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Original Research Article

Prevalence of Bacteria Causing Urinary Tract Infections (Uropathogens) and Their Antibiotic Susceptibility Profile: An Observational Study

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Abstract

Background: One of the most prevalent illnesses in both the community and hospitals is urinary tract infection (UTI). Uropathogens populate the urinary tract, can climb to the bladder and cause cystitis, and can cause acute pyelonephritis and renal damage if they are allowed to enter the kidneys through the ureters. The current study's objective is to ascertain the prevalence of UTIs and the pattern of antibiotic susceptibility in a tertiary care facility.

Methods: This observational study was carried out between June and November of 2025 in the microbiology department of SKMCH in Muzaffarpur, Bihar. 623 mid-stream urine samples were taken from the hospital's indoor and outdoor departments, and a semiquantitative approach was used to culture the samples on UTI chromogenic agar. The Kirby Bauer disc diffusion method was used to conduct an antibiotic sensitivity test.

Results: Prevalence of urinary tract infections is 29% in the study. Escherichia coli (43%) is the most common micro-organism isolated followed by Enterococcus (13%), Staphylococcus aureus (11%), Acinetobacter (10.4%), Klebsiella (8.8%), Pseudomonas (3.3%), Proteus (1.6%), CONS &Citrobacter (1.1%) and Candida (6.6%). The females (56.6%) are more commonly affected than males.

Conclusion: Aminoglycosides and beta-lactamase inhibitors were found to be efficient medications against gram-negative bacteria in the current investigation. Gram-positive bacteria were susceptible to vancomycin and linezolid. The medication nitrofurantoin is safe to use during pregnancy and shows promise in cases of simple UTIs. The burden of disease is rising due to antibiotic resistance and high recurrence rates. In order to prevent multidrug-resistant microorganisms and further lower morbidity and mortality, it is recommended to use antibiotics sparingly in accordance with the hospital's antibiotic policy.

Keywords: Escherichia coli, Urinary tract infections, Uropathogens.

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Introduction

The common urinary tract infection that affects people of all ages is called a urinary tract infection (UTI). UTIs are caused by a variety of microorganisms, including bacteria, viruses, fungi, and parasites. Bacteria are the most common cause of infections. UTIs are caused by microorganisms such as Escherichia coli, Klebsiella, Proteus, Pseudomonas, Citrobacter, Acinetobacter, Enterococcus, and Staphylococcus aureus.[1,2]

Uropathogens vary from place to place depending on demographic features, community or hospital based, use of different antibiotics in different hospital settings also affects the antimicrobial sensitivity profile depending upon the use of broad-spectrum antibiotics.[1,3] There are various factors responsible for the virulence mechanism of uropathogens to enter the urinary tract and cause infection. Enterobacteriaceae family especially Uropathogenic Escherichia coli (UPEC) is frequently associated with UTI. It attaches to the uroepithelium by pili, Type 1 fimbriae, P fimbriae and adhesions promoting bacterial colonization and causing inflammatory response in host.[4–6]

Certain anatomical and physiological features play an important role in urinary tract infections. In females due to the short urethra, faecal contamination of the vaginal orifice is frequently leading to UTI.[1,2] It is more prevalent in females mainly sexually active young women, long term catheterized patients and elderly male individuals.[7] In elderly male individuals due to conditions like neurogenic bladder, prostate enlargement, there is incomplete emptying of bladder leading to residual urine. The vesico-ureteric reflux is common in pregnancy leading to recurrence.[1,4]

Recurrence is common in all such individuals due to the predisposing factors. It is found that about 50% of the females develop urinary tract infection at least once in their lifetime.[1,7]

The predisposing factors responsible for UTI should be identified early and treated in time. Delayed treatment can lead to recurrence and if persist for long time can cause renal complications like hydronephrosis, acute pyelonephritis, acute renal failure, and irreversible kidney damage.[1,5] The aim of the present study is to know the prevalence of urinary tract infection, their causative microorganisms (uropathogens) and antibiotic susceptibility pattern in our tertiary care hospital setup.

Material and Methods

The current study is an observational investigation conducted in the bacteriology laboratory of the department of microbiology at Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, from June 2025 to November 2025 to ascertain the prevalence of bacteria that cause urinary tract infections (Uropathogens) and their antimicrobial sensitivity profile. The study included 673 samples from different hospital departments, both indoors and outdoors, that showed signs of urinary tract infections. Patients with history of increased frequency, urgency, dysuria, suprapubic tenderness, and fever, no history of antibiotics intake within one month were included in this study. Patients with underlying chronic renal disease, on antibiotics were excluded in this study.

A total of 673 non duplicate urine samples were taken both from outpatient departments and various wards. The mid-stream urine (MSU) was collected in a sterile wide mouthed screw-capped container. The first part of the urine was not to be collected (as it might contain commensals from the anterior urethral region). The samples collected were transported to the laboratory, and if there was a delay, the samples were stored at 4^0C till further processing. In the laboratory, uncentrifuged urine sample was observed in 400x magnification for epithelial cells, pus cells, RBCs and any micro-organisms. Culture of the urine samples collected was performed with standard calibrated loop on UTI Chromogenic agar. The inoculated plates were incubated at 37^0C for 18-24 hrs under aerobic conditions. The micro-organisms were identified on the culture media on the basis of colony morphology with different colors i.e., Escherichia coli – purple-colored colonies, Klebsiella –blue mucoid colonies, Acinetobacter – pale-white colonies, Staphylococcus aureus - golden yellow colonies and Enterococcus - blue -green colored, small colonies. Further species identification was done with the help of biochemical reactions as per standard methodology.[8]

Antibiotic Susceptibility Testing (AST) was done for culture plates with significant growth. The isolated colonies from the identified species were suspended in normal saline and the inoculum was prepared. The density of the suspension was compared with the 0.5 Mac Farland's opacity standards. Kirby Bauer's disc diffusion method wasperformed on Muller Hinton agar (HI media).The results were interpretated using the Clinical Laboratory Standards Institute 2024 guidelines.[9]

The antibiotics tested for Gram negative bacteria (potency in μg/disc) (Himedia) were as follows- ampicillin (10), gentamicin (10), amikacin (10), ceftazidime (30), ceftriaxone(30), cefepime(30), amoxicillin-clavulanate (20/10), piperacillin-tazobactam (100/10), ampicillinsulbactam (10/10), ciprofloxacin (5), levofloxacin (5), norfloxacin (10), ertapenem (10), imipenem (10), meropenem (10), nitrofurantoin (300). The antibiotics tested for Gram positive bacteria (potency in μg/disc) (Himedia) were as follows- penicillin (10U), cefoxitin (30), vancomycin (30), linezolid (30). High level gentamicin (120) was used only for Enterococcus spp. Novobiocin (30) is used in Coagulase negative Staphyloccoccusspecies to differentiate between S. saprophyticus and S. epidermidis.

Data was collected on a preformed questionnaire containing personal details, clinical and demographic details of patients. The collected data was entered in an Excel sheet. The results were statistically analysed using Advanced excel software and presented inthe form of tables.

Results

Significant bacteriuria (≥105 CFU) was seen in 181 (29%) of the 623 non-duplicate urine samples taken to investigate the prevalence of UTIs. 341 samples (54.7%) were sterile, 87 samples (13.9%) had negligible growth with a bacterial count of less than 105 CFU/ml, and 14 samples (2.2%) were contaminated. As shown in Table 1, of the total samples obtained, 429 (68.8%) came from OPD patients and 194 (31.1%) from patients admitted to wards.

Table 1: Distribution of total samples

Variable	No. of isolates	Percentage of Isolates
Growth in culture		
Significant growth	181	29%
Non-significant	87	13.9%
Sterile	341	54.7%
Contamination	14	2.2%
Location		
Indoor	429	68.8%
Outdoor	194	31.1%
Total	623	100%

The total number of Gram-negative bacteria among the isolates were 124 (68.5%), whereas Gram-positive isolates were 45 (24.9%), and 12 (6.6%) isolates were Candida, as shown in Table 2. Out of the total culture positive samples, 102 females (56.3%) were culture positive compared to 79 males (43.6%) as described in Table 3.

Table 2: Distribution of different isolates on the basis of morphology

Isolates	No. of isolates	Percentage of Isolates
Gram-positive	45	25%
Gram-negative	124	68%
Candida	12	7%

Table 3: Distribution of culture positive isolates

Gender	No. of isolates	Percentage of Isolates
Female	102	56.3%
Male	79	43.7%
Total	181	100%

Escherichia coli (n=78) was the most common causative organism with 43%, followed by Enterococcus faecalis (n=23) with 13%, followed by Staphylococcus aureus (n=20) with 11%, 19 Acinetobacter spp.(10.4%), 16 Klebsiella spp. (8.8%), 6 Pseudomonas spp (3.3%), 3 Proteus spp (1.6%), 2 Coagulase negative Staphylococcus spp. (1.1%), 2 Citrobacter spp (1.1%) and Candida spp (6.6%).[Table 4]

Antibiotic sensitivity profile of gram negative bacteria (Enterobacteriaceae) and non-fermenters are depicted in Tables 5 and 6. Antibiotic sensitivity profile of gram positive bacteria is shown in Table 7.

Table 4: Distribution of micro-organisms causing urinary tract infection

Micro-organism	Number	Percentage
Escherichia coli	78	43%
Klebsiella	16	8.8%
Proteus spp	3	1.6%
Citrobacter spp	2	1.1%
Pseudomonas spp	6	3.3%
Acinetobacter spp.	19	10.4%
Staphylococcus aureus	20	11%
CONS	2	1.1%
Enterococcus faecalis	23	13%
Candida	12	6.6%

Table 5: Antibiotic sensitivity profile for gram negative bacteria (Enterobacteriaceae)

Drugs	E. coli (n=78)	Klebsiella spp. (n=16)	Citrobacter spp. (n=2)	Proteus spp. (n=3)
Ampicillin	25(32%)	5(31.5%)	0(0%)	3(100%)
Cefriaxone	34(43.5%)	7(43.7%)	1(50%)	2(66.7%)
Ceftazidime	34(43.5%)	7(43.7%)	1(50%)	2(66.7%)
Cefepime	34(43.5%)	7(43.7%)	1(50%)	2(66.7%)
Amoxicillin-clavulanate	73(93.5%)	16(100%)	2(100%)	3(100%)
Piperacillin-tazobactam	73(93.5%)	15(93.7%)	2(100%)	3(100%)
Gentamicin	58(74.3%)	11(68.7%)	1(50%)	2(66.7%)
Amikacin	73(93.5%)	14(87.5%)	1(50%)	2(66.7%)
Ciprofloxacin	32(41%)	7(43.7%)	1(50%)	1(33.3%)
Levofloxacin	73(93.5%)	14(87.5%)	2(100%)	3(100%)
Norfloxacin	25(32%)	8(50%)	0(0%)	0(0%)
Nitrofurantoin	77(98.7%)	13(81.2%)	2(100%)	-
Imipenem	67(85.8%)	13(81.2%)	1(50%)	1(33.3%)
Meropenem	78(100%)	16(100%)	1(50%)	3(100%)
Ertapenem	73(93.5%)	16(100%)	1(50%)	3(100%)

Table 6: Antibiotic sensitivity profile for gram negative bacteria (Non fermenters)

Drugs	Pseudomonas spp. (n=6)	Acenetobacter spp. (n=19)
Ampicillin-Sulbactam	-	11(58%)
Ceftriaxone	-	2(10.5%)
Ceftazidime	4(66.7%)	2(10.5%)
Cefepime	5(83.3%)	5(26.3%)
Piperacillin-tazobactam	5(83.3%)	13(68.4%)
Gentamicin	5(83.3%)	9(47%)
Amikacin	5(83.3%)	11(57.9%)
Ciprofloxacin	4(66.7%)	8(42.1%)
Levofloxacin	6(100%)	17(89.5%)
Imipenem	5(83.3%)	16(84.2%)
Meropenem	6(100%)	17(89.5%)

Table 7: Antibiotic sensitivity profile for gram positive bacteria

Drugs	Staphylococcus aureus (n=20)	CONS(n=2)	Enterococcus (n=23)
Penicillin	6(30%)	1(50%)	12(52%)
Ampicillin	20(100%)	2(100%)	15(65%)
Cefoxitin	10(50%)	1(50%)	-
Erythromycin	19(95%)	2(100%)	23(100%)
Clindamycin	19(95%)	2(100%)	-
Gentamicin	17(85%)	2(100%)	-
High level Gentamicin	-	-	8(34.7%)
Ciprofloxacin	15(75%)	1(50%)	13(56.5%)
Levofloxacin	19(95%)	2(100%)	17(73.9%)
Norfloxacin	11(55%)	1(50%)	20(86.9%)
Nitrofurantoin	19(95%)	2(100%)	21(91.3%)
Vancomycin	20(100%)	2(100%)	23(100%)
Linezolid	20(100%)	2(100%)	23(100%)

Discussion

The most common micro-organism isolated is Escherichia coli (43%) which is concordant with the other studies conducted with 36%,16 42.6%,[17] 48.3%,[10] 59.2%,18 59.8%,3 61.8%,4 70.9%[13] from various parts of India supporting our findings. From outside India, also 27%,[1] 41.9%,19 68.3%.[11,12]

Urinary tract infection is more common in females (56.6%) compared to males. Our findings are in support of other studies with 45.2%,[2] 50.7%,11 58.5%,[18] 62.4%,[4] 65.3%,[15] 73%,[1] 73.6%.[17] The reason may be structural anatomy of female genital tract where uropathogens ascend to bladder with short urethra having close proximity to anal orifice, whereas in males greater length of urethra is surrounded by antibacterial prostatic fluid and dried environment.[15,17,20]Escherichia coli is followed by Enterococcus spp (13%) isolates similar to the studies conducted with 9.2%,[4] 9.7%[2] and 10.1%.[18] Both these organisms are of faecal origin so found responsible to colonize urinary tract and cause infection. In a study,3Enterococcus spp. is the third common micro-organism with 8.7% isolates. Some studies reported Klebsiella as the second common isolates with 9.3%[11] and 9.7%[4] prevalence whereas our study reported Klebsiella (8.8%) as the third common micro-organism after Enterococcus spp (13%).

Staphylococcus aureus accounts for 11% prevalence in our study whereas other studies reported 3.3% isolates.[3,13]

Some studies reported higher prevalence of 31.4%.[19]Proteus (1.6%) and Citrobacter (1.1%) are the least common pathogens reported in our study. Other studies also reported nearly 2% Proteus isolates [3,11,13] and 2% Citrobacter isolates.[3] We have reported only 1.1% Coagulase negative Staphylococcus in the study but it is an important micro-organism found in patients with chronic indwelling urethral catheters.[21] The present study reported 6.6% Candida spp whereas another study reported 2.7% isolates causing urinary tract infections.[3]

In the present study, there are 54.7% Enterobacteriaceae,13.8% non-fermenters and 24.8%-gram positive bacteria. Another study reported similar prevalence with Enterobacteriaceae (76.8%), nonfermenters (5.5%) and gram positive bacteria (14.2%).[4]

In Mehrishi et al., similar findings were found with Enterobacteriaceae (67%), non-fermenters (9.6%) and gram positive bacteria (18%).[3]

Among non-fermenters, 3.3% Pseudomonas spp were reported in our study similar to other studies with 4.1%,[11] 5.4%3 and 9.3%[18] whereas we reported 10.4% Acinetobacter spp in our study which is higher than other studies with 0.98%[13] and 1.6%[3] isolates.

In our study, Enterobacteriaceae showed 80-100% sensitivity to carbapenems like meropenem, imipenem and ertapenem. Among the cephalosporins and beta lactam group of antibiotics, there is nearly 50% resistance and among fluoroquinolones, ciprofloxacin and norfloxacin showed up to 70% resistance whereas levofloxacin shows

90% sensitivity. It has been found that beta-lactamase inhibitors like amoxicillin-clavulanate and piperacillintazobactam have 90% sensitivity to Enterobacteriaceae members. Nitrofurantoin, the drug of urinary route has good sensitivity for Escherichia coli (98.7%). Among aminoglycosides, gentamicin showed 50% sensitivity whereas amikacin is more sensitive (90%).

Our study is supported by the findings of other studies where high resistance is seen in cephalosporins, beta-lactams group of antibiotics, fluoroquinolones to Enterobacteriaceae whereas high sensitivity to Nitrofurantoin, amikacin and carbapenems.[2,3] In another study, carbapenems and beta-lactamase inhibitors are the promising drugs along with Nitrofurantoin with high sensitivity whereas low sensitivity to fluoroquinolones like ciprofloxacin and norfloxacin(98%).[10] It has been suggested that such high resistance of fluroquinolones and beta-lactams group of antibiotics are responsible for multidrug resistant (MDR) which leads to high selection rate of Extended spectrum beta-lactamase (ESBL) producing micro-organisms.[10,22,23] In studies, similar drug resistance pattern was seen in Escherichia coli isolates with high sensitivity to Nitrofurantoin and Beta-lactamase inhibitors.[4,13,16,22]

It has been suggested by various studies that Nitrofurantoin is the most recommended drug for patients of UTI. In pregnancy, Escherichia coli is the most common causative agent for urinary tract infections with high resistance to beta-lactams group and fluroquinolones.

Nitrofurantoin is also safe to be administered in all trimesters of pregnancy and considered as the drug of choice in UTI among pregnant females.[24,25]

Among non-fermenter gram negative bacteria, the present study reported high resistance to third generation cephalosporins (80%), aminoglycosides are moderately sensitive (50-70%) along with fluoroquinolones and amoxicillin-sulbactam whereas high sensitivity to carbapenems (90%). Another study reported high resistance to amoxicillin-sulbactam contrary to our study but other drugs sensitivity pattern for non-fermenters corroborates with our study.

Among gram positive cocci, vancomycin and linezolid showed 100% sensitivity as found in other studies.[3] Our study showed high sensitivity to erythromycin, clindamycin and nitrofurantoin (80-100%), moderate sensitivity to fluoroquinolones like ciprofloxacin, norfloxacin and levofloxacin (50-75%) whereas low sensitivity to penicillin and ampicillin (30-50%). In Staphylococcus aureus and CONS, gentamicin showed high sensitivity (85-100%) and cefoxitin showed 50% sensitivity. In Enterococcus spp, high level gentamicin was 35% sensitive. Similar sensitivity profile was seen among gram positive bacteria in a study which supports our findings.[3]

Conclusion

Before beginning empirical treatment, which should be replaced by specialized medication following the sensitivity assessment, steps should be taken to encourage the collection of urine samples for culture. In order to prevent the indiscriminate use of antibiotics, empirical treatment can be organized in accordance with the antibiotic policy developed by this study. Therefore, stop the development of multidrug resistant (MDR) microorganisms, which can cause illness and mortality. The public, particularly women, should be made aware of the importance of maintaining environmental and personal hygiene in order to minimize fecal contamination of the urinary system, which would lower the infection rate and improve health.

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