Sirte University Scientific Journal (SUSJ)

Journal home page: http://journal.su.edu.ly/index.php/SUSJ/index
DOI: 10.37375/susj.v15i2.3727

Bacterial Uropathogens in Urinary Tract Infection and Antibiotic Susceptibility Patterns among Patients Attending at Tobruk Medical Center, Tobruk, Libya

[1]Eisa S Omar , [1]Fares Elkarimi , [2]Omar M Farag, [2]Nehal K khalil , [2]Farah R salim, [2]Fawzia M Sasi , [2]Mosa A Ali

[1]Department of Microbiology, Faculty of Medicine, University of Tobruk, Tobruk, Libya.
[2]Intern student, Faculty of Medicine, University of Tobruk, Tobruk, Libya.

DOI: https://doi.org/10.37375/susj.v15i2.3727

ARTICLE INFO:

Received 17 September 2025.
Accepted 25 October 2025.
Available online 24 December 2025.

Keywords: Urinary Tract Infection, Uropathogens, Tobruk Medical Center, *E. coli*, Antibiotic Resistance

A B S T R A C T

Urinary tract infections (UTIs) remain one of the most widespread infectious diseases globally and represent a major cause of morbidity across all age groups. This study aimed to identify the bacterial pathogens responsible for UTIs and to evaluate their antibiotic susceptibility profiles. Midstream urine samples were collected from patients attending Tobruk Medical Center, Libya, between August and October 2023, and processed according to standard microbiological procedures. Antimicrobial susceptibility was determined using the Kirby–Bauer disc diffusion technique following Clinical and Laboratory Standards Institute (CLSI) guidelines. Among 130 urine specimens analyzed, 78 (60%) yielded significant bacterial growth. Females accounted for the majority of positive cultures (55; 42%), compared to males (23; 17.9%). *Escherichia coli* and *Klebsiella pneumoniae* were the predominant uropathogens. Both organisms exhibited high sensitivity to carbapenems (Imipenem and Meropenem), while showing considerable resistance to Cefotaxime and Trimethoprim–Sulfamethoxazole. These findings highlight the need for ongoing antimicrobial surveillance and rational antibiotic prescribing to curb rising resistance rates.

Introduction

Urinary tract infections (UTIs) represent one of the most common bacterial illnesses encountered globally and continue to pose a substantial public health burden. They may affect any component of the urinary system, including the kidneys, ureters, bladder, or urethra. Women are disproportionately affected, with an estimated 50–60% experiencing at least one episode during their lifetime (Foxman B et al 2014). Uropathogenic *Escherichia coli* (UPEC) remains the predominant etiological agent, accounting for nearly 80% of community-acquired infections, followed by *Klebsiella, Proteus,* and *Enterococcus* species (Ait-Mimoune N et al 2022).

The clinical spectrum of UTIs ranges from mild lower urinary tract symptoms—such as dysuria and urinary urgency—to serious upper tract infections like pyelonephritis, which can progress to sepsis if inadequately treated (Hooton TM et al 2022). Various factors increase the risk of developing UTIs, including female anatomy, sexual activity, certain contraceptive practices, congenital or acquired urinary tract abnormalities, and systemic diseases such as diabetes mellitus (Schaeffer AJ, Nicolle LE 2018).

Diagnosis relies on clinical assessment supported by laboratory investigations, particularly urinalysis and urine culture. Although antibiotic therapy remains the cornerstone of management, growing antimicrobial resistance among uropathogens has made the selection of effective empirical therapy increasingly difficult (Dobrindt U et al 2021).

UTIs continue to affect individuals of all ages, from neonates to the elderly, and account for an estimated 150 million cases annually worldwide, according to the

World Health Organization (Stapleton AE et al 2020). Their pathogenesis involves the invasion and multiplication of pathogenic microorganisms in the urinary tract, producing presentations that range from asymptomatic bacteriuria to severe renal involvement (Handa VL et al 2018). Again, UPEC is responsible for the majority of these infections; however, other organisms such as *Klebsiella pneumoniae*, *Proteus mirabilis*, and *Enterococcus faecalis* have also become significant contributors . Adhesion molecules, fimbriae, and biofilm-forming capabilities allow these pathogens to persist and evade host defenses, contributing to recurrent or complicated infections (Gupta K et al 2022).

Multiple risk factors have been implicated in the development of UTIs, including female sex, urinary catheterization, metabolic disorders such as diabetes, sexual activity, and urinary tract structural abnormalities (Hari P et al 2024). Symptoms vary widely, from dysuria and suprapubic discomfort to more severe systemic manifestations like fever and chills in cases of pyelonephritis (Moch H, et al 2022).

Antibiotic resistance in uropathogens has escalated globally and is now a major clinical and public health challenge. Reduced susceptibility to commonly used antibiotics including Trimethoprim–Sulfamethoxazole and fluoroquinolones—has been documented in several studies (Handa VL et al 2023). In certain regions, fluoroquinolone resistance among UPEC strains has increased from 5% to more than 30%, and resistance to Trimethoprim–Sulfamethoxazole exceeds 20% Müller, A. E., et al 2020). Resistance arises through multiple mechanisms, such as spontaneous mutation, horizontal gene transfer, and selective pressure from inappropriate antibiotic usage. UPEC strains may also carry plasmids with multiple resistance determinants, while biofilm formation on catheters provides additional protection from antimicrobial agents (Sokhal, B., et al 2021).

The consequences of rising antimicrobial resistance include prolonged illness, increased hospitalizations, greater healthcare costs, and higher risks of complications such as bacteremia and renal damage (Van Hecke O, et al 2017). In response, many healthcare systems have adopted antimicrobial stewardship programs aimed at promoting judicious antibiotic use, encouraging culture-guided therapy, and reducing unnecessary prescriptions (Giamarellou H et al 2023).

Preventive strategies play an essential role in reducing infection rates and slowing resistance development. These include improved personal hygiene, adequate hydration, and consideration of prophylactic antibiotics in high-risk populations. Novel approaches, such as probiotics and bacteriophage therapy, are also being investigated as potential adjuncts to conventional treatments (Wall S. et al 2019).

Given these concerns, the present study aims to identify the bacterial uropathogens isolated from patients with suspected urinary tract infections at Tobruk Medical Center, Tobruk, Libya, and to evaluate their in-vitro susceptibility patterns to commonly used antimicrobial agents.

Materials and Methods

Collection of urine samples and transport:

Patients of all ages and both genders presenting with symptoms suggestive of UTI were included. Midstream urine samples were collected using the clean-catch technique to minimize contamination. Specimens were transported promptly to the microbiology laboratory. In cases where delay was unavoidable, samples were refrigerated at 4°C to prevent bacterial overgrowth.

Sample processing:

Urine samples were inoculated onto Blood agar, CLED agar, MacConkey agar, and Sabouraud agar using standard streaking methods. Plates were incubated aerobically at 37°C for 24 hours. Bacterial isolates were identified based on Gram staining and biochemical tests, including TSI, motility, indole, and urease test.

Antibiotic sensitivity test

McFarland Standards is used in the antimicrobial susceptibility testing procedure where the bacterial suspension is compared to Standard McFarland, prior to swab on Muller Hinton agar. It is a part of quality control to check and adjust the densities of bacterial suspension that can be used for identification and susceptibility proceeds. However, used concentration for the antimicrobial susceptibility testing and the culture media performance testing is done by 0.5 McFarland standards in the microbiological laboratory. (Stamm WE et al 2021)

The Kirby-Bauer disk diffusion method was performed to determine the antibiotic susceptibility to determine by the standard disc diffusion procedure. Commercially prepared antibiotic discs (Oxoid, UK). (6 mm in diameter) belonging to different groups antibiotics were used, Augumentin (30ug), Cefotaxim (30µg), Gentamycin (10 µg), Amikacin (30µg), Nitrofurantoin (300 µg), Septrin (25µg), Imipenem (10µg) and Meropenem (10µg). The zones of inhibition were measured, recorded and interpreted according to the Clinical Laboratory Standard institute provided. [29]

Four to five similar colonies from overnight growth plate were transferred aseptically in sterile distilled water and vigorously agitated to give a turbidity that matches the 0.5 McFarland standards (approximately 108 cfu/ml) .Within 15 min, sterile cotton swab dipped into the culture suspension was used for inoculating the surface of solidified Mueller-Hinton agar plates. Antibiotic discs were dispensed onto the inoculated plate surface agar and incubated at 37 Co for 24 h. The resulted diameters of inhibition zones around the antibiotic discs were measured to nearest whole mm and interpreted according to protocols standardized for the assay of antibiotic compounds as guided by National Committee for Clinical Laboratory Standards “NCCLS”. The results were categorized as: R (resistant) and S (Sensitive) (Jorgensen JH et al 2020)**.**

Statistical analysis:

Data were entered into Microsoft Excel and analyzed using SPSS version 27. Descriptive statistics were applied to determine frequencies and percentages

Results

Out of total 130 patients, Isolates were detected in 78 (60%) specimens. Out of these, 55(42%) were female and 23 (17.9%) were male shown in Table 1. The distribution of infection among patients’ gender was (88/130, 67.6 %) in female patients, while it was (42/130, 32.3 %) in male patients.

Table 1: Gender wise distribution of positive culture cases.

Gender	Number	Percentage%
Male	23	29.5
Female	55	70.5
Total	78	100

Table 2: Distribution of the patients according to the departments.

Department	N0.
AK	**3**
CCU	**3**
FMW	**4**
FSW	**5**
MAT	**11**
NICU	**4**
OPD	**44**
SICU	**4**
	78 Total

Table.4 Antibiotics used and their susceptibility patterns.

Also, out of total 130 patients, there was no growth in 52 (40%) and positive culture in 78 (60%), as shown in Table 3.

Table 3: Distribution showing the total number of positive and negative cultures.

Bacterial growth	Number	Percentage%
No growth	52	**40**
E.coli	45	**34.6**
***Klebsiella* spp**	16	**12.3**
Enterobacter spp	4	**3**
***Proteus* spp**	3	**2.3**
P.aeruginosa	4	**3**
Staph aureus	4	**3**
Acineobacter bumani	2	**1.5**
Total	**130**	**100%**

Table 4 shows percentage of In Vitro Antibiotic Sensitivity Pattern of uropathogens. It was seen that *E. coli* and *Klebsiella* spp were highly sensitive Imipenem, Meropenem and Gentamicin, whereas, *E.coli* and *Klebsiella* spp were highly resistant to Cefotaxim and Septrin shown in Table 5.

Antibiotic	*E.coli*	Klebsiella	Enterobacter	*Acineobacter bumani*	*Staph aureus*	Pseudomonas	Proteus
Augmentin	20.5%	7.6%	0%	1.2%	0%	0%	1.2%
Amikacin	33.3%	6.4%	0%	1.2%	1.2%	0%	1.2%
Cefotaxim	19.2%	0%	1.2%	2.3%	0%	0%	0%
Gentamicin	34.6%	7.6%	0%	0%	1.2%	1.2%	2.3%
Nitrofurantoin	8.5%	0%	1.2%	0%	0%	1.2%	0%
Septrin	9.3%	1.2%	1.2%	0%	0%	0%	2.3%
Imipenem	58.9%	15.3%	3.8%	3.8%	5.12%	8.9%	2.3%
Meropenem	%60	21.7%	5%	1.2%	5.1%	2.3%	0

Table.5 Antibiotics used and their resistance pattrens.

Antibiotic	*E.coli*	Klebsiella	Enterobacter	*Acineobacter bumani*	*Staph aureus*	Pseudomonas	Proteus
Augmentin	11.5%	8.9%	1.2%	0%	1.2%	2.5%	0%
Amikacin	1.2%	3.8%	0%	0%	0%	0%	0%
Cefotaxim	20.5%	2.5%	0%	0%	1.2%	0%	2.3%
Gentamicin	6.4%	6.4%	2.5%	3.8%	0%	0%	0%
Nitrofurantoin	3.8%	3.8%	0%	2.3%	1.2%	1.2%	2.1%
Septrin	17.9%	8.9%	0%	1.2%	1.2%	0%	8.9%
Imipenem	1.2%	1.2%	3.8%	0%	5%	8.9%	6%
Meropenem	2.3%	0%	0%	0%	0%	1.2%	0%

Discussion

Urinary tract infections (UTIs) remain one of the most widespread bacterial diseases, affecting an estimated 150 million individuals annually across the globe. They impose a substantial health and economic burden, particularly among women, of whom nearly 60% will experience at least one symptomatic episode during their lifetime. In the United States alone, UTIs represent the most frequent urological condition and the second most common infection overall, contributing to healthcare costs exceeding $3.5 billion annually (Jorgensen JH et al 2020).

Lower urinary tract infections (cystitis) occur far more frequently in females than males, largely due to anatomical features such as a shorter urethra and proximity of the urethral opening to the perineal region. UTI pathogenesis typically begins with contamination of the periurethral area by gut flora, followed by ascent of bacteria through the urethra into the bladder. Adhesion of these organisms to the uroepithelium is a key step that allows colonization and ultimately infection. When pathogens migrate further to the kidneys, upper UTIs (pyelonephritis) develop. In contrast, UTIs in males are less common and generally associated with structural or functional abnormalities of the urinary tract, particularly in older males (Guermazi-Toumi S et al 2018).

The findings of the present study align with previously published research showing that *E. coli* remains the principal etiological agent of UTIs, followed by other Gram-negative organisms such as *Klebsiella*, *Enterobacter*, and *Proteus* species. Certain pathogens, including *Proteus spp.* and *Pseudomonas aeruginosa*, are more commonly implicated in complicated UTIs and are well known for their ability to form biofilms—structures that enhance bacterial persistence and resistance to treatment (Jacobsen SM et al 2011).

Comparable investigations have documented similar antimicrobial resistance patterns. For instance, studies conducted in Pakistan identified *E. coli* as the most frequently isolated organism (66%), followed by *Candida* spp., *Pseudomonas* spp. (7.3%), *Klebsiella* spp. (5.5%), and *Proteus* spp. (<1%). In that study, *E. coli* demonstrated varying resistance rates to common antibiotics, with particularly high resistance to Ampicillin, Cotrimoxazole, and Ciprofloxacin. Notably, Amikacin and Gentamicin remained among the most effective agents (26). Our findings similarly show resistance to several first-line antibiotics, emphasizing the need for continuous monitoring.

The current results also support earlier observations that Augmentin can be highly effective against certain *E. coli* isolates. In one study, all hemolytic strains were fully sensitive to Augmentin, likely due to its combination of clavulanic acid and penicillin, which helps overcome resistance mediated by β-lactamase production. This highlights the potential benefit of combination therapy in preventing or limiting resistance development (Matsen JM et al 2022).

The elevated resistance rates observed in our study may be attributed to inappropriate antibiotic use, including self-medication and excessive prescribing practices. Similar to findings from other regions, *K. pneumoniae* and *P. mirabilis* demonstrated considerable resistance to Trimethoprim–Sulfamethoxazole, Ampicillin, and Chloramphenicol. Conversely, fluoroquinolones such as Ciprofloxacin, as well as Aminoglycosides like Gentamicin, showed better activity against Gram-negative isolates. This suggests these drugs may still serve as useful options for empirical therapy in the local setting. In contrast, *S. aureus* displayed higher levels of resistance to several β-lactam antibiotics, consistent with studies from Ethiopia (Biadglegne F, et al 2020).

Overall, the antimicrobial resistance patterns identified in this study highlight the pressing need for improved treatment guidelines, consistent antimicrobial stewardship, and periodic surveillance of local susceptibility trends. Such measures will be essential to ensure effective management of UTIs and to slow the progression of antibiotic resistance in the region.

Conclusions

Our findings provide valuable information regarding the burden of urinary tract infections (UTIs) within the studied population. The high frequency of *E. coli* and *Klebsiella pneumoniae* as the major causative agents is consistent with previous research and emphasizes the importance of ongoing monitoring of these organisms in healthcare settings. The strong susceptibility of these isolates to Imipenem and Meropenem indicates that carbapenems continue to be reliable therapeutic choices for managing complicated or resistant UTIs, especially when commonly used antibiotics are no longer effective. This observation is particularly important in the context of the global rise in antimicrobial resistance.

Acknowledgements

The authors express gratitude to the staff of the Microbiology Laboratory at Tobruk Medical Center for their cooperation and technical support.

Conflict of interest: The authors declare no conflict of interest.

References

Ait-Mimoune, N., Hassaine, H., & Boulanoir, M. (2022). Bacteriological profile of urinary tract infections and antibiotic susceptibility of Escherichia coli in Algeria. Iranian Journal of Microbiology, 14(2), 156–160. https://doi.org/10.18502/ijm.v14i2.9180

Biadglegne, F., & Abera, B. (2020). Antimicrobial resistance of bacterial isolates from urinary tract infections at Felge Hiwot Referral Hospital, Ethiopia. Ethiopian Journal of Health Development, 23, 236–238.

Dobrindt, U., Wami, H. T., Schmidt-Wieland, T., Bertsch, D., Oberdorfer, K., & Hof, H. (2021). Compared with cotrimoxazole nitroxoline seems to be a better option for the treatment and prophylaxis of urinary tract infections caused by multidrug-resistant uropathogens: An in vitro study. Antibiotics, 10(6), 645.

Foxman, B. (2014). Urinary tract infection syndromes: Occurrence, recurrence, bacteriology, risk factors, and disease burden. Infectious Disease Clinics, 28(1), 1–3.

Giamarellou, H., Galani, L., Karavasilis, T., Ioannidis, K., & Karaiskos, I. (2023). Antimicrobial stewardship in the hospital setting: A narrative review. Antibiotics, 12(10), 1557.

Guermazi-Toumi, S., Boujlel, S., Assoudi, M., Issaoui, R., Tlili, S., & Hlaiem, M. E. (2018). Susceptibility profiles of bacteria causing urinary tract infections in Southern Tunisia. Journal of Global Antimicrobial Resistance, 12, 48–52.

Gupta, K., & Trautner, B. (2022). Urinary tract infection. Annals of Internal Medicine, 156(5), ITC3–1.

Handa, V. L., Brotman, R. M., Ravel, J., & Tuddenham, S. (2023). Does bacterial vaginosis contribute to urinary tract infection? Current Infectious Disease Reports, 25(2), 17–27.

Hari, P., Meena, J., Kumar, M., Sinha, A., Thergaonkar, R.W., Iyengar, A., Kanitkar, M. (2024). Evidence-based clinical practice guideline for management of urinary tract infection and primary vesicoureteric reflux. Pediatric Nephrology, 39(5), 1639–1668.

Hooton, T. M., Roberts, P. L., & Stapleton, A. E. (2021). Asymptomatic bacteriuria and pyuria in premenopausal women. Clinical Infectious Diseases, 72(8), 1332–1338.

Jacobsen, S. M., & Shirtliff, M. E. (2011). Proteus mirabilis biofilms and catheter-associated urinary tract infections. Virulence, 2(5), 460–465.

Jorgensen, J. H. (2010). Methods for antimicrobial dilution and disk susceptibility testing of infrequently isolated or fastidious bacteria: Approved guideline. NCCLS.

Litwin, M. S., Saigal, C. S., Yano, E. M., Avila, C., Geschwind, S. A., & Hanley, J. M. (2005). Journal of Urology, 173, 933.

Mamuye, Y. (2016). Antibiotic resistance patterns of common Gram-negative uropathogens in St. Paul's Hospital Millennium Medical College. Ethiopian Journal of Health Sciences, 26(2), 93–100.

Matsen, J. M., & Barry, A. L. (2022). Manual of Clinical Microbiology (2nd ed.). American Society for Microbiology.

Moch, H., Amin, M. B., Berney, D. M., Compérat, E. M., Gill, A. J., Hartmann, A., ... Tan, P. H. (2022). The 2022 World Health Organization classification of tumours of the urinary system and male genital organs—Part A. European Urology, 82(5), 458–468.

Müller, A. E., et al. (2020). Antibiotic resistance patterns in urinary tract infections: A systematic review. European Urology Focus, 6(5), 873–883.

Omar, E. S. (2021). Comparative study: The incidence of urinary tract infection in diabetic patients in the Eastern Region of Libya and their antibiotics sensitivity pattern. Sirte University Scientific Journal, 11(2), 77–88.

Schaeffer, A. J., & Nicolle, L. E. (2018). Urinary tract infections in older men. New England Journal of Medicine, 374(6), 562–571.

Sobel, J. D., & Kaye, D. (2005). Urinary tract infections. In Principles and Practice of Infectious Diseases (Vol. 1, pp. 662–690).

Sokhal, B., et al. (2021). Emerging uropathogens in urinary tract infections: A review. Infection and Drug Resistance, 14, 4313–4325.

Stamm, W. E., & Norrby, S. R. (2001). Urinary tract infections: Disease panorama and challenges. Journal of Infectious Diseases, 183(Suppl. 1), S1–S4.

Stapleton, A. E., Wagenlehner, F. M., Mulgirigama, A., & Twynholm, M. (2020). Escherichia coli resistance to fluoroquinolones in community-acquired uncomplicated urinary tract infection in women. Antimicrobial Agents and Chemotherapy, 64(10), e00862-20.

Van Hecke, O., Wang, K., Lee, J. J., Roberts, N. W., & Butler, C. C. (2017). Implications of antibiotic resistance for patients' recovery from common infections in the community. Clinical Infectious Diseases, 65(3), 371–382.

Wall, S. (2019). Prevention of antibiotic resistance. Global Health Action, 12(sup1), 1756191.

Wu, S. Y., Shei-Dei Yang, S., Chang, S. J., & Hsu, C. K. (2022). Emphysematous pyelonephritis. Tzu Chi Medical Journal, 34(3), 297–302.