

ANTIBIOTIC SENSITIVITY PATTERN OF UROPATHOGENS IN THE POSTCOVID ERA – A LABORATORY BASED CROSS-SECTIONAL STUDY IN A TERTIARY CARE HOSPITAL IN SOUTH INDIA

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ABSTRACT

Background: Urinary tract infections (UTIs) are common with rising antimicrobial resistance, especially post-COVID. However, region-specific data on changing uropathogen profiles are limited. This study aimed to determine the distribution and antimicrobial susceptibility of uropathogens and compare the findings with pre-COVID South Indian data. **Materials and Methods:** This retrospective study used culture and sensitivity reports from urine samples collected at a tertiary hospital between January 2024 and December 2025. Urine samples underwent antimicrobial susceptibility testing via the Kirby–Bauer disk diffusion method on Mueller–Hinton agar, interpreted per CLSI M100 standards with ATCC strain quality control. Demographic, cultural, isolated organism, and antibiotic susceptibility data were collected. **Result:** Of the 8955 urine samples, 1603 (17.9%) were culture-positive: 1469 (91.6%) were gram-negative, and 164 (10.2%) were gram-positive. *Escherichia coli* predominated at 729 (45.5%), followed by *Klebsiella* spp. 332 (20.7%), other gram-negatives 378 (23.6%), *Enterococcus* spp. 104 (6.5%), and *Staphylococcus* spp. in 60 (3.7%) patients. *E. coli* showed highest susceptibility to meropenem 697 (95.6%), imipenem 652 (89.5%), and amikacin 640 (87.7%), with lower susceptibility to norfloxacin 332 (45.5%). *Klebsiella* spp. had similar trends with meropenem 317 (95.4%) and imipenem 291 (87.7%). Gram-positive organisms were highly susceptible to vancomycin and linezolid. **Conclusion:** Gram-negative uropathogens predominated, with carbapenems and aminoglycosides retaining high activity, whereas fluoroquinolone susceptibility was lower. Regular surveillance is essential for guiding empirical therapy and ensuring antimicrobial stewardship.

INTRODUCTION

Urinary tract infections (UTIs) are prevalent worldwide, with 150 million incidences per year. In India, the incidence varies from 25% to 37% and is found more commonly among females and geriatric populations, including menopause patients.^[1-3] The important bacterial species causing UTI are *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas*, *Proteus* spp., and *Enterococcus* spp. Among these bacteria, *Escherichia coli* is reported in over 60% incidence in Indian studies.^[1,4,5] UTIs are responsible for causing high morbidity due to repeated attacks, antimicrobial resistance, and further complicated into pyelonephritis and sepsis.^[3,6] Antimicrobial treatment is critical, but the problem of

resistance poses a challenge with monitoring antibiotic susceptibility is vital for guiding therapy and limiting resistant strains.^[4,7] Rising resistance to antibiotics, such as ampicillin, ciprofloxacin, and third-generation cephalosporins, is on the rise. Many strains of *E. coli* and *K. pneumoniae* are known to be ESBL producers, which lead to low susceptibility to beta-lactam drugs.^[1,7]

Multidrug resistance (MDR), extreme drug resistance (XDR), and pan-drug resistance (PDR) have been observed more frequently, especially among postmenopausal females.^[3] ESBL-producing pathogens and carbapenem-resistant strains pose significant challenges in treating UTIs. However, certain antibiotics, including imipenem, amikacin, nitrofurantoin, and fosfomycin, are known to be more

sensitive when studied in India.^[1,4,7] Regional differences exist in the epidemiology and antimicrobial sensitivity pattern, emphasizing the need for continuous surveillance and regional antibiogram.⁸ Prior to the onset of the coronavirus disease 2019 (COVID-19) outbreak, UTI epidemiology and antimicrobial sensitivity and *E. coli* has consistently emerged as the predominant uropathogen.^[2] There was an increase in resistance to commonly used antibiotics like penicillin, while carbapenems and nitrofurantoin remained more potent.^[2]

Local susceptibility data are vital in empirical antibiotic treatment amid multidrug resistance and ESBLs amongst the uropathogens. Regional-based data can be used in developing successful antibiotic prescription strategies to counterbalance infections without increasing AMR rates. These base resistance data indicate the actual resistance profile of UTIs in South India, providing guidance for empirical antibiotic treatment before the COVID-19 era.^[2] The COVID-19 pandemic has led to a significant shift in the health care sector worldwide and locally. Although the virus is not affected by antibiotics, the fear of co-infections, particularly in critical patients, led to increased use, potentially fostering AMR.^[9,10] There have been reports of heavy use of antibiotics during the pandemic, whereby over 50% of the COVID-19 cases were given antibiotics, which is likely to favour the development of resistance in the pathogens.^[11]

The increased use of disinfectants and antibiotics has led to the spread of AMR.^[12] The social aspects associated with the pandemic, including self-medication due to anxiety and poor access to medical services, have led to improper use of antibiotics in South Asia.^[13] Recent findings have indicated a change in the profile of pathogens and their resistance in the post-COVID-19 era. There has been an increase in MDROs such as *Klebsiella pneumoniae* and *Acinetobacter baumannii*, and an increase in carbapenem resistance.^[14] These findings are important in relation to UTIs due to shared pathogens and antibiotics. Systematic data on the prevalence and resistance patterns of uropathogens post-COVID are limited and often based on individual studies or by extrapolating results from different sources.^[15] This makes it difficult to assess the impact of post-COVID conditions on uropathogen dynamics and update recommendations for clinical practice accordingly.

Despite the availability of ample pre-COVID data on uropathogens and their resistance patterns in South India, systematic evidence on any changes that occurred post-COVID is minimal. The increase in antibiotic consumption during the pandemic may have increased bacterial resistance. However, these studies have focused only on infections in other areas and have not been conducted in the context of UTIs. Available data are scattered, regionally based, and derived from outside the area of uropathogens. Region-specific, laboratory-based studies are crucial

for reassessing current antibiograms, informing empirical therapy, and enhancing antimicrobial stewardship. Thus, this study was designed to evaluate the distribution of uropathogens and their antimicrobial susceptibility pattern among urine culture isolates in a tertiary care hospital in South India during the post-COVID era.

Objective

The objective was to determine the distribution of uropathogens and their antimicrobial susceptibility patterns.

MATERIALS AND METHODS

This retrospective cross-sectional study was conducted using culture and sensitivity reports of urine samples with positive cultures from patients attending Government Medical College, Virudhunagar, from January 2024 to December 2025. Ethical approval was obtained from the institutional ethics committee.

Inclusion and Exclusion criteria

This study included urinary samples of patients with symptoms suggestive of urinary tract infection showing significant growth of a single uropathogen, as defined by standard laboratory criteria ($\geq 10^5$ colony-forming units/mL for midstream urine or according to specimen type). Samples showing no growth, mixed growth, or contamination were excluded.

Materials

The materials used in this study included urine samples, culture media, Mueller-Hinton agar, and antibiotic discs for susceptibility testing, including ampicillin, amoxicillin-clavulanate, cephalosporins, piperacillin-tazobactam, fluoroquinolones, cotrimoxazole, nitrofurantoin, aminoglycosides, and carbapenems, as well as standard laboratory equipment.

Methods

Urine samples were processed, and antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar. The results were interpreted according to CLSI M100 performance standards, with routine quality control using the recommended ATCC strains. Data were collected from hospital records, including patient demographics (age and sex), inpatient or outpatient status, date of culture, isolated organism, and antimicrobial susceptibility profile for each antibiotic tested. Data are presented as frequencies and percentages.

RESULTS

A total of 8955 urine samples were processed: 1603 (17.9%) showed positive culture isolates, and 7352 (82.1%) were culture-negative. Among the positive cultures, 1469 (91.6 %) were gram-negative and 164 (10.2 %) were gram-positive. Culture negativity was

higher than positivity, with gram-negative organisms predominating [Table 1].

Table 1: Distribution of Urine Culture Results and Isolate Characteristics

	N (%)
Total urine samples processed	8955
Positive culture isolates	1603 (17.9%)
Negative cultures	7352 (82.1%)
Total Gram-negative isolates	1469 (91.6%)
Total Gram-positive isolates	164 (10.2%)

Escherichia coli was the predominant uropathogen, accounting for 729 (45.5%) cases, followed by Klebsiella spp. with 332 (20.7%) cases. Other Gram-negative isolates accounted for 378 (23.6%) of the

total isolates. Among Gram-positive organisms, Enterococcus spp. accounted for 104 (6.5%) and Staphylococcus spp. for 60 (3.7%) [Table 2].

Table 2: Distribution of Uropathogens

Organism	N (%)
Escherichia coli	729 (45.5%)
Klebsiella spp.	332 (20.7%)
Enterococcus spp.	104 (6.5%)
Staphylococcus spp.	60 (3.7%)
Other Gram-negative isolates	378 (23.6%)

Among Gram-negative uropathogens, Escherichia coli was most susceptible to meropenem 697 (95.6%), followed by imipenem 652 (89.5%) and amikacin 640 (87.7%), with lower rates for gentamicin 459 (63.0%) and norfloxacin 332 (45.5%). Klebsiella spp. showed similar patterns:

meropenem at 317 (95.4%), imipenem at 291 (87.7%), amikacin at 277 (83.5%), gentamicin at 223 (67.2%), and norfloxacin at 168 (50.6%). Non-fermenting bacilli were most susceptible to amikacin (80.8%), followed by gentamicin (68.3%) and Norfloxacin (58.8%) [Table 3].

Table 3: Antibiotic Susceptibility Pattern of Gram-Negative Uropathogens

Antibiotic	N (%)	
	E. coli	Klebsiella spp.
Amikacin	640 (87.7%)	277 (83.5%)
Gentamicin	459 (63.0%)	223 (67.2%)
Nitrofurantoin	538 (73.9%)	192 (57.7%)
Norfloxacin	332 (45.5%)	168 (50.6%)
Piperacillin-Tazobactam	608 (83.4%)	268 (80.7%)
Imipenem	652 (89.5%)	291 (87.7%)
Meropenem	697 (95.6%)	317 (95.4%)

Among Gram-positive uropathogens, Enterococcus spp. was completely susceptible to vancomycin and linezolid at 104 (100%) each, with lower susceptibility to nitrofurantoin at 81 (78.2%).

Staphylococcus spp. showed highest susceptibility to linezolid at 60 (100%), followed by vancomycin at 58 (96.0%), and lower susceptibility to nitrofurantoin at 48 (80.6%) [Table 4].

Table 4: Antibiotic Susceptibility Pattern of Gram-Positive Uropathogens

Antibiotic	N (%)	
	Enterococcus spp.	Staphylococcus spp.
Vancomycin	104 (100%)	58 (96.0%)
Linezolid	104 (100%)	60 (100%)
Nitrofurantoin	81 (78.2%)	48 (80.6%)

DISCUSSION

In our study, culture negativity exceeded positivity, with gram-negative organisms predominating among positive isolates, indicating their major role in tract infections. Escherichia coli was the predominant uropathogen, followed by Klebsiella spp., while Gram-positive organisms like Enterococcus spp. and Staphylococcus spp. were less common, highlighting Gram-negative dominance. This pattern aligns with recent studies that reported E. coli as the main

pathogen, followed by Klebsiella spp. and Enterococcus spp.

A study by William et al., found E. coli, Klebsiella spp. and Enterococcus spp. at 59.8 %, 18.9 %, and 8.3%, respectively.^[16] A 2025 study by Chandrakumar et al., noted E. coli in 44.6% to 50.5% of isolates, Enterococcus spp. at 7.8% to 12.4%, and Klebsiella spp. at 9% to 10.5%.^[17] Another study conducted by Sheeba et al., found E. coli at 57.4%, Klebsiella pneumoniae at 14.3%, and Enterococcus spp. at 6.0%.^[18] Our findings of Escherichia coli (45.5%), Klebsiella spp. (20.7%), Enterococcus spp.

(6.5%), and *Staphylococcus* spp. (3.7%) indicated a similar pattern but with a higher contribution from *Klebsiella*, possibly due to local factors.

In our study, gram-negative uropathogens showed higher susceptibility to carbapenems and aminoglycosides but lower susceptibility to fluoroquinolones, suggesting the preserved efficacy of higher-end antibiotics. Non-fermenting Gram-negative bacilli showed moderate to high susceptibility to aminoglycosides and fluoroquinolones. Gram-positive uropathogens were highly susceptible to glycopeptides and oxazolidinones, with moderate nitrofurantoin activity. This aligns with studies showing preserved carbapenem and aminoglycoside activity but reduced fluoroquinolone and beta-lactam utility.

In a study by Shahab et al., *E. coli* showed high susceptibility to meropenem (99.5%), imipenem (99.6%), colistin (99.9%), polymyxin-B (99.9%), amikacin (96.7%), and gentamicin (97.4%), but low susceptibility to ceftriaxone (34.4%) and ciprofloxacin (31.5%).^[19] A study by Kinila et al., reported an increase in resistance to cephalosporins and piperacillin-tazobactam.^[20] Our findings of the high susceptibility of *E. coli* and *Klebsiella* spp. to meropenem and imipenem, with lower susceptibility to norfloxacin, align with this trend. For Gram-positive isolates, *Enterococcus* spp. showed complete susceptibility to vancomycin and linezolid, and *Staphylococcus* spp. showed high vancomycin activity and susceptibility to linezolid, consistent with recent data showing vancomycin and linezolid as reliable options. A 2022 study by Sherchan et al., reported that all strains were sensitive to colistin, vancomycin, and linezolid.^[21]

Strengths and limitations: This cross-sectional study benefits from a large sample size, standardised Clinical and Laboratory Standards Institute-guided Kirby-Bauer testing, and a post-pandemic timeframe that allows for the stabilisation of prescribing patterns. Limitations include its single-centre, retrospective design, which lacks patient clinical details.

CONCLUSION

The study showed that *E. coli* and *Klebsiella* spp. remain the principal uropathogens, with aminoglycosides and carbapenems retaining good activity. However, susceptibility to nitrofurantoin and fluoroquinolones against *E. coli* and *Klebsiella* was less robust than in pre-COVID south Indian reports. Gram-positive organisms continue to show excellent susceptibility to vancomycin and to linezolid. These findings support the need for regular updates of institutional antibiograms to guide the empirical therapy of urinary tract infections.

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