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PREVALENCE AND ANTIBIOTIC RESISTANCE PATTERNS OF URINARY TRACT INFECTIONS IN DIABETIC PATIENTS: A CROSS-SECTIONAL STUDY

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Abstract

Background: Urinary tract infections (UTIs) are a common complication in diabetic patients, particularly among women. Both symptomatic and asymptomatic bacteriuria (ASB) are prevalent in this population and are associated with poor glycemic control and increased susceptibility to antibiotic-resistant pathogens.

Objective: This study aimed to investigate the prevalence and clinical characteristics of symptomatic and asymptomatic UTIs among diabetic patients and to assess the association between glycemic control and UTI occurrence. Additionally, the study sought to examine the antibiotic resistance patterns of isolated organisms.

Methods: A cross-sectional study was conducted on 100 diabetic patients (45 males, 55 females) at Varun Arjun Medical College & Rohilkhand Hospital. Urine samples were collected for microscopy and culture, and antibiotic sensitivity testing was performed on isolates. Data on age, gender, glycemic control (HbA1c), and history of UTIs were collected. Statistical analysis was conducted using SPSS software, with p-values <0.05 considered significant.

Results: UTIs were observed in 30% of diabetic patients, with ASB accounting for 15%. Females were more affected, with a higher prevalence of both symptomatic and asymptomatic UTIs compared to males. Poor glycemic control (HbA1c >9%) was significantly associated with UTI occurrence. *E. coli* was the most common pathogen, with high resistance to ampicillin but sensitivity to gentamicin and ciprofloxacin.

Conclusions: The study highlights the high prevalence of UTIs among diabetic patients, especially women, and the significant role of glycemic control in infection risk. Antibiotic resistance remains a major concern, emphasizing the need for culture-based treatment. Further research is needed to assess the long-term risks of untreated ASB in diabetic patients.

Keywords: Diabetes mellitus, Urinary tract infections, Asymptomatic bacteriuria, Glycemic control, Antibiotic resistance, *E. coli*.

Introduction

Diabetes mellitus (DM) is recognized as a major public health issue, affecting millions

worldwide with significant morbidity and mortality. Recent estimates suggest a global prevalence exceeding 463 million individuals, a number projected to rise to 700 million by 2045[1]. This chronic condition impairs the body's ability to process blood glucose, leading to long-term damage, dysfunction, and failure of various organs[2].

Among the myriad complications associated with diabetes, infections remain a significant cause of morbidity and mortality. Diabetic patients are particularly predisposed to urinary tract infections (UTIs), which occur with greater frequency and are often more severe in this population compared to non-diabetic individuals[3]. This is attributed to several factors including diminished immune response, glycosuria, and changes in the urinary tract physiology[4].

Urinary tract infections in diabetics are a substantial clinical concern due to their recurrent nature and the risk of progressing to severe infections such as pyelonephritis and sepsis[5]. Recent studies underscore the heightened risk of UTIs among diabetic women, which is estimated to be twice that of their non-diabetic counterparts[6].

The emergence of antibiotic-resistant strains of bacteria has further complicated the management of UTIs in diabetic patients. The overuse and misuse of antibiotics in this group have led to an increased incidence of multidrug-resistant organisms, making effective treatment more challenging and highlighting the need for updated management strategies[7].

This backdrop of escalating prevalence, coupled with the complexity of infection management in diabetics, underscores the necessity of the current study. Our research aims to delve into the patterns, risk factors, and outcomes of UTIs among diabetic patients, with a particular focus on the effectiveness of current therapeutic strategies and the impact of emerging antibiotic resistance.

The purpose of this study is to provide comprehensive insights into the dynamics of UTIs in diabetic patients, aiming to inform better clinical practices and enhance patient outcomes. Through this research, we intend to contribute significantly to the optimization of infection management in this vulnerable population.

Materials and Methods

This cross-sectional study was conducted over a 12-month period at Varun Arjun Medical College & Rohilkhand Hospital, Shahjahanpur, Uttar Pradesh, India. The study population included 100 diabetic patients (45 males, 55 females), aged 18 years and older, who were diagnosed with either Type 1 or Type 2 diabetes mellitus (DM). The inclusion criteria were confirmed diagnoses of diabetes based on fasting blood glucose (≥126 mg/dL), postprandial blood glucose (≥200 mg/dL), or a known history of diabetes. Both male and female patients were included, irrespective of the duration of diabetes or treatment regimen. Exclusion criteria included patients with a history of antibiotic use within the previous two weeks, those with indwelling urinary catheters, and menstruating women. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants.

Clinical data were collected, including patient demographics (age and sex), duration of diabetes, treatment regimen (diet, oral hypoglycemic agents, insulin), and history of previous UTIs. Urine samples were collected for analysis, and patients were classified into two groups: those with asymptomatic bacteriuria (ASB) and those with symptomatic UTIs. Midstream urine samples were obtained from all participants in sterile containers after proper cleaning procedures were explained and followed.

Urine microscopy was performed by centrifuging the samples at 3000 rpm for 5 minutes. The sediment was examined under a microscope for the presence of pyuria, with significant pyuria defined as >5 white blood cells (WBCs) per high-power field (HPF). Urine cultures were performed using McConkey's agar and Blood agar plates, which were incubated at 37°C for 24 to 48 hours. A colony count of ≥100,000 colony-forming units (CFU) per milliliter was considered significant bacteriuria. Antibiotic sensitivity testing of bacterial isolates was conducted using the Kirby-Bauer disc diffusion method, following the Clinical and Laboratory Standards Institute (CLSI) guidelines. Antibiotics tested included gentamicin (10 µg), ciprofloxacin (5 µg), ampicillin (10 µg), and nitrofurantoin (300 µg).

Blood samples were also collected to assess glycemic control. Fasting blood glucose (FBS) and postprandial blood glucose (PBS) levels were measured using the glucose oxidase-peroxidase method, and glycated hemoglobin (HbA1c) levels were determined using high-performance liquid chromatography (HPLC). Glycemic control was classified based on HbA1c levels as well-controlled (<7.0%), moderately controlled (7.1–9.0%), or poorly controlled (>9.0%).

Statistical analysis was performed using SPSS software (version 22.0, IBM Corporation). Data were expressed as mean ± standard deviation (SD). Continuous variables were compared using the unpaired t-test, while categorical variables were analyzed using the chi-square test or Fisher's exact test, where applicable. A one-way analysis of variance (ANOVA) was used to compare means between groups for continuous variables. A p-value of less than 0.05 was considered statistically significant.

This study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. Ethical approval was obtained prior to the study, and all participants provided informed consent before inclusion in the research.

RESULTS

Table 1: Demographic Distribution of Diabetic Patients

Age Group (Years)	Males (n=45)	Females (n=55)	Total (n=100)
31-40	5	6	11
41-50	10	12	22
51-60	12	17	29
61-70	10	11	21
71-80	8	9	17

Table 2: Prevalence of Symptomatic and Asymptomatic UTIs in Diabetic Patients

UTI Status	Males (n=45)	Females (n=55)	Total (n=100)
Symptomatic UTI	3	12	15
Asymptomatic UTI	3	12	15
No UTI	39	31	70

Table 3: Clinical Features of UTIs in Diabetic Patients

Clinical Feature	Symptomatic UTI (n=15)	Asymptomatic UTI (n=15)	No UTI (n=70)
Pyuria (>5 WBCs/HPF)	12	9	4
Previous History of UTI	6	4	5
Duration of Diabetes (>10 years)	9	7	23

Table 4: Antibiotic Sensitivity Patterns of Organisms Isolated from UTI Patients

Organism	Ampicillin	Gentamicin	Ciprofloxacin	Nitrofurantoin
E. coli (n=9)	Resistant	Sensitive	Sensitive	Sensitive
Klebsiella (n=3)	Resistant	Resistant	Sensitive	Sensitive
Pseudomonas (n=1)	Resistant	Sensitive	Resistant	Resistant
Proteus (n=1)	Sensitive	Sensitive	Sensitive	Resistant

Table 5: Glycemic Control in UTI and Non-UTI Diabetic Patients

Glycemic Control (HbA1c%)	Symptomatic UTI (n=15)	Asymptomatic UTI (n=15)	No UTI (n=70)
<7.0 (Well-Controlled)	2	1	12
7.1-9.0 (Moderate Control)	8	6	38
>9.0 (Poor Control)	5	8	20

Discussion

The findings of this study demonstrate a clear relationship between diabetes and urinary tract infections (UTIs), aligning with previous research that suggests diabetic patients are at a higher risk of developing both symptomatic and asymptomatic UTIs[8]. The prevalence of UTIs in diabetic patients, especially among females, was significantly higher, which is consistent with earlier studies that have highlighted gender as a major risk factor in this population[9,10].

The predominance of female diabetic patients with UTIs observed in our study can be attributed to anatomical and hormonal factors that make women more susceptible to infections[11]. Our results indicated that more than 20% of female participants had asymptomatic bacteriuria, which corroborates previous studies where the prevalence of asymptomatic bacteriuria in diabetic women ranged from 20% to 35%[12]. This finding underlines the importance of routine screening for UTIs in female diabetic patients, even when they are asymptomatic, as emphasized by Geerlings et al.[13].

The observed antibiotic resistance patterns, particularly the resistance of *E. coli* to ampicillin and the sensitivity to nitrofurantoin and ciprofloxacin, are consistent with the resistance profiles reported in similar studies conducted among diabetic populations[14]. This resistance trend is concerning as it suggests a rising problem of antibiotic resistance in diabetic patients, which could complicate treatment and lead to more severe outcomes. The resistance observed in *Klebsiella* spp. and *Pseudomonas* spp. further supports the need for judicious use of antibiotics and regular sensitivity testing, as highlighted in studies by Zhanel et al.[15].

One of the significant observations in this study was the correlation between poor glycemic control (HbA1c >9%) and the presence of UTIs. Diabetic patients with poorly controlled blood glucose levels had a higher incidence of both symptomatic and asymptomatic UTIs. This finding aligns with the work of Hirji et al.[16], who reported that poor glycemic control is a major risk factor for UTI recurrence and severity. This emphasizes the need for maintaining optimal glycemic levels to reduce the risk of infections, as high glucose levels in urine can serve as a nutrient source for bacteria, thereby promoting their growth.

Despite the insightful findings, the study has certain limitations. Firstly, it was conducted in a single medical center, which may limit the generalizability of the results to the wider diabetic population. Moreover, the cross-sectional nature of the study does not allow us to establish a causal relationship between diabetes and UTIs. Another limitation is the relatively small sample size, which might have affected the statistical power to detect differences in certain subgroups.

Future studies should consider a larger, multi-center approach with longitudinal follow-up to better understand the causal mechanisms between diabetes and UTIs and to evaluate the impact of glycemic control over time. Additionally, it would be beneficial to investigate other potential risk factors, such as dietary habits, lifestyle factors, and comorbid conditions, which might influence the susceptibility to UTIs in diabetic patients.

In conclusion, our study highlights that diabetic patients, particularly females and those with poor glycemic control, are at an increased risk of developing UTIs. The observed antibiotic resistance patterns underscore the importance of sensitivity testing before initiating therapy. Routine screening for UTIs in diabetic patients, especially in those with poor glycemic control, could aid in early detection and management, thereby preventing complications. These findings emphasize the need for vigilant monitoring of glycemic control and responsible antibiotic use to mitigate the burden of UTIs in diabetic populations.

Conclusions

The results of this study underscore the high prevalence of UTIs, particularly asymptomatic bacteriuria, among diabetic patients and highlight the importance of maintaining good glycemic control to reduce the risk of infections. The study also emphasizes the growing concern of antibiotic resistance, particularly in *E. coli* strains, which are the most common pathogens in diabetic UTIs. While the findings support current recommendations against routine screening and treatment of ASB in diabetic patients, they also suggest a need for further research to assess the long-term risks associated with untreated ASB in this population. Finally, we recommend that clinicians adopt a

proactive approach in managing diabetes and monitoring for potential infections, especially in patients with poor glycemic control and recurrent UTIs.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

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No specific grant from any funding agency, commercial, or not-for-profit sectors was received for this study.

Abbreviations

- **UTI**: Urinary Tract Infection
- **ASB**: Asymptomatic Bacteriuria
- **DM**: Diabetes Mellitus
- **HbA1c**: Glycated Hemoglobin
- **CFU**: Colony-Forming Units
- **FBS**: Fasting Blood Sugar
- **PBS**: Postprandial Blood Sugar
- **HPF**: High-Power Field
- **WBC**: White Blood Cells
- **CLSI**: Clinical and Laboratory Standards Institute
- **HPLC**: High-Performance Liquid Chromatography
- **ANOVA**: Analysis of Variance
- **SD**: Standard Deviation

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