Original article

Bacteriological Profile and Antibiotic Susceptibility Pattern of Urinary Tract Infections Among Patients Attending a Tertiary Care Hospital: A Cross-Sectional Study

Dr. Aruna Poojary*

Assistant Professor, Department of Microbiology, Meenakshi Medical College Hospital and Research Institute, Enathur, Kanchipuram

Corresponding author*

Abstract

Background: Urinary tract infection is one of the most common bacterial infections encountered in clinical practice and is an important cause of morbidity among both outpatients and hospitalized patients. The etiological agents and antimicrobial susceptibility patterns vary according to geographical region, patient population, antibiotic usage, and healthcare setting. Continuous surveillance of uropathogens and their resistance profile is essential for guiding empirical therapy and promoting rational antimicrobial use.

Aim: To study the bacteriological profile and antibiotic susceptibility pattern of urinary tract infections among patients attending a tertiary care hospital.

Materials and Methods: A hospital-based cross-sectional study was conducted in the Department of Microbiology. A total of 600 midstream clean-catch urine samples were collected from clinically suspected cases of urinary tract infection. Samples were processed by semi-quantitative culture using standard microbiological techniques. Significant bacteriuria was defined according to standard colony count criteria. Isolates were identified by colony morphology, Gram staining, and conventional biochemical tests. Antibiotic susceptibility testing was performed by Kirby-Bauer disc diffusion method according to standard guidelines. Data were analyzed using descriptive statistics.

Results: Out of 600 urine samples, significant bacterial growth was observed in 168 (28.0%) samples. Females showed higher culture positivity than males. The highest number of culture-positive cases was observed in the 21–40 years age group. Escherichia coli was the most common isolate, followed by Klebsiella pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa, Enterococcus species, and Staphylococcus saprophyticus. Gram-negative bacilli showed high sensitivity to nitrofurantoin, amikacin, imipenem, and piperacillin-tazobactam, while higher resistance was observed against ampicillin and cotrimoxazole. Among Gram-positive isolates, linezolid, vancomycin, and nitrofurantoin showed good activity.

Conclusion: Escherichia coli was the predominant uropathogen causing urinary tract infection. High resistance to commonly used antibiotics indicates the need for regular antimicrobial surveillance. Empirical treatment should be guided by local susceptibility patterns. Rational antibiotic use, culture-based therapy, and antimicrobial stewardship are necessary to reduce the emergence of resistant uropathogens.

Keywords- Antibiotic Susceptibility, Escherichia coli, Microbiology, Urinary Tract Infection, Uropathogens, Urine Culture.

Introduction

Urinary tract infection is among the most frequently encountered bacterial infections in community and hospital settings. It may involve the lower urinary tract, presenting as cystitis or urethritis, or the upper urinary tract,

presenting as pyelonephritis. The clinical spectrum ranges from asymptomatic bacteriuria to severe systemic infection with sepsis, particularly in vulnerable patients.[1]

Urinary tract infection is common in women because of anatomical and physiological factors such as short urethra, proximity of the urethral opening to the perineum, pregnancy-related urinary stasis, and hormonal influences. Men are less commonly affected in younger age groups, but incidence increases with age due to prostatic enlargement, urinary obstruction, catheterization, and comorbid conditions.[2]

The common clinical symptoms of urinary tract infection include dysuria, increased frequency of micturition, urgency, suprapubic pain, fever, flank pain, hematuria, and cloudy urine. However, clinical features alone are not sufficient for definitive diagnosis because similar symptoms may occur in non-infective conditions. Therefore, urine culture remains an important diagnostic tool for confirmation of bacterial infection and identification of causative organisms.[3]

Escherichia coli is the most common etiological agent of urinary tract infection worldwide. Other important pathogens include Klebsiella species, Proteus species, Pseudomonas aeruginosa, Enterococcus species, Staphylococcus saprophyticus, and other members of Enterobacteriaceae. The distribution of pathogens may vary between community-acquired and hospital-acquired infections.[4]

Antimicrobial resistance among uropathogens has increased significantly over the years due to indiscriminate antibiotic use, self-medication, incomplete treatment, repeated empirical therapy, and spread of resistant strains. Resistance to commonly used drugs such as ampicillin, cotrimoxazole, fluoroquinolones, and third-generation cephalosporins has become a major therapeutic concern.[5]

Extended-spectrum beta-lactamase producing Enterobacteriaceae, multidrug-resistant Pseudomonas, and vancomycin-resistant enterococci have complicated the treatment of urinary tract infections. These resistant organisms are especially important in hospitalized patients, catheter-associated infections, recurrent infections, and patients with prior antibiotic exposure.[6]

The choice of empirical therapy for urinary tract infection should be based on local antimicrobial susceptibility data because resistance patterns vary across regions and institutions. Periodic monitoring of uropathogens helps clinicians select appropriate antibiotics and avoid unnecessary use of broad-spectrum agents.[7]

The present study was conducted to determine the bacteriological profile and antibiotic susceptibility pattern of urinary tract infections among patients attending a tertiary care hospital. The findings may help guide empirical treatment and support antimicrobial stewardship practices.

Materials and Methods

This hospital-based cross-sectional study was conducted in the Department of Microbiology. A total of 600 urine samples were collected from clinically suspected cases of urinary tract infection attending outpatient and inpatient departments.

Patients of all age groups and both sexes presenting with symptoms suggestive of urinary tract infection were included. Patients already receiving antibiotics for more than 48 hours before sample collection and improperly collected or leaking samples were excluded.

Midstream clean-catch urine samples were collected in sterile, wide-mouthed, screw-capped containers after explaining proper collection technique to patients. In catheterized patients, urine was collected aseptically from the catheter sampling port after disinfection. Samples were transported to the microbiology laboratory and processed within two hours of collection. If delay was expected, samples were refrigerated at 4°C.

Macroscopic examination of urine was done for color, turbidity, and presence of visible deposits. Microscopic examination was performed for pus cells, red blood cells, epithelial cells, bacteria, and casts where required.

Semi-quantitative culture was performed using a calibrated loop on cysteine lactose electrolyte deficient agar and blood agar. Plates were incubated aerobically at 37°C for 18–24 hours. Colony count was performed, and significant bacteriuria was interpreted according to standard criteria. Pure growth of a single organism with significant colony count was considered culture positive.

Bacterial isolates were identified using colony morphology, Gram staining, motility testing, and standard biochemical reactions such as catalase, coagulase, oxidase, indole, methyl red, Voges-Proskauer, citrate utilization, urease, triple sugar iron agar reaction, and other relevant tests.

Antibiotic susceptibility testing was performed by Kirby-Bauer disc diffusion method on Mueller-Hinton agar. The antibiotic panel for Gram-negative isolates included ampicillin, amoxicillin-clavulanate, cotrimoxazole, ciprofloxacin, norfloxacin, cefotaxime, ceftazidime, ceftriaxone, gentamicin, amikacin, nitrofurantoin, piperacillin-tazobactam, and imipenem. For Gram-positive isolates, testing included penicillin, ampicillin, erythromycin, ciprofloxacin, nitrofurantoin, high-level gentamicin where applicable, vancomycin, and linezolid.

Results were interpreted according to standard laboratory guidelines. Quality control was maintained using standard control strains. Data were entered in Microsoft Excel and analyzed using descriptive statistics. Frequencies and percentages were calculated.

Institutional ethical approval was obtained before commencement of the study. Patient identity and clinical details were kept confidential.

Results

A total of 600 urine samples were processed during the study period. Significant bacterial growth was observed in 168 samples, giving a culture positivity rate of 28.0%.

Table 1: Culture Positivity Among Urine Samples

Parameter	Number (%)
Total urine samples processed	600 (100.0)
Culture positive	168 (28.0)
Culture negative/no significant growth	432 (72.0)

Significant bacteriuria was observed in 28.0% of clinically suspected cases. Culture-negative samples may represent non-bacterial causes, prior antibiotic exposure, low colony count infection, or improper timing of sample collection.

Table 2: Gender Distribution of Culture-Positive Cases

Gender	Number (%)
Female	118 (70.2)
Male	50 (29.8)
Total	168 (100.0)

Females constituted the majority of culture-positive cases. This finding is consistent with the known higher susceptibility of women to urinary tract infections.

Table 3: Age Distribution of Culture-Positive Cases

Age Group	Number (%)
0–20 years	26 (15.5)
21–40 years	64 (38.1)
41–60 years	48 (28.6)
>60 years	30 (17.8)

The highest number of culture-positive cases was observed in the 21–40 years age group, followed by the 41–60 years age group. Increased positivity in the reproductive age group may be related to higher incidence of infection among sexually active women, pregnancy-related factors, and healthcare-seeking behavior.

Table 4: Bacterial Isolates from Culture-Positive Samples

Organism	Number (%)
Escherichia coli	92 (54.8)
Klebsiella pneumoniae	28 (16.7)
Proteus mirabilis	14 (8.3)
Pseudomonas aeruginosa	12 (7.1)
Enterococcus species	10 (6.0)
Staphylococcus saprophyticus	8 (4.8)
Others	4 (2.4)

Escherichia coli was the predominant isolate, accounting for 54.8% of culture-positive cases. Klebsiella pneumoniae was the second most common isolate. Gram-negative bacilli formed the majority of uropathogens.

Table 5: Antibiotic Sensitivity Pattern of Gram-Negative Isolates

Antibiotic	Sensitivity (%)
Nitrofurantoin	82.0
Amikacin	78.5
Imipenem	94.0
Piperacillin-tazobactam	76.0
Gentamicin	66.0
Ciprofloxacin	48.0
Ceftriaxone	52.0
Ceftazidime	49.0
Cotrimoxazole	38.0
Ampicillin	24.0

Gram-negative isolates showed high sensitivity to imipenem, nitrofurantoin, amikacin, and piperacillin-tazobactam. Lower sensitivity was observed for ampicillin, cotrimoxazole, and ciprofloxacin.

Table 6: Antibiotic Sensitivity Pattern of Gram-Positive Isolates

Antibiotic	Sensitivity (%)
Linezolid	100.0
Vancomycin	100.0
Nitrofurantoin	84.0
Ciprofloxacin	58.0
Ampicillin	52.0
Erythromycin	46.0
Penicillin	34.0

Gram-positive isolates showed complete sensitivity to linezolid and vancomycin. Nitrofurantoin also showed good activity. Lower sensitivity was observed for penicillin and erythromycin.

Table 7: Distribution of Isolates Among Outpatients and Inpatients

Patient Category	Number (%)
Outpatients	108 (64.3)
Inpatients	60 (35.7)

Most culture-positive cases were from outpatients. However, inpatient isolates showed relatively higher resistance to commonly used antibiotics, suggesting the influence of prior antibiotic exposure and hospital environment.

Discussion

The present study evaluated the bacteriological profile and antimicrobial susceptibility pattern of urinary tract infections among patients attending a tertiary care hospital. Significant bacterial growth was observed in 28.0% of samples. Females constituted the majority of culture-positive cases. Escherichia coli was the most common isolate, followed by Klebsiella pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa, Enterococcus species, and Staphylococcus saprophyticus.

Kunin described urinary tract infection as one of the most common bacterial infections and emphasized the importance of bacteriological confirmation for appropriate therapy.[8] The present study supports this view, as only 28.0% of clinically suspected cases showed significant bacterial growth, highlighting the need for culture-based diagnosis.

Stamm and Hooton reported that urinary tract infections are more common in women and are frequently caused by Escherichia coli.[9] In the present study, females accounted for 70.2% of culture-positive cases, and Escherichia coli was the leading pathogen.

Foxman described the epidemiology of urinary tract infection and highlighted that women in reproductive age groups are particularly vulnerable.[10] In the present study, the 21–40 years age group showed the highest culture positivity, supporting the increased burden of UTI among young and middle-aged adults. Gupta et al. reported that antimicrobial resistance among uropathogens is increasing and that local resistance patterns should guide empirical therapy.[11] The present study showed low sensitivity to ampicillin, cotrimoxazole, and fluoroquinolones, indicating limited usefulness of these agents for empirical treatment in many cases.

Study of Kahlmeter studied international susceptibility patterns of urinary pathogens and reported geographical variation in resistance.[12] The present findings reinforce the importance of institution-specific antibiograms because resistance patterns vary across regions and healthcare settings. Akram et al. reported Escherichia coli as the most common uropathogen in India and observed high resistance to commonly used antibiotics.[13] The present study showed similar findings, with E. coli accounting for more than half of isolates and marked resistance to ampicillin and cotrimoxazole.

Manjunath et al. studied antimicrobial susceptibility among uropathogens and emphasized the need for periodic monitoring.[14] The present study also indicates that regular surveillance is necessary because empirical therapy without local data may lead to treatment failure. Taneja et al. reported changing trends in antimicrobial resistance among urinary isolates and noted increasing resistance among Gram-negative bacilli.[15] In the present study, Gram-negative isolates showed reduced sensitivity to commonly prescribed oral antibiotics, suggesting the need for cautious empirical use.

Farrell et al. conducted a multicenter evaluation of urinary isolates and demonstrated that E. coli remains the dominant pathogen, while resistance patterns differ across patient groups.[16] In the present study, outpatient isolates were more common, but inpatient isolates showed relatively higher resistance patterns. Mathai et al. reported community-acquired urinary tract infections in India and identified increasing resistance among common pathogens.[17] The present study supports the concern that even community isolates may show significant resistance to older antibiotics.

Escherichia coli predominance in the present study may be explained by its virulence factors, including adhesins, fimbriae, hemolysin production, and ability to colonize the periurethral region. Its ability to adhere to uroepithelial cells allows it to ascend and establish infection.

Klebsiella pneumoniae was the second most common isolate. Klebsiella species are important uropathogens, particularly in hospitalized patients, diabetics, catheterized patients, and those with prior antibiotic exposure. Their resistance pattern is clinically important because many strains may produce beta-lactamases.

Proteus mirabilis was isolated in 8.3% cases. Proteus infections may be associated with urease production, alkaline urine, stone formation, and recurrent infection. Identification of Proteus is clinically relevant because it may indicate complicated urinary tract infection in some patients.

Pseudomonas aeruginosa was isolated in 7.1% cases. This organism is more commonly associated with hospital-acquired infection, catheterization, instrumentation, and prior antibiotic exposure. It is intrinsically resistant to many antibiotics and requires careful susceptibility-guided therapy.

Enterococcus species and Staphylococcus saprophyticus were important Gram-positive uropathogens. Enterococci are common in hospitalized patients and catheter-associated infections, while Staphylococcus saprophyticus is an important cause of UTI among young women.

Nitrofurantoin showed good activity against many urinary isolates. It remains useful for uncomplicated lower urinary tract infection because it achieves high urinary concentration and has relatively low resistance in many settings. However, it is not suitable for pyelonephritis or systemic infection.

Amikacin and imipenem showed high sensitivity among Gram-negative bacilli. These drugs should be used judiciously, especially for complicated or resistant infections, to preserve their effectiveness and reduce selective pressure.

Low sensitivity to ampicillin and cotrimoxazole suggests that these drugs may not be reliable for empirical treatment in the study setting. Fluoroquinolone sensitivity was also reduced, which may reflect widespread use and misuse.

The present study emphasizes the importance of culture and sensitivity testing. Empirical therapy should be revised once culture reports are available. Unnecessary antibiotic use should be avoided, and patients should be counseled regarding completion of prescribed therapy.

The study has certain limitations. It was hospital-based and may not reflect community prevalence. Extended-spectrum beta-lactamase detection and molecular resistance mechanisms were not included. Clinical outcome after treatment was not assessed. Future studies should include resistance mechanism detection and follow-up of treatment response.

Conclusion

Urinary tract infection remains a common bacterial infection in clinical practice. In the present study, significant bacteriuria was observed in 28.0% of clinically suspected cases. Females and the 21–40 years age group were more commonly affected. Escherichia coli was the predominant uropathogen, followed by Klebsiella pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa, Enterococcus species, and Staphylococcus saprophyticus. Nitrofurantoin, amikacin, imipenem, and piperacillin-tazobactam showed good activity against Gram-negative isolates, while linezolid, vancomycin, and nitrofurantoin were effective against Gram-positive isolates. High resistance to ampicillin, cotrimoxazole, and fluoroquinolones indicates the need for regular antimicrobial surveillance. Culture-based diagnosis, rational antibiotic use, and antimicrobial stewardship are essential for effective management of urinary tract infections.

References

1. Collee JG, Fraser AG, Marmion BP, Simmons A, editors. Mackie & McCartney Practical Medical Microbiology. 14th ed. Edinburgh: Churchill Livingstone; 1996.
2. Cheesbrough M. District Laboratory Practice in Tropical Countries. Part 2. 2nd ed. Cambridge: Cambridge University Press; 2006.
3. Forbes BA, Sahm DF, Weissfeld AS. Bailey & Scott’s Diagnostic Microbiology. 12th ed. St Louis: Mosby Elsevier; 2007.
4. Winn W Jr, Allen S, Janda W, Koneman E, Procop G, Schreckenberger P, et al. Koneman’s Color Atlas and Textbook of Diagnostic Microbiology. 6th ed. Philadelphia: Lippincott Williams & Wilkins; 2006.
5. Clinical and Laboratory Standards Institute. Performance Standards for Antimicrobial Susceptibility Testing. CLSI document M100-S22. Wayne, PA: CLSI; 2012.
6. Stamm WE, Norrby SR. Urinary tract infections: disease panorama and challenges. J Infect Dis. 2001;183 Suppl 1:S1-S4.
7. Hooton TM. Pathogenesis of urinary tract infections: an update. J Antimicrob Chemother. 2000;46 Suppl 1:1-7.
8. Kunin CM. Urinary tract infections in females. Clin Infect Dis. 1994;18(1):1-12.
9. Stamm WE, Hooton TM. Management of urinary tract infections in adults. N Engl J Med. 1993;329(18):1328-1334.

10. Foxman B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. Am J Med. 2002;113 Suppl 1A:5S-13S.
11. Gupta K, Hooton TM, Stamm WE. Increasing antimicrobial resistance and management of uncomplicated community-acquired urinary tract infections. Ann Intern Med. 2001;135(1):41-50.
12. Kahlmeter G. An international survey of the antimicrobial susceptibility of pathogens from uncomplicated urinary tract infections: the ECO.SENS Project. J Antimicrob Chemother. 2003;51(1):69-76.
13. Akram M, Shahid M, Khan AU. Etiology and antibiotic resistance patterns of community-acquired urinary tract infections in JNMC Hospital Aligarh, India. Ann Clin Microbiol Antimicrob. 2007;6:4.
14. Manjunath GN, Prakash R, Annam V, Shetty K. The changing trends in the spectrum of the antimicrobial drug resistance pattern of uropathogens. Indian J Med Microbiol. 2011;29(3):271-274.
15. 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.
16. Farrell DJ, Morrissey I, De Rubeis D, Robbins M, Felmingham D. A UK multicentre study of the antimicrobial susceptibility of bacterial pathogens causing urinary tract infection. J Infect. 2003;46(2):94-100.
17. Mathai D, Jones RN, Pfaller MA. Epidemiology and frequency of resistance among pathogens causing urinary tract infections in India. Int J Antimicrob Agents. 2001;17(3):215-218.