ORIGINAL ARTICLE https://doi.org/10.52206/jsmc.2025.15.2.1046 OPEN ACCESS

Shifting Trends in the Causative Mycobacterial Agents of Urinary Tract Infection and their Sensitivity Pattern on Antibiograms in Female Diabetic Patients

Sher Afghan Khan,[1] Qandeel Shoukat,[1] Maria Bibi,[1] Zainab Khattak,[1] Inayat ur Rahman,[2] Masud uz Zaman,[1] Qadeer Nawaz[1]

1. Gajju Khan Medical College, Swabi, Pakistan
2. Saidu College of Dentistry, Swat, Pakistan

ABSTRACT

Background: It is important to avoid using broad spectrum therapy for Urinary Tract Infections as it can contribute to drug resistance. A quick analysis of causative agent and their antibiograms is necessary for cost effective empirical therapy.
Objectives: To determine the bacteria profile in urine sample of Urinary Tract Infections in diabetics and to determine the antibiotic susceptibility and sensitivity patterns of those bacteria.
Materials and Methods: It was a descriptive type of cross sectional study conducted in of Bacha Khan Medical Complex Swabi for 3 months.
Results: A total of 280 samples were collected from the microbiology lab. Out of which 234 were E. coli (83.6%), 16 were Klebsiella Pneumonia (5.7%), 13 were Proteus Mirabilis (4.6%), 10 were Pseudomonas (3.6%), 7 were Enterococcus faecalis (2.5%). Resistance was found for Amoxicillin+clauvulanic acid and Ciprofloxacin, while the organisms were found to be highly sensitive to Ertapenem, Meropenem, Imipenem and 100% sensitive to vancomycin.
Conclusion: The most dominant organism was E.coli in culture and sensitivity reports followed by Klebsiella pneumonia then Proteus mirabilis, Pseudomonas and Enterococcus faecalis. Among antibiotics ciprofloxacin and amoxicillin showed least sensitivity in Urinary Tract Infections patients with diabetes and most effective antibiotics in the previous researches (doxycycline and cefepime) also showed alarmingly less sensitivity to uropathogens found in diabetics. The thing that stood out was that all these pathogens were highly sensitive to Imipenem, Meropenem, Ertapenem and Vancomycin.
Keywords: Diabetes Mellitus, Resistance, Sensitivity, Urinary Tract Infections (UTI), Uropathogen.

This article may be cited as: Khan SA, Shoukat Q, Bibi M, Khattak Z, Rahman IU, Zaman MU, et al. Shifting Trends in the Causative Mycobacterial Agents of Urinary Tract Infection and their Sensitivity Pattern on Antibiograms in Female Diabetic Patients. *J Saidu Med Coll.* 2025;15(2):192-196. https://doi.org/10.52206/jsmc.2025.15.2.1046

INTRODUCTION

Urinary tract infection (UTI) contains a broad spectrum of infections ranging from the kidneys to the urethra.[1,2] It is one of the most frequent microbial disorders.[3,4] According to an estimate, about 150 million people around the world suffer from UTI's every year.[5,6] It is also one of the major factor of illness and the second most frequent reason for hospital admissions.[7] Several clinical factors such as anatomical difference, hormonal effects and behavioral patterns make women more prone to it than men.[8]

Patients with diabetes are more likely to develop UTIs than non-diabetics. Diabetes can change the chemical makeup of urine which can support the growth of bacteria. These UTIs in diabetics are more severe which can lead to complications like dysuria, organ damage and occasionally even death from complicated UTIs (pyelonephritis). The higher chance of UTI among diabetic patient along with the rising prevalence of Diabetes globally in recent years may cause significant strain on medical expenses.[9] Gram-negative bacteria are the primary cause of UTI, but gram-positive organisms can also cause it. E. coli and Staphylococcus are the most prevalent pathogens. Antibiotic-resistant urinary infections may also arise as a result of the high rates of antibiotic prescriptions, particularly broad spectrum antibiotics, for UTIs in this patient population.[10] Additionally, giving these people a lot of antibiotics—especially broad-spectrum ones—for UTIs may result in the development of additional bacteria in the urinary tract that are resistant to antibiotics.[11] Appropriate antibiotic administration in patients with complex UTI seems to shorten hospital stay, which improves patient outcomes and lowers medical expenses.[12,13]

A detailed and brief study is needed to improve the prescription of antibiotics. As per the Infectious Diseases Society of America's recommendation, it is very essential for the physician to get local data of resistance patterns in order to track the changing susceptibility pattern of pathogen.[14,15] As very less research has been conducted on the pathogens specific culture and resistance pattern this information will help doctors choose effective treatment and evaluate a thorough antibiograms which may help to limit the development of drug resistance.[16]

This study was important because there is very less structured data on microbial profile of UTIs in female diabetic patients for identifying the most effective antibiotics for different types of prevailing bacteria. Physician can effectively treat the patients with more susceptible antibiotic cover by lowering the burden of diabetic related UTI infections. It appears that giving the right antibiotics to patient with UTI can reduce their hospital stay, enhance patient outcomes and decrease medical costs.[17,18]

Correspondence: Dr. Sher Afghan Khan
Assistant Professor,
Gajju Khan Medical College, Swabi, Pakistan
Email: sher_ak@hotmail.com

Received: August 23rd, 2024 - 1st Revision: December 17th 2024
2nd Revision: February 11th 2025 - 3rd Revision: March 06th 2025
Accepted: March 06th, 2025

The aim of this study was to identify the bacteria profile and determine their sensitivity pattern in urine sample of UTI diabetic patients.

MATERIALS AND METHODS

This study was a descriptive cross-sectional research aimed at assessing the prevalence of urinary tract infections (UTIs) in female diabetic patients who were between 40 to 60 years of age and were exclusively using oral hypoglycemic drugs. The sample size of 280 participants was calculated using the RAOSOFT online sample size calculator, which incorporated a 95% confidence interval, a 5% margin of error, and a 10% prevalence of UTIs in female diabetic patients.[19] The study was conducted over a three-month period, from 10th July to 10th October 2023, at Gajju Khan Medical College (GKMC) and Bacha Khan Medical Complex (BKMC) in Swabi, Pakistan. Ethical approval for the study was granted by the Ethical Review Board (letter no. 2252/Ethical Board/GKMC), and informed consent was obtained from all the participants to ensure their voluntary participation and protection of their rights.

In terms of methodology, the study focused specifically on female diabetic patients between the ages of 40 and 60 who were only using oral hypoglycemic drugs, excluding those on insulin or other forms of medication. In diabetic female patients at BKMC/GKMC, the process of urine collection, storage, transportation, and culture and sensitivity (C/S) testing was performed with great care to ensure accurate results. The first step in the process was urine collection, where the patient was instructed to clean the genital area with an antiseptic wipe and to collect a midstream urine sample in a sterile, leak-proof container. This method reduced contamination and ensured that the urine sample was as clean as possible for accurate testing. The container was labeled with the patient's details, including name, date and time of collection, to avoid confusion. Diabetic patients, due to their increased susceptibility to infections, were given special attention to ensure they followed proper hygiene practices. Once the sample was collected, it was crucial to handle it properly to prevent any degradation or bacterial overgrowth. If the sample could not be processed immediately, it was stored in a refrigerator at 2-8°C for no longer than 24 hours. However, the sample was transported to the laboratory as soon as possible to avoid any complications in testing. The transportation of the urine sample required careful handling to prevent spillage or contamination. The sample was placed in a sealed bag or transport container, and if the transport time was lengthy, it was kept cool using ice packs or refrigerated conditions.

Once the sample reaches the laboratory, the C/S testing was carried out. The first step in the culture process involved inoculating the urine sample onto appropriate media, such as MacConkey agar or Cystine Lactose Electrolyte Deficient (CLED) agar. These media helped grow bacterial colonies that could later be identified. The plates were incubated at 37°C for 24-48 hours, allowing bacteria to grow and form colonies. After incubation, microbiologists examine the growth and perform further tests, such as gram staining and biochemical assays, to identify the bacterial species present. Following the identification of microorganisms, sensitivity testing is carried out to determine which antibiotics are effective against the bacteria. This testing often included the antibiotic disc diffusion method, where antibiotic-impregnated discs were placed on the cultured plate and the zones of inhibition were measured to assess antibiotic effectiveness. In addition, broth dilution methods was used to determine the minimal inhibitory concentration (MIC) for each antibiotic. The results of these tests was then compiled into a report, which includes the type of microorganism identified and the antibiotics to which it was sensitive or resistant. The final report was provided for inferring results depicted below.

RESULTS

The urine samples that were collected showed the leading pathogen comprised of E. coli with 234 (83.6%) number of cases causing UTI in diabetics followed by klebsiella pneumoniae 16 (5.7%) cases and proteus mirabilis 13 (4.6%) cases.

The study found that the highest level of antibiotic resistance in the urine samples of diabetic patients was observed against Amoxicillin+Clavulanic Acid, followed by Ciprofloxacin and Cefepime. These three antibiotics demonstrated the lowest effectiveness against the leading pathogens identified in the samples, suggesting a high level of resistance within the diabetic population in the study. This finding highlights the growing issue of antimicrobial resistance, which could lead to difficulties in treating urinary tract infections in these patients. The pathogens' resistance to these commonly used antibiotics is concerning, as they are frequently prescribed for UTI management, pointing to the need for alternative therapeutic strategies and better surveillance of antibiotic resistance patterns.

On a more positive note, the study as depicted in table 01 also revealed that all three major pathogens were 100% sensitive to Vancomycin, an important antibiotic used primarily for treating Gram-positive infections, including those resistant to other antibiotics. This was in contrast to the Imipenem and Meropenem family of antibiotics, which showed a high sensitivity rate of 98% for these pathogens. Additionally, Fosfomycin and Amikacin demonstrated lower effectiveness, with sensitivity rates of 93% and 80%, respectively. These results suggest that Vancomycin may be a reliable treatment option for UTIs caused by the identified pathogens in diabetic patients, offering a potential solution to the challenge of antibiotic resistance in this population.

Table 01. Urine Culture of bacterias against their sensitivity pattern.

	E.Coli		K.P		Proteus Mirabilis		Enterococcus Faecalis		Pseudomonas	
Antibiotics	**S (%)**	**R (%)**	**S (%)**	**R (%)**	**S (%)**	**R (%)**	**S (%)**	**R (%)**	**S (%)**	**R (%)**
Imipenem	98.30	1.70	100	0	100	0	42.90	57.10	90	10
Amoxicillin+Clauvulinic Acid	1.30	98.70	0	100	0	100	0	100	10	90
Ciprofloxacin	2.60	97.40	6.30	93.80	15.40	84.60	0	100	10	90
Amikacin	80.80	19.20	93.80	6.30	76.90	23.10	14.30	85.70	60	40
Colistin	79.50	20.50	100	0	69.20	30.80	42.90	57.10	60	40
Cefepime	34.20	65.80	37.50	62.50	7.70	92.30	14.30	85.70	40	60
Doxycycline	39.30	60.70	56.30	43.80	7.70	92.30	14.30	85.70	50	50
Erythromycin	89.70	10.30	93.80	6.20	84.60	15.40	42.90	57.10	90	10
Ertapenem	97.40	2.60	100	0	100	0	28.60	71.40	90	10
Fosfomycin	93.20	6.80	56.30	43.80	84.60	15.40	71.40	28.60	90	10
Meropenem	98.30	1.70	100	0	100	0	42.90	57.10	90	10
Ofloxacin	57.30	42.70	56.30	43.80	38.50	61.50	42.90	57.10	60	40
Pippercillin TZP	75.20	24.80	75	25	92.30	7.70	28.60	71.40	60	40
Vancomycin	100	0	100	0	100	0	100	0	100	0

DISCUSSION

As microbial resistance continues to rise, it is essential for doctors to consider local antibiogram data before prescribing empirical treatments for UTIs. Studies like this one provide valuable insights into the pathogens responsible for UTIs and their resistance patterns, helping healthcare providers make informed decisions. This information can guide the development of prescription guidelines to ensure more effective treatment, reduce the spread of resistance, and improve patient outcomes. The spread of multidrug resistant bacteria has been significantly aided by the misuse of antibiotics and application of an insufficient antibiotic regimen.

In our study the leading pathogen was found to be E. coli (83.6%) causing UTI in diabetics which was also found to be the leading pathogen in researches carried out in Department of Microbiology, University of Karachi and also at tertiary care hospital of Peshawar.[16,20] According to our study resistance has increased towards ciprofloxacin which also coincides with the research carried out at tertiary care hospital of Peshawar.[20]

In our study, Escherichia coli (E. coli) exhibited higher sensitivity to less frequently prescribed antibiotics, including Imipenem, Meropenem, Amikacin, and Erythromycin. This finding aligns with previous studies, suggesting that these antibiotics are often preserved from overuse, maintaining their effectiveness against uropathogens. According to Teng J et al., 2023 carbapenems like Imipenem and Meropenem continue to show high efficacy against multidrug-resistant strains of E. coli, highlighting their importance as last-resort treatments. Additionally, Amikacin, an aminoglycoside, remains effective due to its relatively limited use in empirical therapy for UTIs. However, the growing reliance on these antibiotics may lead to emerging resistance if their use increases. Therefore, it is crucial to balance the use of broad-spectrum antibiotics with appropriate stewardship to prevent future resistance. This highlights the need for continuous surveillance and more targeted antibiotic prescribing practices.[21]

According to Shaikh SM et al., amikacin is potential antibiotic for UTI in diabetics which also matches our study. [22] This study also demonstrated that these uropathogen are resistant to the antibiotic ciprofloxacin. Because of this, medical professionals should exercise caution before prescribing a patient with UTI the medication ciprofloxacin.

In our research organisms showed exceptional sensitivity towards Imipenem and Meropenem, which are not administered in routine to patients that present in inpatient and outpatient departments of the hospitals. This pattern of sensitivity is in alignment with the other researches carried out by Hamadalneel YB et al., in Sudan and Ahmad S. et al., in Peshawar.[23,20] All of these studies highlights the alarming rise in antibiotic resistance especially with commonly used drugs. It also emphasis on the importance of prescribing proper antibiotics according to area wise antibiograms and need for alternative treatment strategies.

CONCLUSION

In this study E. coli was found to be the leading pathogen causing UTI in diabetics followed by K-pneumonia, P-mirabilis, pseudomonas, E. faecalis. Our study showed that resistance has increased towards the commonly prescribed antibiotics like ciprofloxacin, amoxicillin +clavulanic acid which should not be prescribed any more in order to reduce medical cost and to obtain more curative results. According to our research organisms are showing a good sensitivity pattern towards Erythromycin, Imepenem, Meropenem, Ertapenem and vancomycin. Physician should have a good knowledge of antibiograms of the area in order to prescribe antibiotic for the treatment of UTI. Proper C/S should be done in order to reduce the resistance and cost of medical treatment.

Ethical Consideration

The permission was taken from the institute's Ethical review Board of Gajju khan Medical College/Bacha Khan Medical Complex, Peshawar, Pakistan, having diary No. 2252/Ethical Board/GKMC.

Acknowledgements

Not applicable.

Funding

There is no role of any funding agency in this study.

Conflict of Interest

Authors declared no conflict of interest.

REFERENCES

1. Mancuso G, Midiri A, Gerace E, Marra M, Zummo S, Biondo C. Urinary tract infections: the current scenario and future prospects. *Pathogens.* 2023 Apr 20;12(4):623. https://doi.org/10.3390/pathogens12040623
2. Trześniewska-Ofiara Z, Mendrycka M, Woźniak-Kosek A. Urinary tract infections: epidemiological and clinical aspects. *Medical Studies/Studia Medyczne.* 2024 Apr 1;40(2):208-15. https://doi.org/10.5114/ms.2024.140982
3. Silva A, Costa E, Freitas A, Almeida A. Revisiting the frequency and antimicrobial resistance patterns of bacteria implicated in community urinary tract infections. *Antibiotics (Basel).* 2022;11(6):768. https://doi.org/10.3390/antibiotics11060768
4. Mancuso G, Midiri A, Gerace E, Marra M, Zummo S, Biondo C. Urinary tract infections: the current scenario and future prospects. *Pathogens.* 2023;12(4):623. https://doi.org/10.3390/pathogens12040623
5. Gebretensaie Y, Atnafu A, Girma S, Alemu Y, Desta K. Prevalence of Bacterial Urinary Tract Infection, Associated Risk Factors, and Antimicrobial Resistance Pattern in Addis Ababa, Ethiopia: A Cross-Sectional Study. *Infect Drug Resist.* 2023 May 16;16:3041-3050. https://doi.org/10.2147/IDR.S402279
6. Kang TB, Hisham Y, Lee Y, Jhun H, Kim J, Kim S. Diabetes and bacterial infection. *International Journal of Clinical Endocrinology and Metabolism.* 2022 Sep 24;8(1):001-8. https://doi.org/10.17352/ijcem.000054
7. Yasmeen BN, Islam S, Islam S, Uddin MM, Jahan R. Prevalence of urinary tract infection, its causative agents, and antibiotic sensitivity pattern: A study in Northern International Medical College Hospital, Dhaka. *North Int Med Coll J.* 2015;7(1):105–9. https://doi.org/10.3329/nimcj.v7i1.25704
8. Yenehun WG, Belete AY, Erku AW. Prevalence of Bacterial Urinary Tract Infection and Antimicrobial Susceptibility Patterns Among Diabetes Mellitus Patients Attending Zewditu Memorial Hospital, Addis Ababa, Ethiopia. *Infect Drug Resist.* 2021 Apr 15;14:1441-1454. https://doi.org/10.2147/IDR.S298176.
9. Ahmad S, Hussain A, Khan MS, Shakireen N, Ali I. Diabetes mellitus and urinary tract infection: Causative uropathogens, their antibiotic susceptibility pattern and the effects of glycemic status. *Pakistan Journal of Medical Sciences.* 2020 Nov;36(7):1550. https://doi.org/10.12669/pjms.36.7.2881
10. McCowan C, Bakhshi A, McConnachie A, Malcolm W, Barry SJ, Santiago VH, et al. E. coli bacteraemia and antimicrobial resistance following antimicrobial prescribing for urinary tract infection in the community. *BMC infectious diseases.* 2022 Oct 28;22(1):805.
11. Woldemariam HK, Geleta DA, Tulu KD. Common uropathogens and their antibiotic susceptibility pattern among diabetic patients. *BMC Infect Dis.* 2019;19(1):43. https://doi.org/10.1186/s12879-018-3669-5
12. Nauclér P, Huttner A, van Werkhoven CH, Singer M, Tattevin P, Einav S, et al. Impact of time to antibiotic therapy on clinical outcome in patients with bacterial infections in the emergency department: implications for antimicrobial stewardship. *Clin Microbiol Infect.* 2021 Feb;27(2):175-181. https://doi.org/10.1016/j.cmi.2020.02.032
13. Shallcross L, Rockenschaub P, Blackburn R, Nazareth I, Freemantle N, Hayward A. Antibiotic prescribing for lower UTI in elderly patients in primary care and risk of bloodstream infection: A cohort study using electronic health records in England. *PLoS Med.* 2020 Sep 21;17(9):e1003336. https://doi.org/10.1371/journal.pmed.1003336
14. Morel CM, de Kraker MEA, Harbarth S. Enhanced Surveillance Expert Consensus Group (CANSORT-SCI). Surveillance of Resistance to New Antibiotics in an Era of Limited Treatment Options. *Front Med (Lausanne).* 2021 Apr 19;8:652638. https://doi.org/10.3389/fmed.2021.652638
15. Torumkuney D, Kundu S, Vu GV, Nguyen HA, Pham HV, Kamble P, et al. Country data on AMR in Vietnam in the context of community-acquired respiratory tract infections: links between antibiotic susceptibility, local and international antibiotic prescribing guidelines, access to medicines and clinical outcome. *J Antimicrob Chemother.* 2022 Sep 6;77(Suppl_1):i26-i34. https://doi.org/10.1093/jac/dkac214

16. Truong WR, Hidayat L, Bolaris MA, Nguyen L, Yamaki J. The antibiogram: key considerations for its development and utilization. *JAC Antimicrob Resist.* 2021 May 25;3(2):dlab060. https://doi.org/10.1093/jacamr/dlab060
17. Gutema T, Weldegebreal F, Marami D, Teklemariam Z. Prevalence, Antimicrobial Susceptibility Pattern, and Associated Factors of Urinary Tract Infections among Adult Diabetic Patients at Metu Karl Heinz Referral Hospital, Southwest Ethiopia. *Int J Microbiol.* 2018 Nov 1;2018:7591259. https://doi.org/10.1155/2018/7591259
18. Aamir AH, Raja UY, Asghar A, Mahar SA, Ghaffar T, Ahmed I, et al. Asymptomatic urinary tract infections and associated risk factors in Pakistani Muslim type 2 diabetic patients. *BMC Infect Dis.* 2021 Apr 26;21(1):388. https://doi.org/10.1186/s12879-021-06106-7.
19. Czajkowski K, Broś-Konopielko M, Teliga-Czajkowska J. Urinary tract infection in women. *Prz Menopauzalny.* 2021 Apr;20(1):40-47. https://doi.org/10.5114/pm.2021.105382
20. Ahmad S, Ali F, Qureshi SA, Uzma B, Shakeela Q, Sabir MS, et al. The evaluation of antibiotic susceptibility pattern and associated risk factors of UTI in tertiary care hospital of Peshawar. *Pak J Pharm Sci.* 2022 May;35(3(Special)):897-903. PMID: 35791585.
21. Teng J, Imani S, Zhou A, Zhao Y, Du L, Deng S, et al. Combatting resistance: Understanding multi-drug resistant pathogens in intensive care units. *Biomed Pharmacother.* 2023 Nov;167:115564. https://doi.org/10.1016/j.biopha.2023.115564.
22. Shaikh SM, Tiwari S, Purandare VB, Bhalekar P, Bhake R, Patil NB, et al. Clinico-Microbiological Profile of Urinary Tract Infections in Patients with Type 2 Diabetes: A Study Based in a Hospital Dedicated to Diabetes Care. *Chronicle of Diabetes Research and Practice.* 2025 Jan 1;4(1):26-30. https://doi.org/10.4103/cdrp.cdrp_10_24
23. Hamadalneel YB, Ahmed HO, Alamin MF, Almahy WM, Almustafa ZM, Yousif YM, et al. Prevalence and Antimicrobial Sensitivity Patterns of Uropathogens in Wad Medani, Sudan: A Three Years, Cross-Sectional Study. *Infect Drug Resist.* 2024 May 28;17:2131-2140. https://doi.org/10.2147/IDR.S464501. PMID: 38828377; PMCID: PMC11143980.

DATA SHARING STATEMENT: The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

AUTHORS' CONTRIBUTION

The following authors fulfill authorship criteria as per ICMJE guidelines;

Khan SA, Shoukat Q: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.

Bibi M, Khattak Z: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.

Rahman IU, Zaman MU: Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.

Nawaz Q: Analysis and interpretation of data, critical revision, final approval, agreed to be accountable for all the work.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License, which permits unrestricted use, distribution & reproduction in any medium provided that original work is cited properly.