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Original Article

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Antimicrobial profile of urinary tract infections at a tertiary care teaching hospital of Central India

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Abstract

***Background & Aims*:** Urinary tract infections (UTI) are a leading cause of bacterial infections in humans.The widespread use of antibiotics has resulted in the emergence of antibiotic-resistant microorganisms. Hence, the current study was conducted to investigate the antibiotic sensitivity pattern of uropathogens in UTI.

***Materials & Methods*:** A total of 642 urine samples were collected from suspected UTI patients and tested microbiologically. Antimicrobial susceptibility tests were performed for the isolated pathogens using the Kirby- Bauer disk diffusion method.

***Results*:** Out of 642 urine samples, 308 (48%) were found to exhibit significant bacteriuria. Females had a higher rate of UTI (68%) than males (32%), with a higher prevalence in the middle-aged group, while males reported a higher prevalence in the elderly group, which was statistically significant. The most common organism was *Escherichia coli* (57.2%), followed by *Klebsiella pneumoniae* (26.3%), *Pseudomonas aeruginosa* (8.4%), *Proteus spp.* (3.6%), *Enterococcus spp.* (2.6%), and *Staphylococcus aureus* (1.9%). UTI were more common in middle-aged female patients (31 to 45 years), while in males, high prevalence was seen in older patients (>45 years). Meropenem, Gentamicin, Nitrofurantoin, and Co-Trimoxazole were amongst the most sensitive drugs against *E.coli* and *K.pneumoniae*.

***Conclusion*:**Due to the irrational and injudicious use of antibiotics, commonly isolated uropathogens have a changing resistance pattern, resulting in reduced treatment effectiveness. This could be overcome by routine antimicrobial resistance surveillance, antimicrobial stewardship measures, and culture-guided therapy.

***Keywords*:** Antibiotic susceptibility pattern, Antimicrobial resistance, Bacteriuria, *Escherichia coli*, Urinary tract infection, Uropathogens

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Introduction

In a healthcare setting, urinary tract infection (UTI) is one of the most common infectious diseases (1). UTI affects people of all ages, including neonates and the elderly (2). Every year, approximately 150 million people worldwide are diagnosed with UTI. Every woman has a lifetime risk of developing UTI of 60%, while men have a lifetime risk of only 13% (3). The

frequency is higher in women than in men due to anatomical predisposition or a higher microbial load in the urothelial mucosa as well as other host factors such as urinary tract obstruction, sexual activity, and pregnancy (4).

Gram-negative enteric bacilli, particularly *Escherichia coli* and *Klebsiella* species, and gram positive-organisms such as *Staphylococcus saprophyticus* and *Enterococcus* species, are common pathogens responsible for UTI (5).

Currently, UTI is mostly treated empirically, especially in villages and small towns of India, due to lack of awareness and the unavailability of culture facilities. To make better decisions, the physician should have current knowledge of the organisms and recommend a bacteriological examination of urine samples, along with their antibiogram, to determine the susceptibility pattern of antibiotics against uropathogens (4,6).

The current scenario of rapidly emerging multidrug resistance among uropathogens, especially due to irrational and injudicious drug therapy, is a serious public health issue and warrants the necessity of regular Antimicrobial Resistance (AMR) surveillance. This trend varies with time and location. Therefore, periodic antimicrobial sensitivity screening at the local level is imperative for culture-guided therapy and for generating the epidemiological data required for formulating institutional Antibiotic Policy. Prompt and appropriate antimicrobial therapy helps to reduce renal scarring and progressive kidney damage (4, 5, 6).

In this region of Northern Madhya Pradesh, very few studies related to the antimicrobial sensitivity pattern of uropathogens have been conducted in the recent past, leading to a paucity of data. To fill this gap, a cross-sectional hospital-based study was conducted at a tertiary care teaching hospital in this region, aimed at exploring the causative agents of UTI and their antimicrobial susceptibility patterns.

Materials & Methods

This study was conducted in the Department of Microbiology over a period of 12 months, from May 2023 to April 2024, in a tertiary care hospital in Central India. A total of 642 urine samples were collected from clinically suspected UTI patients from both hospitalized and out-patient settings, irrespective of their age and sex, from a tertiary care hospital in Central India. The minimum sample size was calculated using the formula $N= 4PQ/d^2$ where P is the prevalence of UTI reported in previous surveillance studies in the region, Q is 100-P, and d is the allowable error.

- **Inclusion criteria:** All the urine samples collected for culture sensitivity from clinically suspected UTI cases attending the tertiary care center, irrespective of their age and gender, during the study period (1year).
- **Exclusion criteria:** Samples that yielded more than three types of colonies on culture, suggestive of contamination and hence rendered inappropriate for further processing.

The majority of the samples were clean-catch mid-stream samples, while some samples were collected from catheterized patients. All samples were processed within 2 hours of collection. Microscopy and culture on Cystine Lactose Electrolyte-Deficient (CLED) medium, MacConkey, and blood agar were performed. Direct microscopy involved urine wet mount (for assessing pus cells, RBCs, cellular debris/amorphous material, crystals, parasites, bacilli, etc.). The clinical features and colony count ($\geq 10^5$ cfu/ml) of the isolates were used to determine significance of growth (7). Bacterial pathogens were identified using standard microbiological techniques such as Gram staining, motility, and biochemical reactions (7).The Kirby-Bauer disk diffusion method was used to perform antimicrobial susceptibility testing (8).The resistance data were interpreted in accordance with the Clinical Laboratory Standards Institute (CLSI) guidelines (9).

Statistical Analysis: The study data were tabulated and analyzed using Microsoft Office Excel with appropriate statistical tools related to percentages and proportions. Pearson's chi-square test was used as the test of significance, with the significance level set at $p < 0.05$.

Results

Among the 642 urine samples included in this study, only 308 samples (48%) were found to have significant bacteriuria (10^5 cfu/ml), while the remaining samples had either a very low bacterial count or sterile urine.

Out of the 308 samples, 209 (68 %) were obtained from female patients, while 99 (32%) were obtained from male patients**.**Among females, a high prevalence was seen in the middle-aged group (31 to 45 years), whereas in males, a high prevalence was seen in the older age (> 45 years) group**.**The gender-wise distribution among different age groups was found to be statistically significant (Table 1).

Table 1. Age and gender wise distribution of UTI cases

Age (in years)	Female	Male	p value	Total
< 18	9 (3%)	10 (3.2%)	0.048	19 (6.2%)
18-30	24 (8%)	4 (1.3%)	0.033	28 (9.1%)
31-45	108 (35%)	5 (1.6%)	< 0.00001	113 (36.7%)
> 45	68 (22%)	80 (26%)	< 0.00001	148 (48%)
Total	209 (68%)	99 (32%)		308 (100%)

Level of significance set at $p \leq 0.05$ using Chi square test

E.coli 176 (57.2%) was the most common isolate causing UTI among the 308 uropathogens examined. *Klebsiella pneumoniae* 81(26.3%) was the second most common isolate, followed by *Pseudomonas aeruginosa* 26(8.4%), *Proteus spp.* 11(3.6%), *Enterococci* 8(2.6%), and *Staphylococcus aureus* 6(1.9%) (Figure1).

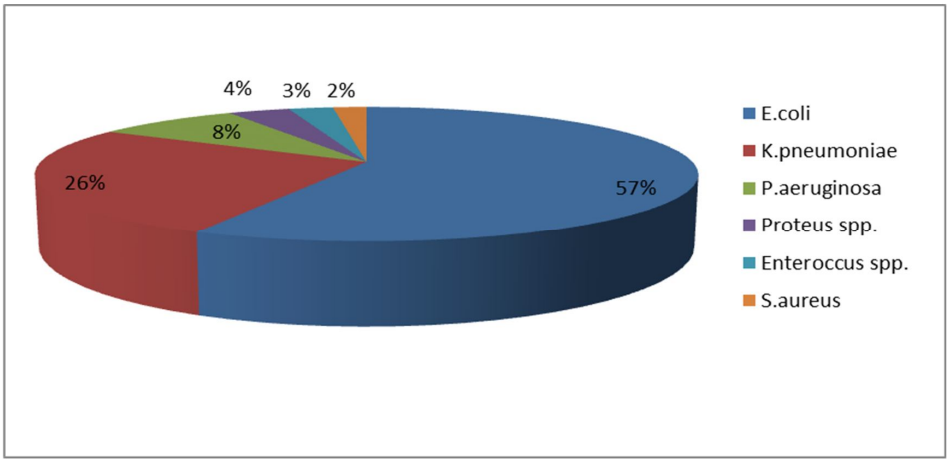

Fig.1. Percentage distribution of bacterial uropathogens

The overall susceptibility of organisms demonstrated significant resistance to Amoxicillin, fluoroquinolones, and ceftriaxone, with low susceptibilities ranging from 26-48%. However, Meropenem(81.2%), Gentamicin (79.9%), Nitrofurantoin (78.2%), and Sulphamethoxazole/Trimethoprim (Co-Trimoxazole) (74.4%) showed relatively good susceptibility, making them better treatment options.The sensitivity pattern of antimicrobial agents for the isolated organisms is depicted in (Table2).

Table 2. Antimicrobial sensitivity pattern of Uropathogens

S.No.	Antibiotics	E.coli	K.pneumoniae	P.aeruginosa	Proteus spp.	S.aureus	Enterococcus spp.	p value
1.	Meropenem	93.7%	71.6%	26.9%	90%	50%	75%	< 0.01
2.	Gentamicin	89.8%	69.1%	34.6%	90%	83.3%	87.5%	< 0.01
3.	Nitrofurantoin	79.5%	61.7%	30.7%	81.8%	0	87.5%	< 0.01
4.	Co-trimoxazole	78.4%	56.7%	19.2%	81.8%	66.7%	62.5%	< 0.01
5.	Tetracycline	74.4%	54.3%	23.1%	72.7%	83.3%	50%	< 0.01
6.	Amoxyclav	52.3%	50.6%	11.5%	63.6%	50%	50%	< 0.01
7.	Cefepime	48.2%	40.7%	7.6%	54.5%	33.3%	37.5%	< 0.01
8.	Ceftriaxone	30.7%	27.1%	3.8%	45.5%	33.3%	25%	< 0.01
9.	Ciprofloxacin	26.7%	20.9%	15.4%	36.4%	66.7%	37.5%	< 0.01
10.	Norfloxacin	21.5%	17.3%	15.4%	36.4%	66.7%	37.5%	< 0.01
11.	Azithromycin	18.7%	14.8%	3.8%	27.3%	16.7%	25%	< 0.01
12.	Amoxycillin	13.6%	11.1%	0	18.2%	3%	12.5%	< 0.01

Level of significance set at $p \leq 0.05$ using Chi square test

Discussion

UTI is not only one of the most common diseases diagnosed worldwide, but it also places a significant burden on healthcare due to the high prevalence of infection in both community and nosocomial settings. The availability of new antimicrobials has improved UTI management; however, UTI management has been hampered by the emergence of antimicrobial drug resistance.

In our study, the prevalence of UTI was found to be 48%, while other studies of UTI from India, conducted by Dash et al. (10) and Mehta et al. (11) has shown prevalence of 34.5% and 36.68%, respectively. However, a higher prevalence was observed in a study by Devanand et al. (12) (53.82%). This variation may be attributed to highly diverse ethnicity, ecology, environment, sanitation, cultural/dietary/infection control practices, prevailing bacterial flora and socio-economic-educational disparities, which are constantly changing with time and location in India.

In this study, we found a higher prevalence of UTI in females (68%) than in males (32%), which is similar to other studies that found a higher frequency of UTI in females (12,13). The close proximity of the urethral meatus to the anus, shorter urethra, sexual intercourse, incontinence, and poor toilet habits all contribute to the high prevalence of UTI in females (12). Moreover, a higher incidence was observed in middle-aged females and older males, which could be attributed to prostate disease in males, responsible for the increase in UTI incidence above the age of 45years. Smita S et al. (14) and Devanand et al. (12) both reported similar findings.

In this study, *E.coli, K.pneumoniae, Pseudomonas aeruginosa, Proteus spp., Enterococcus spp.,* and *S.aureus* grew significantly similar to other studies where *E.coli* and *K.pneumoniae* infections were the most common isolates (14,15).

Meropenem, Gentamicin, Nitrofurantoin, and Cotrimoxazole were the most effective antimicrobial agents in this study, with percentage susceptibilities of 81.2%, 79.9%, 78.2%, and 74.4%, respectively. Fluoroquinolones, Amoxicillin, and third-generation Cephalosporins showed higher resistance, with percentage susceptibilities ranging from 14% to 48%. According to a study done by Sajed et al. (16), Gentamicin exhibited highest sensitivity (92.3%), followed by Imipenem (90.2%), while Cefotaxime was least effective against uropathogens. A similar trend was observed in a number of studies conducted in the Indian subcontinent, consistent with global findings in recent years.This is attributed to the injudicious, irrational, and inappropriate prescription practices particularly with Fluoroquinolones and beta-lactams, especially third-generation Cephalosporins, in UTI

cases, worsened by over-the-counter availability of antibiotics and poor implementation of infection control practices in hospital settings. If this trend continues, it would have grave consequences, including increased morbidity, mortality, treatment failures, prolonged hospital stays and financial burden on the community. These malpractices result in positive selection pressure, leading to the emergence of multi-drug-resistant and even pan-resistant strains of pathogenic microbes, posing a serious challenge to clinicians who will be gradually left with no weapon in their arsenal as gradually all antibiotics would be rendered ineffective in the future.

The susceptibility of the isolates to the tested antibiotics varied according to species in this study. Meropenem (93.7%), Gentamicin (89.8%), and Nitrofurantoin (79.5%) had the highest sensitivity among *E.coli* isolates. While *K.pneumoniae* isolates were found to exhibit high susceptibility towards Meropenem (71.6%) and Gentamicin (69.1%) similar to other studies (17).

In our study,*P.aeruginosa* isolates exhibited high resistance against most antibiotics, as reported in other similar studies (17,18).

Limitations: As this was a purely laboratory-based, single-center cross-sectional study conducted over a short span with a limited budget and scope, it has its own limitations.Hence, the association of these factors with UTI could not be explored. Other limitations included the lack of patient comorbidity data, the lack of molecular characterization of resistant strains, and the lack of follow-up information on treatment outcomes. However, such preliminary studies could be expanded into large-scale, multi-centric epidemiological studies with extramural funding, and paving the way for more extensive research involving analysis of all possible socio-cultural, environmental, racial, geographical, ecological, clinical, dietary, microbiological, molecular, biochemical, immunological, health care, and sanitary factors with cause effect relationships and follow-up studies with treatment outcomes.

Conclusion

According to the findings of this study, *E.coli* is the most commonly isolated uropathogen, followed by *K.pneumoniae.* Females were more affected than males, and significant antimicrobial resistance was reported against commonly prescribed antibiotics such as Fluoroquinolones and third generation Cephalosporins due to irrational and injudicious drug therapy.

The antimicrobial sensitivity data of uropathogens generated in this study can be compared with other similar studies conducted in recent years in the region to determine the current AMR trend of uropathogens locally. This would help in formulating an institutional antibiotic policy, in determining the empirical therapeutic regimens, and promoting culture-guided therapy. Antimicrobial stewardship measures involving AMR surveillance, antibiotic policy framing, prescription auditing with relevant restrictions, regulated empirical regimens followed by culture-guided therapy, and cyclic rotation of commonly prescribed antibiotics, along with the strict implementation of infection control measures, constitute the key strategy to tackle this problem effectively.

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Ethical statement

The study was conducted after prior approval of the institutional ethics committee (1623/IECBMHR/GMC/2023).

Data availability

Raw data is available with the Corresponding author and can be made available as per ethical guidelines.

Conflict of interest

All authors declare No conflict of interest.

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References

1. Alonto AM, Mahon CR, Lehman DC, Manuselis G. Textbook of diagnostic Microbiology. 3rd ed. St. Louis: Saunders: Elsevier; 2007.
2. Kalpana S, Hegadi SS. Characterization and antimicrobial susceptibility testing of uropathogens from urinary tract infections. Int J Curr MicrobiolAppl Sci 2015;4(2):1010–6.
3. Nalini R, Ramya JE. Recent Sensitivity Pattern of Escherichia Coli in Urinary Tract Infection. RRJMB 2014; 3(3):31-5.
4. Sohail M, Khurshid M, Saleem HGM, Javed H, Khan AA. Characteristics and antibiotic resistance of urinary tract pathogens isolated from Punjab, Pakistan. Jundishapur J. Microbiol 2015;8(7):e19272. http://dx.doi.org/10.5812/jjm.19272v2
5. Razak S, Gurushantappa V. Bacteriology of urinary tract infection and antibiotic susceptibility pattern in a tertiary care hospital in South India. Int. J. Med. Sci. Public Health 2012;1(2):109. http://dx.doi.org/10.5455/ijmsph.2012.1.109-112
6. Bhargava K, Nath G, Bhargava A, Kumari R, Aseri GK, Jain N. Bacterial profile and antibiotic susceptibility pattern of uropathogens causing urinary tract infection in the eastern part of Northern India. Front. Microbiol 2022;13:965053. http://dx.doi.org/10.3389/fmicb.2022.965053
7. Collee JG, Miles RS, Watt B. Tests for the identification of bacteria. In: Collee JG, Fraser AG, Marmion BP, Simmons A, editors. Mackie and McCartney Practical Medical Microbiology. 14th ed. New York: Churchill Livingstone; 2006.
8. Bauer AW, Kirby WMM, Sherris JC, Turck M. Antibiotic susceptibility testing by standard single disc method. Am J Clin Pathol 1966; 45: 493-6. https://doi.org/10.1093/ajcp/45.4_ts.493.
9. Wayne, PA Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing; 27th informational supplement. Inform Suppl 2011;31(1):100-21. https://sid.ir/paper/655659/en
10. 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. Family Community Med 2013;20(1):20–6. http://dx.doi.org/10.4103/2230-8229.108180
11. Mehta M, Bhardwaj S, Sharma J. Screening of urinary isolates for the prevalence and antimicrobial susceptibility of Enterobacteria other than Escherichia coli. Int. J. Pharm. Sci 2013; 3 (1):100–4.
12. Prakash D, Saxena RS. Distribution and Antimicrobial Susceptibility Pattern of Bacterial Pathogens Causing Urinary Tract Infection in Urban Community of Meerut City, India. ISRN Microbiology; 2013: 749629. https://doi.org/10.1155/2013/749629
13. Singh VP, Mehta A. Bacteriological profile of urinary tract infections at a tertiary care hospital in Western Uttar Pradesh, India. Int J Res Med Sci 2017; 5: 2126-29. https://doi.org/10.18203/2320-6012.ijrms20171855
14. Sood S, Gupta R. Antibiotic resistance pattern of community acquired uropathogens at a tertiary care hospital in jaipur, rajasthan. Indian J. Community Med 2012;37(1):39–44. http://dx.doi.org/10.4103/0970-0218.94023
15. Razak S, Gurushantappa V. Bacteriology of urinary tract infection and antibiotic susceptibility pattern in a tertiary care hospital in South India. Int. J. Med. Sci. Public Health 2012;1(2):109. http://dx.doi.org/10.5455/ijmsph.2012.1.109-112
16. Sajed AN, Institute of Molecular Biology and Biotechnology The University of Lahore-Pakistan. Prevalence of urinary tract infections and their antibiotic sensitivity in tertiary care hospital Lahore. IOSR J. Dent. Med. Sci 2014;13(12):57–61. http://dx.doi.org/10.9790/0853-131225761
17. Prakasam AKC, Kumar KGD, Vijayan M. Infection and their Antibiotic utilisation pattern in Kerala: A Cross Sectional Study on Distribution of Urinary Tract. Int J Pharm Tech Research 2012;4 (3):1309-16.
18. Mehta A, Gupta HK, Tripathi K. Antimicrobial susceptibility pattern of uropathogens at a tertiary care hospital in central india during COVID era. Int J Pharm Pharm Sci 2023; 15 (5): 28-33. https://dx.doi.org/10.22159/ijpps.2023v15i5.47533.