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Investigation of some bacterial causes of urinary tract infection in diabetic patients in Al-Muthanna Province

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Abstract. ***Background.*** *Urinary tract infections (UTIs) are among the most common infections affecting diabetic patients, contributing to increased morbidity and healthcare burden. This study purposed to investigate the prevalence and bacterial causes of UTIs among diabetic patients in Al-Muthanna Province, Iraq, and to determine the antimicrobial susceptibility patterns of the isolated pathogens.* ***Materials and methods.*** *A total of 200 urine samples were collected from diabetic patients presenting with UTI symptoms. Bacterial identification and antibiotic susceptibility testing were conducted using standard microbiological methods.* ***Results.*** *The results showed that 123 (61.5 %) samples were positive for bacterial growth. Escherichia coli was the most prevalent organism (52 %), followed by Klebsiella pneumoniae (19.5 %), Staphylococcus aureus (13 %), Proteus mirabilis (8 %), and Pseudomonas aeruginosa (6.5 %). High resistance was observed against ampicillin and TMP-SMX, while nitrofurantoin and imipenem showed the highest sensitivity.* ***Conclusions.*** *These findings underscore the need for continuous surveillance and appropriate empirical therapy to manage UTIs in diabetic individuals.*

Keywords: *Klebsiella pneumoniae; Staphylococcus aureus; Proteus mirabilis; Pseudomonas aeruginosa; urinary tract infections*

Introduction

Urinary tract infections (UTIs) are a common and recurrent problem among diabetic patients due to immune dysfunction, poor glycemic control, and structural abnormalities in the urinary tract [1]. Diabetes mellitus, particularly type 2, has been identified as a significant risk factor for both asymptomatic and symptomatic bacteriuria [2]. The anatomical and physiological changes associated with diabetes such as autonomic neuropathy, increased glucose content in urine, and bladder dysfunction increase the risk of urinary stasis and subsequent infection. Furthermore, impaired neutrophil function and altered cytokine response in diabetic patients contribute to reduced host defenses against invading uropathogens [3].

The most commonly implicated uropathogens in diabetic patients include *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Proteus mirabilis*, and *Pseudomonas aeruginosa* [4, 5]. These pathogens may present with more severe symptoms or complications in diabetics, including pyelonephritis, renal abscesses, and emphysematous infections. In recent years, there has been an alarming rise in antibiotic resistance among these pathogens, complicating the choice of empirical therapy and increasing the risk of treatment failure [6].

Understanding the local epidemiology and resistance patterns of uropathogens is crucial for effective treatment planning and for reducing the burden of recurrent infections and hospitalizations in diabetic individuals. However, limited data exist from the southern regions of Iraq, including Al-Muthanna Province. This study was therefore designed to fill this gap by identifying the bacterial agents responsible for UTIs in diabetic patients and analyzing their antibiotic resistance profiles.

The current research aims to determine the prevalence of UTIs in diabetic patients and to identify the bacterial pathogens responsible for UTIs, also to analyze the antibiotic resistance patterns of the isolated bacteria.

Materials and methods

Study design and population

A cross-sectional study was conducted from January to March 2025 at Al-Hussein Teaching Hospital in Al-Muthanna Province. A total of 200 diabetic patients (both type

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1 and type 2) presenting with symptoms suggestive of UTI were included.

Sample collection

Midstream urine samples were collected in sterile containers and transported immediately to the microbiology laboratory. The samples were collected from different age groups years, 49 males and 74 females who at Al-Hussein Teaching Hospital for the period January to March 2025.

Bacterial isolation

All samples were cultured and activated in brain heart Infusion broth (BHI) for 24 hours at a temperature of 37 °C in order to stimulate the potential presence of bacteria, then transferred to the selective culture medium (chromogenic agar) for a period of 24 to 48 hours in order to diagnose and isolate the bacteria and assure it with biochemical examinations [7]. The media used are UTI chromogenic agar, *E.coliforms* chromogenic agar and CHROMagar Pseudomonas. Traditional media was also used to confirm the results of the cultures such as MacConkey agar, EMB agar. Biochemical tests as IMVIC tests [8].

Bacterial identification

Isolates diagnosed depending on Bergey's manual [9] and according to the methods used by [10].

Antibiotic susceptibility testing

The Kirby-Bauer disk diffusion method was used according to CLSI guidelines. Antibiotics tested included: ampicillin, TMP-SMX, ciprofloxacin, ceftriaxone, nitrofurantoin, imipenem, gentamicin, and vancomycin (for Gram-positive organisms).

Ethical approval

The Medical Ethical Committee of College of Science, Al-Muthanna University approved this study (No. 11 on 3/1/2025).

Statistic

In the present study, the following statistical methods were applied: descriptive statistics were utilized to summarize the distribution of cases by calculating frequencies and percentages. The Chi-square test (χ^2) was conducted to assess differences in the distribution of positive cases among distinct categories. The p-value was significance of associations at < 0.05.

Results

The data show a high prevalence of UTIs among diabetic patients, indicating that diabetes significantly increases susceptibility to urinary infections. This is consistent with previous findings linking impaired immune responses and glycosuria in diabetics to higher infection rates. Females accounted for 60 % of positive cases, aligning with the well-known anatomical predisposition due to a shorter urethra and its proximity to the anus. This also reflects global epidemiological patterns. The highest infection rate (45.5 %) was found in the 41–60 age group, suggesting that middle-aged adults with diabetes are at increased risk. This could be due to a longer duration of illness, poor glycemic control, and age-related changes in immunity or bladder function. Type 2 diabetics had a significantly higher proportion of UTIs (72 %), likely due to the higher prevalence of type 2 diabetes in the general population and its stronger association with obesity and metabolic syndrome. The age group 41–60 years had the highest infection rate, likely due to longer disease duration and compromised immunity (Table 1).

Table 1. UTI prevalence and demographics

Parameter	No.	%
Positive cultures	123	61.5
Negative cultures	77	38.5
Sex		
Female	74	60
Male	49	40
Age group, years		
< 40	23	18.7
41–60	56	45.5
> 60	44	35.8
Type of diabetes		
1	35	28
2	88	72

E.coli was the most frequently isolated organism, accounting for more than half (52 %) of all UTI cases. This aligns with global data identifying *E.coli* as the predominant uropathogen, due to its ability to adhere to uroepithelial cells via fimbriae. *Klebsiella pneumoniae* (19.5 %) was the second most common pathogen, which is consistent with other reports in diabetic populations. This organism is also notable for its capacity to produce extended-spectrum beta-lactamases (ESBLs), leading to multidrug resistance. *Staphylococcus aureus* was identified in 16 % of cases, suggesting possible skin or catheter-related infections, or ascending infections in patients with poor hygiene or impaired immune systems. *Proteus mirabilis* and *Pseudomonas aeruginosa* were less common but are typically associated with complicated UTIs, recurrent infections, and prior antibiotic use (Table 2).

The resistance profile of *E.coli* revealed high resistance to ampicillin (83 %) and TMP-SMX (68 %), making these

Table 2. Frequency of bacterial isolates

Bacterial species	No.	%
Escherichia coli	64	52
Klebsiella pneumoniae	24	19.5
Staphylococcus aureus	16	13
Proteus mirabilis	11	9
Pseudomonas aeruginosa	8	6.5

Table 3. Antibiotic resistance patterns, %

Antibiotic	*E.coli*	*K.pneumoniae*	*S.aureus*	*P.aeruginosa*
Ampicillin	83	100	–	–
TMP-SMX	68	60	–	–
Ceftriaxone	55	72	–	–
Ciprofloxacin	25	30	–	40
Nitrofurantoin	10	18	–	–
Imipenem	5	5	–	15
Gentamicin	15	18	–	22
Vancomycin	–	–	0	–

agents less favorable as empirical therapy options in diabetic patients. These rates are in line with global trends indicating increased resistance among Gram-negative uropathogens.

K.pneumoniae showed 100 % resistance to ampicillin and high resistance to third-generation cephalosporins (72 %), reinforcing the need for sensitivity testing before treatment. This organism is well-known for harboring ESBL genes. Fluoroquinolones like ciprofloxacin had lower resistance rates (25 % in *E.coli* and 30 % in *K.pneumoniae*), making them relatively effective, though still requiring cautious use to prevent resistance escalation. Nitrofurantoin and imipenem exhibited excellent activity against *E.coli* and *K.pneumoniae*, making them potential choices, especially for lower UTIs and multidrug-resistant infections, respectively. *P.aeruginosa* demonstrated moderate resistance to ciprofloxacin (40 %) and gentamicin (22 %), consistent with its known capacity to resist multiple drug classes. Importantly, *S.aureus* was fully sensitive to vancomycin, maintaining its status as the drug of choice for Gram-positive cocci in serious infections (Table 3).

Discussion

The prevalence of UTIs among diabetic patients was 61.5 %, aligning with findings from [11] in Ethiopia and [12] in Iraq. Female patients were more commonly affected, consistent with [2], who attributed this to anatomical factors.

Escherichia coli was the most common isolate (52 %), consistent with [4, 5], who also identified *E.coli* as the leading cause of UTIs in diabetics. *Klebsiella pneumoniae* was the second most prevalent pathogen, as reported by [13]. The presence of *Staphylococcus aureus* aligns with [14], suggesting possible contamination or secondary bacteremia. *Proteus mirabilis* and *Pseudomonas aeruginosa* were also isolated and are often associated with complicated UTIs, as reported by [13].

Given the increased use of antibiotics and the resulting increase in antibiotic resistance, identifying the antibiotic susceptibility pattern of this organism can be useful in treating most patients with UTI [15, 16].

High resistance to ampicillin (83 % in *E.coli* and 100 % in *K.pneumoniae*) is consistent with the global trends reported by [6, 15, 16]. TMP-SMX and ceftriaxone also showed reduced efficacy, supporting similar findings in [5]. Nitrofurantoin and imipenem maintained high sensitivity, aligning with clinical reports on their retained effectiveness. *S.aureus* was fully sensitive to vancomycin, as confirmed by [17]. Moderate resistance by *P.aeruginosa* to ciprofloxacin and gentamicin agrees with studies by [18].

The results of this study were consistent with the findings of [19], which indicated that the predominant causative organism for complicated and uncomplicated urinary tract infections is *Escherichia coli*, followed by *Klebsiella pneumoniae*, *Enterococcus faecalis*, and *Proteus mirabilis*. The current study also agreed with the findings of [20], where it was found that the most common bacteria was *Staphylococcus aureus* (38.75 %), followed by *Enterobacter cloacae* (36.25 %), *Pseudomonas aeruginosa* (27.5 %), *Escherichia coli* (26.25 %), and *Klebsiella pneumoniae* (25 %). *Staphylococcus epidermidis* and *Streptococcus agalactiae* also appeared (21.25 %) each, *Proteus mirabilis* (17.5 %), and *Enterococcus faecalis* (11.25 %), while S*taphylococcus saprophyticus* was the least (5 %).

Conclusions

UTIs are highly prevalent among diabetic patients in Al-Muthanna Province, with *E.coli* being the predominant pathogen. High levels of antimicrobial resistance, especially to first-line drugs, underline the importance of local antibiograms and tailored therapy. Nitrofurantoin and imipenem remain effective options for empirical treatment.

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Дослідження деяких бактеріальних причин інфекцій сечовивідних шляхів у пацієнтів із діабетом у провінції Аль-Мутанна

Резюме. Актуальність. Інфекції сечовивідних шляхів (ІСШ) є одними з найпоширеніших інфекцій, що вражають пацієнтів із діабетом, підвищуючи захворюваність і навантаження на охорону здоров'я. **Мета:** дослідити поширеність та бактеріальні причини ІСШ серед осіб із діабетом у провінції Аль-Мутанна (Ірак), а також визначити моделі чутливості виділених збудників до антимікробних препаратів. **Матеріали та методи.** Загалом було зібрано 200 зразків сечі в пацієнтів із діабетом, які мали симптоми ІСШ. Ідентифікацію бактерій і тестування на чутливість до антибіотиків проводили за допомогою стандартних мікробіологічних методів. **Результати.** Ріст бактерій виявлено в 123 (61,5 %) зразках. Найпоширенішим мікроорганізмом була *Escherichia coli* (52 %), далі йшли *Klebsiella pneumoniae* (19,5 %), *Staphylococcus aureus* (16 %), *Proteus mirabilis* (8 %) та *Pseudomonas aeruginosa* (6,5 %). Висока резистентність спостерігалася до ампіциліну й TMP-SMX, тоді як нітрофурантоїн та іміпенем показали найвищу чутливість. **Висновки.** Ці результати підкреслюють необхідність постійного спостереження та відповідної емпіричної терапії при інфекціях сечовивідних шляхів в осіб із діабетом.

Ключові слова: *Klebsiella pneumoniae*; *Staphylococcus aureus*; *Proteus mirabilis*; *Pseudomonas aeruginosa*; інфекції сечовивідних шляхів