IMC Journal of Medical Science
July 2024; Vol. 18(2):007.
DOI: https://doi.org/10.55010/imcjms.18.019

Open Access
Research Article

Antimicrobial susceptibility pattern of Gram-negative uropathogens at a tertiary care hospital in Gujarat

Mihirkumar K Oza, Shirishkumar Patel, Beena Jagad, Ravindra Jadeja, Kairavi Desai*

Department of Microbiology, Government Medical College, Sir Takhtasinhji Hospital, Bhavnagar, Gujarat, India-364001

Abstract

Background and objectives: Urinary tract infections remain one of the most common infections in the community and susceptibility of uropathogens to commonly used antimicrobials has declined over the years. It is important to periodically study the antibiogram of uropathogens, so that empiric treatment can be determined using recent data and thus improving patient outcomes. The present study evaluated the antibiotic resistance trend of prevalent Gram-negative uropathogens in urine samples received at the microbiology laboratory at a tertiary care hospital.

Material and methods: The study was conducted at the Department of Microbiology, Sir Takhtsinhji Hospital, Bhavnagar for one year period from March 2021 to February 2022. All received urine samples for culture and sensitivity were included in the study. All samples were subjected to culture and sensitivity using standard methods.

Results: During study period, 918 (18.6%) organisms were isolated from 4938 urine samples. Out of 918, 85.1% (781) was Gram-negative and 9.8% was Gram-positive bacteria while 5.1% was *Candida* spp. *Escherichia coli* was the most prevalent (61.7%) of the total Gram-negative isolates. Gram-negative isolates were most resistant to amoxicillin/clavulanic acid, quinolones, trimethoprim/sulfamethoxazole. The rate of resistance to aminoglycosides, nitrofurantoin, third generation cephalosporins and carbapenems was comparatively low.

Conclusion: Antimicrobial resistance of the prevalent uropathogens should be monitored routinely to plan effective empirical therapy.

Introduction

Urinary tract infection (UTI) is a common bacterial infection encountered in the community and hospitals. UTI accounts for 35% of total hospital acquired infections (HAIs). It is a leading cause of morbidity and healthcare expenditures in people of all ages [1]. Predisposing factors for UTI are age, gender, race, nutrition, hygiene, and immune status of the patients [2]. Post-menopausal women have a higher incidence of UTI due to uterine prolapse, less estrogen activity, altered vaginal microbiota, and associated co-morbid conditions like diabetes mellitus [3,4]. Prolonged hospital stay due to other medical and surgical problems and urinary catheterization are the most important risk factors among older people of both sexes.

***Correspondence**: *Kairavi Desai, Department of Microbiology, Government Medical College, Sir Takhtasinhji Hospital, Bhavnagar, Gujarat, India-364001. E-mail:drkairavi@yahoo.in*

It is important to know the trends of antimicrobial susceptibility patterns of bacteria causing UTI at a given locality or hospital to ensure effective treatment. First and second generation cephalosporins, nitrofurantoin and fluoroquinolones are the most effective drugs for community acquired UTIs. On the other hand, parenteral therapy with third generation cephalosporins and carbapenems are often needed to treat nosocomial UTIs as the causative bacteria exhibit a high degree of resistance to commonly used antimicrobial agents [5,6]. Since patterns of antibiotic resistance in a wide variety of pathogenic organisms vary even over short period of time and depend on the site of isolation and different environments, periodic evaluation of antibacterial susceptibility of pathogenic bacteria is always needed. In view of the above, the current study was planned to find out the prevalence of Gram-negative uropathogens and their antimicrobial susceptibility patterns at a tertiary care hospital in Gujarat, India.

Materials and methods

The study was conducted, at a tertiary care hospital, Bhavnagar, Gujarat, India from March 2021 to February 2022.The study was approved by the Institutional Sub-Ethical Committee prior to commencement of study. Ethical approval letter No. 1050/2021. Date: 24/02/2021.

All the urine samples received for culture and sensitivity in microbiology laboratory were included in the study. Repeat urine samples from the same admission were excluded. Samples were processed immediately to ensure maximum recovery of the pathogen. Culture was performed on cystine-lactose-electrolyte deficient (CLED) agar and plates were incubated overnight at 35-37^{0}C [7]. A sample was considered culture positive if the bacterial count was ≥ 10^5 and ≥ 10^3 colony forming unit/mL (CFU/mL) for non-catheterized and catheterized patient respectively. The isolates were identified by motility and standard bio-chemical tests. Antibiotic susceptibility of organisms was performed by Kirby-Bauer disk diffusion method on Mueller-Hinton agar plates with following antibiotics: trimethoprim/sulfamethoxazole (23.75/1.25µg), nitrofurantoin (30µg), gentamicin (10µg), tobramycin (10µg), amikacin (30µg), tetracycline (30µg), amoxicillin-clavulanic acid (20/10µg), ciprofloxacin (5µg), ofloxacin (5µg), norfloxacin (10µg), ceftriaxone (30µg), ceftazidime (30µg), cefotaxime (30µg), cefepime (30µg), piperacillin (100µg), piperacillin/tazobatum (100/10µg), and meropenem (10µg). Diameters of the zones of inhibition were interpreted according to CLSI 2022 guideline [8].

Results

During the study period, a total 4938 specimens were received of which 4332 and 606 samples were received from in-patient and outpatient department (IPD, OPD) respectively. Out of total 4938 samples, 918 (18.6%) yielded signification growth. Significant bacterial growth was present in 19.2% and 14.5% of urine samples from IPD and OPD respectively.

Table-1: *Culture results of urine samples according to source, age, gender and types of bacteria.*

Variables	**Culture positive Number (%)**
Total culture positive (n=4938)	918 (18.6%)
Urine samples from:	**Number (%)**
IPD (n=4332)	830 (19.2)
OPD(n=606)	88 (14.5%)
Male(n=2430)	383 (15.8%)
Female (n=2508)	535 (21.3%)
Age group in years (n=918)	
0-18	80 (8.7)
19-30	152 (16.6)
31-45	241 (26.3)
46-60	242 (26.4)
>60	203 (22.1)
Types of organisms (n=918)	
Gram-negative bacteria	781 (85.1)
Gram-positive bacteria	90(9.8)
Fungus (*Candida* spp)	47(5.1)
Escherichia coli	482(61.7)[a]
Klebsiella pneumoniae	235(30.1)[a]
Pseudomonas spp.	58(7.4)[a]
Proteus spp.	6(0.7)[a]

Note: IPD: Inpatient department; OPD: Outpatient department; a: % out of Gram-negative bacteria

Out of 2430 samples from male and 2508 samples from female, 383 (15.8%) and 535 (21.3%) were culture positive respectively. Out of 918 isolates, 781 (85.1%) were Gram-negative bacteria. Among the Gram-negative bacteria, most prevalent organism was *Escherichia coli* (61.7%) followed by *Klebsiella pneumoniae* (30.1%) and *Pseudomonas* spp (7.4%) [Table-1].

Detail rate of resistance of total isolated Gram-negative uropathogens to different antimicrobial agents is shown in Table-2. Out of 781 Gram-negative bacteria, 81.2% were resistant to amoxicillin/clavulanic acid while least resistance was observed against meropenem and 3rd generation cephalosporins except ceftriaxone (Table-2).

Escherichia coli isolates were most resistant to amoxicillin /clavulanic acid (84.6%) while resistance to ceftazidime and meropenem was 0.4% and 0.2% respectively. Out of 235 isolated *Klebsiella pneumoniae*, 95.3% and 51.9% were resistant toamoxicillin/clavulanic acid and trimethoprim/ sulfamethoxazole respectively. *Pseudomonas*s pp isolates were most resistant to piperacillin (58.6%) followed by ceftazidime (34.5%). Detail antimicrobial resistance patter to different Gram-negative isolates is shown in Table-3.

Table-2: *Pattern of resistance of total isolated Gram-negative uropathogens to different antimicrobial agents (N=781)*

Antimicrobial agents	Resistant Number (%)
Amikacin	132 (16.9)
Gentamycin	132 (16.9)
Tobramycin	144 (18.4)
Cotrimoxazole	289 (37)
Tetracycline	270 (34.6)
Ciprofloxacin	314 (40.2)
Norfloxacin	291 (37.3)
Ofloxacin	200 (25.6)
Amox/clav	634 (81.2)
Ceftazidime	24 (3.1)
Cefotaxime	4 (0.5)
Cefepime	7 (0.9)
Ceftriaxone	193 (24.7)
Meropenem	1 (0.1)
Piperacillin	34 (4.3)
Pip/tazo	12 (1.5)
Nitrofurantoin	63 (8.1)

Note: *Cotrimoxazole – Trimethoprim/ sulfamethoxazole; Amox/clav – Amoxicillin/ clavulanic acid; Pip/tazo – Piperacillin/tazobactam*

Table-3: *Antimicrobial resistance pattern of isolated Gram-negative bacteria (N=781)*

Antimicrobial agent	*E. coli* (N=482)	*K. pneumoniae* (N=235)	*Pseudomonas*s spp. (N=58)	*Proteus* spp. (N=6)
	Resistant n(%)	Resistant n(%)	Resistant n(%)	Resistant n(%)
Amikacin	75 (15.6)	47 (20)	10 (17.2)	-
Gentamycin	70 (14.5)	49 (20.9)	13 (22.4)	-
Tobramycin	82 (17)	52 (22.19)	10 (17.2)	-
Amox/clav	408 (84.6)	224 (95.3)	-	2 (33.3)
Ceftriaxone	128 (26.5)	64 (27.2)	-	1 (16.7)
Ceftazidime	2 (0.4)	2 (0.9)	20 (34.5)	-
Cefotaxime	3 (0.6)	1 (0.4)	-	-
Cefepime	3 (0.6)	2 (0.9)	2 (3.4)	-
Ciprofloxacin	185 (38.4)	114 (48.5)	13 (22.4)	2 (33.3)
Norfloxacin	178 (36.9)	111 (47.2)	-	2 (33.3)
Ofloxacin	120 (24.9)	79 (33.6)	-	1 (16.7)
Tetracycline	161 (33.4)	109 (46.4)	-	-
Cotrimoxazole	166 (34.4)	122 (51.9)	-	1 (16.7)
Meropenem	1 (0.2)	0	0	-
Piperacillin	-	-	34 (58.6)	-
Pip/tazo	4 (0.8)	6 (2.6)	2 (3.4)	0
Nitrofurantoin	33 (6.8)	30 (12.8)	-	-

Note: (-) means drug have intrinsic resistance or test not done; Amox/clav – Amoxicillin/clavulanic acid; Cotrimoxazole – Trimethoprim/sulfamethoxazole; Pip/tazo – Piperacillin/tazobactam

Discussion

Effective management of UTI depends on identification of the causative organism and choosing a suitable antibiotic for the treatment. Development of resistance to commonly used antibiotics is a major concern worldwide, causing failure of treatment in different types of infections, including UTI [9]

In this study, the results show that 18.6% of the urine samples from our hospital yielded significant pathogens. The finding is similar to other reported studies [10-12]. In the present study, *E. coli* was the most frequently isolated organism from our urine samples. Previous studies also reported *E. coli* as the most common cause of UTIs in the Indian population, followed by other uropathogens like *Klebsiella*, *Pseudomonas, Proteus*, *Enterococcus and Staphylococcus*s species [10-14]. Resistance to amikacin observed in our study (15.5%) was closely comparable to other studies (16% - 23.9%) reported from India [12,13,15]. In the present study, 34.4% *E. coli* was resistant to cotrimoxazole, while in other studies across India the resistance rate was found between 48% to 56.7% [16,13]. In our study, we found low rate of resistance of *E coli* to nitrofurantoin (6.8%) while others reported the rate as 15.9% to 35.3% [10,12,13]. However, Sood et al [11] found the rate as 5.8%. In the current study, 38.4% of *E. coli* was resistant to ciprofloxacin while other studies reported the rates between 36% to 66% [16,17]. Over use of quinolones has led to this increase in resistance. We observed very low rate of resistance of *E. coli* to meropenem (0.2 %) when other studies reported the rate around 19% [10,13]. Meropenem is a costly drug and, therefore, less frequently used. Low rate of resistance of *E. coli* to ceftazidime, cefotaxime and nitrofurantoin found in our study suggests that these antimicrobial agents would be useful for empiric therapy in UTI patients. *Klebsiella pneumoniae* were the second most isolated uropathogens (30.08%) in our study. The findings are similar to various studies done across India [12,21]. Among the *Klebsiella pneumoniae* isolates, resistance to amoxycillin/clavulanic acid (95.3%) was similar to Shah D et al (90%) [12]. In our study, resistance to other antimicrobials namely meropenem, piperacillin/tazobactam and nitrofurantoin ranged between 0-12.7%. However, previous studies reported much higher rate of resistance to these antimicrobials [12,22,23]. Non-fermenter such as *Pseudomonas aeruginosa* is an important cause of healthcare-associated UTI. Due to good clinical practice in our hospital, the resistance rate of isolated *Pseudomonas* spp to different antimicrobial agents are low compared to other studies [11,21,24].

Gram-negative bacteria are the most common bacterial cause of UTI. Antimicrobial resistance to first and second line antimicrobial agents should be monitored regularly to avoid treatment failure. Overprescribing of antibiotics is associated with an increased risk of adverse effects and treatment failures due to emergence of resistant bacteria. Every center needs to carry out regular surveillance on prevalent uropathogens and their antimicrobial resistance pattern for effective therapy and control of hospital infection.

Acknowledgement

The authors would like to acknowledge the contributions of staff and laboratory personnel of the Department of Microbiology, Government Medical College, Sir Takhtasinhji Hospital, Bhavnagar, Gujarat, India-364001

Conflict of interest

Authors declared no conflict of interest

References

1. Sastry AS, Bhat S. Essential of medical microbiology. 3rd ed; Section 10: Chapter 76. 2021; p. 745-755.
2. Jones RN, Thornsberry C. A review of in vitro antimicrobial properties and spectrum of activity. *Rev Inf Dis.* 1982; **4** Suppl: S300-S315. doi:10.1093/clinids/4.supplement_2.s300.
3. McGowan Jr JE. Antimicrobial resistance in hospital organisms and its relation to antibiotic use. *Rev Infect Dis*. 1983; **5**(6): 1033-1048. doi:10.1093/clinids/5.6.1033.

4. Harbarth S, Harris AD, Carmeli Y, Samore MH. Parallel analysis of individual and aggregated data on antibiotic exposure and resistance in gram-negative bacilli. *Clin Infect Dis*. 2001; **33**(9): 1462- 1468. doi:10.1086/322677.

5. Jack DS, Donald K. Urinary tract infections. In: Mandel GL, Bennett JE, Dolin R, editors.Principles and practice of infectious diseases. London: Elsevier Churchill Livingstone, 2005; p. 875-878.

6. Wammanda RD, Ewa BO. Urinary tract pathogens and their antimicrobial sensitivity patterns in children. *Ann Trop Paediatr.* 2002; **22**(2): 197-198.doi:10.1179/atp.2002.22.2.197.

7. Cheesbrough M. Examination of urine. District laboratory practice in tropical countries - Part two. 2nd ed. Cambridge University Press. 2006; P. 105-115.

8. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing; 32nd ed. CLSI supplement M100S. Clinical and Laboratory Standards Institute, Wayne PA; 2022.

9. Huttner A, Harbarth S, Carlet J, Cosgrove S, Goossens H, Holmes A, et al. Antimicrobial resistance: a global view from the 2013 World Healthcare Associated infections forum. *Antimicrob Resist Infect Control*. 2013; **2**: 31. doi: 10.1186/2047-2994-2-31.

10. Ramu S. Retrospective study on susceptibility and resistance pattern of urinary pathogens in a tertiary care hospital. *Int J Basic Clin Pharmacol*. 2019; **8**(1): 2211-2215. doi:10.18203/2319-2003.ijbcp20194257.

11. 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. doi:10.4103/0970-0218.94023.

12. Shah D, Shah A, Patel L, Pethani J, Limbachia U, Shah H. Microbiological profile and antibiogram of uropathogens isolated at a tertiary care hospital. *J Krishna Inst Med Sci Univ*. 2021; **10**(1): 15-26.

13. Lohariwal Y, Das NK, Mirza S, Gandham N, Patil R, Mukhida S, et al. Fosfomycin susceptibility among *Escherichia coli* causing urinary tract infection in a tertiary care centre in western Maharashtra. *IMC J Med Sci.* 2023; **17**(1): 008. doi: https://doi.org/10.55010/imcjms.17.008.

14. Kamat US, Fereirra A, Amonkar D, Motghare DD, Kulkarni MS. Epidemiology of hospital acquired urinary tract infections in a medical college hospital in Goa. *Indian J Urol*. 2009; **25**(1): 76-80. doi:10.4103/0970-1591.45542.

15. Somashekara SC, Deepalaxmi S, Jagannath N,Ramesh B, Laveesh MR, Govindadas D. Retrospective analysis of antibiotic resistance pattern to urinary pathogens in a tertiary care hospital in South India. *J Basic Clin Pharma*. 2014; **5**(4): 105-108. doi:10.4103/0976-0105.141948.

16. George CE, Norman G, Ramana GV, Mukherjee D, Rao T. Treatment of uncomplicated symptomatic urinary tract infections: resistance patterns and misuse of antibiotics. *J Fam Med Prim Care*. 2015; **4**(3): 416-421. doi:10.4103/2249-4863.161342.

17. Kashef N, Djavid GE, Shahbazi S. Antimicrobial susceptibility patterns of community-acquired uropathogens in Tehran, Iran. *J Infect Dev Ctries*. 2010; **4**(4): 202-206. doi:10.3855/jidc.540.

18. Adeyemo AA, Gbadegesin RA, Onyemenem TN, Ekweozor CC. Urinary tract pathogens and antimicrobial sensitivity patterns in childreninIbadan, Nigeria. *Ann Trop Paediatr*. 1994; **14**(4): 271-274. doi:10.1080/02724936.1994.11747728.

19. Odutola A, Ogunsola FT, Odugbemi T, Mabedeje FB. A study on the prevalence of urinary tract infection in hypertensive patients attending an urban hospital in Lagos, Nigeria. *Nig Qt J Hosp Med.* 1998; **8**(3): 190-192.

20. Ozumba UC. Increasing incidence of bacterial resistance to antibiotic byisolates from urinary tract. *Niger J Clin Pract*. 2005; **8**(2): 107–9.

21. Patel HB, Soni ST, Bhagyalaxmi A, Patel NM. Causative agents of urinary tract infections and their antimicrobial susceptibility patterns at a referral center in Western India: an audit to help clinicians prevent antibiotic misuse. *J*

Family Med Prim Care. 2019; **8**(1): 154-159. doi:10.4103/jfmpc.jfmpc_203_18.

22. Prakash D, Saxena RS. Distribution and antimicrobial susceptibility pattern of bacterial pathogens causing urinary tract infection in urban community of Meerut City, India. *ISRN Microbiol*. 2013; **2013**: 749629. doi:10.1155/2013/749629.
23. Singhal A, Sharma R, Jain M, Vyas L. Hospital and community isolates of uropathogens and their antibiotic sensitivity pattern from a tertiary care hospital in Northwest India. *Ann Med Heal Sci Res*. 2014; **4**(1): 51-56. doi:10.4103/2141-9248.126611.
24. Patil RA, Pandey R, Gandham N, Mirza SB, Vyawahare CR, Khan S, et al.Bacterial co-infection in Covid-19 patient visiting a tertiary care hospital in Maharashtra. *IMC J Med Sci*. 2023; **17**(2): 006. doi: https://doi.org/10.55010/imcjms.17.016.

Citer this article as:
Oza MK, Patel S, Jagad B, Jadeja R, Desai K. Antimicrobial susceptibility pattern of Gram-negative uropathogens at a tertiary care centre in Gujarat. *IMC J Med Sci*. 2024; 18(2):007.
DOI: https://doi.org/10.55010/imcjms.18.019