Section: General Medicine

Original Research Article

ETIOLOGICAL PROFILE AND ANTIMICROBIAL SUSCEPTIBILITY PATTERNS IN COMPLICATED URINARY TRACT INFECTIONS

Prashanth M[1], Anagha S[2]

[1]Assistant Professor, General Medicine, Chikmagalur Institute of Medical Sciences, Karnataka, India.
[2]Senior Resident, Department of Anaesthesia, Mahabodhi Medical College, Gaya, Bihar, India.

Received : 11/08/2025
Received in revised form : 01/10/2025
Accepted : 16/10/2025

Keywords:
Complicated UTI, CAUTI, BPH, Antimicrobial resistance.

Corresponding Author:
Dr. Prashanth M,
Email: drprashanth64@gmail.com

DOI: 10.47009/jamp.2025.7.5.250

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (5); 1315-1319

ABSTRACT

Background: Urinary tract infections (UTIs) are among the most prevalent bacterial infections, with complicated UTIs (cUTIs) posing significant clinical challenges due to their association with underlying genitourinary abnormalities, high recurrence rates and increasing antimicrobial resistance. Regional variations in uropathogen distribution and antibiotic susceptibility necessitate local surveillance to guide effective management. This study aimed to identify the underlying causes of cUTI, determine the spectrum of causative organisms, and analyse their antibiotic sensitivity and resistance patterns. **Materials and Methods:** This cross-sectional observational study was conducted over one year (January 2024-June 2025) at Chikkamagalur Institute of Medical Sciences, involving patients clinically suspected of having cUTI. Both in-patients and out-patients were included. Data were collected through detailed history, clinical examination, and relevant investigations. **Results:** Females constituted 56.67% of cases, with a mean age of 56.76 years. Uncontrolled diabetes mellitus (58.3%) was the most common predisposing factor, followed by catheter-associated UTI (CAUTI), benign prostatic hyperplasia (BPH), and urinary stone disease. *Escherichia coli* (60.83%) was the predominant uropathogen, followed by *Klebsiella* (11.67%) and *Pseudomonas* (10.83%). *Enterococci* (3.33%) were the most frequent Gram-positive isolates. Resistance rates were highest for beta-lactams and quinolones. *Enterobacteriaceae* showed the least resistance to Nitrofurantoin and Carbapenems. *Pseudomonas* showed high susceptibility to carbapenems. All Gram-positive isolates were sensitive to vancomycin and linezolid. **Conclusion:** cUTIs were more common in females, with diabetes mellitus, CAUTI, urinary stones, BPH, and recurrent UTIs being significant risk factors. E. coli was the most commonly isolated pathogen, and high rates of resistance to commonly used antibiotics such as quinolones and beta-lactams were observed. Carbapenems, aminoglycosides, and acid-resistant beta-lactams with sulbactam emerged as effective therapeutic options for empirical treatment in this setting.

INTRODUCTION

Urinary tract infections (UTIs) are one of the most common bacterial infections, affecting over 150 million people each year worldwide.[1] A condition in which bacteria are established and multiplying within the urinary tract and are clinically classified into uncomplicated and complicated UTI. A complicated UTI is urinary infection occurring in a patient with a structural or functional abnormality of the genitourinary tract. While UTIs cause severe public health problems, they are caused by a wide range of organisms, most commonly, Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis, Enterococcus faecalis and Staphylococcus saprophyticus.[2]

Injudicious use of antibiotics in different countries mirrors the global increase in the development of resistant strains.[3] Extended-spectrum β-lactamase (ESBL) producing bacteria shown resistance to most antibiotics such as penicillins, cephalosporins, and the monobactam aztreonam, except for the carbapenem group, are on a steady rise in the population.[4] Higher recurrence rates and increased antimicrobial resistance among uropathogens often increase the economic burden due to infections.[5] The current study was undertaken to investigate the causes of the complicated UTI in patients and their microbial profile and antibiotic sensitivity.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

MATERIALS AND METHODS

A cross-sectional observational study was conducted in the Department of General Medicine, Chikkamagalur Institute of Medical Sciences, Chikkamagaluru, India for a year, between month of January 2024 to June 2025. All the patients presenting to the medicine department with clinically showing the criteria for UTI were included in the study.

Prevalence of urinary tract infection of 47% was reported in an earlier publication6, the sample size was calculated using the formula for prevalence studies: P = 47%, q = 100 − 47 = 53%, and absolute error (d) = 8%, resulting in a sample size of 155. Patients included were aged older than 18 years who fulfilled the criteria for cUTI, and the individuals were recruited to study as per the ethical committee recommendations and obtained informed consent to participate in the study. Asymptomatic healthy females of reproductive age, menstruating females, and patients currently on antibiotic therapy in the past two weeks were excluded in this study. Descriptive analysis was performed using mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. Data were also represented using charts, graphs, plots, and illustrations.

Quantitative variables were assessed for normality using visual inspection of histograms and Q-Q plots, as well as statistical tests including the Shapiro–Wilk and Kolmogorov–Smirnov tests. Associations between explanatory variables and categorical outcomes were evaluated using cross-tabulation and comparison of percentages. Odds ratios with 95% confidence intervals. Statistical significance for the distribution of values in two groups was assessed using the chi-square test. When the overall sample size was less than 20 or if the expected frequency in any cell was less than 5, Fisher's exact test was used. A p-value <0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS version 22.

RESULTS

Diabetes mellitus is enriched among the risk factors contributing to cUTI.

Patients were enrolled in the study (n=155) based on the estimated sample size. All patients who demonstrated significant growth on urine culture were included for further evaluation. In our study, urine specimens which showed a significant growth (n= 120) were therefore assessed for underlying risk factors and the antibiogram of the isolated pathogens. In the patient cohort, 43.3 percent were males (n=52) and 56.6 percent were females (n=68). The patient's ages had a distribution range of 18 to 86 years, with a mean age of 56.76 (± 13.43) years. [Table 1]

Our study suggests that Diabetes mellitus is a major predisposing factor for cUTI. 58.3% patients who presented with the condition were diabetic, including both males and females (Table 1 and Figure 1A and 1B). Among males, BPH (13.3%) and stricture urethra (3.3%) were additional important risk factors (Figure 1A), with higher incidence in those aged over 60 years (Table 2). Catheter-associated UTI (CAUTI) was identified in 12.5 % of patients, with a slight male preponderance (7.5%). Recurrent UTI (R-UTI) accounted for 15 % of the cases, showing a slight female preponderance (8.33%) (Table 1 and Figure 1B). Underlying renal dysfunction was observed in 20 % of the study population. Among the presenting complaints, increased urinary frequency and urgency were the most common symptoms, followed by fever and dysuria. [Figure 1C]

26.66% (n=32) of patients with complicated UTI had no sonological abnormalities. The most common ultrasonographic finding was cystitis (27.5%), with the majority occurring in females (20.8%). The other frequent findings included renal/ureteric calculi (15.8%) and BPH (15%). Pyelonephritis was observed in 10% of patients, most commonly among females (6.66%). Additionally, 15% of patients demonstrated nephropathic (medical renal disease) changes on ultrasonography. [Figure 1D]

Members of the Enterobacteriaceae family were the predominant pathogens isolated. The Enumeration of the isolated and cultured most common organisms/ pathogens shows enrichment for Escherichia coli was 60.83%, followed by Klebsiella 11.67% and pseudomonas 10.83% (Figure 2A, Table 3). Among the Gram-positive isolates, Enterococcus species (3.33%) were the most frequent, followed by Staphylococcus aureus and Coagulase-negative staphylococci. [Figure 2A, Table 3]

Diabetic patients with cUTI, E.coli (58.57%) was the predominant isolate, followed by Klebsiella (15.71%), Pseudomonas (10%) and Proteus (7.14%) (Figure 2B Table 4). In cases of CAUTI, the most common isolate was E.coli (46.66%) followed by klebsiella (26.66%), Pseudomonas (6.67%) and Proteus (6.67%). Among patients with BPH, E.coli (56.25%). was again the predominant pathogen, followed by Klebsiella (18.75%) and Proteus (18.75%). Enterococcus species were identified with equal frequencies in both groups (Figure 2C, Table 4). In patients with Urinary stone disease and Recurrent UTI, the most common organism isolated was E.coli followed by Klebsiella and Pseudomonas. [Figure 2D, Table 4]

We have investigated the sensitivity pattern of these cultured organisms, E.coli showed least resistance to nitrofurantoin (16.4%) followed by piperacillin-taobactam (17.8%), meropenem (21.2%) and amikacin (21.9%). High resistance rates were observed to frequently prescribed agents like amoxicillin-clavulinic acid (86.31%), quinolones (80.82%), and third-generation cephalosporins (74-80%), cotrimoxazole (64%) and nalidixic acid (73.9%). [Figure 3A] Enterobacteriaceae other than E.coli (klebsiella, proteus, citrobacter) exhibited a resistance pattern similar to that of E.coli. Maximum

ISSN (O): 2687-5365; ISSN (P): 2753-6556

resistance was against amoxicillin-clavulinic acid followed by third-generation cephalosporins, quinilones, cotrimoxazole and nalidixic acid. These organisms were most susceptible to carbapenem group (22-33%), followed by nitrofurantoin, piperacillin-tazobactam, amikacin, and gentamicin. (Figure 3B) Pseudomonas species demonstrated the highest susceptibility to carbapenems (7.69%), followed by gentamicin (15.4%). Highest resistance was to amoxicillin-clavulinic acid (92.3%) followed by ciprofloxacin and cephalosporins. [Figure 3C] All the Gram-positive cocci in the present study were fully sensitive to Vancomycin and linezolid. Among commonly used antibiotics, the lowest resistance was seen against carbapenems, followed by nitrofurantoin and aminoglycosides (except for Staphylococcus aureus). In contrast, the least effective agents against Gram-positive bacteria were amoxicillin-clavulinic acid, norfloxacin and nalidixic acid. [Figure 3D]

DISCUSSION

Complicated urinary tract infections (cUTIs) are a major cause of bacteraemia and contribute significantly to mortality among critically ill patients worldwide. The emergence of extended-spectrum β-lactamase (ESBL)–producing organisms has further complicated treatment strategies[REF] Understanding the microbial aetiology and antibiotic susceptibility patterns of cUTIs is therefore essential for guiding empirical therapy. In the current study we describe a cross sectional study with investigations on the cUTI in individuals, underlying pathogens and their diversity in the sensitivity for antibiotics and treatment outcomes.

Our study describes a clinical investigation of the 120 patients who presented with Urinary tract infections. A female predominance consistent with previously published studies.[5,7,8]

The mean standard deviation for age of participants was 56.76 ± 13.43 years, with a female predominance noted in individuals older than 40 years. These observations concur with an earlier study.[9] Diabetes mellitus was the most common predisposing factor for cUTI in our study, present in 58.3% of patients (p = 0.03). Numerous studies have demonstrated an increased risk of UTI among diabetic individuals. Studies earlier published has established similar trend of Diabetes and UTI.[10-12]

Benign prostatic hyperplasia (BPH) was identified as an underlying risk factor in 13.3% of patients, accounting for 30.79% of male cases. The majority of affected patients were older than 50 years, with a mean age of 67.125 years. BPH prevalence varies across studies and cohorts 41.5%(10), 28.57%,[13] and 7.79%,[12] respectively, and these differences likely reflect variation in the proportion of elderly patients included. Urinary stone disease was present in 13.3% of cases, and catheter-associated UTI (CAUTI) in 12.5%.[12]

Increased urinary frequency (67.5%) and urgency (60%) were the most common presenting symptoms, followed by fever and dysuria. Similar symptom profiles were observed in studies,[10,14] where frequency (65.26%), urgency (62.10%), and dysuria (62.10%) predominated; fever was present in 45.26% of patients. Increased urinary frequency and urgency were the most common presenting symptoms, followed by fever and dysuria. Similar symptom profiles were observed in studies previously reported. Escherichia coli was the most frequently isolated organism, followed by Klebsiella sp. (11.67%) and Pseudomonas sp. (10.83%). The earlier studies by Eshwarappa and co-workers,[9] and Manikandan and co-workers,[15] have reported similar observations. Microbial distribution is consistent with studies by E. coli, predominating in female patients. The predominance was also observed for Klebsiella, Pseudomonas, Enterococcus, coagulase-negative staphylococci (CoNS), and Staphylococcus aureus. (Table 5A) E. coli remains the most common organism, accounting for more than 50% of isolates in nearly all referenced studies. Its predominance is likely due to its natural colonization of the large bowel and its fimbriae, which facilitate adhesion to the urinary tract mucosa.

Most of the diabetics with cUTI had E.coli as the predominant isolate, followed by Klebsiella, Pseudomonas and Proteus. However, slightly increased prevalence of Klebsiella was observed in diabetic patients compared to non-diabetics, which is consistent with the following studies. [Table 5B] In CAUTI cases, E. coli was the most common isolate (46.66%), followed by Klebsiella (26.66%), Pseudomonas (6.67%), and Proteus (6.67%). Similar E. Coli predominance has been reported by Nandini MS et al,[21] and Wazait HD et al.[22] The higher CAUTI prevalence in our study may be attributed to biofilm formation and the increasing burden of antibiotic-resistant organisms. Among patients with BPH, E. coli was again the predominant isolate, followed by Klebsiella and Proteus. Comparable patterns have been reported in earlier publication,[13] and Agbuguj JO.[23] In patients with urinary stone disease, E. coli was also the predominant pathogen, followed by Klebsiella and Pseudomonas, consistent with findings in earlier studies.[24, 25]

Antibiotic Resistance and Susceptibility Patterns

In this study, the antimicrobial potency and spectrum of selected agents across multiple antimicrobial classes were evaluated against common uro-pathogens. Both Gram-negative bacilli and Gram-positive cocci demonstrated markedly high resistance to β-lactam antibiotics.[26] Among Gram-negative isolates, Escherichia coli—the most frequently recovered organism—showed the lowest resistance to nitrofurantoin , followed by piperacillin–tazobactam and carbapenems. The highest resistance was observed against β-lactams and fluoroquinolones. These results align with those reports.[10-12] Other Enterobacteriaceae demonstrated similar susceptibility trends, showing the greatest

ISSN (O): 2687-5365; ISSN (P): 2753-6556

sensitivity to carbapenems followed by nitrofurantoin, piperacillin–tazobactam, amikacin, and gentamicin. Pseudomonas aeruginosa exhibited maximum susceptibility to carbapenems and gentamicin. These findings correspond with those of Javiya and co-workers,[27] except for the higher amikacin resistance which observed in current study.

All Gram-positive cocci were uniformly sensitive to vancomycin and linezolid. Among commonly used agents, the lowest resistance was noted to carbapenems, followed by nitrofurantoin and aminoglycosides (except in Staphylococcus aureus). The sensitivity for antibiotics has remained unchanged from the earlier report.[28,29]

Overall, both Gram-negative and Gram-positive organisms showed high resistance to β-lactams, fluoroquinolones, cotrimoxazole, and nalidixic acid. Combination therapy with piperacillin or cephalosporins plus sulbactam demonstrated lower resistance than monotherapy. Carbapenems emerged as the most effective antimicrobial class, followed by nitrofurantoin, aminoglycosides, and piperacillin–tazobactam, suggesting that these agents should be prioritized for use in severe or complicated UTIs and preserved to slow resistance development. The high resistance rates observed may be attributed to repeated or prolonged antibiotic exposure, geographic variations in microbial ecology, hygiene practices, and differences in healthcare delivery. Frequent antibiotic use may disrupt periurethral flora, facilitating colonization by uropathogens and promoting horizontal gene transfer of resistance determinants. Given the evolving nature of antimicrobial resistance, continuous surveillance and routine monitoring are essential to inform region-specific empirical therapy. Strengthening infection-control practices remains critical to reducing the spread of resistant organisms.

CONCLUSION

This study found that complicated UTIs were more prevalent in females with a patient age of 56 years and an isolation of causative pathogen in them. The major associated risk factors were diabetes mellitus, CAUTI, urinary stone disease, benign prostatic hyperplasia (BPH), and recurrent UTI. Gram-negative organisms predominated, with Escherichia coli being the most frequently isolated pathogen.

A high level of resistance to commonly used antibiotics, including quinolones and β-lactams, was observed. Based on the susceptibility patterns identified, carbapenems, aminoglycosides, and β-lactam/β-lactamase inhibitor combinations (e.g., with sulbactam) appear to be the most effective options for empirical treatment of complicated UTIs in this hospital setting.

REFERENCES

1. Stamm Walter E, Norrby S Ragnar. Urinary Tract Infections: Disease Panorama and Challenges. The Journal of Infectious Diseases [Internet]. 2001 Mar [cited 2019
   Stamm WE, Norrby SR. Urinary tract infections: disease panorama and challenges. J Infect Dis. 2001;183 Suppl 1:S1-4.
2. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015;13(5):269-84.
3. Gyssens IC. Antibiotic policy. Int J Antimicrob Agents. 2011;38 Suppl:11-20.
4. Oteo J, Perez-Vazquez M, Campos J. Extended-spectrum [beta]-lactamase producing Escherichia coli: changing epidemiology and clinical impact. Curr Opin Infect Dis. 2010;23(4):320-6.
5. Yadav M, Pal R, Damrolien S, Khumanthem SD. Microbial spectrum of urinary tract infections and its antibiogram in a tertiary care hospital. International Journal of Research in Medical Sciences. 2017;5:2718-22.
6. Patel S, Taviad PP, Sinha M, Javadekar TB, Chaudhari VP. Urinary Tract Infections (UTI) Among Patients at G.G. Hospital & Medical College, Jamnagar. National Journal of Community Medicine. 2012;3(01):138-41.
7. Shanthi J aKS. . Incidence, distribution and antibiogram of uropathogens isolated from patients with urinary tract infections. Adv Applied Sci Res. 2012;3(3410-3404).
8. De Vecchi E, Sitia S, Romano CL, Ricci C, Mattina R, Drago L. Aetiology and antibiotic resistance patterns of urinary tract infections in the elderly: a 6-month study. J Med Microbiol. 2013;62(Pt 6):859-63.
9. Eshwarappa M, Dosegowda R, Aprameya IV, Khan MW, Kumar PS, Kempegowda P. Clinico-microbiological profile of urinary tract infection in south India. Indian J Nephrol. 2011;21(1):30-6.
10. Kakde P, Redkar NN, Yelale A. Urinary Tract Infection in Elderly: Clinical Profile and Outcome. J Assoc Physicians India. 2018;66(6):14-7.
11. Mahesh E RD, Indumathi VA,Punith K, Kirthi R, Anupama HA. . Complicated urinary tract infection in a tertiary care centre in South India. Al Ameen Journal of Medical Sciences. 2010;3(2):120-7.
12. Khan R, Saif, Q., Fatima, K., Meher, R., Shahzad, H., & Anwar, K. . Clinical and bacteriological profile of UTI patients attending a North Indian tertiary care center. Journal of Integrative Nephrology and Andrology. 2015;2(1):246-52.
13. Mishra PP, Prakash V, Singh K, Mog H, Agarwal S. Bacteriological Profile of Isolates From Urine Samples in Patients of Benign Prostatic Hyperplasia and or Prostatitis Showing Lower Urinary Tract Symptoms. J Clin Diagn Res. 2016;10(10):DC16-DC8.
14. Little P, Merriman R, Turner S, Rumsby K, Warner G, Lowes JA, et al. Presentation, pattern, and natural course of severe symptoms, and role of antibiotics and antibiotic resistance among patients presenting with suspected uncomplicated urinary tract infection in primary care: observational study. BMJ. 2010;340:b5633.
15. Manikandan C, & Amsath, A. PREVALENCE AND DISTRIBUTION OF BACTERIA AND FUNGI ISOLATED FROM PATIENTS WITH URINARY TRACT INFECTION S IN PATTUKKOTTAI, TAMILNADU, INDIA. International Journal of Pure and Applied Zoology. 2013;1(3):213
16. Sharma S, Govind B, Naidu SK, Kinjarapu S, Rasool M. Clinical and laboratory profile of urinary tract infections in type 2 diabetics aged over 60 Years. Journal of clinical and diagnostic research: JCDR. 2017 Apr;11 (4):OC25.
17. Chiţa T, Licker M, Sima A, Vlad A, Timar B, Sabo P, Timar R. Prevalence of urinary tract infections in diabetic patients. Romanian Journal of Diabetes Nutrition and Metabolic Diseases. 2013 Jun 1;20 (2):99-105.
18. Hamdan HZ, Kubbara E, Adam AM, Hassan OS, Suliman SO, Adam I. Urinary tract infections and antimicrobial

ISSN (O): 2687-5365; ISSN (P): 2753-6556

sensitivity among diabetic patients at Khartoum, Sudan. Annals of clinical microbiology and antimicrobials. 2015 Dec;14(1):26.
19. Li X, Chen Y, Gao W, Ye H, Shen Z, Wen Z, Wei J. A 6-year study of complicated urinary tract infections in southern China: prevalence, antibiotic resistance, clinical and economic outcomes. Therapeutics and clinical risk management. 2017; 13:1479.
20. Kibret M, Abera B. Prevalence and antibiogram of bacterial isolates from urinary tract infections at Dessie Health Research Laboratory, Ethiopia. Asian Pacific journal of tropical biomedicine. 2014 Feb 1;4(2):164-8.
21. Nandini. M.S KM. Bacteriological Profile of Catheter Associated Urinary Tract Infection and its Antimicrobial Susceptibility Pattern in a Tertiary Care Hospital. African Journal of Biomedical Research. 2024;27(4S):6476-81.
22. Wazait HD PH, Veer V, Kelsey M, Van Der Meulen JH, Miller RA. Catheter- associated urinary tract infections: prevalence of uropathogens and pattern of antimicrobial resistance in a UK hospital (1996–2001). BJU international. 2003;91(9):8069.
23. Agbugui JO, Obarisiagbon EO, Osaigbovo II. Bacteriology of urine specimens obtained from men with symptomatic benign prostatic hyperplasia. Nigerian Journal of Surgery. 2016;22(2):65-9.
24. Chen D, Zhang Y, Huang J, Liang X, Zeng T, Lan C, et al. The analysis of microbial spectrum and antibiotic resistance of uropathogens isolated from patients with urinary stones. Int J Clin Pract. 2018;72(6):e13205.
25. Kannan SM, Revathy, C., & Sucilathangam, G.). Bacteriology and chemical composition of urolithiasis accompanying urinary tract infection in a tertiary care hospital. International Journal of Scientific Research. 2018;7(10):29-32.
26. Kothari A, Sagar V. Antibiotic resistance in pathogens causing community-acquired urinary tract infections in India: a multicenter study. J Infect Dev Ctries. 2008;2(5):354-8.
27. Javiya VA, Ghatak SB, Patel KR, Patel JA. Antibiotic susceptibility patterns of Pseudomonas aeruginosa at a tertiary care hospital in Gujarat, India. Indian J Pharmacol. 2008;40(5):230-4.
28. Kumar S BD, Sayal P. . Bacterial Uropathogens and Empirical Treatment in Urinary Tract Infection in a Tertiary Care Institute. Int J Curr Microbiol App Sci 2016;5(4):47-54.
29. Tayebi Z SS, Goudarzi M, Rahimi MK, Boromandi S, Bostanabad SZ, Mirzaii A, Mahdiyoun M. . Frequency and antibiotic resistance pattern in gram-positive uropathogenes isolated from hospitalized patients with urinary tract infection in Tehran. Iran J Genes Microb Immun. 2014;2014(1):1-9.

ISSN (O): 2687-5365; ISSN (P): 2753-6556