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PREVALENCE OF GRAM NEGATIVE BACTERIAL ISOLATES CAUSING URINARY TRACT INFECTION WITH THEIR ANTIMICROBIAL SUSCEPTIBILITY PATTERN AT TERTIARY CARE HOSPITAL, RAJKOT.

Medical Microbiology

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ABSTRACT

Introduction: Urinary tract infection is microbial invasion of urinary tract that extends from renal cortex to urethral meatus. Anatomically, upper UTI involves kidney and ureter and causes pyelonephritis and ureteritis while lower urethra involves urethra and bladder which causes cystitis, asymptomatic bacteriuria, urethritis and acute urethral syndrome. Based on source of infection,it can be catheter associated causing CAUTI or community acquired. UTI are the most common hospital acquired infection accounting for 35% of total HAIs in India.It involves all age groups and sexes but predominantly seen in females. Uropathogenic E.coli is the most common cause of all forms of UTI accounting for 70% of cases. In healthcare settings these agents are often multidrug resistant leading to increase in morbidity and healthcare expenditure. **Aim-** The objective of this study is to study the prevalence of Gram negative bacterial isolates causing urinary tract infection and their antimicrobial susceptibility pattern. **Material And Methods-** 200 urine samples were received at tertiary care hospital,Rajkot from December 2024 to May 2025 and were subjected to Gram stain, culture and biochemical reactions. **Results-** Out of 200 urine samples,37(18.5%) were positive for UTI isolates. UTI was more prevalent in females 22(59.45%) isolates compared to males 15(40.54%) isolates. Among females,21-40 year age group was more commonly affected(63.63%) while in males >60 year age group(60%) was more prone to UTI. E coli was the most common isolate(64.86%).Carbapenems and Aminoglycosides showed higher susceptibility compared to Fluoroquinolones and Cephalosporins. **Conclusion-** The present study reported E.coli as the most common pathogen causing UTI affecting mainly females. Aminoglycosides and Meropenem showed higher sensitivity.This study will help to improve treatment recommendations in a specific geographical region.It also allows the comparison of situation in Rajkot with other regions within and outside the state as well as country. Knowing the antimicrobial susceptibility pattern helps as an aid to treatment and judicious use of antibiotics.

KEYWORDS

Urinary tract infection, Gram negative, Antimicrobial susceptibility.

INTRODUCTION

Urinary tract infection (UTI) is the most common HAIs (hospital acquired infections) accounting for 35% of total HAIs [1]. It is the most extensively occurring nosocomial bacterial infection in human communities throughout the world [2,3,4]. Microbial invasion in Urinary tract infection can occur anywhere from renal cortex to urethral meatus[5]. There are three major routes by which uropathogens can invade and spread within the urinary tract, including the ascending, hematogenous and lymphatic pathways. Ascending route is the commonest route of infection in females. Catherterization and cystoscopy can cause UTI in both males and females by ascending route. Descending route of infection is caused by hematogenous spread as result of bacteremia[6,7]. The growth of bacterium in urothelium could be benign or severe, resulting in acute inflammation, and an indicative case could be defined by a wide range of symptoms, such as fever, tiredness, dysuria, burning micturition, anorexia, and vomiting[8-13].Women are much more prone to UTIs than men, mainly due to the female lower urinary tract anatomy and its proximity to the reproductive organs. Most women are prone to develop asymptomatic bacteriuria in pregnancy[14,15]. UTI may be community-acquired or nosocomial. E. coli, Klebsiella pneumoniae, Proteus species, Enterobacter species,Pseudomonas aeruginosa are some of the important Gram negative organisms causing UTI[16].

In almost all cases of UTI, empirical antimicrobial treatment initiates before the laboratory results for urine culture are available due to which there has been a steady increase in the level of resistance to commonly used antibiotics[17]. The emergence of extended-spectrum beta-lactamase has threatened the empirical use of cephalosporins and ciprofloxacin. Microorganisms use various mechanisms to develop any resistance.[18] Detection of UTI-causing pathogens and resistance of these pathogens to commonly prescribed antibiotics is essential in improving the efficacy of treatment.

UTIs lead to major economic and public health burdens and affect the quality of life for affected individuals[19,20,21,22]. Escherichia coli is responsible for uncomplicated pyelonephritis and cystitis and is followed by other Enterobacteriaceae species such as Klebsiella pneumoniae and Proteus mirabilis and by Gram-positive bacteria such as Staphylococcus saprophyticus, and Enterococcus faecalis[23,24]. Various agents are used to treat uncomplicated UTIs and pyelonephritis such as trimethoprim-sulfamethoxazole, fosfomycin, trometamol, pivmecillinam, nitrofurantoin monohydrate, fluoroquinolones, and beta-lactams[20]. The development of bacterial resistance to presently available antibiotics results from the indiscriminate and widespread use of antibiotics.[25,26] Bacteria producing extended-spectrum betalactamases (ESBLs) showing resistance to most antibiotics except for the carbapenem group, are steadily increasing in the population.[27,28]

MATERIAL AND METHODS

The present study was conducted on urine samples received at the Bacteriology Laboratory, Department of Microbiology from patients of all ages and sex suspected of UTI at Tertiary Care Hospital, Rajkot, Gujarat, India.The study was conducted on 200 urine samples from Dec 2024 to May 2025.All urine samples were collected as per the proforma which included serial number, registration number, lab number, age, sex, ward,date of collection of sample and clinical features of patients.Samples collected from urobag were excluded.

Clean catch midstreasm urine samples were collected aseptically in a sterile,wide mouth,leak proof,screw capped container and were brought to the laboratory as early as possible (within 2 hours). Isolation and identification of bacterial pathogens were done by microscopy and culture methods. Urine samples were examined macroscopically for colour and turbidity and were mixed thoroughly, uncentrifuged, and microscopically by wet mount followed by Gram stain. In the present study, Blood agar, Nutrient agar & MacConkey agar were used for culture.For culture,a calibrated sterile Nichrome wire loop with a 1.3 mm diameter, delivering 0.001 ml, was used for the semi-quantitative plating method. A loopful of the well-mixed urine sample was inoculated on Blood, MacConkey, and Nutrient agar plates which were incubated aerobically at 37°C for 24 hours. Postincubation, the plates were examined for bacterial growth. A significant bacterial count was defined as any count equal to or exceeding 100,000 CFU/ml.Bacterial isolates were identified using conventional biochemical tests.

RESULTS

Table 1: No Of Positive Isolates

Prevalence	Number of samples	Percentage(%)
Negative	163	81.5%
Significant bacteriuria	37	18.5%
Total	200	100%

Out of total 200 urine samples,37(18.5%) were positive for UTI isolates.

Table 2: Gender-wise Prevalence Of UTI

Gender(n=37)	Percentage(%)
Male(15)	40.54%
Female(22)	59.45%

Out of total 200 samples,37 were positive, among which 22 isolates(59.45%) were of female patients while 15 isolates(40.54%) were of male patients. So in the present study, the prevalence of UTI was higher in female patients than in male patients.

Table 3: Age And Genderwise Prevalence Of UTI (Total 37 Positive Isolates)

Age (year)	Cases (n=22) (Female)	Cases(n=15) (Male)	Percentage (%)
0-20	2(5.40%)	1(2.70%)	8.10%
21-40	14(37.83%)	2(5.40%)	43.24%
41-60	4(10.81%)	3(8.10%)	18.91%
>60	2(5.40%)	9(24.32%)	29.72%

The study analyzed the distribution of UTI cases across different age groups and genders among 37 positive cases. In the 0-20 years age group, there were 3 cases (8.10%), with females accounting for 2 cases (5.40%) and males 1 case (2.70%). The 21-40 years age group had 16 cases (43.24%), predominantly females with 14 cases (37.83%) and males 2 cases (5.40%). The 41-60 years age group recorded 7 cases (18.91%), with 4 female cases (10.81%) and 3 males cases (8.10%). For those over 60 years, there were 11 cases (29.72%), with females having 2 cases (5.40%) and males 9 cases (24.32%). This data highlights the highest prevalence of UTIs in females within the 21-40 years age group, whereas, for males, the highest prevalence was observed in those over 60 years of age.

Table 4: Distribution Of Positive Isolates

Organism	Positive isolates (n=37)	Percentage(%)
E.coli	24	64.86%
Klebsiella spp.	7	18.91%
Proteus mirabilis	3	8.10%
Pseudomonas aeruginosa	2	5.40%
Proteus vulgaris	1	2.70%

Among 37 positive UTI isolates, E. coli was the most dominantnt isolate, present in 24 samples (64.86%). Klebsiella spp.accounted for 7 samples (18.91%), making it the second most common isolate. Proteus mirabilis was identified in 3 samples (8.10%), while Proteus vulgaris was isolated from 1 sample accounting for (2.70)%. Pseudomonas aeruginosa was present in 2 samples (5.40%). This distribution shows the dominance of E. coli, in UTI infections caused by Gram negative isolates.

Table 5: Antibiotic Sensitivity Percentage Of Isolates

Antibiotics	E.coli (24)	Klebsiella spp (7)	Proteus spp(4)	Pseudomonas aeruginosa(2)
Ampicillin	20.83%	-	-	-
Ampicillin sulbactam	62.50%	57.14%	75%	-
Amoxicillin clavulanic acid	45.83%	57.14%	-	-
Piperacillin tazobactam	87.50%	71%	100%	100%
Cefuroxime	29.16%	42.84%	50%	-
Cefotaxime	33.33%	57.14%	75%	-
Ceftazidime	37.50%	57.14%	75%	50%
Ceftriaxone	33.33%	57.14%	75%	-
Cefepime	45.83%	71.42%	75%	50%
Imipenem	91.66%	85.71%	75%	100%
Meropenem	100%	85.71%	75%	100%
Aztreonam	50%	71.42%	75%	100%
Amikacin	91.66%	85.71%	75%	50%
Gentamicin	83.33%	71.42%	75%	50%
Cotrimoxazole	58.33%	71.42%	-	-
Levofloxacin	37.50%	71.42%	50%	-
Ciprofloxacin	37.50%	71.42%	50%	-
Tetracycline	45.83%	71.42%	-	-
Norfloxacin	37.50%	71.42%	100%	50%
Nitrofurantoin	95.83%	85.71%	-	-
Fosfomycin	95.83%	-	-	-
Tigecycline	95.83%	100%	-	-

Table 5 provides a detailed summary of the antibiotic sensitivity patterns of bacterial isolates- Escherichia coli (E. coli), Klebsiella spp., Proteus spp., and Pseudomonas aeruginosa. The percentages indicate the proportion of bacterial strains that are sensitive to each antibiotic tested.

For E. coli (24 samples),highest sensitivities were observed with meropenem (100%), nitrofurantoin,fosfomycin and tigecycline (each 95.83%), and imipenem and amikacin (both 91.66%). Moderate sensitivity was found with antibiotics such as piperacillin-tazobactam (87.50%), while lower sensitivity was seen with antibiotics like levofloxacin and ciprofloxacin (37.5% each). Klebsiella spp.(7 samples) showed highest sensitivity to tigecycline (100%), followed by imipenem, meropenem, and amikacin(each 85.71%). It also exhibited moderate sensitivity to several antibiotics including piperacillin-tazobactam (71%) and fluoroquinolones (71.42%), with no significant resistance noted. Proteus spp. (4 samples) demonstrated perfect sensitivity to piperacillin-tazobactam (100%), as well as high sensitivity to norfloxacin(100). It showed moderate sensitivity to antibiotics like, cefotaxime, ceftazidime, and ceftriaxone (all 75%), but lower sensitivity to cefuroxime,levofloxacin and ciprofloxacin (each 50%). Pseudomonas aeruginosa (2 samples) exhibited complete sensitivity to piperacillin-tazobactam, imipenem, meropenem, and aztreonam (all 100%). However, it showed only partial sensitivity to ceftazidime and cefepime (both 50%) and amikacin and gentamycin (both 50%)

DISCUSSION

In the present study, the prevalence of UTI was found to be 18.5%(Table 6).Comparison with other similar studies show that the prevalence rates of UTIs vary widely. Different studies report varying rates, reflecting periodic and geographical differences in UTI prevalence. This variation emphasizes the importance of regional studies to accurately determine local prevalence rates and tailor treatment protocols accordingly.

Table 6: Comparison of overall prevalence of UTI with other studies.

Author	Year	Prevalence(%)
Smita Sood et al[29]	2012	17.16%
Nazreen Khan et al[30]	2016	36.64%
Kalal et al[31]	2016	28%
Patel et al[32]	2019	45.69%
Mohapatra et al[33]	2022	10%
Behera et al[34]	2022	12.6%
Present study	2025	18.5%

Table 7: Comparisons Of Gender-wise Prevalence Of UTI With Other Studies.

Author	Year	Female(%)	Male(%)
Alka Nerulkar et al[35]	2012	57.74%	42.26%
Rezina Parveen et al[36]	2015	61.33%	38.67%
Nazreen Khan et al[30]	2016	68.87%	31.33%
Pardeshi et al[37]	2018	66%	34%
Malik et al[38]	2021	77%	23%
Present study	2025	59.45%	40.54%

In the present study, out of 37 positive isolates, 22 were found in female patients, accounting for 59.45% of the total positive isolates. Comparisons with other similar studies consistently show a higher prevalence rate of UTIs in female patients compared to male patients. This trend is reflected across various studies, indicating a common finding of UTIs being more prevalent among females than males. This gender disparity in UTI prevalence underscores the importance of gender-specific considerations in UTI prevention, diagnosis, and treatment strategies.

Table 8: Comparison Of Age Groups And Gender-wise UTI Prevalence With Other Studies

Author	Year	Age group (year)	Prevalence (%)
Female			
Smita Sood et al[29]	2012	21-40	38.42%
Nazreen Khan et al[30]	2016	21-40	46.49%

Present study	2025	21-40	63.63%
Male			
Smita Sood et al[29]	2012	21-40	46.92%
Nazreen Khan et al[30]	2016	21-40	23.07%
Present study	2025	21-40	60%

In the present study, the highest prevalence of urinary tract infections (UTIs) among female patients was found in the age group of 21-40 years which consisted 14 isolates out of total 22 female UTI isolates (63.63%). In contrast, the highest prevalence of UTIs in male patients was observed in the elderly age group (above 60 years) which had 9 isolates out of 15 male UTI isolates in >60 year age group. Similar results were observed in other studies, and comparisons of these studies are shown in Table 8.

In the present study,out of 37 positive isolates,E coli was the dominant Gram negative uropathogen accounting for 64.86% cases(24 isolates) followed by Klebsiella spp with 18.91% cases(7 isolates). Proteus species were 10.81%(4 cases) while Pseudomonas aeruginosa were 5.40% with 2 cases. The above findings were comparable with other studies on UTI caused by Gram negative bacteria. Comparatively, earlier studies showed varying prevalence rates, with Escherichia coli ranging from 34.5% (Alka Nerulkar et al., 2012)[35] to 68% (Atul Kothari and Vishal Sagar et al., 2008)[39]. Klebsiella spp. was most prevalent in the study by Mohammed Akram et al. (2007) at 22%[40], while the lowest prevalence was reported by Smita Sood and Ravi Gupta et al. (2012) at 6.64%[29]. Proteus mirabilis was notably more prevalent in the study by R Shyamala et al. (2013) at 13.5%[41]. The prevalence of Pseudomonas aeruginosa peaked in the study by Devanand Prakash et al. (2013) at 21.9%[42].

Comparison of Antibiotic sensitivity (%) of E. coli with other studies- In the present study, ampicillin sensitivity was 20.83%, while higher sensitivities were noted for meropenem (100%), imipenem (91.66%), and nitrofurantoin (95.83%) but lower sensitivity for Ciprofloxacin (37.5%) and Ceftriaxone (33.33%). Comparatively, Patel et al. (2018)[32] showed high sensitivity to imipenem (91.69%) but lower sensitivity to other antibiotics like ciprofloxacin (18.97%) and cotrimoxazole (32.02%). Malik et al. (2021)[38] reported high sensitivity to amikacin (90.6%) and tigecycline (100%) but lower sensitivity to ceftriaxone (32.1%) and ciprofloxacin (26.4%). Mohapatra et al. (2022)[33] found high sensitivity to amikacin (92.8%) and nitrofurantoin (86.7%) but moderate sensitivity to ceftriaxone (59%) and cotrimoxazole (62.7%). Pardesi et al. (2018)[37] showed notable sensitivity to meropenem (96.18%) and gentamycin (90.76%), with moderate responses to cotrimoxazole (53.82%) and ciprofloxacin (29.4%). These variations highlight the dynamic nature of antibiotic resistance and the need for continuous monitoring and updating of treatment protocols.

CONCLUSION

This study analyzed 200 urine samples, of which 37(18.5%) were positive for urinary tract infection (UTI) isolates and majority (163 isolates,81.5%) had no bacterial pathogen.Gender-wise, UTIs were more prevalent in female patients (59.45%) compared to male patients (40.54%). The distribution of UTI cases across different age groups and genders revealed that the highest prevalence in females was in the 21-40 years age group (63.63%), while for males, it was in the >60 years age group (60%). In terms of Gram negative bacterial isolates,E coli was predominant(64.86%) followed by Klebsiella spp.(18.91%), Proteus spp.(10.81%) with 3 isolates of Proteus mirabilis(8.10%) and 1 isolate of Proteus vulgaris(2.70%) and Pseudomonas aeruginosa (5.40%).

Antibiotic sensitivity testing revealed that E. coli showed high sensitivity to meropenem (100%), nitrofurantoin (95.83%), and imipenem and amikacin (both 91.66%). Klebsiella spp. displayed 100% sensitivity to tigecycline, followed by 85.71% sensitivity to imipenem, meropenem, and aztreonam(71.42%). Proteus spp. demonstrated perfect sensitivity to piperacillin-tazobactam(100%), meropenem, and gentamycin (each 75%), while Pseudomonas aeruginosa showed 100% sensitivity to piperacillin-tazobactam, imipenem, meropenem, and aztreonam.

Based on the study, it can be recommended that nitrofurantoin should be preferred instead of cotrimoxazole and ciprofloxacin. Aminoglycosides and carbapenems should be preferred over fluoroquinolones and cephalosporins. The findings highlight the importance of carbapenems like meropenem and imipenem in treating infections caused by these bacterial species, emphasizing the need for tailored antibiotic therapy based on specific bacterial profiles.

The study shows the prevalence of Gram negative bacteria causing urinary tract infection.It also shows the antimicrobial susceptibility pattern of isolates.Knowing the sensitivity and resistance pattern of isolates helps as an aid to treatment and judicious use of antibiotics.

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