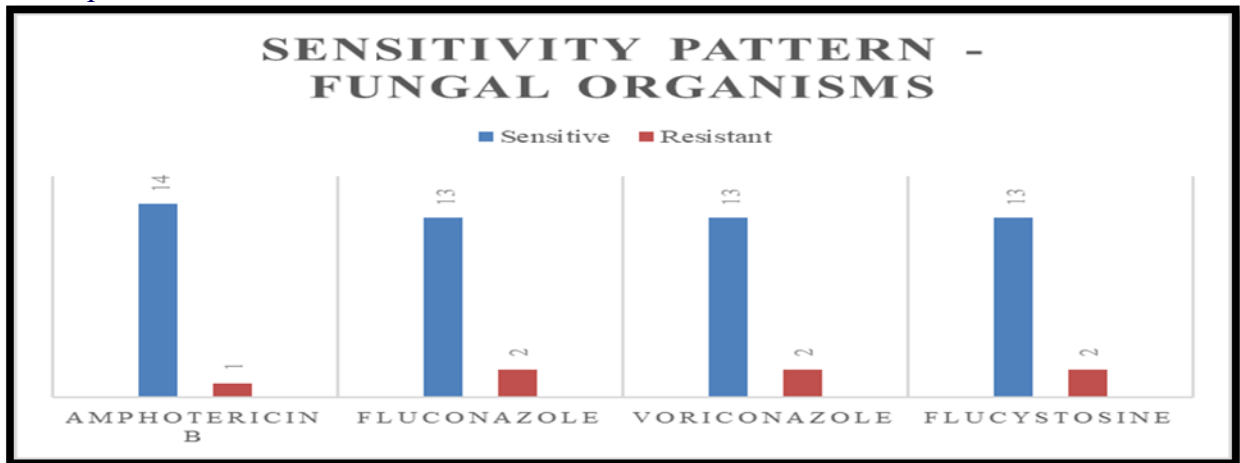


Figure 6: sensitivity pattern of fungal organisms

Discussion

The study results demonstrate that UTIs are very common among T2DM patients with *E. coli* being the most prevalent infection. This frequent isolation of MDROs in the population being studied is consistent with results elsewhere, where the numbers of ESBL-producing

Enterobacteriaceae and carbapenem-resistant Enterobacteriaceae (CRE) are high. Jagadeesan et al. (2022) (1) found similar trends in Northern India, with ESBL-forming pathogens such as *E. coli* and *Klebsiella* being more prevalent in diabetic patients and leading to severer infections than in non-diabetics. Studies by He et al. (2018) (2) and Alqasim et al. (2018) (3) demonstrate that UTIs are more likely to affect diabetic women, particularly those with poorly managed HbA1c. Our results are consistent with those of Nath et al. (2021) (4), where they found that elevated HbA1c (>7.5%) is associated with higher risk for UTI, further demonstrating the importance of hyperglycemia in favour of bacterial growth.

Wang et al. (2013) (5) showed that elevated urine glucose increases the viability of uropathogens, especially *E. coli* strains carrying virulence genes, further demonstrating the effects of poor glycemic control on UTI risk. A diabetic patient's immune impairment makes them prone to chronic MDRO infections, making treatment more challenging. Shill et al. (2010) (6) concluded that the predominant pathogen, *E. coli*, is becoming less responsive to cephalosporins and fluoroquinolones, curtailing treatment and increasing the likelihood of complications such as pyelonephritis and kidney abscesses. Similarly, Kumar et al. (2020) (7) noted the greater prevalence of pyelonephritis in diabetics than in the general population, further demonstrating the severe course of UTIs in these patients.

We also confirm evidence from international studies, showing that meropenem and fosfomycin were particularly sensitive to resistant pathogens, making them potential empirical candidates for diabetics with severe UTI symptoms. Both Nath

et al. (2021) and Shill et al. (2010) (4,6) have stated meropenem to be effective against ESBL and carbapenem-resistant organisms which call for the importance of resistance-based empirical therapy. The findings support the growing calls for local guidelines on empirical antibiotic use in high diabetic populations considering the scavenging resistances.

In 25 % of the study population, catheterization was found to be a risk factor for higher UTI recurrence. Catheter-induced UTIs (CAUTI) in diabetic patients were about highly difficult to treat due to outbreaks of biofilms forming organisms as reported by Coelho et al. (2007) and Santosh et al. (2019) (8,9). These organisms settle in the catheters biofilms; hence, they are protected from antibiotics and the immune system. Our observations suggest that catheterized patients have recurrent infections and therefore emphasize CAUTI prevention by the use of catheters as little as possible and maintaining sterile techniques of catheter insertion.

Although complications are rare, they are more common among diabetic patients with unregulated glycemic control, the most serious of which is often emphysematous pyelonephritis. Huang et al. Carvalho et al (2000) (10) reported that UTI complications can be aggravated by uncontrolled hyperglycemia leading to a recommendation for management of diabetes as part of the UTI management.

Enterococcus faecium had a greater prevalence (6.67) than *Enterococcus faecialis* in our study. The increased occurrence of enterococci in human and poultry isolates is mainly attributed to the massive use, often indiscriminately, of broad-spectrum antibiotics. Members of the genus *Enterococcus* are frequently implicated in nosocomial infections.

The prevalence rate of *Candida* infection was less in our study and commensurate with similar studies; that is, however not true for catheterized patients.

All these infections were usually susceptible to routine antifungal agents. In particular, the emergence of multidrug-resistant *Candida* strains is a growing concern, especially in immune compromised patients, those receiving broad-spectrum antimicrobials and prolonged hospitalization, elderly and diabetic patients.

In our study, meropenem was the most frequently chosen empirically, followed by piperacillin-tazobactam, cefoperazone sulbactam and ceftriaxone. This choice was likely due to a history of recurrent UTIs for the patient, their presenting symptoms at the time and a rising rate of ESBL prevalence: possible factors explaining why the overall mortality was lower in our hospital.

Thus, the current study reinforces the need of predictive antibiotic stewardship in the case of diabetic patients afflicted with a number of UTIs.²

Conclusion

The high level of resistant organisms makes it essential that update in clinical guidelines regarding empirical antibiotic therapy for UTIs is fasttracked, particularly so for patients living with diabetes mellitus, states the study. Seed Abstract: *E. coli* and *Klebsiella* species are prevalent uropathogens, making meropenem and fosfomycin among the most frequent use of potential first-line agents against them because gram-negative pathogens have dominated recently [6]. Correct therapy should be started as soon as possible for rapid recovery, and culture samples are always taken before starting therapy to allow treatment optimization and prevent resistance. For type 2 diabetic patients, empiric treatment should be with Fosfomycin or Meropenem in case of any suspicion for gram-negative infection. It is also important to realize the possibility of UTIs due to gram-positive organisms and yeasts such as *Candida*, so empirical treatment may not be sufficient.

In all catheterized patients, prevention strategies should be emphasized to reduce the use of antimicrobials and the harboring of multidrug resistance organisms, with special emphasis to vancomycin-resistant and *Candida auris* in regions of such high prevalence like in India with its challenges of isolating carbapenem-resistant enterobacteriaceae. Future studies should assess interventions to prevent UTIs in diabetics with important emphasis on strict glycemic control and prudent use of antibiotics to curtail the risk for resistance.

Limitations:

- Due to the limited sample size, there wasn't enough data to compare the clinical and laboratory characteristics of men vs. women, early vs. late elderly, or young, middle, and late elderly subgroups.
- History of sexual contact and benign prostatic hyperplasia was not accounted for.
- There was no control group included.
- The number of individual organism infections was quite low. Hence, detailed organism-specific analysis was possible in only in few organisms.

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