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CHANGING FACE OF URINARY TRACT INFECTIONS: CONTEMPORARY UROPATHOGENS, ANTIMICROBIAL RESISTANCE, AND THERAPEUTIC CHALLENGES IN WESTERN UTTAR PRADESH

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ABSTRACT

Background: Urinary tract infections (UTIs) are among the most common bacterial infections and a major cause of antimicrobial use worldwide. The increasing prevalence of antimicrobial resistance (AMR) among uropathogens has compromised empirical therapy, highlighting the need for institution-specific surveillance to guide evidence-based treatment. The objective is to determine the bacteriological profile and antimicrobial susceptibility patterns of culture-positive urinary tract infections in a tertiary care teaching hospital in Western Uttar Pradesh, India.

Materials and Methods: A retrospective laboratory-based observational study was conducted in the Department of Microbiology from December 2025 to March 2026. Of 120 culture-positive clinical specimens, 45 culture-positive urine isolates were included. Bacterial identification was performed using conventional microbiological methods, and antimicrobial susceptibility testing was carried out by the Kirby–Bauer disc diffusion method according to standard laboratory guidelines. Data were analysed using descriptive statistics.

Results: Urine specimens constituted 37.5% (45/120) of all culture-positive clinical samples. Most patients were aged 61–80 years (42.2%), female (57.8%), and hospitalized (77.8%). Escherichia coli was the predominant uropathogen (53.3%), followed by Klebsiella spp. (20.0%) and Enterococcus spp. (13.3%), while Gram-negative bacilli accounted for 84.45% of all isolates. Meropenem, amikacin, and fosfomycin demonstrated the highest in vitro activity against most Gram-negative isolates, whereas widespread resistance was observed to ciprofloxacin, third-generation cephalosporins, and cotrimoxazole. Recent advances Vaccination has emerged as a promising non-antibiotic strategy for the prevention of recurrent urinary tract infections (rUTIs). The legal approval of vaccine is awaited for clinical use.

Conclusion: Escherichia coli remains the predominant uropathogen in Western Uttar Pradesh, with Gram-negative bacilli accounting for most culture-positive UTIs. The preserved activity of meropenem, amikacin, and fosfomycin, together with increasing resistance to commonly prescribed empirical antibiotics, underscores the need for routine culture and antimicrobial susceptibility testing, periodic institutional antibiograms, and antimicrobial stewardship to optimize empirical therapy and contain the spread of antimicrobial resistance.

Keywords: Urinary tract infection; Uropathogens; Antimicrobial resistance; Antibiogram; Escherichia coli; Antimicrobial stewardship; UTI vaccine.

INTRODUCTION

Urinary tract infections (UTIs) are among the most common bacterial infections encountered in clinical practice and constitute a major cause of morbidity, healthcare utilization, and antimicrobial consumption worldwide. Approximately 150 million people develop UTIs annually, resulting in a substantial clinical and economic burden through outpatient visits, emergency consultations, hospital admissions, and antibiotic prescriptions.[1-4] The European Association of Urology (EAU) and Infectious Diseases Society of America (IDSA) guidelines recommend prompt diagnosis and appropriate antimicrobial therapy to prevent complications and improve patient outcomes.[2,3].

UTIs occur across all age groups but are particularly common among women, elderly individuals, patients with diabetes mellitus, urinary tract abnormalities, indwelling urinary catheters, and immunocompromised hosts.[2,4] Untreated or inadequately managed infections may progress to pyelonephritis, renal abscess, bacteremia, urosepsis, renal impairment, prolonged hospitalization, and increased healthcare expenditure.[3,4]

The microbiological spectrum of UTIs is dominated by Gram-negative bacilli, with Escherichia coli accounting for nearly 70–90% of community-acquired infections and remaining the most frequently isolated uropathogen worldwide.[1,4] Other important pathogens include Klebsiella pneumoniae, Proteus mirabilis, Enterobacter spp., Pseudomonas aeruginosa, Enterococcus spp. and Staphylococcus aureus.[4,7] The predominance of uropathogenic E. coli is attributed to multiple virulence determinants, including type 1 and P fimbriae, adhesins, biofilm formation, siderophore production, toxins, and immune evasion mechanisms that facilitate colonization and persistence within the urinary tract.[6,7].

The distribution of uropathogens and their antimicrobial susceptibility patterns vary considerably across geographical regions, healthcare settings, patient populations, and antibiotic prescribing practices, necessitating continuous regional surveillance to guide empirical antimicrobial therapy.[2,5]

Antimicrobial resistance (AMR) among uropathogens has emerged as one of the most significant threats to effective management of UTIs worldwide.[11,12]. In India, irrational antimicrobial use, easy over-the-counter availability of antibiotics, inappropriate empirical prescribing, inadequate infection prevention measures, and limited antimicrobial stewardship have accelerated the emergence and dissemination of multidrug-resistant organisms, particularly extended-spectrum β-lactamase (ESBL)-producing Enterobacterales.[5,13]. Recent Indian studies have consistently reported increasing resistance to fluoroquinolones, third-generation cephalosporins, and cotrimoxazole among urinary isolates, while aminoglycosides, nitrofurantoin, fosfomycin, and carbapenems continue to demonstrate relatively better activity against many Gram-negative uropathogens.[8,9]

The World Health Organization (WHO), through the Global Antimicrobial Resistance and Use Surveillance System (GLASS), has identified AMR as one of the greatest threats to global public health and has emphasized strengthening microbiological surveillance to guide national antimicrobial policies.[11]. Likewise, the Global Burden of Antimicrobial Resistance Study estimated that bacterial AMR was associated with approximately 4.95 million deaths globally in 2019, highlighting the urgent need for coordinated surveillance and antimicrobial stewardship initiatives.[12]

In India, the Indian Council of Medical Research (ICMR) Antimicrobial Resistance Surveillance Network has documented progressive increases in resistance among common urinary pathogens and has strongly recommended the development of institution-specific antibiograms to optimize empirical therapy and support antimicrobial stewardship programmes (10 a). One recent study published in 2026 has given the fair idea combating antimicrobial resistance with precision medicine(10b) Furthermore, contemporary epidemiological studies have demonstrated marked regional variation in pathogen distribution and antimicrobial susceptibility, reinforcing the need for local surveillance data rather than reliance on national averages. [9,14]

Despite the high burden of urinary tract infections in Northern India, published data from Western Uttar Pradesh remain limited. Institution-specific information regarding the bacteriological profile and antimicrobial susceptibility of urinary isolates is essential for evidence-based empirical treatment, antimicrobial stewardship, and resistance surveillance. Therefore, the present study was undertaken to determine the bacteriological profile and antibiotic susceptibility patterns of culture-positive urinary tract infections in a tertiary care teaching hospital in Western Uttar Pradesh. The findings are expected to provide a contemporary regional antibiogram that will facilitate rational empirical antibiotic selection and contribute to ongoing efforts for development of new drugs and vaccines to combat antimicrobial resistance including UTI.[10, 11,15]

MATERIALS AND METHODS

Study Design and Setting: This retrospective, laboratory-based observational study was conducted in the Department of Microbiology of a tertiary care teaching hospital in Western Uttar Pradesh, India. The study was carried out over four months from December 2025 to March 2026. Microbiological records of culture-positive clinical specimens received during the study period were reviewed. Of the 120 culture-positive clinical specimens processed, 45 culture-positive urine isolates were included for detailed analysis of the bacteriological profile and antimicrobial susceptibility pattern of urinary tract infections.

Study Population: The study included patients of all age groups and both sexes whose urine samples yielded significant bacterial growth on culture. Samples were received from both outpatient (OPD) and inpatient (IPD) departments.

Inclusion Criteria

(i) Culture-positive urine specimens showing significant bacterial growth.
(ii) Patients of all age groups and both genders.
(iii) Urine samples received from OPD and IPD patients during the study period.

Exclusion Criteria

(i) Urine cultures showing no bacterial growth.
(ii) Mixed bacterial growth suggestive of contamination.
(iii) Duplicate isolates from the same patient.
(iv) Incomplete laboratory records.

Sample Processing and Bacterial Identification: Urine specimens were processed according to standard microbiological procedures. Samples were cultured on appropriate bacteriological media and incubated aerobically at 35–37°C for 18–24 hours. Bacterial isolates were identified by colony morphology, Gram staining, and standard biochemical tests using conventional microbiological methods.

Antimicrobial Susceptibility Testing: Antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method on Mueller–Hinton agar following standard laboratory procedures. The antibiotics tested represented the commonly prescribed antimicrobial classes used in the treatment of urinary tract infections, including carbapenems, aminoglycosides, fluoroquinolones, cephalosporins, β-lactam/β-lactamase inhibitor combinations, sulfonamides, and fosfomycin.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26. Categorical variables were expressed as frequencies and percentages. Results are presented using tables and descriptive statistics. Where appropriate, associations between categorical variables may be assessed using the Chi-square test or Fisher's exact test, with a p value <0.05 considered statistically significant.

Strengths of the study: It provides recent specific microbiological data from Western Uttar Pradesh, where published information on urinary tract infections and antimicrobial resistance remains limited. Inclusion of demographic characteristics together with bacteriological identification and antimicrobial susceptibility testing allowed a comprehensive evaluation of culture-confirmed urinary tract infections and generated an institutional antibiogram that may assist clinicians in selecting appropriate empirical therapy.

Limitations of the study: This was a retrospective, single-centre study which may limit the generalizability of the findings. Molecular characterization of resistance mechanisms, including ESBL and carbapenemase production, was not performed, and important clinical variables such as previous antibiotic exposure, urinary catheterization, recurrent infection and treatment outcomes were unavailable because of the retrospective study design

RESULTS

A total of 120 culture-positive clinical specimens were identified during the study period, of which 45 (37.5%) were urine samples included for detailed analysis of urinary tract infections.

Research Data Distribution in Tabular form:

Table 1: Distribution of culture-positive isolates according to specimen type (n=120)

Specimen type	Number of isolates (n)	Percentage (%)
Urine	45	37.5
Pus	33	27.5
Sputum	20	16.7
Blood	7	5.8
Swab	5	4.3
ET aspirate	4	3.3
Tissue	4	3.3
Ascitic fluid	1	0.8
Wound	1	0.8
Total	120	100.0

Table 2: Demographic and Clinical Characteristics of Patients with Culture-positive Urine Samples (n=45)

Table 2A: Age-wise Distribution

Age group (years)	n	%
21–40	7	15.6
41–60	17	37.8
61–80	19	42.2
>80	2	4.4
Total	45	100.0

Table 2B: Gender-wise Distribution

Gender	n	%
Male	19	42.2
Female	26	57.8
Total	45	100.0

Table 2C: Patient Category

Category	n	%
IPD	35	77.8
OPD	10	22.2
Total	45	100.0

Table 2D: Department-wise Distribution

Department	n	%
Cardiology	1	2.2
Casualty	1	2.2
General Medicine	32	71.1
General Surgery	5	11.1
Obstetrics & Gynaecology	3	6.7
MICU	1	2.2
Neurology	1	2.2
Ophthalmology	1	2.2
Total	45	100.0

Table 3: Distribution of positive urine samples based on Uropathogen

Uropathogen	n	%
Escherichia coli	24	53.3
Klebsiella spp.	9	20.0
Enterococcus spp.	6	13.3
Enterobacter spp.	2	4.4
Acinetobacter spp.	2	4.4
Staphylococcus aureus	1	2.2
Proteus mirabilis	1	2.2
Total	45	100.0

Table 4: Age-wise organism distribution

Organism	<20	21–40	41–60	61–80	>80	Total
Acinetobacter spp	0	0	1	1	0	2
Enterobacter spp	0	1	0	1	0	2
Enterococcus spp	0	1	1	3	1	6
Escherichia coli	0	4	9	10	1	24
Proteus Mirabilis	0	0	0	1	0	1
Stayphylococcus aureus	0	0	0	1	0	1
klebsiella spp	0	1	6	2	0	9
Total	0	7	17	19	2	45

Table 5: Sex-wise organism distribution

Organism	Male	Female	Total
Acinetobacter spp	2	0	2
Enterobacter spp	0	2	2
Enterococcus spp	3	3	6
Escherichia coli	10	14	24
Proteus Mirabilis	1	0	1
Stayphylococcus aureus	0	1	1
klebsiella spp	3	6	9
Total	19	26	45

Table 6: Gram group distribution

Group	n	%
GPC	7	15.55
GNB	38	84.45
Total	45	100.0

Table 7: Antibiotic Sensitivity Pattern According to Antibiotic Group

Antibiotic Group	Sensitive Antibiotic	Organisms Showing Sensitivity
Carbapenems	Meropenem	E. coli, Klebsiella spp., Acinetobacter spp., Enterobacter spp., Proteus mirabilis, Staphylococcus aureus
Aminoglycosides	Amikacin	E. coli, Klebsiella spp., Acinetobacter spp., Enterobacter spp., Proteus mirabilis, Staphylococcus aureus

Aminoglycosides	Tobramycin	Acinetobacter spp.
Fluoroquinolones	Levofloxacin	E. coli, Klebsiella spp., Enterococcus spp., Acinetobacter spp., Staphylococcus aureus, Enterobacter spp., Proteus mirabilis
Fluoroquinolones	Ciprofloxacin	Enterobacter spp., Enterococcus spp.
β-lactam/β-lactamase inhibitor	Piperacillin–Tazobactam	E. coli, Klebsiella spp., Acinetobacter spp., Enterobacter spp., Proteus mirabilis
β-lactam/β-lactamase inhibitor	Ampicillin–Sulbactam	Staphylococcus aureus
Phosphonic acid derivative	Fosfomycin	E. coli, Klebsiella spp., Enterococcus spp., Enterobacter spp., Proteus mirabilis, Staphylococcus aureus
Cephalosporins	None	None

Table 8: Antibiotic Resistance Pattern According to Antibiotic Group

Antibiotic Group	Resistant Antibiotic	Organisms Showing Resistance
Fluoroquinolones	Ciprofloxacin	E. coli, Klebsiella spp., Acinetobacter spp., Staphylococcus aureus, Proteus mirabilis
Cephalosporins	Cefotaxime	E. coli, Klebsiella spp., Enterococcus spp., Acinetobacter spp., Staphylococcus aureus, Proteus mirabilis
Cephalosporins	Ceftazidime	E. coli, Klebsiella spp., Enterococcus spp., Acinetobacter spp., Staphylococcus aureus, Enterobacter spp., Proteus mirabilis
Sulfonamides	Cotrimoxazole	All seven organisms
β-lactam/β-lactamase inhibitor	Ampicillin–Sulbactam	E. coli, Klebsiella spp., Acinetobacter spp., Enterobacter spp., Proteus mirabilis
β-lactam/β-lactamase inhibitor	Piperacillin–Tazobactam	Enterococcus spp., Staphylococcus aureus
Carbapenems	Meropenem	Enterococcus spp.
Aminoglycosides	Amikacin	Enterococcus spp.
Phosphonic acid derivative	None	None

Table 9: Overall Summary by Antibiotic Class

Antibiotic Class	Overall Interpretation
Carbapenems	Excellent activity against Gram-negative isolates; resistance only in Enterococcus spp.
Aminoglycosides	Amikacin active against most Gram-negative isolates; resistance only in Enterococcus spp.
Fluoroquinolones	Levofloxacin active against all seven organisms; Ciprofloxacin showed widespread resistance.
Phosphonic acid derivative	Fosfomycin active against six of seven organisms; no resistance reported.
β-lactam/β-lactamase inhibitor	Piperacillin–Tazobactam active mainly against Gram-negative isolates; Ampicillin–Sulbactam active only against S. aureus.
Cephalosporins	Marked resistance to Cefotaxime and Ceftazidime.
Sulfonamides	Cotrimoxazole showed widespread resistance.

Table 10: Comparison of the Present Study with Recent Indian Studies on Uropathogens and Antimicrobial Resistance

Study	Region	Predominant uropathogen (%)	Major resistance reported	Antibiotics retaining good activity	Comparison with present study
Present study (2026)	Western Uttar Pradesh	E. coli (53.3%)	Ciprofloxacin, Cefotaxime, Ceftazidime, Cotrimoxazole	Meropenem, Amikacin, Fosfomycin	Reference study
Singh et al. (2022)	Multicentric India	E. coli (~57%)	Fluoroquinolones, Cotrimoxazole, Cephalosporins	Carbapenems	Similar pathogen distribution and resistance profile
Pal et al. (2023)	Karnataka	E. coli (~64%)	Fluoroquinolones, β-lactams	Aminoglycosides, Carbapenems	Comparable antibiogram
Khan et al. (2023)	Jammu & Kashmir	E. coli (~61%)	3rd-generation cephalosporins, Fluoroquinolones	Carbapenems, Piperacillin–Tazobactam	Similar resistance pattern
Indian retrospective study (2025)	India	E. coli (~69%)	Ciprofloxacin, Cephalosporins	Fosfomycin, Carbapenems	Closely parallels present study
Badoni et al. (2026)	Uttarakhand	E. coli (69.3%)	Higher resistance in Klebsiella pneumoniae	Fosfomycin (E. coli)	Supports culture-guided fosfomycin use

DISCUSSION

Urinary tract infections continue to represent one of the commonest bacterial infections encountered in clinical practice, and their management has become increasingly challenging because of the rapid emergence of antimicrobial resistance.[16] The present study provides contemporary institution-specific data on the bacteriological profile and antimicrobial susceptibility patterns of culture-positive urinary tract infections from a tertiary care teaching hospital in Western Uttar Pradesh. Among all culture-positive clinical specimens processed during the study period, urine constituted the largest specimen category [Table 1], indicating that UTIs remain a major contributor (37.5%) to the microbiological workload in the tertiary care hospital. The study further demonstrated that elderly patients (61-80yrs), females and hospitalized individuals (77.8%) constituted the majority of culture-positive cases [Table 2], Escherichia coli remained the predominant (53.3%) uropathogen [Table 3], Gram-negative bacilli accounted (84.45%) for most isolates [Table 6], and meropenem, amikacin and fosfomycin retained the highest antimicrobial activity [Table 7–9].[17] Conversely, substantial resistance to fluoroquinolones, third-generation cephalosporins and cotrimoxazole highlights the continuing erosion of commonly used empirical treatment options.71.1% of urine culture positive cases were originated from general medicine department and 77.8% from hospitalized patients [Table 2 C &D]. These findings suggest that a substantial proportion of infections represented complicated or healthcare-associated UTIs rather than uncomplicated community-acquired disease. The concentration of cases within medical wards therefore likely reflects the greater burden of elderly patients with chronic comorbidities rather than a department-specific phenomenon. Collectively, these findings reinforce the importance of continuous surveillance to support evidence-based empirical therapy and antimicrobial stewardship.

The microbiological spectrum observed in this study remained consistent with the established epidemiology of urinary tract infections. Escherichia coli accounted for more than half (53.3%) of all isolates.[18], followed by Klebsiella spp. (20%) and 13.3% Enterococcus spp. [Table 3], confirming that Enterobacterales continue to dominate urinary tract infections in this region.[19] The predominance of E. coli across different age groups and in both sexes [Table 4 and 5] indicates that host demographic factors exert relatively little influence on the principal aetiological agent, although the increasing contribution of Klebsiella spp. and Enterococcus spp. among older hospitalized patients probably reflects greater healthcare exposure, urinary instrumentation and prior antibiotic use.[20] The marked predominance of Gram-negative bacilli [Table 6] further supports this interpretation and agrees with national and international surveillance studies demonstrating that Enterobacterales remain the leading cause of both community- and hospital-acquired UTIs. The comparatively lower frequency of Gram-positive organisms does not diminish their clinical importance, particularly in patients with urinary catheters, prolonged hospitalization or recurrent infections, where they may present significant therapeutic challenges. Overall, the bacteriological profile observed in the present study closely resembles that reported from other tertiary-care hospitals in India, while also emphasizing the need for local surveillance because the relative prevalence of individual pathogens may vary according to patient characteristics and healthcare setting.

The antimicrobial susceptibility profile observed in the present study has important therapeutic implications for the management of urinary tract infections. Overall, meropenem, amikacin and fosfomycin demonstrated the highest in vitro activity against the predominant uropathogens [Table 7], while the overall antibiogram [Table 9] confirmed these agents as the most reliable therapeutic options in our study. Meropenem retained excellent activity against almost all Gram-negative isolates, reflecting the continued effectiveness of carbapenems against multidrug-resistant Enterobacterales. Similarly, amikacin showed high susceptibility among the major Gram-negative pathogens, supporting its role in the treatment of severe or complicated UTIs requiring parenteral therapy. Fosfomycin also exhibited favourable activity against most urinary isolates.[21] and remained the most promising oral agent.[22] particularly for uncomplicated lower urinary tract infections . These findings are encouraging because they indicate that despite the increasing burden of antimicrobial resistance, effective treatment options remain available when antimicrobial therapy is guided by microbiological evidence.[23] Similar susceptibility patterns have been reported by the Indian Council of Medical Research (ICMR) Antimicrobial Resistance Surveillance Network and several recent Indian studies, which consistently identify carbapenems, aminoglycosides and fosfomycin as the most active agents against contemporary uropathogens.

In contrast, the resistance profile observed in the present study raises concern regarding the continued usefulness of several commonly prescribed empirical antibiotics. As shown in Table 8, resistance to ciprofloxacin, cefotaxime, ceftazidime and cotrimoxazole was widespread.[24] Among the predominant urinary pathogens, indicating that these antibiotics should no longer be used empirically without knowledge of local susceptibility patterns. The overall antibiogram [Table 9] further corroborated these findings by demonstrating poor performance of fluoroquinolones, third-generation cephalosporins and sulfonamides compared with carbapenems and aminoglycosides. Although levofloxacin retained activity against a broader range of organisms than ciprofloxacin, the marked variability within the fluoroquinolone class suggests that susceptibility testing should guide their clinical use rather than assuming class-wide effectiveness. Likewise, the extensive resistance to third-generation cephalosporins strongly suggests the probable presence of extended-spectrum β-lactamase (ESBL)-producing Escherichia coli and Klebsiella spp., although phenotypic or molecular confirmation was beyond the scope of the present study. Similar resistance trends have been documented across India and are largely attributed to indiscriminate antimicrobial use, selective antibiotic pressure and increasing dissemination of multidrug-resistant organisms.

Taken together, the susceptibility and resistance findings [Table 7–9] emphasize the dynamic nature of antimicrobial resistance among urinary pathogens and reinforce the need for periodic revision of empirical treatment protocols based on current institutional antibiograms.[25] While carbapenems should be preserved for appropriately selected patients with severe or complicated infections.[26] the sustained activity of fosfomycin offers an important opportunity to reduce unnecessary use of reserve antibiotics in uncomplicated UTIs. Routine urine culture and antimicrobial susceptibility testing therefore remain indispensable.[27] particularly for hospitalized patients, recurrent infections and treatment failures, enabling clinicians to optimize antimicrobial therapy while minimizing further selection of resistant organisms.

Comparison of the present findings with recent Indian studies [Table 10] demonstrates remarkable consistency in the epidemiology of urinary tract infections despite geographical variation. Across studies, Escherichia coli remained the predominant uropathogen, followed by Klebsiella spp., although the proportion of E. coli varied from approximately 53% to 69%. The slightly lower prevalence of E. coli and relatively higher isolation of Klebsiella spp. and Enterococcus spp. in the present study are likely attributable to the predominance of elderly hospitalized patients with complicated urinary tract infections.[28] urinary catheterization.[29], prior antimicrobial exposure and associated comorbidities. Despite these differences in pathogen distribution, the antimicrobial susceptibility profile was comparable with contemporary Indian reports, which consistently demonstrate preserved activity of carbapenems, aminoglycosides and fosfomycin, together with increasing resistance to fluoroquinolones, third-generation cephalosporins and cotrimoxazole. The close agreement between our findings and multicentric Indian surveillance data indicates that antimicrobial resistance among urinary pathogens has become a widespread national concern rather than a problem confined to individual institutions. At the same time, the observed regional differences support the continued need for institution-specific surveillance because empirical treatment based solely on national averages may not adequately reflect local resistance patterns.

Recent Development: Vaccination has emerged as a promising non-antibiotic strategy for the prevention of recurrent urinary tract infections (rUTIs), particularly in the context of increasing antimicrobial resistance and the limitations of long-term antibiotic prophylaxis. Among the available immunotherapeutic approaches, MV140 (Uromune) is a sublingually administered polyvalent vaccine composed of heat-inactivated whole bacterial strains of the most common uropathogens, including Escherichia coli, Klebsiella pneumoniae, Proteus vulgaris, and Enterococcus faecalis. Sublingual administration is designed to stimulate both mucosal and systemic immune responses through activation of the mucosal immune system, thereby enhancing protection against recurrent urinary infections. Clinical studies of MV140 have consistently demonstrated a favorable safety profile, but no UTI vaccine has yet received broad international regulatory approval for routine clinical use.[30,31]

CONCLUSION

This study demonstrates that Escherichia coli remains the predominant uropathogen causing culture-positive urinary tract infections in Western Uttar Pradesh, with Gram-negative bacilli accounting for the majority of isolates. Elderly patients, females, and hospitalized individuals constituted the most affected groups. Meropenem, amikacin, and fosfomycin retained excellent antimicrobial activity, whereas widespread resistance to ciprofloxacin, third-generation cephalosporins, and cotrimoxazole highlights the growing challenge of antimicrobial resistance and the declining reliability of commonly used empirical therapies. These findings emphasize the need for routine culture and antimicrobial susceptibility testing, periodic institutional antibiograms, and robust antimicrobial stewardship to optimize empirical treatment and preserve the effectiveness of existing antibiotics. Continued regional surveillance and multicentric studies are warranted to monitor evolving resistance patterns and guide evidence-based management of urinary tract infections.

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 May;13(5):269-84. doi: 10.1038/nrmicro3432. Epub 2015 Apr 8. PMID: 25853778; PMCID: PMC4457377.
2. Bonkat G, Bartoletti R, Bruyère F, et al. EAU Guidelines on Urological Infections. Arnhem (The Netherlands): European Association of Urology; 2025.
3. Gupta K, Hooton TM, Naber KG etal ; Infectious Diseases Society of America; European Society for Microbiology and Infectious Diseases. International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: A 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. Clin Infect Dis. 2011 Mar 1;52(5):e103-20. doi: 10.1093/cid/ciq257. PMID: 21292654.
4. Foxman B. Urinary tract infection syndromes: occurrence, recurrence, bacteriology, risk factors, and disease burden. Infect Dis Clin North Am. 2014 Mar;28(1):1-13. doi: 10.1016/j.idc.2013.09.003. Epub 2013 Dec 8. PMID: 24484571.
5. Rajagopal K, Chandy SJ, Graham JP. A One Health Review of Community-Acquired Antimicrobial-Resistant Escherichia coli in India. Int J Environ Res Public Health. 2021 Nov 18;18(22):12089. doi: 10.3390/ijerph182212089. PMID: 34831844; PMCID: PMC8625392.
6. Bunduki GK, Heinz E, Phiri VS, et al . Virulence factors and antimicrobial resistance of uropathogenic Escherichia coli (UPEC) isolated from urinary tract infections: a systematic review and meta-analysis. BMC Infect Dis. 2021 Aug 4;21(1):753. doi: 10.1186/s12879-021-06435-7. PMID: 34348646; PMCID: PMC8336361.
7. Ghosh A, Bandyopadhyay D, Koley S, et al .Uropathogenic Escherichia coli in India-an Overview on Recent Research Advancements and Trends. Appl Biochem Biotechnol. 2021 Jul;193(7):2267-2296. doi: 10.1007/s12010-021-03521-z. Epub 2021 Feb 17. PMID: 33595784.

8. Kothari A, Sagar V. Antibiotic resistance in pathogens causing community-acquired urinary tract infections in India: a multicenter study. J Infect Dev Ctries. 2008 Oct 1;2(5):354-8. doi: 10.3855/jidc.196. PMID: 19745502.
9. Venugopal S, Chunchanur S, Panigrahy R, et al ; Investigators of the CAUTION-ED Study (Community-Acquired UTI and Emerging Drug Resistance). Changes in antimicrobial resistance of Escherichia coli isolated from community-associated urinary tract infection before and during the COVID-19 pandemic in India. J Glob Antimicrob Resist. 2024 Jun;37:165-167. doi: 10.1016/j.jgar.2024.02.022. Epub 2024 Mar 7. PMID: 38458537.
10. a- Indian Council of Medical Research. Antimicrobial Resistance Surveillance and Research Network (AMRSN): Annual Report 2023. New Delhi: Indian Council of Medical Research; 2024.https://www.icmr.gov.in/icmrobject/uploads/Report/1763981012_icmramrsnannualreport2024.pdf

10. b -Shinde A, Mohan A, Bulusu VM, et al . Current status of antimicrobial resistance in Indian healthcare system: combating antimicrobial resistance with precision medicine. Front Antibiot. 2026 Jan 28;5:1632790. doi: 10.3389/frabi.2026.1632790. PMID: 41685100; PMCID: PMC12891089.

11. World Health Organization. Global Antimicrobial Resistance and Use Surveillance System (GLASS) Report 2024. Geneva: World Health Organization; 2024. https://www.who.int/initiatives/glass
12. Murray, C.J., et al. (2022) Global Burden of Bacterial Antimicrobial Resistance in 2019: A Systematic Analysis. The Lancet, 399, 629-655. doi:10.1016/S0140-6736(21)02724-0.
13. Taneja N, Sharma M. Antimicrobial resistance in the environment: The Indian scenario. Indian J Med Res. 2019 Feb;149(2):119-128. doi: 10.4103/ijmr.IJMR_331_18. PMID: 31219076; PMCID: PMC6563737.
14. Tandogdu Z, Wagenlehner FM. Global epidemiology of urinary tract infections. Curr Opin Infect Dis. 2016 Feb;29(1):73-9. doi: 10.1097/QCO.0000000000000228. PMID: 26694621.
15. O'Brien VP, Hannan TJ, Nielsen HV, et al . Drug and Vaccine Development for the Treatment and Prevention of Urinary Tract Infections. Microbiol Spectr. 2016 Feb;4(1):10.1128/microbiolspec.UTI-0013-2012. doi: 10.1128/microbiolspec.UTI-0013-2012. PMID: 26999391; PMCID: PMC4887100.
16. Mardourian M, Lyons H, Rhodes Brunner J, et al. Prevalence of antimicrobial resistance in urine, blood, and wound pathogens among rural patients in Karnataka, India. Antimicrob Steward Healthc Epidemiol. 2023;3(1):e91. Published 2023 May 15. doi:10.1017/ash.2023.162
17. Marepalli NR, Nadipelli AR, Manohar Kumar Jain RJ, Parnam LS, Vashyani A. Patterns of Antibiotic Resistance in Urinary Tract Infections: A Retrospective Observational Study. Cureus. 2024;16(6):e62771. Published 2024 Jun 20. doi:10.7759/cureus.62771
18. Bhargava K, Nath G, Bhargava A, et al. Bacterial profile and antibiotic susceptibility pattern of uropathogens causing urinary tract infection in the eastern part of Northern India. Front Microbiol. 2022;13:965053. Published 2022 Aug 9. doi:10.3389/fmicb.2022.965053
19. Rizvi M, Malhotra S, Agarwal J, et al. Regional variations in antimicrobial susceptibility of community-acquired uropathogenic Escherichia coli in India: Findings of a multicentric study highlighting the importance of local antibiograms. IJID Reg. 2024;11:100370. Published 2024 Apr 25. doi:10.1016/j.ijregi.2024.100370
20. Rizvi M, Malhotra S, Sami H, et al. Klebsiella pneumoniae urinary tract infection: A multicentric study highlights significant regional variations in antimicrobial susceptibility across India. IJID Reg. 2025;14:100605. Published 2025 Feb 19. doi:10.1016/j.ijregi.2025.100605
21. Thakur P, Kaur N, Chauhan S, et al . Fosfomycin resistance in extended-spectrum beta-lactamase producing Escherichia coli isolated from urinary tract-infected patients in a tertiary care hospital. J Med Microbiol. 2025;74(7):002039. doi:10.1099/jmm.0.002039
22. M V, Jacob ES, Sivagamasundari P, et al . A Retrospective Analysis of Urinary Tract Infections With Special Reference to the Phenotypic and Genotypic Detection of Fosfomycin-Resistant Escherichia coli Isolates at a Tertiary Care Center in South India. Cureus. 2025;17(7):e87359. Published 2025 Jul 5. doi:10.7759/cureus.87359
23. Mohapatra S, Pundir S, Panigrahy R,et al . Phenotypic and genotypic characterization of antimicrobial-resistant uropathogens in community settings of India: A multicentric cross-sectional study. J Glob Antimicrob Resist. 2026 May;48:35-43. doi: 10.1016/j.jgar.2026.02.003. Epub 2026 Feb 18. PMID: 41720396.
24. Niranjan V, Malini A. Antimicrobial resistance pattern in Escherichia coli causing urinary tract infection among inpatients. Indian J Med Res. 2014 Jun;139(6):945-8. PMID: 25109731; PMCID: PMC4165009.
25. Klein RD, Hultgren SJ. Urinary tract infections: microbial pathogenesis, host–pathogen interactions and new treatment strategies. Nature Reviews Microbiology. 2020;18(4):211–226. doi:10.1038/s41579-020-0324-0. PMID: 32005842.
26. Simoni A, Schwartz L, Junquera GY, et al . Current and emerging strategies to curb antibiotic-resistant urinary tract infections. Nat Rev Urol. 2024 Dec;21(12):707-722. doi: 10.1038/s41585-024-00877-9. Epub 2024 May 7. PMID: 38714857; PMCID: PMC11540872.
27. Wagenlehner FME, Bjerklund Johansen TE, Cai T, et al . Epidemiology, definition and treatment of complicated urinary tract infections. Nat Rev Urol. 2020 Oct;17(10):586-600. doi: 10.1038/s41585-020-0362-4. Epub 2020 Aug 25. PMID: 32843751.
28. Wagenlehner FM, Cek M, Naber KG, et al . Epidemiology, treatment and prevention of healthcare-associated urinary tract infections. World J Urol. 2012 Feb;30(1):59-67. doi: 10.1007/s00345-011-0757-1. Epub 2011 Sep 7. PMID: 21898083.
29. Chenoweth CE, Gould CV, Saint S. Diagnosis, management, and prevention of catheter-associated urinary tract infections. Infect Dis Clin North Am. 2014 Mar;28(1):105-19. doi: 10.1016/j.idc.2013.09.002. Epub 2013 Dec 8. PMID: 24484578; PMCID: PMC9580547.
30. Nickel JC, Kelly KL, Griffin A, Elterman D, Clark-Pereira J, Doiron RC. MV140 sublingual vaccine reduces recurrent urinary tract infection in women Results from the first North American clinical experience study. Can Urol Assoc J. 2024;18(2):25-31. doi:10.5489/cuaj.8455
31. Hernández-Sánchez JE, Lorenzo-Gómez MF, González-Enguita C. Current Evidence on Safety, Efficacy and Efficiency of Sublingual Vaccine Uromune® in Prevention of Recurrent Urinary Tract Infections: A Literature Review. Pathogens. 2025 Dec 30;15(1):42. doi: 10.3390/pathogens15010042. PMID: 41599026; PMCID: PMC12845384.