Original Article

Bacteriological Spectrum and Antimicrobial Susceptibility Patterns of Uropathogens Isolated from Patients with Urinary Tract Infections in a Tertiary Care Hospital

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Abstract

Background: Urinary tract infections (UTIs) are one of the most frequently occurring bacterial infections in community and hospital environments and are a major cause of morbidity in the world. UTIs are becoming more difficult to treat, as multidrug-resistant organisms have become increasingly common. Bacteriological profile and antimicrobial susceptibility testing has to be done on an ongoing basis to inform empirical treatment and prevent the development of resistant bacteria. **Material and Methods:** This observational study was conducted in the Microbiology Laboratory of a tertiary care hospital between 2024-2025.A total of 300 urine samples were collected from hospitalized patients with suspected urinary tract infections. Urine samples were processed using standard microbiological techniques, and significant bacteriuria was determined according to the Kass criteria. Identification of isolates was carried out using conventional biochemical methods. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. **Results:** Out of 300 urine samples, 93 (31%) showed significant bacteriuria. The highest number of culture-positive cases was observed in the 20–40 years age group (39.8%). Escherichia coli was the predominant isolate (50.5%), followed by Klebsiella pneumoniae (20.4%), Enterococcus spp. (11.8%), Pseudomonas spp. (8.6%), Acinetobacter spp. (5.4%), and Staphylococcus aureus (3.2%). Among Gram-negative isolates, Colistin and Polymyxin B showed 100% susceptibility, followed by Meropenem and Imipenem, while lower susceptibility was observed with cephalosporins and fluoroquinolones. Gram-positive isolates demonstrated high susceptibility to Vancomycin and Linezolid. **Conclusion:** Escherichia coli remains the most common uropathogens in urinary tract infections. The study highlights increasing resistance to commonly used antibiotics and emphasizes the need for continuous surveillance of antimicrobial susceptibility patterns and implementation of antimicrobial stewardship programs to ensure effective management of urinary tract infections.

Keywords: Urinary tract infection; Uropathogens; Antimicrobial susceptibility; Escherichia coli; Multidrug resistance; Kirby–Bauer method.

Received: 03 May 2026 **Revised: 19 May 2026** **Accepted: 01 June 2026** **Published: 12 June 2026**

Introduction

Urinary tract infection (UTI) is one of the most common bacterial infections affecting individuals of all age groups and represents a significant cause of morbidity among both outpatient and hospitalized patients in tertiary care centers worldwide.[1,2] UTIs account for a substantial proportion of healthcare-associated infections and impose a considerable burden on healthcare systems due to their high prevalence and recurrence rates.[3] Among hospitalized patients, urinary catheterization is recognized as one of the most important predisposing factors for the development of urinary tract infections, particularly catheter-associated urinary tract infections (CAUTIs), which are frequently encountered in tertiary healthcare settings.[4,5]

The clinical presentation of UTIs varies widely, ranging from uncomplicated lower urinary tract infections such as cystitis to more severe upper urinary tract infections, including pyelonephritis and in complicated cases, urosepsis.[1,6] The management of UTIs has become increasingly challenging due to the rising prevalence of multidrug-resistant (MDR) uropathogens, which significantly limit available therapeutic options and lead to increased morbidity, mortality, and healthcare costs.[7,8]

In developing countries such as India, the increasing trend of antimicrobial resistance among uropathogens has been largely attributed to the inappropriate and excessive use of antibiotics, self-medication practices, lack of antimicrobial stewardship programs, and inadequate infection control measures within

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DOI:
10.21276/amit.2026.v13.i2.734

How to cite this article: Kumar R, Singh S, Choudhary M, Singh N. Bacteriological Spectrum and Antimicrobial Susceptibility Patterns of Uropathogens Isolated from Patients with Urinary Tract Infections in a Tertiary Care Hospital. Acta Med Int. 2026:13(2):623-627.

healthcare facilities.[9,10] Continuous surveillance of the bacteriological profile of uropathogens and their antimicrobial susceptibility patterns is therefore essential for guiding clinicians in the selection of effective empirical therapy and for preventing the spread of resistant strains in both hospital and community settings.[11,12]

Therefore, the present study was undertaken to evaluate the bacteriological profile and antimicrobial susceptibility patterns of uropathogens isolated from urinary tract infection cases presenting to a tertiary care hospital.

Materials and Methods

The present observational study was conducted in the Microbiology Laboratory of a tertiary care centre of Hind Institute of Medical Sciences, Safedabad, Barabanki, UP, between the period 2024–2025.

Sample collection: Midstream clean-catch urine samples were collected in sterile, wide-mouthed containers from patients presenting with clinical features suggestive of urinary tract infection (UTI). The samples were transported to the laboratory without delay and processed within 2 hours of collection to ensure optimal recovery of pathogens.

In catheterized patients, urine samples were collected aseptically from the designated sampling port of the catheter, rather than from the drainage bag, to minimize the risk of contamination. Prior to sample collection, the sampling port was disinfected using an alcohol swab, following which urine was aspirated using a sterile syringe and transferred into a sterile container.

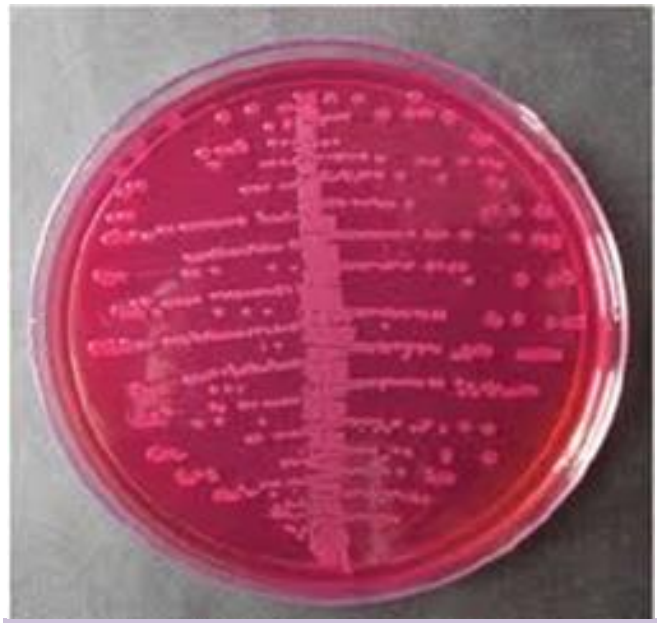

Figure 1: Semi-quantitative streaking of urine sample on MacConkey agar

All samples were appropriately labelled and promptly transported to the laboratory for microbiological analysis. In cases where immediate processing was not feasible, the specimens were stored under refrigerated conditions. Strict adherence to aseptic techniques was maintained throughout the collection and handling procedures to prevent contamination and ensure the accuracy of results.

Laboratory procedures: Urine cultures were performed using standard microbiological techniques based on a semi-quantitative method. A calibrated loop technique was employed to inoculate urine specimens onto Blood Agar, MacConkey agar, Nutrient agar, and Cystine Lactose Electrolyte Deficient (CLED) agar plates. The inoculated culture media were incubated aerobically at 37 °C for 18–24 hours, after which the plates were examined for bacterial growth.

The interpretation of urine culture results was carried out according to the conventional Kass criteria,[13] whereby colony counts were used to differentiate between significant bacteriuria and insignificant growth. A colony count of $\geq 10^5$ colony-forming units per millilitre (CFU/mL) of urine was considered indicative of significant bacteriuria suggestive of urinary tract infection.

Antibiotics sensitivity testing: The isolated organisms were identified using standard microbiological techniques, including colony morphology, Gram staining, and conventional biochemical tests. Antimicrobial susceptibility testing of the isolates was performed in accordance with the Clinical and Laboratory Standards Institute (CLSI) guidelines.[14]

Antibiotic susceptibility testing was carried out using the Kirby–Bauer disk diffusion method (manual technique) on Mueller–Hinton agar plates. The results of antimicrobial susceptibility were interpreted based on CLSI-recommended zone diameter criteria.

Results

During the study period, a total of 300 urine samples were collected from hospitalized patients and processed using standard microbiological techniques for isolation and identification of bacterial pathogens. Of the 300 urine samples analyzed, 93 (31%) demonstrated significant bacteriuria and were categorized as culture-positive, while 207 (69%) showed no bacterial growth and were considered culture-negative.

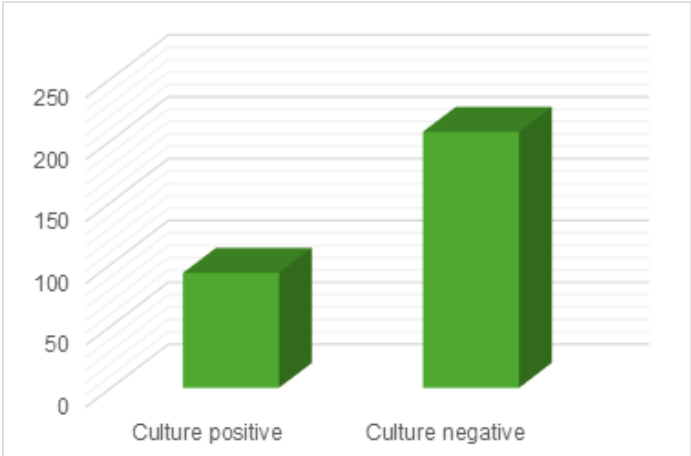

Figure 2: Distribution of culture-positive and culture-negative urine samples among the total 300 samples analyzed.

Demographic distribution of culture-positive cases: Among the 93 culture-positive cases, the highest number of cases was observed in the 20–40 years age group, accounting for 37

(39.8%) cases. This was followed by the 50–60 years age group, which constituted 17 (18.3%) cases.
The 40–50 years age group accounted for 13 (14.0%) cases, while 11 (11.8%) cases were reported in the 60–70 years age group. The 0–20 years age group contributed 9 (9.7%) cases, and the lowest number of cases was observed in the 70–80 years age group, comprising 6 (6.4%) cases. [Table 1]

Table 1: Age-wise distribution of culture-positive cases (n=93)

Age groups (yrs)	Number	Percentage (%)
0-20	9	9.7%
20-40	37	39.8%
40-50	13	14.0%
50-60	17	18.3%
60-70	11	11.8%
70-80	6	6.4%
Total	93	100%

Among the 93 culture-positive urinary isolates, Escherichia coli was the most frequently isolated organism, accounting for 47 (50.5%) of the isolates. This was followed by Klebsiella pneumoniae, which constituted 19 (20.4%) of the total isolates.
Among the non-fermenting Gram-negative bacilli, Pseudomonas spp. accounted for 8 (8.6%) isolates, while Acinetobacter spp. was isolated in 5 (5.4%) cases. Among Gram-positive organisms, Enterococcus spp. accounted for 11 (11.8%) isolates, whereas Staphylococcus aureus was isolated in 3 (3.2%) cases. [Table 2]

Table 2: Distribution of urinary isolates (n=93)

Organism	Number	Percentage (%)
E. coli	47	50.5%
Klebsiella Pneumoniae	19	20.4%
Pseudomonas spp.	8	8.6%
Acinetobacter spp.	5	5.4%
Enterococcus spp.	11	11.8%
Staphylococcus aureus	3	3.2%
Total	93	100%

Antibiotics Susceptibility testing of Gram-negative isolates: Among Gram-negative isolates, Escherichia coli showed the highest susceptibility to Colistin and Polymyxin B (100%), followed by Meropenem and Imipenem (87.2%), and Amikacin (83.0%). Lower susceptibility was observed with Ceftazidime and Ceftriaxone (42.6%).
Klebsiella pneumoniae isolates demonstrated 100% susceptibility to Colistin and Polymyxin B, followed by Meropenem, Imipenem, and Amikacin (78.9%), while lower susceptibility was noted with Ceftazidime and Ceftriaxone (31.6%).
Among Pseudomonas spp., Colistin and Polymyxin B showed 100% susceptibility, followed by Meropenem and Imipenem (62.5%), whereas Ciprofloxacin showed lower susceptibility (37.5%).
Acinetobacter spp. exhibited 100% susceptibility to Colistin and Polymyxin B, moderate susceptibility to Meropenem and Imipenem (60.0%), and no susceptibility to Ciprofloxacin (0%). [Table 3]

Table 3: Antibiotic susceptibility pattern of Gram-negative isolates (n=79)

Antibiotics name	E. coli (n=47)	Klebsiella Pneumoniae (n=19)	Pseudomonas spp. (n=8)	Acinetobacter spp. (n=5)
Amikacin	39(83%)	15(78.9%)	5(62.5%)	2(40%)
Ceftazidime	20(42.6%)	6(31.6%)	4(50%)	1(20%)
Ceftriaxone	20(42.6%)	6(31.6%)	4(50%)	1(20%)
Cefepime	27(57.4%)	8(42.1%)	4(50%)	1(20%)
ciprofloxacin	23(48.9%)	7(36.8%)	3(37.5%)	0(0%)
Aztreonam	22(46.8%)	9(47.4%)	4(50%)	-
Meropenem	41(87.2%)	15(78.9%)	5(62.5%)	3(60%)
Imipenem	41(87.2%)	15(78.9%)	5(62.5%)	3(60%)
Ampicillin/Sulbactam	36(76.6%)	11(57.9%)	3(37.5%)	3(60%)
Pipracillin/Tazobactam	37(78.7%)	13(68.4%)	5(62.5%)	3(60%)
Colistin	47(100%)	19(100%)	8(100%)	5(100%)
Polymyxin B	47(100%)	19(100%)	8(100%)	5(100%)
Total	47(100%)	19(100%)	8(100%)	5(100%)

Among Staphylococcus aureus isolates, MRSA showed complete resistance to Penicillin but remained fully sensitive to Vancomycin, Linezolid, and Gentamicin. MSSA demonstrated 100% sensitivity to most tested antibiotics except Penicillin, to which it was resistant. [Table 4]

Table 4: Antibiotics sensitive pattern of Staph. aureus (n=97)

Antibiotics	MRSA (2)		MSSA (1)	
	Sensitive	Resistant	Sensitive	Resistant
Penicillin	0(0%)	2(100%)	0	1(100%)
Clindamycin	1(50%)	1(50%)	1(100%)	0(0%)
Ciprofloxacin	1(50%)	1(50%)	1(100%)	0(0%)
Co-trimoxazole	1(50%)	1(50%)	1(100%)	0(0%)
Gentamycin	2(100%)	0(0%)	1(100%)	0(0%)
Vancomycin	2(100%)	0(0%)	1(100%)	0(0%)
Linezolid	2(50%)	0(0%)	1(100%)	0(0%)

Enterococcus spp. showed 100% sensitivity to Vancomycin and Linezolid, while high sensitivity was observed with Ciprofloxacin, Doxycycline, and Minocycline (81.8%). The lowest sensitivity was observed with high-level Gentamicin (54.5%). [Table 5]

Table 5: Antibiotics sensitivity pattern of Enterococcus spp.

Antibiotics	Enterococcus spp. (n=11)	
	Sensitive	Resistant
Ampicillin	7(63.6%)	4(36.4%)
Penicillin	7(63.6%)	4(36.4%)
Ciprofloxacin	9(81.8%)	2(18.2%)
Gentamycin (HLG)	6(54.5%)	5(45.5%)
Tetracycline (U)	7(63.6%)	4(36.4%)
Doxycycline (U)	9(81.8%)	2(18.2%)
Minocycline (U)	9(81.8%)	2(18.2%)
Fosfomycin (U)	8(72.7%)	3(27.3%)
Nitrofurantoin (U)	8(72.7%)	3(27.3%)
Vancomycin	11(100%)	0(0%)
Linezolid	11(100%)	0(0%)

Discussion

UTI is still one of the most frequently infecting bacteria in both community and hospital settings, causing a large proportion of morbidity and health care expenditure in the world. The present study aimed to determine the antibacterial spectrum and antimicrobial resistance pattern of uropathogens obtained from patients admitted in a tertiary care hospital. To identify similarities and differences with regard to the distribution and resistance patterns of bacteria, the findings of the present study were compared with those of previous studies.

Of the 300 urine samples collected in this study, 93 (31%) had significant bacteriuria. This culture positivity rate is similar to the study findings by Taneja et al,[8] who reported the culture positivity rate of 25–35% in hospitalized patients. The same results were found in investigations so far by Stamm and Norrby,[3] that emphasized that UTI infections are prevalent in hospitalized patients. The rate of culture positivity seen in this study was moderate which may be due to better infection control and timely processing of samples.

The age distribution of culture positive cases of the current study showed that most of the UTIs occurred in the age group 20-40 years (39.8%) and 50-60 years (18.3%). These findings agree with those of Foxman,[2] who found that the risk factors which lead to UTIs are more common in young adults. Flores-Mireles et al,[1] reported similar observations, that young and middle-aged are most susceptible to UTIs.

In this study, Escherichia coli was the sole most common uropathogen with a percentage of 50.5% followed by Klebsiella pneumoniae (20.4%) and Enterococcus spp (20%). (11.8%). These results corroborate the previous one reported by Flores-Mireles et al,[1] which found E. coli as the main cause of UTIs in over 50% of cases worldwide. Taneja et al,[8] found the same results with E. coli predominately followed by Klebsiella spp. in urine. Pointing to the high rate of E. coli in UTIs, the organism's virulence factors could be responsible for its ability to associate with the urinary tract either through the presence of adhesins or through its ability to form biofilms.

Gram-negative bacteria present in the current collection were completely susceptible to Colistin and Polymyxin B, suggesting that these two antibiotics are still effective against multidrug-resistant pathogens. The same was observed by Laxminarayan and Chaudhury,[10] who emphasized on the continued sensitivity of polymyxins on resistant Gram-negative organisms in the developing nations. Additionally, carbapenems such as Meropenem and Imipenem demonstrated high susceptibility rates, particularly against E. coli and Klebsiella pneumoniae isolates. These findings are consistent with studies conducted by Kumar et al,[9] which reported carbapenems as highly effective agents against extended-spectrum beta-lactamase (ESBL)-producing organisms.

However, the present study observed relatively lower susceptibility to third-generation cephalosporins such as Ceftazidime and Ceftriaxone, particularly among Klebsiella pneumoniae isolates. Similar trends of reduced susceptibility to cephalosporins have been reported in previous studies by Gupta et al,[6] which emphasized the growing resistance among Gram-negative organisms due to excessive and irrational antibiotic use. The reduced effectiveness of fluoroquinolones, particularly Ciprofloxacin, observed in the present study also correlates with findings reported by Kumar et al,[9] who identified fluoroquinolone resistance as a significant concern in developing countries.

Among Gram-positive isolates, Enterococcus spp. showed 100% sensitivity to Vancomycin and Linezolid, indicating the absence of vancomycin-resistant Enterococcus (VRE) strains in the present study. Similar findings were reported by World Health Organization (WHO) surveillance data,[12] which indicated that vancomycin resistance remains relatively low in certain healthcare settings with effective antibiotic stewardship practices. In the present study moderate resistance to high-level Gentamicin is found but it is in agreement with the results reported by Kumar et al,[9] which reported increase in emergence of resistance in Enterococcus species.

In this study, the isolates of staphylococcus aureus showed that all of the isolates were susceptible to Vancomycin, Linezolid and Gentamicin, while 100% of the isolates were resistant to penicillin, especially the MRSA isolates. First, these results are similar to previous reports according to the guidelines of CLSI,[14] suggesting that glycopeptides and oxazolidinones are still good therapeutic alternatives for methicillin-resistant Staphylococcus aureus infections. The present study showed that susceptibility to Vancomycin and Linezolid remained unchanged, indicating the need to practice rational antibiotic use to prevent resistant strains.

The results of the present study highlight the need for ongoing monitoring of the antimicrobial resistance pattern to inform antibiotic treatment and prevent the emergence of antimicrobial resistance. Frequent surveillance of resistance patterns is crucial to maximize effectiveness of treatments and for better patient outcome. The priority of measures to improve infection control policies and rational antibiotic prescribing has also been noted in global antimicrobial resistance reports by the World Health Organization.[12]

In summary, the results obtained in the present study have confirmed that Escherichia coli is the most common uropathogenic organism in UTI and polymyxins and carbapenems exhibited the most potent activity against Gram-negative organisms. But the emergence of resistance to several widely-used antibiotics like cephalosporins and fluoroquinolones highlights the need for further monitoring and the implementation of antimicrobial stewardship (AMS) in tertiary care hospital settings.

Conclusion

The present study showed that 31% of the UTI were positive on culture among the hospitalized patients. The majority of uropathogens were Gram negative, with Escherichia coli as the most frequently found, followed by Klebsiella pneumoniae and Enterococcus spp.

Colistin, Polymyxin B and carbapenems were the most susceptible groups in Gram-negative isolates, while reducing susceptibility of cephalosporins and fluoroquinolones indicates increasing antimicrobial resistance. The gram positive isolates, especially Enterococcus spp., and Staphylococcus aureus were found to be highly sensitive to Vancomycin and Linezolid.

The results underscore the need for periodic monitoring of antimicrobial resistance patterns and judicious use of antibiotics to properly treat empirical therapy and prevent the spread of multidrug resistant uropathogens.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. 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):269–284.
2. Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. Am J Med. 2002;113(Suppl 1A):5S–13S.
3. Stamm WE, Norrby SR. Urinary tract infections: disease panorama and challenges. J Infect Dis. 2001;183(Suppl 1):S1–S4.
4. Nicolle LE. Catheter-associated urinary tract infections. Antimicrob Resist Infect Control. 2014;3:23.
5. Hooton TM, Bradley SF, Cardenas DD, et al. Diagnosis, prevention, and treatment of catheter-associated urinary tract infection in adults. Clin Infect Dis. 2010;50(5):625–663.
6. Gupta K, Hooton TM, Naber KG, et al. International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women. Clin Infect Dis. 2011;52(5):e103–e120.
7. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections and antimicrobial resistance. Nat Rev Microbiol. 2015;13(5):269–284.
8. Taneja N, Chatterjee SS, Singh M, Singh S, Sharma M. Pediatric urinary tract infections in a tertiary care center from north India. Indian J Med Res. 2010;131:101–105.
9. Kumar SG, Adithan C, Harish BN, et al. Antimicrobial resistance in India: a review. J Nat Sci Biol Med. 2013;4(2):286–291.
10. Laxminarayan R, Chaudhury RR. Antibiotic resistance in India: drivers and opportunities for action. PLoS Med. 2016;13(3):e1001974.
11. CLSI. Performance Standards for Antimicrobial Susceptibility Testing. 33rd ed. Wayne, PA: Clinical and Laboratory Standards Institute; 2023.
12. World Health Organization. Antimicrobial resistance: global report on surveillance. Geneva: WHO; 2014.
13. Kass EH. Bacteriuria and the diagnosis of infections of the urinary tract. Arch Intern Med. 1957;100(5):709–714.
14. Clinical and Laboratory Standards Institute (CLSI). Performance Standards for Antimicrobial Susceptibility Testing. 35th ed. CLSI supplement M100. Wayne, PA: CLSI; 2025.