

Bacterial Profile and Antibiotic Resistance Patterns in Urinary Tract Infections at a Tertiary Care Hospital

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Abstract:

Background: Urinary tract infections (UTIs) rank among the most prevalent bacterial infections observed in clinical settings. The rise in antimicrobial resistance has made empirical therapy more difficult, especially in tertiary care settings.

Objectives: To determine the bacterial profile of UTIs and examine antibiotic resistance patterns among uropathogens isolated at a tertiary care hospital.

Methods: A hospital-based prospective observational study was carried out over one year (2024–2025) at Jawahar Lal Nehru Medical College, Bhagalpur. Midstream urine samples from 100 clinically suspected UTI patients were processed using standard microbiological techniques. The Kirby–Bauer disc diffusion method was used to test for antimicrobial susceptibility, as per CLSI guidelines. Descriptive statistics and the chi-square test were used to do the statistical analysis.

Results: 62% of the samples showed significant bacteriuria. *Escherichia coli* was the most common isolate (45.2%), followed by *Klebsiella pneumoniae* (21.0%). There was a lot of resistance to ampicillin and cotrimoxazole, but nitrofurantoin and carbapenems were more sensitive.

Conclusion: The study highlights a high prevalence of multidrug-resistant uropathogens, emphasizing the need for continuous surveillance and rational antibiotic use.

Keywords: Urinary Tract Infection, Uropathogens, Antibiotic Resistance, Tertiary Care Hospital.

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Introduction

Urinary tract infections (UTIs) constitute a significant public health problem impacting individuals across all age groups and both genders, with a greater incidence observed in females due to anatomical and physiological factors [1]. UTIs constitute a considerable percentage of community-acquired and nosocomial infections, resulting in significant morbidity and healthcare expenditures [2]. The causes of UTIs change over time and in different places, but *Escherichia coli* is still the most common pathogen in the world [3].

The widespread and often irrational use of antibiotics has contributed to the emergence of antimicrobial resistance among uropathogens, limiting therapeutic options and increasing the risk of treatment failure [4]. Resistance to commonly prescribed drugs such as beta-lactams, fluoroquinolones, and cotrimoxazole has been increasingly reported from both developed and developing countries [5]. In India, the burden of

antibiotic resistance is particularly alarming due to easy over-the-counter availability of antibiotics and inadequate antimicrobial stewardship [6].

Knowledge of local bacterial profiles and their susceptibility patterns is essential for formulating empirical treatment guidelines and improving patient outcomes [7]. Tertiary care hospitals, which manage complicated and referred cases, often encounter higher rates of resistant organisms [8]. Periodic surveillance studies are therefore crucial to monitor trends in uropathogens and resistance patterns [9].

This study was undertaken to analyze the bacterial spectrum causing UTIs and their antibiotic resistance patterns in a tertiary care hospital in eastern India, thereby providing evidence-based data to guide clinicians in appropriate antibiotic selection [10–13].

Materials and Methods

Study Design and Setting: A prospective observational study was conducted in the Department of Microbiology, Jawahar Lal Nehru Medical College, Bhagalpur, over a period of one year (2024–2025).

Study Population and Sample Size: A total of 100 patients clinically suspected of having UTIs were included. Patients of all age groups and both genders were enrolled after obtaining informed consent.

Inclusion and Exclusion Criteria: Patients with symptoms suggestive of UTI were included. Patients already on antibiotics or with contaminated samples were excluded.

Sample Collection and Processing: Midstream clean-catch urine samples were collected in sterile containers. Samples were cultured on CLED and MacConkey agar and incubated at 37°C for 24 hours. Significant bacteriuria was defined as $\geq 10^5$ CFU/mL.

Identification and Antibiotic Susceptibility Testing: Bacterial identification was performed using standard biochemical tests. Antibiotic

susceptibility testing was done by Kirby–Bauer disk diffusion method following CLSI guidelines.

Statistical Analysis: Data were analyzed using SPSS version 26. Categorical variables were expressed as percentages. Chi-square test was used to assess association between variables, with $p < 0.05$ considered statistically significant.

Results

A total of 100 urine samples from clinically suspected UTI patients were processed during the study period. Out of these, 62 samples showed significant bacteriuria, giving an overall culture positivity rate of 62%, while 38 samples showed no growth.

Gender-wise Distribution of Culture Positive Cases: There were 62 culture-positive cases, and 37 of them (59.7%) were females and 25 of them (40.3%) were males. This shows that females were more likely to be affected. There was a statistically significant difference in culture positivity between females and males ($\chi^2 = 4.72$, $p = 0.03$), which means that females are more likely to get UTIs. **Table 1** shows the gender-wise distribution of culture-positive cases.

Table 1: Gender-wise Distribution of Culture Positive UTI Cases (n = 62)

Gender	Number of cases	Percentage (%)
Male	25	40.3
Female	37	59.7
Total	62	100

Distribution of Uropathogens Isolated: A total of 62 bacterial isolates were recovered from culture-positive samples. *Escherichia coli* was the most predominant organism isolated in 28 cases (45.2%), followed by *Klebsiella pneumoniae* in 13 cases

(21.0%). Other organisms included *Enterococcus* spp. (14.5%), *Pseudomonas aeruginosa* (11.3%), and *Staphylococcus aureus* (8.0%).

The distribution of uropathogens is summarized in Table 2 and graphically represented in Figure 1.

Table 2: Distribution of Uropathogens Isolated from Urine Samples (n = 62)

Organism	Number of isolates	Percentage (%)
<i>Escherichia coli</i>	28	45.2
<i>Klebsiella pneumoniae</i>	13	21.0
<i>Enterococcus</i> spp.	9	14.5
<i>Pseudomonas aeruginosa</i>	7	11.3
<i>Staphylococcus aureus</i>	5	8.0
Total	62	100

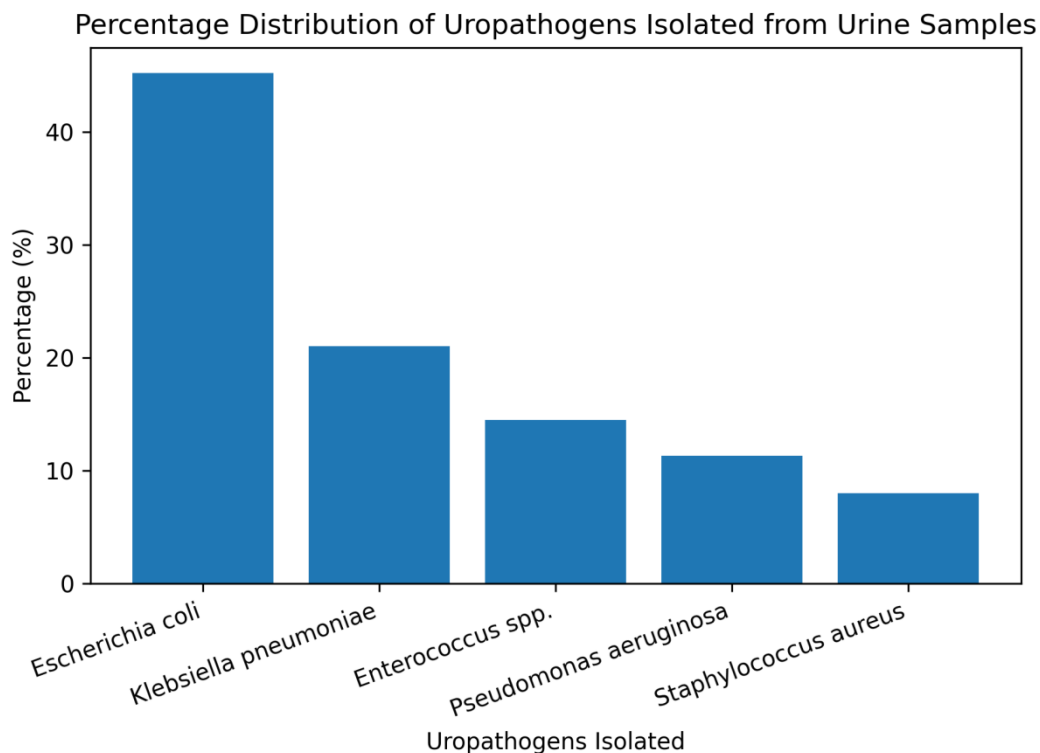


Figure 1: Bar diagram showing percentage distribution of uropathogens isolated from urine samples.

Antibiotic Susceptibility Pattern of Uropathogens: Antibiotic susceptibility testing showed that the bacteria were very resistant to common antibiotics, especially ampicillin and cotrimoxazole. *E. coli* was most resistant to ampicillin (75%) and cotrimoxazole (68%), but it was more sensitive to nitrofurantoin (78%) and imipenem (95%).

Klebsiella pneumoniae isolates also demonstrated high resistance to ampicillin (82%) and ciprofloxacin (64%). *Enterococcus spp.* showed comparatively higher sensitivity to nitrofurantoin (72%).

The antibiotic susceptibility pattern of major isolates is shown in Table 3.

Table 3: Antibiotic Susceptibility Pattern of Major Uropathogens (%)

Antibiotic	<i>E. coli</i> (n=28)	<i>Klebsiella</i> (n=13)	<i>Enterococcus</i> (n=9)
Ampicillin	25	18	30
Cotrimoxazole	32	28	35
Ciprofloxacin	40	36	42
Nitrofurantoin	78	65	72
Imipenem	95	92	NA

A statistically significant difference in resistance was observed between ampicillin and nitrofurantoin among *E. coli* isolates ($\chi^2 = 18.6$, $p < 0.001$), indicating superior efficacy of nitrofurantoin.

Antibiotic Resistance Pattern of *Escherichia coli*: Since *E. coli* was the predominant isolate, its

resistance pattern was analyzed separately. The highest resistance was observed against ampicillin (75%), followed by cotrimoxazole (68%) and ciprofloxacin (60%). Resistance to nitrofurantoin was relatively low (22%), while imipenem showed minimal resistance (5%). This resistance profile is illustrated in Figure 2.

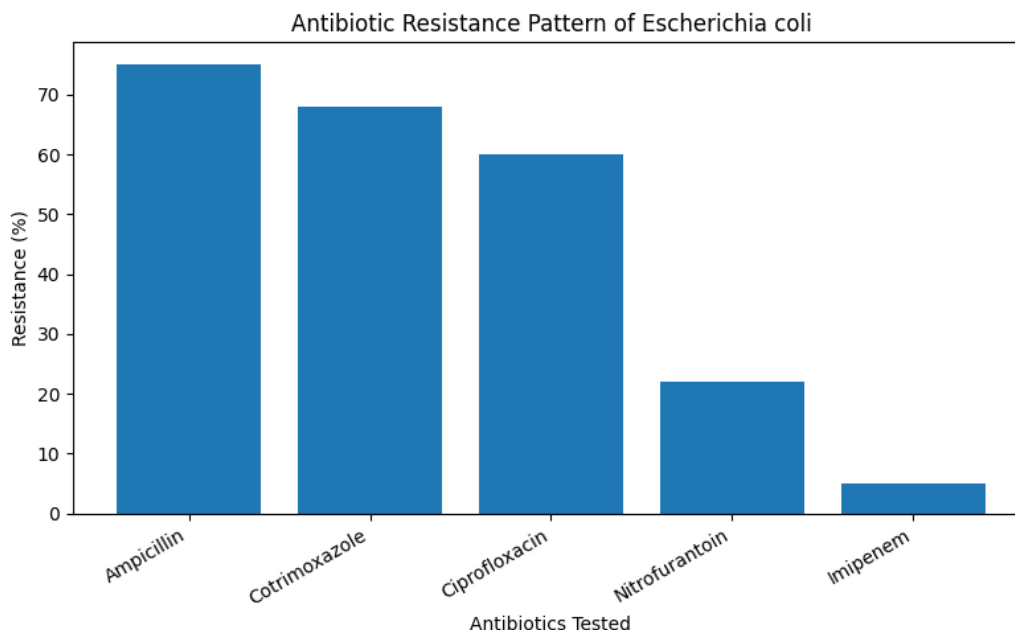


Figure 2: Bar chart depicting antibiotic resistance pattern of Escherichia coli isolates.

Summary of Key Statistical Findings

In the current study, the overall culture positivity rate for clinically suspected urinary tract infection cases was 62%. There were significantly more culture-positive UTIs in women than in men (59.7% vs. 40.3%), and this difference was statistically significant ($\chi^2 = 4.72$, $p = 0.03$). *Escherichia coli* was determined to be the predominant uropathogen, representing 45.2% of all isolates. The antibiotic susceptibility analysis showed that gram-negative isolates, especially *E. coli*, were very resistant to ampicillin and cotrimoxazole. On the other hand, nitrofurantoin was much more effective than ampicillin ($\chi^2 = 18.6$, $p < 0.001$), which shows that it is better for empirical therapy. Carbapenems, particularly imipenem, exhibited the highest overall sensitivity rates (>90%) against gram-negative uropathogens. These findings collectively underscore a statistically significant prevalence of antimicrobial resistance among UTI pathogens and highlight the necessity of evidence-based antibiotic selection guided by local susceptibility data.

Discussion

Urinary tract infections continue to be a prevalent clinical problem in tertiary care hospitals, where complex and recurrent cases are often observed. The current study found a culture positivity rate of 62%, which is similar to earlier hospital-based studies and reflects appropriate clinical suspicion and microbiological confirmation [14,15].

Escherichia coli was the most common uropathogen (45.2%), followed by *Klebsiella pneumoniae* and other gram-positive and non-

fermenting organisms. This distribution aligns with prior studies that have identified *E. coli* as the predominant cause of UTIs, attributable to its virulence factors, such as adhesion and biofilm formation [16,17]. The notable isolation of *Klebsiella*, *Enterococcus*, and *Pseudomonas* species highlights the diverse etiological spectrum of UTIs in tertiary care settings, often associated with hospitalization and prior antibiotic exposure [18–20].

A high level of resistance to commonly used antibiotics such as ampicillin, cotrimoxazole, and fluoroquinolones was observed, in line with resistance trends reported from other Indian studies [21,22]. In contrast, nitrofurantoin demonstrated better activity against most isolates, supporting its continued role as an effective oral agent for uncomplicated UTIs, as recommended by current guidelines [23]. Carbapenems showed the highest sensitivity rates; however, their use should be restricted to severe or multidrug-resistant infections to prevent further resistance development [24].

Overall, the findings emphasize the importance of continuous surveillance of uropathogens and their antimicrobial susceptibility patterns. Institution-specific antibiograms and rational antibiotic use are essential to optimize empirical therapy and limit the spread of antimicrobial resistance [25].

Conclusion

UTIs at this tertiary care hospital were predominantly caused by *E. coli*, with a high prevalence of resistance to commonly used antibiotics. Nitrofurantoin remains a good choice for oral use, but carbapenems should be used with

care. Regular monitoring of resistance patterns is imperative for guiding empirical therapy.

References

1. Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. *Dis Mon.* 2003;49(2):53–70.
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):269–284.
3. Ronald A. The etiology of urinary tract infection: traditional and emerging pathogens. *Dis Mon.* 2003;49(2):71–82.
4. Gupta K, Hooton TM, Stamm WE. Increasing antimicrobial resistance and the management of uncomplicated community-acquired urinary tract infections. *Ann Intern Med.* 2001;135(1):41–50.
5. Sanchez GV, Master RN, Karlowsky JA, Bordon JM. In vitro antimicrobial resistance of urinary *Escherichia coli* isolates. *Clin Infect Dis.* 2016;63(2):242–250.
6. Laxminarayan R, Duse A, Wattal C, Zaidi AK, Wertheim HF, Sumpradit N, et al. Antibiotic resistance—the need for global solutions. *Lancet Infect Dis.* 2013;13(12):1057–1098.
7. Stamm WE, Norrby SR. Urinary tract infections: disease panorama and challenges. *J Infect Dis.* 2001;183(Suppl 1):S1–S4.
8. Kahlmeter G. An international survey of the antimicrobial susceptibility of pathogens from uncomplicated urinary tract infections. *J Antimicrob Chemother.* 2003;51(1):69–76.
9. Dash M, Padhi S, Mohanty I, Panda P, Parida B. Antimicrobial resistance in pathogens causing urinary tract infections in a rural community of Odisha, India. *J Infect Dev Ctries.* 2013;7(12):112–117.
10. Hooton TM. Clinical practice: uncomplicated urinary tract infection. *N Engl J Med.* 2012;366(11):1028–1037.
11. Talan DA, Takhar SS, Krishnadasan A, Abrahamian FM, Mower WR. Fluoroquinolone-resistant and extended-spectrum β -lactamase-producing *Escherichia coli* infections. *Clin Infect Dis.* 2008;46(7):106–113.
12. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. CLSI document M100. Wayne, PA: CLSI; 2023.
13. Kumar MS, Lakshmi V, Rajagopalan R. Occurrence of extended spectrum beta-lactamases among Enterobacteriaceae isolates in a tertiary care hospital. *Indian J Med Microbiol.* 2017;35(1):129–134.
14. Zhanel GG, Hisanaga TL, Laing NM, DeCorby MR, Nichol KA, Weshnowski B, et al. Antibiotic resistance in urinary tract isolates. *Int J Antimicrob Agents.* 2006;28(4):296–303.
15. Kothari A, Sagar V. Antibiotic resistance in pathogens causing community-acquired urinary tract infections in India. *J Clin Diagn Res.* 2008;2(2):504–507.
16. Manikandan S, Ganesapandian S, Singh M, Kumaraguru AK. Antimicrobial susceptibility pattern of urinary tract infection causing human pathogenic bacteria. *Asian J Med Sci.* 2011;3(2):56–60.
17. Bonkat G, Bartoletti R, Bruyère F, Cai T, Geerlings SE, Köves B, et al. EAU guidelines on urological infections. *Eur Urol.* 2020;78(2):275–288.
18. Nicolle LE. Urinary tract infection. *Crit Care Clin.* 2013;29(3):699–715.
19. Patwardhan V, Kumar D, Goel V, Singh S. Changing trends in antimicrobial resistance of uropathogens. *Indian J Med Microbiol.* 2012;30(1):100–105.
20. Arjunan M, Al-Salamah AA, Amuthan M. Prevalence and antimicrobial susceptibility of uropathogens. *Int J Basic Clin Pharmacol.* 2019;8(1):123–129.
21. Dash N, Al-Zarouni M, Al-Kous N, Al-Shehhi F, Al-Najjar J, Senok A. Distribution and resistance trends of urinary pathogens in a tertiary care hospital. *J Lab Physicians.* 2020;12(1):52–56.
22. Medina M, Castillo-Pino E. An introduction to the epidemiology and burden of urinary tract infections. *Ther Adv Urol.* 2019;11:1–7.
23. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Pathophysiology of urinary tract infections. *Nat Rev Microbiol.* 2015;13(5):269–284.
24. Gupta K, Trautner BW. Urinary tract infection, pyelonephritis, and prostatitis. *Mandell Douglas Bennett's Principles Pract Infect Dis.* 2011;7:957–985.
25. Taneja N, Sharma M. Antimicrobial resistance in the environment: the Indian scenario. *Indian J Med Res.* 2016;144(1):1–3.