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Incidence and Treatment of Urinary Tract Infection in Diabetes Mellitus and Non-Diabetes Mellitus patients in a Tertiary Care Hospital

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KEYWORDS

Diabetes Mellitus, Urinary Tract Infection, Hyperglycemia, Comorbidities, Antimicrobial Resistance

ABSTRACT:

Introduction:

Urinary tract infections (UTIs) are a significant health concern, particularly in diabetic populations due to the interplay of hyperglycemia and immune dysfunction. This study investigates the incidence, clinical manifestations, and economic burden of UTIs in diabetic versus non-diabetic patients at a tertiary care hospital in India, a country with a high prevalence of diabetes.

Methods:

This prospective observational study included 235 patients, divided into diabetic (n=172) and non-diabetic (n=63) groups. Data on demographics, clinical symptoms, laboratory results, and treatment costs were collected. Statistical analyses were performed to identify significant differences in UTI incidence, symptom severity, and economic impact between the two groups.

Results:

Diabetic patients exhibited a significantly higher incidence of UTIs (73.2%) compared to non-diabetic patients (26.8%). They also presented with more severe symptoms, such as high fever, dysuria, and frequent urination. Laboratory findings indicated more pronounced abnormalities in diabetic patients, including elevated white blood cell counts and electrolyte imbalances. The direct treatment costs were higher in the diabetic group (₹91,029) than in the non-diabetic group (₹70,476), reflecting the complexity of managing UTIs in diabetic patients.

Conclusion:

The study highlights the increased susceptibility, severity, and economic burden of UTIs in diabetic patients. Effective management strategies tailored to this high-risk group are crucial to improving clinical outcomes and reducing healthcare costs, particularly in regions with a high prevalence of diabetes.

1. Introduction

Urinary tract infections (UTIs) remain a significant public health concern globally, especially among populations with predisposing conditions such as diabetes mellitus (DM).[1] UTIs are among the most common bacterial infections, affecting millions of individuals worldwide, with women being disproportionately impacted.[2] In diabetic individuals,

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the risk of UTIs is notably higher due to the complex interplay between hyperglycemia, immune dysfunction, and other complications arising from poor glycemic control.[3] As India currently holds the title of the diabetes capital of the world, with over 77 million individuals diagnosed as of 2021, the increasing burden of UTIs in this population necessitates comprehensive studies aimed at understanding and managing these infections more effectively.[4,5]

Diabetes mellitus, particularly Type 2 diabetes, has been recognized as one of the fastest-growing chronic diseases globally. Projections indicate that the number of people affected by diabetes in India will rise to an estimated 134 million by 2045.[6] This increase will undoubtedly exacerbate the prevalence of infections, including UTIs, which are already more common in diabetic patients. The primary reason for the higher incidence of UTIs in diabetic individuals is multifactorial, with hyperglycemia playing a central role.[7] Elevated blood sugar levels can lead to glycosuria, a condition where glucose is present in the urine, creating an environment conducive to bacterial growth. Additionally, diabetes compromises both the innate and adaptive immune responses, further predisposing patients to infections like UTIs.[8]

UTIs can be classified into two broad categories: uncomplicated and complicated. Uncomplicated UTIs occur in individuals without structural or functional abnormalities of the urinary tract, whereas complicated UTIs are associated with underlying conditions such as kidney stones, benign prostatic hyperplasia, or long-term catheter use.[9] Diabetic patients are more likely to experience complicated UTIs due to the chronic nature of their condition and the associated risk factors, including poor glycemic control, autonomic neuropathy leading to incomplete bladder emptying, and increased susceptibility to uropathogens.

The incidence of UTIs in diabetic patients is not only higher but also tends to present with more severe symptoms and outcomes compared to non-diabetic individuals.[10] Studies have shown that diabetic patients experience recurrent UTIs at a higher rate and are more likely to develop complications such as pyelonephritis, renal abscesses, and urosepsis. Moreover, the frequent use of broad-spectrum antibiotics in this population has led to an alarming increase in antimicrobial resistance, complicating treatment protocols and prolonging hospital stays.[11] The economic burden of UTIs in diabetic individuals is substantial, with extended hospitalizations, increased healthcare utilization, and the need for more intensive treatments contributing to the overall costs. In non-diabetic individuals, UTIs are generally easier to manage, with standard antibiotic therapies proving effective in most cases.[12] However, in diabetic patients, the combination of impaired immune function, recurrent infections, and antibiotic resistance makes the management of UTIs a more complex and costly endeavor. Furthermore, diabetic patients are more prone to asymptomatic bacteriuria, which, if left untreated, can progress to symptomatic UTIs and further complicate treatment outcomes.[13]

This study aims to investigate the incidence and treatment costs associated with UTIs in diabetic and non-diabetic patients at a tertiary care hospital. By examining the prevalence of UTIs in these two groups, the study seeks to identify any significant correlations between diabetes and UTI susceptibility, as well as to explore the impact of comorbidities, such as hypertension and chronic kidney disease, on infection rates and treatment outcomes. Additionally, the study will analyze the direct and indirect costs of UTI treatment in both diabetic and non-diabetic patients, providing valuable insights into the economic burden of these infections and the potential for cost-saving interventions through improved management strategies. The findings of this study will contribute to the growing body of literature on the management of UTIs in diabetic populations and will provide healthcare professionals with evidence-based recommendations for optimizing treatment protocols. Ultimately, reducing the incidence of UTIs in diabetic patients will not only improve patient outcomes but also help to alleviate the financial strain on healthcare systems, particularly in countries like India where diabetes is highly prevalent.

2. METHODOLOGY

Study Design

The study followed a prospective observational design, which was selected to observe and document the incidence and treatment outcomes of urinary tract infections (UTIs) in both diabetic and non-diabetic patients in a real-world clinical setting. This design

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allows for the collection of data from patients as they naturally progress through their treatment without any intervention or manipulation from the research team, ensuring the validity of clinical observations. The study's prospective nature enables the tracking of UTI development and outcomes as they unfold over time, particularly important for understanding the differences between diabetic and non-diabetic populations.

Study Setting

This research was conducted at Sudha Multispeciality Tertiary Care Hospital located on Perundurai Road, Erode, which serves as a major regional center for treating patients with various urological and diabetic conditions. The hospital was chosen because of its diverse patient population and strong emphasis on treating both diabetes and urinary tract infections, providing the necessary infrastructure and expertise to support this study.

Study Population

The study included a total of 235 patients, who were stratified into two groups: those with diabetes mellitus and those without. These participants were randomly selected using a simple random sampling method to avoid bias and ensure that the sample was representative of the hospital's patient population. The sample size was calculated using the OpenEpi software (version 2.1.3) with a confidence level of 95% and a power of 80%, resulting in a required sample size of 220 patients. To account for any potential dropouts or incomplete data, the sample size was increased by 5%, resulting in the final count of 235 participants.

Study Duration

The study was carried out over a six-month period, beginning in March 2022 and concluding in August 2022. This duration allowed for sufficient time to collect comprehensive data on UTI incidences, treatments, and patient outcomes while also accommodating seasonal variations that may influence infection rates.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Male and female patients between the ages of 18 and 75.
- Patients diagnosed with diabetes mellitus (Type 1 and Type 2).
- Patients presenting with typical symptoms of urinary tract infections, such as dysuria, frequency, or urgency.
- Menopausal women and those using birth control methods (e.g., diaphragms).
- Patients diagnosed with trichomoniasis, chlamydiosis, or gonorrhea as comorbid conditions.

Exclusion Criteria:

- Pregnant women due to the complexities associated with gestational diabetes and UTI risks.
- Patients undergoing treatment for cancer or those with significant cognitive impairments or psychiatric conditions.
- Patients with suspected ovarian inflammation or overactive bladder.

Data Collection

Data was meticulously gathered from patient medical records and through structured patient interviews using a detailed Data Collection Proforma. This proforma was specifically designed for the study and pre-tested to ensure it captured all relevant information. The collected data included:

- Demographics: age, gender, occupation, and medical history.
- Clinical symptoms: frequency of urination, dysuria, fever, and any complications associated with the UTI.
- Medical history, including comorbidities such as hypertension, chronic kidney disease (CKD), and benign prostatic hyperplasia (BPH).
- Laboratory values, including complete blood counts (CBC), urine cultures, HbA1c levels, and kidney function tests.
- Drug prescriptions for UTI and diabetes management, focusing on both the type of medications used and their dosage.
- Economic data: The direct and indirect costs associated with UTI treatment, including hospitalization,

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diagnostic tests, and the economic impact of patient time lost to illness.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Ethics Committee of the hospital. All participants provided informed consent, acknowledging their voluntary participation in the study. Confidentiality was strictly maintained, and patients were assured that their personal and medical information would only be used for research purposes. Participants were also informed of their right to withdraw from the study at any time without any repercussions on their treatment.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics version 20. The following statistical methods were employed:

- Descriptive statistics were used to summarize patient demographics, clinical presentations, and treatment outcomes.
- The Chi-square test (χ^2) was applied to assess the statistical significance of categorical variables such as gender distribution and UTI incidence between diabetic and non-diabetic groups.
- Independent t-tests were used to compare continuous variables such as blood glucose levels, body mass index (BMI), and treatment costs between the diabetic and non-diabetic groups.
- Pearson's correlation coefficient was calculated to determine the strength of the relationship between diabetes status and UTI susceptibility.
- P-values of less than 0.05 were considered statistically significant, highlighting meaningful differences between the study groups.

Study Phases

Phase I – Identifying the Need for the Study:

A comprehensive literature review was conducted to establish the need for further research on UTI incidence in diabetic populations. Ethical approval and consent were secured before data collection began.

Phase II – Data Collection:

Patient recruitment was initiated, and comprehensive medical histories were documented. Clinical symptoms, laboratory results, and treatment data were systematically recorded using the pre-validated Data Collection Proforma.

Phase III – Data Analysis:

Data was analyzed using the methods outlined above, with comparisons made between diabetic and non-diabetic patients in terms of UTI incidence, treatment outcomes, and associated costs.

Phase IV – Report Compilation:

The results of the study were compiled into a detailed report, offering insights into UTI management and outcomes in diabetic and non-diabetic populations.

Outcome Measures

The primary outcome measure was the incidence of UTIs in both diabetic and non-diabetic patients. Secondary outcome measures included:

- Cost of treatment: A comprehensive analysis of the direct and indirect costs associated with UTI management in both groups.
- Identification of risk factors: Key factors such as gender, menopause, comorbidities, and medication use were examined for their contribution to UTI incidence and severity.
- Evaluation of concomitant medications: The use of diabetes-related medications and their potential interactions with UTI treatments were analyzed to identify patterns that may influence treatment outcomes.
- Comorbidity impact: The role of hypertension, CKD, and other comorbidities in influencing UTI outcomes in diabetic patients was also explored.

3. RESULTS

The study involved 235 patients, with 172 (73.2%) being diabetic and 63 (26.8%) non-diabetic. A significant aspect of this study was the comparison between these two groups in terms of age, gender, clinical presentations, laboratory investigations, risk factors, and treatment outcomes.

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Age Distribution

The mean age of the diabetic group was 52.9 years, significantly older compared to the non-diabetic group, which had a mean age of 41 years ($P < 0.001$). This indicates that older individuals with diabetes are more prone to urinary tract infections (UTIs) than their non-diabetic counterparts. Table 1 shows the age distribution, revealing that while younger individuals (20-29 years) dominated the non-diabetic group (31.7%), the diabetic group had a higher concentration of older individuals in the 40-59 age range.

Age Groups (Years)	Diabetic Subjects (%)	Non-Diabetic Subjects (%)
20-29	0.6	31.7
30-39	8.7	23.8
40-49	30.2	15.9
50-59	31.4	11.1
60-69	20.3	14.3
70-79	8.7	3.2
Total	100.0	100.0
Mean ± SD	52.9 ± 10.7	41.0 ± 15.3

Table 1: Age Distribution of Diabetic and Non-Diabetic Patients with UTI

Gender Distribution

In terms of gender, the study found that women were more prone to UTIs, with 63% of the study population being female and 37% male. This was consistent across both groups, although the prevalence was higher in diabetic females (51.1%) compared to non-diabetic females (11.9%). This difference in gender susceptibility was statistically significant ($P < 0.05$), as shown in Figures 1 and 2 from the study. The results align with existing literature that women, especially post-menopausal women, are more vulnerable to UTIs, and this risk increases in individuals with diabetes.

Clinical Features

The clinical symptoms of UTIs differed significantly between diabetic and non-diabetic patients. Among diabetic patients, the most common symptoms were high fever (reported in 89 patients), dysuria (67 patients), and frequent urination (62 patients), followed by vomiting (59 patients). In contrast, non-diabetic patients primarily reported burning sensations during urination (38 patients), dysuria (28 patients), hematuria (22 patients), and vomiting (22 patients). The statistical comparison indicated that burning sensation, foul-smelling urine, high fever, hematuria, and pelvic pain were significantly more common in non-diabetic patients, while diabetic patients showed more frequent occurrences of high fever and frequent urination. This data underscores the more severe and widespread symptomatology in diabetic patients.

Risk Factors in Women

The risk factors associated with UTI in diabetic and non-diabetic women were particularly revealing. Among the diabetic women, menopause emerged as a dominant risk factor, affecting 102 women, compared to only 8 non-diabetic women. Additionally, while non-diabetic women had a higher use of contraceptives (11 compared to 6 diabetic women), menopause, diabetes, and older age were the primary risk factors in diabetic patients. This suggests that hormonal changes associated with menopause, coupled with diabetes, exacerbate the risk of UTIs.

Laboratory Investigations

Several laboratory parameters were significantly different between diabetic and non-diabetic patients. For instance, white blood cell (WBC) count was elevated in both groups, but significantly higher in diabetic patients ($P = 0.019$). Similarly, diabetic patients showed higher abnormalities in hemoglobin, total red blood cell count (RBC), and mean corpuscular hemoglobin concentration (MCHC), with statistically significant differences observed ($P < 0.05$). Table 2 provides a detailed comparison of laboratory values between the two groups, revealing significant deviations in renal function markers, such as serum creatinine, and electrolyte levels, particularly sodium and potassium.

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Lab Investigation	Diabetic Patients (%)	Non-Diabetic Patients (%)	Significance (P-value)
WBC (High)	77.9	73.0	0.019
Hemoglobin (Low)	54.1	38.1	<0.01
Total RBC (Low)	45.9	17.5	<0.001
MCHC (High)	1.2	0.0	0.003
Sodium (Low)	48.8	14.3	<0.001
Potassium (Low)	45.9	22.2	0.004
Chloride (Low)	43.6	9.5	<0.001
Serum Creatinine (High)	33.1	25.4	0.469

Table 2: Laboratory Investigations in Diabetic and Non-Diabetic Patients with UTI
These laboratory results highlight the more pronounced metabolic disturbances in diabetic patients with UTIs, which contribute to the complexity of managing infections in this group.

Direct and Indirect Costs

The economic burden of treating UTIs was also examined. Diabetic patients incurred higher direct costs for treatment, with a mean expenditure of 91,029 INR compared to 70,476 INR in non-diabetic patients. However, this difference was not statistically significant (P = 0.077). Indirect costs, which include loss of work and other non-medical expenses, were also higher for diabetic patients (4,923 INR) than for non-diabetics (4,426 INR), though again, the difference was not statistically significant (P = 0.351). Table 17 provides a summary of these cost comparisons.

Cost Type	Diabetic Patients (Mean ± SD)	Non-Diabetic Patients (Mean ± SD)	Significance (P-value)
Direct	91,029 ± 7.8	70,476 ± 8.1	0.077
Indirect	4,923 ± 3.2	4,426 ± 3.7	0.351

Table 3: Direct and Indirect Costs in Diabetic and Non-Diabetic Patients with UTI

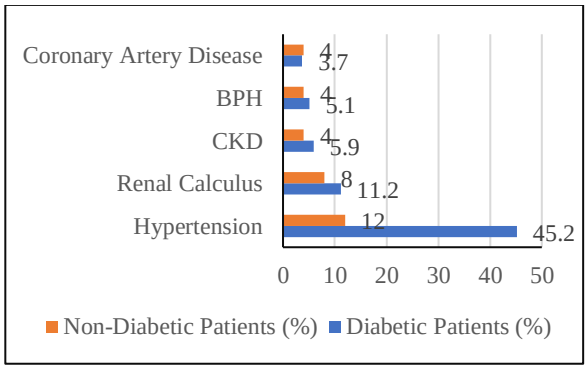
Medications Prescribed

In terms of treatment, the study found that the most frequently prescribed antibiotics for diabetic patients were trimethoprim/sulfamethoxazole (105 patients), nitrofurantoin (54 patients), and cefoperazone/sulbactam (24 patients). In non-diabetic patients, nitrofurantoin (42 patients), levofloxacin (35 patients), and trimethoprim/sulfamethoxazole (25 patients) were the most commonly prescribed antibiotics (Figures 20 & 21). This highlights the reliance on similar antibiotics across both groups, although the frequency of use differed.

Comorbidities

The study also highlighted the prevalence of comorbidities in UTI patients. Among diabetic patients, hypertension was the most common comorbidity (45.2%), followed by renal calculus (11.2%) and chronic kidney disease (CKD) (5.9%). Non-diabetic patients had lower incidences of hypertension (12%) and renal calculus (8%) (Tables 13 & 14). This further emphasizes the greater overall health burden carried by diabetic patients.

Figure 1: Comorbidities in Diabetic and Non-Diabetic Patients with UTI



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4. DISCUSSION

In this study, 235 participants were included and divided into two groups: 172 (73.2%) were diabetic and 63 (26.8%) were non-diabetic. This division aligns with research conducted by Ramrakhia et al. (2020), which showed that diabetic patients have a significantly higher incidence of urinary tract infections (UTIs) compared to non-diabetic individuals.[14] Our study further supports the finding that diabetic patients are more susceptible to UTIs, primarily due to elevated glucose levels in the urine, which fosters bacterial growth. The elevated blood glucose also impairs immune functions, making diabetic individuals more prone to infections.

The study also confirms the results reported by Kotalwar et al. (2021), indicating that hyperglycemia is a major risk factor for UTIs.[15] Among the participants in our study, 63% were female and 37% were male, closely mirroring the findings of Akhtar et al. (2021), who reported a higher prevalence of UTIs in females (60.7%) compared to males (39.3%).[16] This gender difference is consistent with well-established knowledge that anatomical and hormonal factors make females more prone to UTIs, especially in post-menopausal women. Additionally, 36.2% of UTI cases in our study occurred in women of reproductive age, which aligns with findings from Saber et al. (2021), who observed that 41.2% of women in this age group were affected by UTIs.[17] Diabetes, gender, and age remain crucial risk factors for UTI development, as emphasized by Walelgn et al. (2021). These factors were also highly prevalent in our study's diabetic population.[18]

Other significant risk factors identified in our study include catheterization (38.3%), renal calculi (49%), and sickle cell disease (0.42%). These findings are similar to those of Subudhi et al. (2021), who also found higher rates of catheter-associated UTIs (CAUTIs) in both male and female patients with type 2 diabetes, heart disease, and chronic kidney disease (CKD). In our study, 72% of the diabetic women were post-menopausal, while 6.8% used contraceptives.[19] This contrasts with the study by Odoki et al. (2019), which found that 32.2% of women using contraceptives and 36% of post-menopausal women had higher UTI risks. The hormonal changes associated with menopause and the use of contraceptives clearly influence UTI risk in women.[20]

Family history was another contributing factor, present in 3.4% of cases, and corresponds to findings by Storme et al. (2019), which indicated that frequent sexual intercourse and family history are substantial risk factors for UTIs.[21] Furthermore, 31% of the participants in our study had elevated creatinine levels, which is consistent with the findings of Vignesh et al. (2019), who demonstrated that UTIs are often associated with impaired kidney function, especially in diabetic patients ($P < 0.05$).[22] Regarding treatment, antibiotics such as levofloxacin, ciprofloxacin, trimethoprim/sulfamethoxazole, and nitrofurantoin were commonly used in our study. This pattern of prescription is similar to the resistance trends observed in the study by Thakur et al. (2019), where these antibiotics were commonly used but showed variable resistance in UTI pathogens.[23]

Finally, this study highlights the increased healthcare costs associated with untreated UTIs in diabetic patients. Our findings are consistent with the work of Gopalakrishnan et al. (2017), who demonstrated that untreated UTIs in diabetic patients lead to extended hospital stays and increased healthcare expenditures due to the progression of infections into more serious conditions. Addressing UTIs early and effectively can prevent complications, reduce hospital stays, and minimize economic burdens on patients.

5. CONCLUSION:

The study reveals a significant disparity in the incidence of urinary tract infections (UTIs) between diabetic and non-diabetic patients, with 73.2% of diabetic individuals affected compared to 26.8% of non-diabetic patients, alongside more severe symptoms such as high fever (52%), dysuria (39%), and frequent urination (36%) in the diabetic group. This heightened susceptibility in diabetics, particularly among post-menopausal women (72%), is linked to factors like hyperglycemia, compromised immune function, and comorbidities such as hypertension (45.2%) and renal calculi (11.2%). The study also identified key laboratory abnormalities, including elevated white blood cell counts and electrolyte imbalances, which further complicate UTI management in diabetic patients. From an economic perspective, the average direct treatment cost for diabetic patients was significantly higher at ₹91,029 compared to ₹70,476 for non-diabetics, due to more complex

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treatment needs, recurrent infections, and prolonged hospital stays. These findings highlight the need for improved UTI management strategies in diabetic populations to reduce health complications and financial burdens, particularly in regions with a high prevalence of diabetes like India.

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