Indian Journal of Microbiology Research 2024;11(4):277–282

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Microbiology Research

Journal homepage: https://www.ijmronline.org/

Original Research Article

Epidemiology, microbiological profile and susceptibility pattern of uropathogens from a tertiary care hospital in central India

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ARTICLE INFO

Article history:
Received 29-07-2024
Accepted 19-09-2024
Available online 09-12-2024

Keywords:
UTI
Urinary tract infection
Uropathogens
Antibiogram
Microbiological profile
Antimicrobial susceptibility

ABSTRACT

Background: Urinary tract infections (UTIs) are the second most common infection in the community, whereas in hospitals, they are the most common healthcare-associated infections. Monitoring factors like the most common causative organisms and their susceptibility pattern is essential for tailored management and practicing antimicrobial stewardship. This study was done to determine the epidemiology, microbiological profile, and susceptibility pattern of uropathogens to make better antibiotic policy.

Materials and Methods: This was a retrospective descriptive study done at the Department of Microbiology, Pt. JNM Medical College, Raipur, Chhattisgarh in which analysis of the culture isolates obtained from urine samples received between January 2022 to December 2022 was performed.

Results: Out of 2893 urine samples, 784 (27.1%) showed significant growth on culture. Females were more affected than males with male to female ratio being 1:2.3. Most common causative organism found in our study was *Escherichia coli*(41.9%) followed by *Enterococcus* species (23.9%), non-albicans *Candida* species(11.09%) and *Klebsiella pneumoniae*(10.3%). *Escherichia coli* isolates showed 100% susceptibility to fosfomycin; 93% for nitrofurantoin, and 93% for carbapenems. In the case of isolates of *Klebsiella pneumonia,* the susceptibility percentage for nitrofurantoin and carbapenems were 59% and 82% respectively. In *Enterococcus species* isolates were 100% susceptible to Teicoplanin and Fosfomycin, 82% for Nitrofurantoin.

Conclusion: *Escherichia coli* followed by *Enterococcus* species the most common uropathogen. Nitrofurantoin and Fosfomycin were the most effective antibiotics against uropathogens.

1. Introduction

Urinary tract infections (UTIs) are the most prevalent bacterial infections seen in clinical settings, and its presentations range from asymptomatic bacteriuria to severe sepsis.[1] It poses a significant healthcare burden, as it is one of the leading causes of hospital visits, contributing substantially to morbidity as well. It was estimated that there were 404.61 million cases of UTIs globally in 2019, resulting in 236,790 deaths and 520,200 disability-adjusted life years (DALYs).[2] UTIs accounted for 75% of hospital-acquired infections among patients admitted to a urology ward as indicated by a study conducted in India.[3] The high incidence of UTIs burdens the healthcare systems and individuals leading to increased healthcare costs and greater antibiotic consumption, which can promote antimicrobial resistance.[4]

Gram-negative bacteria, particularly *Escherichia coli* (uropathogenic), are the predominant uropathogens responsible for UTIs. Other common urinary pathogens include *Klebsiella* species, *Proteus* species, *Staphylococcus aureus, Enterobacter* species, *Citrobacter*

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https://doi.org/10.18231/j.ijmr.2024.048

species, *Pseudomonas aeruginosa*, *Acinetobacter* species, *Enterococcus* species, and *Candida* albicans.[5] The isolation of multidrug-resistant organisms is common, especially among patients using urinary catheters in the upper urinary tract or with prior urinary tract infections.[6]

To reduce the emergence of resistance and optimize the treatment outcomes targeted antibiotics based on susceptibility testing are essential.[7] The distribution of uropathogens and their susceptibility patterns can differ significantly across regions, making the generation of local antimicrobial resistance data vital for guiding empirical treatment and developing stewardship programs.[8]

This study aimed to characterize the epidemiology, microbiological profile, and antimicrobial susceptibility patterns of uropathogens isolated from patients at a tertiary care hospital in Chhattisgarh state, central India, and contribute data that could be valuable for formulating healthcare policies at local, national, and global levels.

2. Materials and Methods

This retrospective descriptive study was conducted in the Department of Microbiology at Pt. Jawahar Lal Memorial Medical College in Raipur, Chhattisgarh, India, from January 2022 to December 2022. During this period, 2,893 urine samples were collected from patients in both inpatient and outpatient departments of Dr. BR Ambedkar Memorial Hospital, Raipur, following standard sample collection protocols. Only the first isolate from each patient was included, and duplicate samples were excluded. The urine samples were processed for colony counts using a semi-quantitative method on cystine lactose electrolyte-deficient (CLED) agar medium with calibrated loops, according to standard protocols. Susceptibility testing was performed using the Kirby-Bauer disk diffusion method and interpreted according to the Clinical and Laboratory Standards Institute (CLSI) guidelines in the M100 document, 32nd edition. Data on age, gender, location (OPD/IPD), and other demographic factors of the positive cases were recorded. As this study is retrospective, the data were collected from records in the microbiology department and analyzed further.

2.1. Sample collection

As per the patient's condition, either midstream clean catch urine or urine from Foley's catheter was collected and transported to the lab within 2 hours for further processing following standard microbiological protocols. In case of delay, the specimen was stored in the refrigerator for not more than 24 hours.[9]

2.2. Culture

Each specimen was cultured on Cystine Lactose Electrolyte Deficient (CLED) Agar using the semi-quantitative Calibrated Loop/Surface Streak Method. Plates were incubated aerobically at 35–37°C for 18–24 hours. Specimens showing significant growth, with bacteria growing $>10^4$ colony-forming units (CFU/mL) with a single morphotype or up to 2 types, were considered significant and processed further for identification and susceptibility testing. Specimens belonging to patients with signs of systemic infection or recurrent urinary tract infections were also considered significant and processed if a single pure-growth organism was isolated even when the colony counts were $<10^4$CFU/mL.[10]

2.3. Identification

The isolated organisms were identified through conventional methods by observing biochemical reactions as per standard microbiological practices.[11]

2.4. Antimicrobial susceptibility testing

It was conducted using the Kirby-Bauer disc diffusion method as per CLSI M-100 guidelines (32nd edition). Antibiotic susceptibility of the isolates was tested on Mueller-Hinton agar plates, with results interpreted after incubation at 37°C for 24 hours by measuring the zone of inhibition.[12]

2.5. Ethical statement

The study received approval from the Institutional Ethics Committee of Pt. J.N.M. Medical College, Raipur, on 28-03-2022. All procedures adhered to the ethical standards of the 2008 Declaration of Helsinki.

2.6. Statistical analyses

These were performed using SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA), WHONET, and Microsoft Excel. Data were presented in the form of tables, charts, and graphs to comprehensively elucidate the findings.

3. Results

Total number of urine samples received from suspected UTI cases was 2893 out of which 1719 samples were from inpatients and 1174 samples were from outpatients. Out of 2893 samples, 784 showed significant growth on culture, 602 showed insignificant bacteriuria and 1507 showed no growth.

3.1. Patient demography

Females were more affected (70.28%) than males (29.72%), thus giving female to male (F: M) ratio as2.3:1. Among females most common age group affected was 21-40 years (36.73%) while in males most common age group affected was 41-60 years. (Table 1).

3.2. Location wise distribution

A maximum number of samples that showed significant growth belonged to the Department of Gynaecology & Obstetrics (32.65%) followed by the Department of Medicine (32.02%).(Table 2)

3.3. Microbiological profile

Most common causative organism found in this study was *Escherichia coli* (41.9%) followed by *Enterococcus* species (23.98%). Significant growth of *Candida* species was found in 13.3%of samples out of which only 2.29% were of *Candida albicans* remaining were non-albicans. (Table 3)

3.4. Antimicrobial susceptibility pattern

3.4.1. Gram-negative isolates

Among the Gram-negative fermenter group, *Escherichia coli* isolates showed 100% susceptibility to fosfomycin; for nitrofurantoin, the susceptibility was 93% while for carbapenems it was 96%.

In the case of isolates of *Klebsiella pneumonia,* the susceptibility percentage for carbapenems, fluoroquinolones, and nitrofurantoin were 82%, 72%, and 59% respectively. (Table 4)

Among the Gram-negative non-fermenter group, *Acinetobacter baumanniii* isolates were most susceptible to meropenem (68%) and piperacillin-tazobactam (62%).

Isolates of *Pseudomonas aeruginosa* showed maximum susceptibility to gentamicin (92%), netilmicin (89%), and piperacillin-tazobactam (87%). (Table 4)

3.4.2. Gram-positive isolates

In *Enterococcus* species isolates, no resistance was seen against teicoplanin and Fosfomycin, 82% were susceptible to Nitrofurantoin, 97% were susceptible to linezolid and 94% were susceptible to Vancomycin. Among the 12 isolates of *Staphylococcus aureus,* 8 were methicillin-resistant *Staphylococcus aureus* (MRSA). (Table 5)

Table 1: Distribution of UTI cases according to age & gender

Age (in years)	Male	Female
0-20	58 (7.40%)	81(10.33%)
21-40	58(7.40%)	288(36.73%)
41-60	65 (8.29%)	127(16.20%)
61-80	49 (6.25%)	50(6.38%)
81 Above	3 (0.38%)	5(0.64%)
Total	**233**	**551**

Male to Female Ratio (M:F) = 1:2.3

Table 2: Distribution of UTI cases according to location

Name of Department	Number of cases
Gynaecology & obstetrics	256 (32.65%)
Oncology	14(1.79%)
Dermatology	3(0.38%)
ENT	2(0.26%)
ICU	54(6.89%)
Medicine	251(32.02%)
OPD	26(3.32%)
Orthopedics	16(2.04%)
Paediatrics	68(8.67%)
Surgery	94(11.99%)
Total	**784**

Table 3: Microbiological profile of UTI cases

Organisms isolated	
Gram Negative (Fermenters)	
Escherichia coli	329 (41.96%)
Klebsiella pneumoniae	81(10.33%)
Citrobacter species	3(0.38%)
Proteus species	5(0.63%)
Gram Negative (Non-Fermenters)	
Acinetobacter baumannii	23(2.93%)
Pseudomonas aeruginosa	38(4.85%)
Gram positive cocci	
Enterococcus species	188(23.98%)
Staphylococcus aureus	12(1.53%)
Yeasts	
Candida albicans	18(2.29%)
Non-albicans Candida	87(11.09%)
Total	**784**

4. Discussion

A comprehensive understanding of microbial distribution and its resistance patterns is critical for the effective management and treatment of urinary tract infections (UTIs). This study revealed that UTIs were more prevalent among females, corroborating earlier findings that females are at a higher risk due to their shorter urethra and proximity of the urethral opening to the anus. Age-wise, the sexually active females were more affected, possibly due to increased exposure and poor hygiene maintenance. In men, an increase in the incidence was seen at the age between 40-60 years which could be associated with increased urinary retention caused due to benign prostrate hypertrophy in that age group. These results aligned with another study from India.[13]

Escherichia coli emerged as the predominant pathogen, responsible for the majority of UTIs, followed by *Enterococcus species*. This pattern is in concurrence with numerous studies globally, indicating that *Escherichia coli* is the most common uropathogen, accounting for up to 80% of UTIs.[14] Notably, there was a substantial prevalence of other uropathogens, such as *Klebsiella pneumoniae, Pseudomonas aeruginosa,* and *Acinetobacter baumannii*, indicating a preponderance of Gram-negative bacilli as responsible agents for UTIs in this region as corroborated in another study.[15] Although 105 isolates of *Candida*

Table 4: Antibiogram 1: % susceptibility of gram-negative isolates in urine sample

Antibiogram 1; Gram Negative bacilli in Urine Sample	***Escherichia coli***	***Klebsiella pneumoniae***	***Acinetobacter baumannii***	***Pseudomonas aeroginosa***
Number of Isolates	329	81	23	19
Ampicillin	16%	R	R	R
Ampicillin/Sulbactam	60%	48%	50%	-
Amoxicillin-clavulanate	59%	49%	R	R
Piperacillin/Tazobactum	64%	55%	62%	87%
Cefotaxime	22%	26%	41%	R
Ceftriaxone	24%	36%	41%	R
Ceftazidime	31%	45%	53%	82%
Cefepime	43%	50%	60%	79%
Aztreonam	60%	49%	R	R
Cephazolin	15%	30%	R	R
Imipenem	96%	82%	67%	80%
Meropenem	96%	81%	69%	83%
Ciprofloxacin	76%	72%	60%	_
Levofloxacin	71%	71%	67%	66%
Gentamicin	73%	59%	59%	92%
Amikacin	80%	56%	43%	82%
Netilmicin	-	-	-	89%
Tobramycin	-	-	-	57%
Cefuroxime	21%	30%	38%	-
Cefoxitin	36%	42%	38%	R
Nitrofurantoin	93%	59%	48%	-
Cotrimoxazole	50%	46%	61%	R

R-Intrinsically Resistant [1], N-Not to be reported even if susceptible [1], "-"-No breakpoints available

Table 5: Antibiogram 2: % susceptibility of Gram-positive isolates in Urine sample

Antibiogram 2; Gram Positive cocci in Urine Sample	**Enterococcus species**	**Staphylococcus aureus**
Number of Isolates	188	4
Ampicillin	78%	-
Penicillin	77%	-
Cefoxitin	R*	33%
Rifampin	R*	100%
Ciprofloxacin	29%	-
Levofloxacin	52%	-
Nitroforantoin	82%	-
Gentamicin	R*	50%
Gentamicin (High level)	68%	
Linezolid	97%	100%
Doxycycline	50%	75%
Higl Level Streptomycin	76%	-
Vancomycin	94%	-
Teicoplanin	100%	-
Trimethoprim/Sulfamethoxazole	R*	100%

R-Intrinsically Resistant [1], N-Not to be reported even if susceptible [1], "-"-No breakpoints available

species with significant growth were found, their clinical implication as uropathogenic is hard to establish.

Antibiotic susceptibility testing revealed that *Escherichia coli* and *Klebsiella pneumoniae* exhibited resistance to multiple antibiotics, including ampicillin, cotrimoxazole, and third-generation cephalosporins, a trend increasingly reported worldwide.[16,17] This high level of resistance can be attributed to the irrational use of antibiotics and the lack of proper stewardship. Consequently, this development necessitates a careful selection of empirical therapy, with nitrofurantoin and fosfomycin recommended for uncomplicated UTIs, as supported by similar studies.[18,19]

This study had several limitations. Being a retrospective observational study, it is subject to selection bias. Additionally, we were unable to assess or report on potential clinical outcomes such as symptoms, complications, treatment efficacy, and recurrence rates. As it was a retrospective study the data to determine whether the infection was hospital acquired could not be retrieved. The sample collection method, performed either by hospital staff or by patients themselves, introduced variability that was beyond our control. Moreover, errors in the collection, storage, and transport of specimens to the laboratory could not be determined which may have further impacted the study's findings.

5. Conclusion

In conclusion, this study provides valuable insights into the current status of UTIs in Central India. *Escherichia coli* remains the most common causative agent followed by *Klebsiella pneumoniae*. Point of concern was high level of associated multi-drug resistance. Nitrofurantoin emerged to be the choice for empirical therapy. However, future research should adopt a prospective study design to enhance diagnosis and treatment for patients in the region. Escherichia coli remains the principal uropathogen, and the increasing antimicrobial resistance underscores the need for routine surveillance, rational antibiotic use, and effective infection control measures. Efforts should focus on minimizing the spread of resistant bacteria through appropriate infection control, which is a crucial step in addressing the issue of resistant microorganisms.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare that there are no conflicts of interest associated with this manuscript.

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Cite this article: Gahlot R, Netam S, Dadarya S, Sherwani N, Gaur S. Epidemiology, microbiological profile and susceptibility pattern of uropathogens from a tertiary care hospital in central India. *Indian J Microbiol Res* 2024;11(4):277-282.