Section: Skin & V.D

Original Research Article

ASSESSING URINARY TRACT INFECTIONS IN DIABETES MELLITUS PATIENTS: A COMPREHENSIVE HOSPITAL-BASED STUDY IN EASTERN INDIA

Udayanath Behera[1], Deepak Ranjan Nayak[2], Sandeep Kumar Tripathy [3], Manasi Mishra[4]

[1]Assistant Professor, Department of Anaesthesia, SCB Medical college and Hospital, Cuttack, Odisha, India
[2]Assistant Professor, Department of Surgery, SCB Medical college and Hospital, Cuttack, Odisha, India
[3]Assistant Professor, Department of Paediatrics, SLN Medical college & Hospital, Koraput, Odisha, India.
[4]Assistant Professor, Department of Skin & V.D. Fakir Mohan Medical College & Hospital, Balasore, Odisha, India.

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Corresponding Author:
Dr. Manasi Mishra,
Email: manasi.mishra004@gmail.com

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Abstract

Background: Diabetes Mellitus (DM) is a metabolic disorder prevalent in contemporary society, leading to a decrease in lifespan, considerable morbidity as a result of diabetes-related microvascular issues, an elevated susceptibility to macrovascular complications, and a reduction in overall quality of life. In individuals with diabetes, urinary tract infection (UTI) is a frequently occurring infection. DM disrupts the genitourinary system, and UTI can result in severe complications such as discomfort during urination, organ impairment, and, in severe cases, fatality due to complex UTI. The present study aimed to investigate the types of UTI-causing pathogens, their connection with the clinical characteristics of diabetic patients, and their susceptibility to various antimicrobial agents. **Materials and Methods:** We conducted a one-year cross-sectional descriptive study at a tertiary care hospital. Our study included a total of 70 DM patients with UTI who met the inclusion criteria. Our research tools encompassed questionnaires, clinical examinations, and various investigations. The grading of pus cells into specific categories served as the dependent variable, while clinical parameters (including DM duration, glycosylated hemoglobin levels, history of previous UTI episodes, and past catheterization) were considered independent variables. **Result:** The incidence of UTI in individuals with DM was most frequently observed in women aged 50 and above. Fever emerged as the most common symptom, and UTI was most prevalent in patients with a history of diabetes lasting less than 10 years. E. coli was the predominant pathogen isolated in UTI cases. Gram-negative bacilli displayed susceptibility to imipenem, gentamycin, and nitrofurantoin, while Gram-positive cocci showed sensitivity to vancomycin, linezolid, and tetracycline in the majority of patients. Furthermore, we observed a significant association between poor glycemic control and the presence of a higher quantity of pus cells in urine. **Conclusion:** The current investigation found that women and those over 50 had a primarily higher prevalence of urinary tract infections (UTI) among those with diabetes mellitus (DM). This result is consistent with a 2009 study by Janifer J. et al. that found that female diabetes patients had a noticeably greater prevalence of lower UTI.

INTRODUCTION

Diabetes Mellitus (DM) is a metabolic ailment prevalent in modern society. It is primarily characterized by elevated blood sugar levels, leading to the risk of microvascular damage, which can result in conditions such as retinopathy, nephropathy, and neuropathy. DM is associated with a reduction in life expectancy, considerable morbidity arising from diabetes-specific microvascular complications, an

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increased susceptibility to macrovascular issues, and an overall decrease in the quality of life.[1,2]

Urinary tract infection (UTI) is a commonly observed infection in diabetic patients. UTIs are prevalent in clinical practice and contribute significantly to morbidity and healthcare expenses. Patients with diabetes are reported to have a higher incidence of asymptomatic bacteriuria, acute pyelonephritis, and UTI-related complications.[3] DM affects the genitourinary system, making UTIs a potential source of severe complications, including dysuria, organ damage, and even fatal outcomes in cases of complicated UTIs such as pyelonephritis.[1-5]

Throughout the lifetime of individuals living with diabetes, urinary tract infections (UTIs) consistently rank among the top ten concurrent or complicating health conditions. The clinical and economic implications of UTIs in the context of diabetes are substantial. Moreover, the emergence of multi-drug-resistant (MDR) bacterial strains is on the rise, underscoring the need to assess the prevalence of UTIs in diabetic patients and explore the susceptibility of bacterial isolates to antimicrobial agents. This investigation is of paramount importance for epidemiologists, scientists, healthcare planners, and clinicians alike.

As a result, the current study was undertaken to identify the pathogens responsible for UTIs in diabetic patients, examine their association with the patients' clinical profiles, and evaluate their susceptibility to various antimicrobial treatments. This research aims to provide valuable insights into managing UTIs in individuals with diabetes and addressing the growing concern of antimicrobial resistance.

Objectives

1. To analyze the clinical characteristics of patients with diabetes mellitus and urinary tract infections (UTIs) admitted to a tertiary care hospital.
2. To assess the bacteriological aspects, including the identification of the types of organisms (bacteria) isolated and their antibiotic susceptibility.
3. To determine potential associations between key clinical features and bacteriological variables, shedding light on the relationship between patient profiles and UTI-causing pathogens and their antibiotic sensitivity.

MATERIALS AND METHODS

Study Design: This research employed a cross-sectional, descriptive-observational study design.

Study Participants, Setting, and Period: The study included diabetic patients with urinary tract infections (UTIs) who were admitted to the medical wards of Fakir Mohan Medical College and Hospital, Balasore, Odisha, a tertiary care facility. The study spanned a one-year period.

Data Analysis: We calculated percentages to summarize qualitative data. Chi-square analysis was applied to examine the relationships within qualitative data. The study's dependent variables were based on the grading of pus cells, categorized into three distinct levels, while independent variables included clinical parameters like the duration of diabetes mellitus (DM), glycosylated hemoglobin levels, history of previous UTI episodes, past catheterization, and a history of urinary obstruction. The statistical significance of our findings was determined using p-values, with results below 0.05 considered significant, below 0.001 denoted as highly significant, and below 0.0001 regarded as very highly significant. In situations where the expected count in a cell was less than 5, we applied the Fischer's Exact test for analysis.

DM is defined by the following criteria: Fasting plasma glucose of ≥ 7.0 mmol/l (126 mg/dl).

2-hour plasma glucose of ≥ 11.1 mmol/l (200 mg/dl).

Significant Pyuria: The presence of more than 10 pus cells per high-power field in a centrifuged fresh urine specimen.

Significant Bacteriuria: Defined as having more than 105 microorganisms per ml of urine.

Asymptomatic Bacteriuria (ASB): ASB is defined as the presence of at least 105 colony-forming units of the same urinary tract pathogen per ml in two consecutive clean voided midstream urine cultures, without symptoms of a urinary tract infection (UTI).

Glycosylated Hemoglobin (HbA1c): Diabetic patients are categorized into two groups based on their glycosylated Hb levels:

- HbA1c levels of ≤ 7% (indicating better glycemic control)
- HbA1c levels of > 7% (indicating poorer glycemic control)

Urinary Tract Infection (UTI) Assessment, Culture, and Sensitivity: The evaluation of UTI in diabetic patients followed the clean catch method, involving the collection of midstream urine samples in sterile containers following thorough cleaning of the peri-meatal area. In some instances, 24-hour total urine samples were gathered to assess renal excretory and concentration capabilities.

Microscopic examination of uncentrifuged urine wet films was conducted to identify the presence of pus cells, erythrocytes, microorganisms, and casts. Standard microbiological procedures were employed for sample processing. The MacConkey's Agar plate was utilized for culturing microorganisms. Bacterial identification was based on colony color and the fermentation of various sugars such as glucose, sucrose, lactose, maltose, mannitol, and xylose. Gram staining and species confirmation were achieved through in-house biochemical tests.

Gram-negative organisms, including E. coli, Klebsiella pneumonia, and Proteus mirabilis, were distinguished via microscopy. E. coli was identified by medium-sized colonies with a pink-to-red hue, confirmed through a positive indole test. In contrast, K. pneumonia exhibited large, pink-to-mauve colonies, with confirmation through negative oxidase and indole tests. P. mirabilis was characterized by

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small, pale-to-colorless colonies that tested positive for indole and urease but negative for oxidase. Enterococcus faecalis, the sole Gram-positive microorganism isolated, was identified by the presence of small turquoise colonies with coccoid morphology, which tested negative for catalase and positive for bile esculin.

To assess antimicrobial susceptibility, the disc diffusion method was employed. Isolate colonies were suspended in normal saline to a 0.5 McFarland standard, and the suspensions were inoculated onto Muller-Hinton agar using disposable sterile swabs. Incubation was carried out for 18–24 hours, adhering to the Clinical and Laboratory Standards Institute (CLSI) guidelines. Control strains E. coli ATCC® 25922 and E. faecalis ATCC® 29212 were used. Antimicrobial susceptibility and resistance were determined by measuring the zone diameter of isolate growth according to CLSI guidelines.

Gram-negative isolates were tested against a range of antibiotics, including amikacin, ampicillin, ampicillin/sulbactam, piperacillin, piperacillin-tazobactam, cefotaxime, ceftazidime, cefoxitin, norfloxacin, nitrofurantoin, gentamicin, ciprofloxacin, levofloxacin, and imipenem. Gram-positive isolates underwent testing with oxacillin, cefoxitin, erythromycin, linezolid, vancomycin, teicoplanin, rifampin, chloramphenicol, cotrimoxazole, ciprofloxacin, gentamicin, amikacin, and tetracycline. The antibiotic sensitivity was reported as either R (Resistant), I (Intermediate), or S (Sensitive).

RESULTS

A total of 70 patients were enrolled in the study. Among these patients, 54 (77%) were females with diabetes mellitus, while 23 (16%) were males with diabetes mellitus. The occurrence of urinary tract infection was more prevalent in the age group of over 50 years (31%), followed by 41-50 years (29%), 31-40 years (23%), and 30 years and younger (17%). In terms of family history, 27 patients (39%) had a family history of hypertension, 17 (24%) had a family history of both diabetes and hypertension, 14 (20%) had a family history of diabetes only, and 12 (17%) had no family history of systemic diseases. Out of the 70 patients, 57 (81%) had a normal BMI, 7 (10%) were classified as overweight, and 2 (3%) were categorized as obese. Additionally, 48 (69%) of the patients had hypertension, while 22 (31%) were normotensive.

An analysis of urinary tract infection symptoms revealed that fever was the most common symptom, affecting 91% of the patients. Dysuria was the next most frequent symptom, reported by 69% of the patients. Abdominal pain, suggestive of pyelonephritis, was present in 26% of the patients, while lower abdominal pain (cystitis) was observed in 14% of cases. Renal colic was experienced by 16% of the cases, and numbness and tingling of extremities were reported by 29% of the patients. In [Figure 1], the data indicates that the majority of urinary tract infections were caused by the Escherichia coli (E. coli) group of organisms, accounting for 52 (74%) cases.

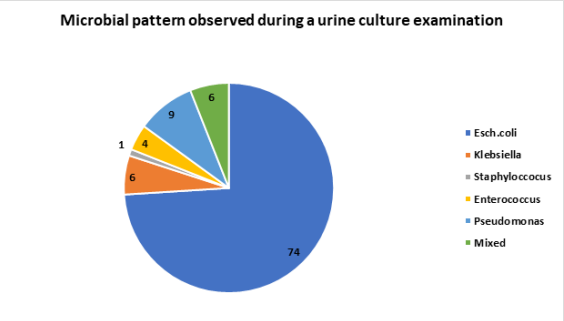

Figure 1: The Microbial pattern observed during a urine culture examination.

Six (9%) patients had infections attributed to Pseudomonas, while 4 (6%) patients each had mixed infections and Klebsiella infections. Four percent of cases were linked to Enterococcus, and 1% were associated with Staphylococcus infections.

Table 1: Antibiotic sensitivity pattern in DM patients

Organism isolated	Patients Sensitive to	Patients Resistance to
Esch.coli	Imipenem, Gentamycin, Amikacin, Tazobactum with Piperacillin, Cefoperazone with Sulbactum, Ticarcillin with Clavullinic acid, Nitrofurantoin, Cefotaxime	Nalidixic acid, Norfloxacin, Ciprofloxacin, Amoxclav, Lomefloxacin, Cotrimazole, Cephalexin
Klebsiella	Imipenem, Tazobactum with Piperacillin, Cefoperazone with Sulbactum, Gentamycin, Amikacin, cefoxitin, Nitrofurantoin, Cefotaxime	Nalidixic acid, Norfloxacin, Ciprofloxacin, Amoxclav, Lomefloxacin, Cotrimazole, Cephalexin
Staphylococcus	Vancomycin, Linezolid, tetracycline, Nitrofurantoins, Norfloxacin	Chloramphenicol and Oflaxacin
Enterococcus	Vancomycin Linezolid, tetracycline, Nitrofurantoins, Norfloxacin	Chloramphenicol and Oflaxacin
Pseudomonas	Imipenem, Gentamycin, Amikacin, Tazobactum with Piperacillin, Cefoperazone with Sulbactum, Ticarcillin with Clavullinic acid, Nitrofurantoin.	Nalidixic acid, Norfloxacin, Ciprofloxacin, Amoxclav, Lomefloxacin, Cotrimazole, Cephalexin

Table 2: Association of variables with pus cells on microscopy

Variables	Number (n=70)	Grading of pus cells on urine microscopy			Chi Square/ Exact value	P value
		11-20	21-30	>=31		
Duration of Diabetes	<= 10 years	43	10	10	3.9	p=0.173
	>10 years	2	1	4		

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Glycemic control HbA1c	<=7%	41	0	0	56	p<0.0001
	>7%	1	14	14		
Past Urethral obstruction	Yes	4	4	5	3.403	p=0.194
	No	37	11	9		
Past Urethral instrumentation	Yes	1	0	3	4.124	p=0.183
	No	41	14	12		
Past Urinary infections	Yes	5	1	5	4.007	p=0.176
	No	37	13	10		
Past urethral catheterization	Yes	1	0	3	4.123	p=0.189
	No	40	15	12		

In [Table 1], the data shows that Gram-Negative Bacilli (GNB) demonstrated sensitivity to multiple antibiotics, including imipenem, gentamicin, nitrofurantoin, tazobactam with piperacillin, cefoperazone with sulbactam, cefotaxime. In contrast, Gram Positive Cocci (GPC) displayed sensitivity to various antibiotics such as vancomycin, linezolid, tetracycline, nitrofurantoin, and norfloxacin in the majority of the patients.

[Table 2] illustrates the association of variables with the presence of pus cells on microscopy. Notably, glycemic control, as measured by HbA1c levels, displayed a significant association with an increased number of pus cells observed on microscopy. This finding suggests that the level of glycemic control may be linked to the severity of the urinary tract infection as indicated by the presence of pus cells.

DISCUSSION

The present study revealed that the incidence of urinary tract infections (UTI) in individuals with diabetes mellitus (DM) was predominantly higher in women and in those aged 50 years and older. This finding aligns with research by Janifer J. et al. in 2009, which also observed a significantly higher prevalence of lower UTI in female diabetic patients.[6,7]

Among the symptoms, fever was the most common, followed by dysuria. Hoepelman A. (2003) discussed that lower UTIs often present with classical symptoms such as dysuria, frequency, urgency, hematuria, and abdominal discomfort, while upper tract involvement, such as acute pyelonephritis, is characterized by fever, chills, flank pain, costovertebral angle tenderness, and other general symptoms like nausea and vomiting.[8,9]

Furthermore, our study indicated that UTIs were more common in patients with a history of diabetes lasting less than 10 years. A retrospective study by Gorter K. et al. in the Netherlands also found that women with diabetes, particularly with a duration of diabetes exceeding 5 years, were at risk of recurrent UTIs (crude OR 3.6; 95% CI 2.5–5.1) when compared to women without diabetes.[10,11]

The study revealed a significant association between glycemic control, as measured by HbA1c levels, and the presence of pus cells on microscopy (p<0.0001). This observation is in line with research conducted by Patterson J. et al. in 1997, which identified older age, duration of DM, and the level of DM control as risk factors for UTIs among diabetic patients. Nearly half of the patients in our study had a predisposing cause for UTI. Corson C. et al. in 2004 found that patients with long-term catheterization often experience UTIs caused by organisms that produce biofilms, making eradication even more challenging.[12,13]

In terms of causative organisms, E. coli was the most commonly isolated pathogen in UTI cases in our study. This corresponds with Baqai R. et al.'s research in 2008, which reported E. coli as the major isolate in diabetic patients with UTIs, followed by S. aureus, S. saprophyticus, Proteus spp., E. fecalis, and Candida.[14]

In the current study, several key findings emerged. The incidence of urinary tract infections (UTI) in individuals with diabetes mellitus (D.M.) was notably higher in women, particularly those aged 50 years and older. The most prevalent symptom observed among the majority of cases was fever, followed by dysuria. Furthermore, UTI was more commonly observed in patients with a history of diabetes lasting less than 10 years, and nearly half of the patients had a predisposing cause for UTI. Regarding urine analysis, the majority of patients exhibited pus cells in the range of 11-20 per high-power field (HPF). The most frequently isolated organism in UTI cases was Escherichia coli (E. coli).[15]

Moreover, the study found that Gram-negative bacilli displayed sensitivity to antibiotics such as imipenem, gentamicin, nitrofurantoin, tazobactam with piperacillin, cefoperazone with sulbactam, and cefotaxime. Gram-positive cocci, on the other hand, were sensitive to antibiotics including vancomycin, linezolid, tetracycline, nitrofurantoin, and norfloxacin in most patients. Notably, poor glycemic control was significantly associated with a higher number of pus cells in the urine. These findings shed light on the epidemiology of UTIs in diabetic patients and provide insights into the antimicrobial sensitivity patterns of the causative organisms, emphasizing the importance of glycemic control in managing UTIs in this patient population.

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CONCLUSION

The current investigation found that women and those over 50 had a primarily higher prevalence of urinary tract infections (UTI) among those with diabetes mellitus (DM). This result is consistent with a 2009 study by Janifer J. et al. that found that female diabetes patients had a noticeably greater prevalence of lower UTI

Fever was the most prevalent symptom, followed by dysuria. Hoepelman A. (2003) talked about how upper tract involvement, like acute pyelonephritis, is characterised by fever, chills, flank pain, costovertebral angle tenderness, and other general symptoms like nausea and vomiting. Lower UTIs, on the other hand, frequently present with classical symptoms like dysuria, frequency, urgency, hematuria, and abdominal discomfort.

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