Original Article

Evaluation of Antibiotic Resistance Patterns of Common Gram-negative Uropathogens in Tertiary Care Hospital of Eastern India

Dr. Jitendra Prasad[1], *Dr. Nilam Kumari[2]

1. Assistant Professor, Department of Microbiology, Narayan Medical College & Hospital, Sasaram, Bihar, India.
2. Tutor, Department of Pathology, Medinirai Medical College & Hospital, Palamu, Jharkhand, India.

***Corresponding author's E-mail:** kumarinilam82@gmail.com

Received: 27-01-2023; **Revised:** 22-02-2023; **Accepted:** 26-02-2023; **Published on:** 15-03-2023.

ABSTRACT

Introduction: In recent decades, the widespread use of antibiotics has led to an increasing incidence of antibiotic resistance in uropathogens worldwide. Therefore, urinary tract infections are the leading cause of high antibiotic use and resistance worldwide. However, because patterns of bacterial resistance are constantly altering, it is important to monitor antimicrobial susceptibility. It bring information on pathogens isolated from patients and aids in the selection of the most relevant empirical antimicrobial therapy.

Aims/ objective: The aim of the present study was to evaluate the resistance patterns of Gram-negative isolates from suspected urinary tract infections.

Materials and Method: Patients with documented urinary tract infections due to positive growth of microorganisms in urine samples were included in the analysis. A positive culture was defined as an isolation of greater than or equal to 105 colony forming units/mL or greater. Antimicrobial susceptibility testing was performed on Muller-Hinton agar using the Kirby-Bauer disc diffusion method according to Clinical Laboratory Standards Institute (CLSI) criteria. Descriptive statistics were used to represent and compare data using ratios, percentages, frequencies and cross-tabulations.

Results: *E.coli* was causative pathogens in 67.69% of UTI due to gram negative pathogens. Greater than 70% of E. coli was sensitive to ampicillin, amoxicillin, nalidixic acid, and tetracyclines. E. Coli was least sensitive to gentamicin and cotrimoxazole. All Acinetobacter and Providencia isolates were resistant to fluoroquinolones. Only one-third of pseudomonas isolates were sensitive to fluoroquinolones. Two third of pseudomonas isolates were resistant to ≥6 antimicrobials. Most of the *E. coli* isolates were resistant to at least 2 antimicrobials.

Conclusion: The result of our study and its comparison with previous study led us to conclusion that antibiotic policy of the hospital should be based on resistance pattern observed in local survey.

Keywords: Antibiotic Resistance, Urinary Tract Infection, Gram-negative Uropathogens.

QUICK RESPONSE CODE →

DOI: 10.47583/ijpsrr.2023.v79i01.022

DOI link: http://dx.doi.org/10.47583/ijpsrr.2023.v79i01.022

INTRODUCTION

Nowadays, urinary tract infections (UTIs) are one of the most frequent diseases encountered in clinical practice, affecting people of all ages, from new-borns to the elderly. [1, 2] Urinary tract infection (UTI) is a term used for a various clinical conditions ranging from asymptomatic presence of bacteria in urine to severe forms of kidney disease with sepsis.[3] An estimated 150 million UTIs occur annually, resulting in over $6 billion in direct medical costs for him. In developing countries, it is more common among people of lower socioeconomic status. [4, 5] Many urological procedures are at undue risk without effective antimicrobials against urinary tract pathogens.

Treatment of UTI depends on age, sex, underlying medical conditions, infectious agents, and involvement of the lower or upper urinary tract. According to the Infectious Diseases Society of America (IDSA) guidelines, co-trimoxazole is the drug recommended for the treatment of UTI when the prevalence of resistance is <10% >20% (6). Other drugs used to treat UTIs include fluoroquinolones, cephalosporin and other beta-lactams with or without beta-lactamase inhibitors. [6]

Therefore, up-to-date knowledge of urinary tract pathogens and their susceptibility patterns is critical for appropriate antibiotic selection and use, as well as appropriate prescribing strategies. Over the last few decades, widespread use of antibiotics has led to an increasing incidence of antibiotic resistance in urinary tract pathogens worldwide. Therefore, UTIs have become an important driver of global antibiotic use and resistance.[7-11]

Urinary tract infections are caused by Gram-negative uropathogenic bacteria such as Escherichia coli, Klebsiella, Pseudomonas, and Enterobacter. and the genus Proteus. [13-18] The WHO also states that Escherichia coli, particularly cephalosporin- and/or fluoroquinolone-resistant isolates,

are the most common causative agents of community-acquired and nosocomial HAIs, and are also the major agents of hospital-acquired and community-acquired UTIs.[19]

Klebsiella isolates are the second most common bacterium in nosocomial infections, followed by Pseudomonas isolates.[5, 20, 21] Mortality associated with urinary tract infections is significantly higher after bacteremia with strains resistant to at least one drug from three or more antibiotic classes, defined as multidrug-resistant (MDR) strains.[22, 23] The appearance and spread of MDR Gram-negative uropathogens in communities and hospitals further increases therapeutic challenges.[24, 25] These problems are most likely due to inadequate prophylactic or curative traditional antibacterial therapy rather than an association with elevated virulence of uropathogenic strains.[26, 27] In addition, the frequency of MDR strains in communities extends the problem of resistance beyond hospitals, as drug-resistant uropathogens can be traced from communities to hospitals and vice versa. [28, 29]

The prevalence of drug-resistant urinary tract pathogens and the countless problems that result are among the concerns of the medical community, as treatments are often unsuccessful, risk patient mortality, and are costly. Increasing MDR therefore reduces the number of effective drugs available for treating UTIs, leaving very limited choice for treating patients with these infections.[30-32] Furthermore, in developing countries, facilities for simple tests such as urine cultures and antimicrobial susceptibility testing are still inadequate, leading to misdiagnosis of UTIs and irrational antibiotic treatment, accelerating the emergence of MDR strains. [33-35]

However, because patterns of bacterial resistance are constantly changing, it is important to monitor antimicrobial susceptibility. It provides information on pathogens isolated from patients and aids in the selection of the most applicable empirical antimicrobial therapy. In addition, on-going antimicrobial resistance surveillance is important to monitor variance in this resistance. The aim of this study was therefore to evaluate the resistance patterns of Gram-negative isolates from suspected urinary tract infections.

MATERIALS AND METHODS

This was a cross-sectional study conducted in tertiary care centre of eastern India from August 2020 to July 2021. The anticipated risk to the study participant was less than minimal so exemption from ethics committee review was taken. The study was done under the guidelines of good laboratory practice (GLP). The participant information sheet was provided and explained to the patients and written informed consent was taken.

Inclusion Criteria

All patients aged 12 years and older who presented to the outpatient and inpatient department of general medicine with a clinically suspected diagnosis of urinary tract infection (dysuria, urinary frequency, fever, lower abdominal pain) were recruited in the study. Urine samples of these patients were sent for urine culture and susceptibility testing.

Exclusion Criteria

Patients with active menstruation, PID, tubo-ovarian disease, colitis, appendicitis, epididymitis, orchitis identified clinically or by examinations were excluded from this study.

Patients with UTI evidenced by positive growth of the organism in urine samples were included in the analysis. A positive culture was defined as a isolation of greater than or equal to 10^5 colony-forming units/mL or greater in a midstream urine sample.

Data Collection

Age and gender were obtained from patient inquiry forms. A total of 318 participants with suspected UTI were recruited using serial sampling techniques. Clean midstream urine specimens were collected from enrolled patients using sterile jars. The minimum acceptable urine sample volume was 10 ml. All samples were analyzed instantly upon arrival at the laboratory to assure the isolation of pathogenic organisms present in urine and to prevent overcrowding of pathogenic organisms.

Culture

Urine samples were inoculated directly onto blood agar and MacConkey agar with the hep of a sterile standard calibrated wire loop (0.001). Streaked culture plates were aerobically incubated at 37°C for 24 hours. The number and type of colonies were counted on blood agar plates and significant bacteriuria was determined. Cultures with colony counts greater than 10^5 cfu/ml were considered significant for isolated individual bacteria. Identification of bacterial isolates was performed using colony nature on blood agar, MacConkey agar and bacterial Gram reaction and biochemical testing by standard procedures.

Antimicrobial Sensitivity

Antimicrobial susceptibility testing was performed on Muller-Hinton agar using the Kirby-Bauer disk diffusion method according to the criteria of the Clinical Laboratory Standards Institute (CLSI). [36] A suspension of 3-5 colonies of newly grown test organisms was introduced, comparable to a 0.5 McFarland standard. The swab was centrifuged with the suspension to completely cover the surface of the Mueller-Hinton agar. After allowing the plate to dry for 3-5 minutes, the disc was spread evenly over the inoculation plate using sterile forceps and incubated at 37 °C for 18-24 hours. The diameter of the zone of inhibition surrounding the disc was measured with scale. We classified the results based on the CLSI 2018 guidelines. [16] The antimicrobial agents tested were: Ampicillin (Amp), Amoxycillin (10 µg), Chloramphenicol (30µg), Nalidixic Acid (NA), Nitrofurantoin (300 µg), Gentamicin (10µg), Ciprofloxacillin (5µg), Ceftazidime

(30µg), Ceftriaxone (30 µg), Norfloxacin (NOR), Doxycycline (30µg), Cotrimoxazole (25µg), and Tetracycline (30 µg).

Statistical Analysis

The data was entered and analysed using Microsoft Excel 365. The descriptive statistics was used to express and compare the data using proportion, percentage, frequency and cross-tabulation.

OBSERVATIONS AND RESULTS

Table 1: Baseline demographic and clinical characteristics of the patients (n=65)

Variables	Number of Patients with Gram Negative isolate (n=65)	Percentage %
Age		
<18	10	15.38
18-40	27	41.54
41-60	18	27.69
>60	10	15.38
Sex		
Male	19	29.23
Female	46	70.77
Sexual Activity		
Active	41	63.08
Not Active	24	36.92
Clinical feature		
Dysuria	47	72.31
Urgency	44	67.69
Fever	50	76.92
Abdominal pain	44	67.69

A total of 318 urine specimens were examined for isolations and identifications of bacteria and susceptibility testing. Of these, 71 (22.32%) urine samples showed significant bacterial growth. The number of gram negative isolates was 65 (20.44%), and gram positive isolate was 6 (1.89%).

Most of the patients with UTI were females of age group 18-40. Most of patients were sexually active. More than 70% of patients had symptoms of fever and dysuria.

Table 2: Distribution of significant gram-negative uropathogenic microorganisms among patients with urinary tract infection

Variables	Number of Patients with Gram Negative isolate (n=65)	Percentage %
Escherichia coli	44	67.69
Klebsiella spp.	9	13.85
Proteus spp.	5	7.69
Pseudomonas spp.	3	4.62
Enterobacter spp.	2	3.08
Acinetobacter spp.	1	1.54
Providenicia spp.	1	1.54

E.coli was causative pathogens in 67.69% of UTI due to gram negative pathogens. Next common gram negative uropathogen was klebsiella responsible for UTI in 13.85% of patients.

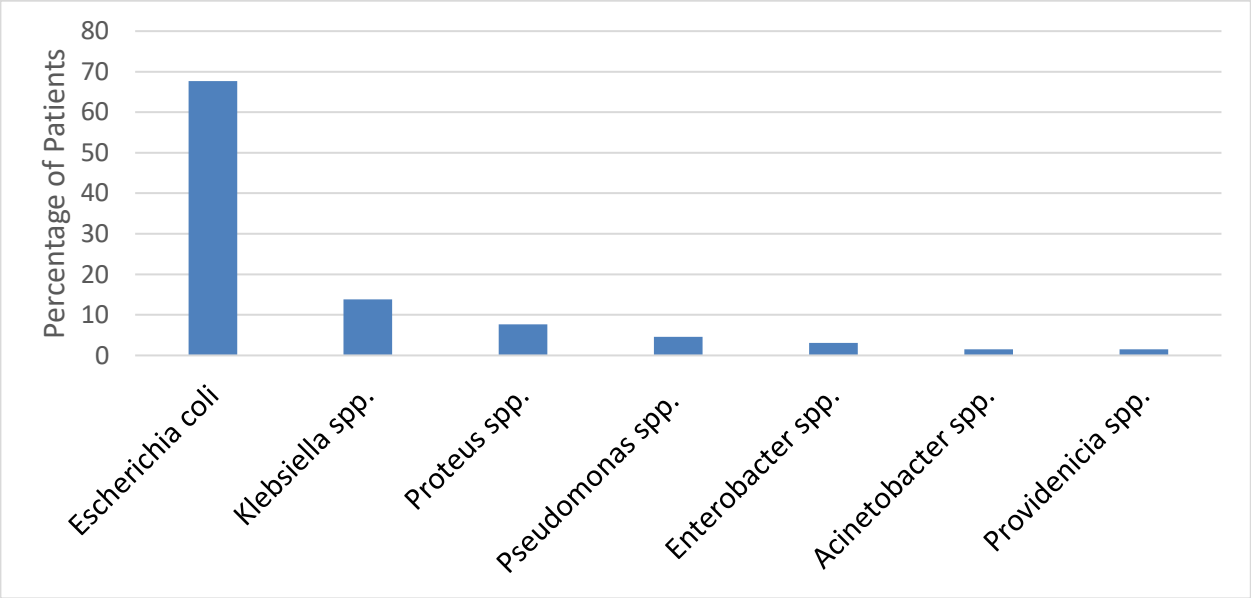

Figure 1: Distribution of significant gram-negative uropathogenic microorganisms among patients with urinary tract infection

Table 3: Antimicrobial susceptibility in percentage of bacterial isolates towards different antimicrobials

Bacteria	*Escherichia coli*	*Klebsiella spp.*	*Proteus spp.*	*Pseudomonas spp.*	*Enterobacter spp.*	*Acinetobacter spp.*	*Providencia spp.*
No of Isolate	44	9	5	3	2	1	1
Ampicillin	79.55	88.89	60.00	100	100.00	100.00	100.00
Chloramphenicol	29.55	55.56	40.00	33.33	50.00	0	0
Amoxycillin	75	66.67	60.00	100	50.00	100.00	0
Cotrimoxazole	22.73	55.56	0	66.67	50.00	0	0
Ciprofloxacin	54.55	55.56	20.00	33.33	0	0	0
Ceftriaxone	45.45	66.67	0	33.33	0	0	0
Nitrofurantoin	20.45	44.44	40.00	33.33	0	0	0
Gentamicin	22.73	33.33	20.00	66.67	50.00	100.00	0
Nalidixic Acid	72.73	44.44	60.00	0	50.00	100.00	100.00
Ceftazidime	31.82	66.67	60.00	66.67	50.00	0	0
Norfloxacin	68.18	66.67	20.00	33.33	0	0	0
Doxycycline	72.73	66.67	60.00	33.33	0	100.00	100.00
Tetracycline	84.09	33.33	60.00	66.67	50.00	100.00	100.00

Greater than 70% of *E.coli* was sensitive to ampicillin, amoxycillin, nalidixic acid, and tetracyclines. E. Coli was least sensitive to gentamicin and cotrimoxazole. All Acinetobacter and Providencia isolates were resistant to fluoroquinolones. Only one-third of pseudomonas isolates were sensitive to fluoroquinolones.

Table 4: Antimicrobial resistance pattern of different gram negative uropathogens

Bacteria	No of Isolate	0	1	2	3	4	5	≥6
Escherichia coli	44	1	8	15	11	6	1	2
Klebsiella spp.	9	2	0	4	0	0	2	1
Proteus spp.	5	0	2	1	1	0	1	0
Pseudomonas spp.	3	0	0	1	0	0	0	2
Enterobacter spp.	2	0	0	0	0	1	1	0
Acinetobacter spp.	1	0	0	0	0	0	1	0
Providenicia spp.	1	0	0	0	0	0	0	1

Two third of pseudomonas isolates were resistant to ≥6 antimicrobials. Most of the *E.coli* isolates were resistant to at least 2 antimicrobials.

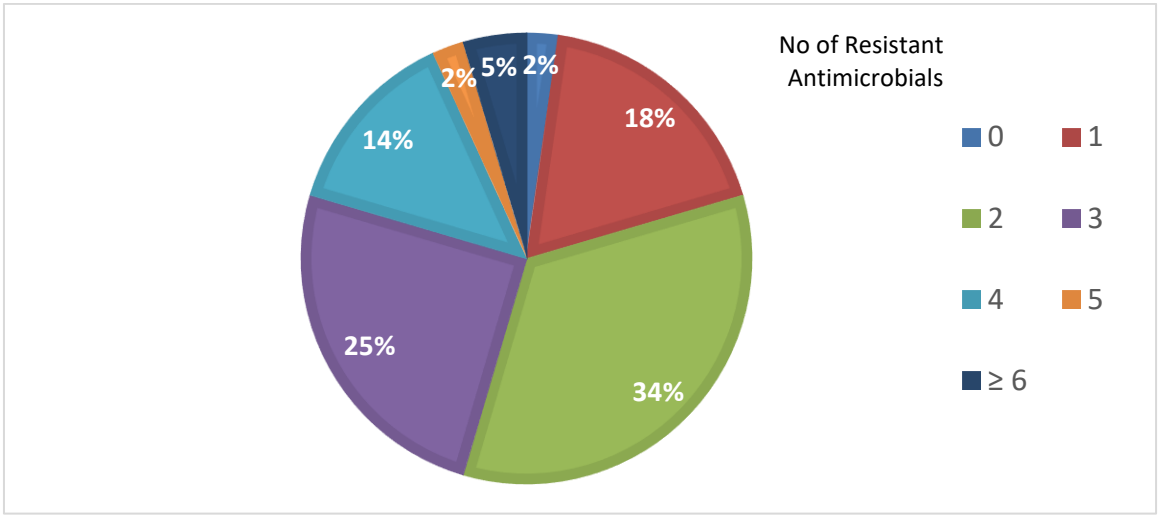

Figure 2: Proportion of *E. coli* resistant to different number of antimicrobials

DISCUSSION

E. coli was the commonest gram negative bacteria causing complicated and uncomplicated urinary tract infection as described previously.

The prevalence of bacteriuria in the study was 22.32%. It is almost comparable with what had been earlier reported by Yismaw et al. (17.8%), Hamdan et al. (19.5 %), Osanyinpeju et al. (17.3%) and Rabindra et al. (21%).[37-40] However, prevalence of bacteriuria in our study is lower than the findings of studies done in India (32%), Iraq (49.1%) and Pakistan (51.03%).[41-43] Differences in the proportion of urinary tract pathogens in different studies can be explained by differences in the methodologies used, environment, community social habits, personal hygiene standards, and education.

In this study, Escherichia coli were by far the most commonly isolated bacterium, present in 67.69% of Gram-negative organisms. This compares with the findings of Hamdan et al., where E. coli accounted for 42.4% of their Gram-negative isolates (38). This also applies to the results of Blomberg et al. where E. coli accounted for 38% of Gram-negative isolates and 25% of all isolates.[44] Similarly, many authors have made the same finding.[45, 46]

Given that most treatments for urinary tract infections are empirical and that urinary tract pathogens are increasingly resistant to antibiotics, frequently updated data on antimicrobial susceptibility patterns are needed for empirical treatment. The aim of this study was to characterize the susceptibility profile of Gram-negative uropathogen isolates from patients at a tertiary care centre in the East India. The percentage of E. coli isolates resistant to ampicillin reached 79.55% in our setting. Such high levels of resistance to ampicillin have been cited by many other studies from various parts of the world. For example, studies in India demonstrate that ampicillin-resistant strains were observed in 80% and 76% of E. coli (47, 48). [47, 48] In Africa (including Sudan, Tanzania, Kenya, and Senegal), E. coli in urine isolates have been reported to have a high pattern of antimicrobial resistance. [38, 49-51] Similarly, other studies have reported high tolerance of E. E. coli to various antibiotics has been observed in Latin America and Costa Rica. [52, 53]

Other Gram-negative isolates of Proteus species in our study demonstrated 40% resistance to ampicillin and amoxicillin. There was 100% resistance to co-trimoxazole. This differs from the results of Yismaw et al. in which 100% resistance to ampicillin and amoxicillin-clavulanate and 100% sensitivity to co-trimoxazole have been reported. [37] K. pneumoniae showed 85.2% resistance to ampicillin. This is similar to the study by Yismaw et al., Osanyinpeju et al. and Ghenghesh et al. [37, 39, 54]

In this study, multidrug resistance (MDR = resistance to two or more drugs) was observed in more than 70% of bacterial uropathogen isolates. This is higher than the study by Yismaw et al. (59.8%).[37] This indicates that very high levels of multi-drug resistance to commonly used antibiotics have been found. Antimicrobial resistance is recognized as a result of antimicrobial use and abuse.[55] Therefore, the reason for this alarming event could be inappropriate and wrong administration of antimicrobials in empirical treatment.

CONCLUSION

The increasing trend of antibiotic resistance indicates that rational, evidence based and conservative use of antimicrobials in the community is required. The result of our study and its comparison with previous study led us to conclusion that antibiotic policy of the hospital should be based on resistance pattern observed in local survey. Most of the gram negative uropathogens were resistant for fluoroquinolones, gentamicin and cotrimoxazole. They are considered as appropriate antimicrobials for empirical treatment for urinary tract infections with the absence of culture and sensitivity setting.

Most Gram-negative uropathogens were resistant to fluoroquinolones, gentamicin, and cotrimoxazole. They are frequently used antibiotics for empirical treatment of urinary tract infections when culture and sensitivity report of patient is not available.

REFERENCES

1. Jamil, A. Zafar, M.U. Qamar, H. Ejaz, J. Akhtar, A. Waheed, Multi-drug resistant Klebsiella pneumoniae causing urinary tract infections in children in Pakistan, Afr. J. Microbiol. Res. 2014;8:316–319.
2. N. Ramesh, C.S. Sumathi, V. Balasubramanian, K.R. Palaniappan, V.R. Kannan, Urinary tract infection and antimicrobial susceptibility pattern of extended spectrum of beta lactamase producing clinical isolates, Adv. Biol. Res. 2008;2:78–82.
3. Weichhart T, Haidinger M, Hörl WH, Säemann MD. Current concepts of molecular defence mechanisms operative during urinary tract infection. Eur J Clin Invest. 2008;38:29–38.
4. S. Manikandan, S. Ganesapandian, M. Singh, A. Kumaraguru, Antimicrobial susceptibility pattern of urinary tract infection causing human pathogenic bacteria, Asian J. Med. Sci. 2011;3:56–60.
5. W.F. Nabbugodi, Prevalence of Urinary Tract Infection, Microbial Aetiology, and Antibiotic Sensitivity Pattern Among Antenatal Women Presenting with Lower Abdominal Pains in Kenyatta National Hospital, University of Nairobi, 2013.
6. Zervos MJ, Hershberger E, Nicolau DP, Ritchie DJ, Blackner LK, Coyle EA, et al. Relationship between fluoroquinolone use and changes in susceptibility to fluoroquinolones of selected pathogens in 10 United States teaching hospitals, 1991–2000. Clin Infect Dis. 2003;37:1643–1648.
7. E. Santo, M.M. Salvador, J.M. Marin, Multidrug-resistant urinary tract isolates of escherichia coli from ribeirão preto, São paulo, Brazil, Braz. J. Infect. Dis. 2007;11:575–578.
8. R. Khoshbakht, A. Salimi, H.S. Aski, H. Keshavarzi, Antibiotic susceptibility of bacterial strains isolated from urinary tract infections in Karaj, Iran, Jundishapur J. Microbiol. 2012;6:86–90.

9. A. Zalmanovici Trestioreanu, H. Green, M. Paul, J. Yaphe, L. Leibovici, Antimicrobial agents for treating uncomplicated urinary tract infection in women, Cochrane Lib. (2010).
10. C. Costelloe, C. Metcalfe, A. Lovering, D. Mant, A.D. Hay, Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: systematic review and meta-analysis, BMJ 2010;340: c2096.
11. H.M. Zowawi, P.N. Harris, M.J. Roberts, P.A. Tambyah, M.A. Schembri, M.D. Pezzani, D.A. Williamson, D.L. Paterson, The emerging threat of multidrugresistant Gram-negative bacteria in urology, Nature Rev. Urol. 2015;12:570– 584.
12. W.H. Organization, Antimicrobial Resistance: Global Report on Surveillance, World Health Organization, 2014.
13. R.J. Ackermann, P.W. Monroe, Bacteremic urinary tract infection in older people, J. Am. Geriatr. Soc. 1996;44:927–933.
14. R.H. Latham, K. Running, W.E. Stamm, Urinary tract infections in young adult women caused by Staphylococcus saprophyticus, JAMA 1983;250: 3063– 3066.
15. A. Ronald, The etiology of urinary tract infection: traditional and emerging pathogens, Dis. Mon. 2003;49:71–82.
16. M. Heidary, H. Goudarzi, A. Hashemi, G. Eslami, M. Goudarzi, A.S. Chirani, S. Amraei, The prevalence of genes that encode Quinolone resistance in Klebsiella pneumoniae strains isolated from hospitalized patients during 2013–2014, Arc. Pediatr. Infect. Dis. 2016; (In press).
17. M. Heidary, A. Bahramian, H. Goudarzi, G. Eslami, A. Hashemi, S. Khoshnood, To study the association between AcrAB and Qep A efflux pumps and ciprofloxacin resistance among Escherichia coli and Klebsiella pneumoniae clinical strains, Arak Med. Univ. J. 2016;19:1–10.
18. M. Heidary, A. Bahramian, A. Hashemi, M. Goudarzi, V.F. Omrani, G. Eslami, H. Goudarzi, Detection of acrA, acrB, aac (60)-Ib-cr, and qepA genes among linical isolates of Escherichia coli and Klebsiella pneumoniae, Acta Microbiol. Immunol. Hung. 2016; 1–7.
19. N. Allocati, M. Masulli, M.F. Alexeyev, C. Di Ilio, Escherichia coli in Europe: an overview, Int. J. Environ. Res. Public Health 2013;10:6235–6254.
20. M. Alzohairy, H. Khadri, Frequency and antibiotic susceptibility pattern of uro-pathogens isolated from community and hospital-acquired infections in Saudi Arabia-a prospective case study, Br. J. Med. Res. 2011;1:45.
21. M. Sedighi, M. Halajzadeh, R. Ramazanzadeh, N. Amirmozafari, M. Heidary, S. Pirouzi, Molecular detection of b-lactamase and integron genes in clinical strains of Klebsiella pneumoniae by multiplex polymerase chain reaction, Rev. Soc. Bras. Med. Trop. 2017;50:321–328.
22. K. Laupland, T. Ross, J.D. Pitout, D. Church, D. Gregson, Community-onset urinary tract infections: a population-based assessment, Infection 2007;35: 150–153.
23. L.E. Nicolle, S. Bradley, R. Colgan, J.C. Rice, A. Schaeffer, T.M. Hooton, Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults, Clin. Infect. Dis. 2005; 643–654.
24. R. Ikram, R. Psutka, A. Carter, P. Priest, An outbreak of multi-drug resistant Escherichia coli urinary tract infection in an elderly population: a casecontrol study of risk factors, BMC Infect. Dis. 2015;15:224.
25. J. Horcajada, E. Shaw, B. Padilla, V. Pintado, E. Calbo, N. Benito, R. Gamallo, M. Gozalo, J. Rodríguez-Baño, Healthcareíassociated, communityíacquired and hospitalíacquired bacteraemic urinary tract infections in hospitalized patients: a prospective multicentre cohort study in the era of antimicrobial resistance, Clin. Microbiol. Infect. 2013;19: 962–968.
26. T. Demir, T. Buyukguclu, Evaluation of the in vitro activity of fosfomycin tromethamine against Gram-negative bacterial strains recovered from community-and hospital-acquired urinary tract infections in Turkey, Int. J. Infect. Dis. 2013;17:e966–e970.
27. F. Yeganeh-Sefidan, R. Ghotaslou, M.T. Akhi, M.R. Sadeghi, Y. Mohammadzadeh-Asl, H.B. Baghi, Fosfomycin, interesting alternative drug for treatment of urinary tract infections created by multiple drug resistant and extended spectrum b-lactamase producing strains, Iran. J. Microbiol. 2016;8: 125.
28. S.B. Levy, B. Marshall, Antibacterial resistance worldwide: causes, challenges and responses, Nat. Med. 2004;10:S122–S129.
29. A. Gomez-Simmonds, M. Greenman, S.B. Sullivan, J.P. Tanner, M.G. Sowash, S. Whittier, A.-C. Uhlemann, Population structure of Klebsiella pneumoniae causing bloodstream infections at a New York City tertiary care hospital: diversification of multidrug-resistant isolates, J. Clin. Microbiol. 2015;53:2060–2067.
30. D.M. Arana, M. Rubio, J.-I. Alós, Evolution of antibiotic multiresistance in Escherichia coli and Klebsiella pneumoniae isolates from urinary tract infections: a 12-year analysis (2003–2014), Enferm. Infecc. Microbiol. Clin. 2017;35:293–298.
31. M. Anvarinejad, F. Sh, F. Emamghoreishi, M. Hoseini, Investigating the frequency of multi-drug resistant strains of escherichia coli isolated from urinary tract infection in children, J. Jahrom Univ. Med. Sci. 2012;9: 18.
32. S.S. de Andrade, A.C. Gales, H.S. Sader, Antimicrobial Resistance in Gramnegative Bacteria from Developing Countries. In Antimicrobial Resistance in Developing Countries, Springer, 2010, 249–266.
33. S. Eshetie, C. Unakal, A. Gelaw, B. Ayelign, M. Endris, F. Moges, Multidrug resistant and carbapenemase producing Enterobacteriaceae among patients with urinary tract infection at referral Hospital, Northwest Ethiopia, Antimicrob. Resistance Infect. Control 2015;4:12.
34. S.-Y. Lee, Y.-J. Park, J.K. Yu, S. Jung, Y. Kim, S.H. Jeong, Y. Arakawa, Prevalence of acquired fosfomycin resistance among extended-spectrum (-lactamaseproducing Escherichia coli and Klebsiella pneumoniae clinical isolates in Korea and IS26-composite transposon surrounding fosA3, J. Antimicrob. Chemother. 2012;67:2843–2847.
35. J.D. Siegel, E. Rhinehart, M. Jackson, L. Chiarello, Management of multidrugresistant organisms in health care settings, 2006, Am. J. Infect. Control 2007;35:S165–S193.
36. Clinical and Laboratory Standards Institute (CLSI), author Clinical and Laboratory Standards Institute document M2-A9 [ISBN 1-56238-586-0] 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087–1898 USA: CLSI; 2012.

Performance Standards for Antimicrobial Disk Susceptibility Tests; Approved Standard—Ninth Edition.

37. Yismaw G, Asrat D, Woldeamanuel Y, Unakal C G. Urinary Tract Infection: Bacterial etiologies, drug resistance profile and associated risk factors in diabetic patients attending Gondar University Hospital, Gondar, Ethiopia. Euro J Exp Bio. 2012;2(4):889–898.
38. Hamdan Z H, Eman K, Amar M A, Onab S H, Sarah O S, Ishag A. Urinary tract infections and antimicrobial sensitivity among diabetic patients at Khartoum, Sudan. Annals of Clinical Microbiology and Antimicrobials. 2015;14(26):1–6.
39. Osanyinpeju O S, Akinleye O M, Deji A M, Olaniyan J T, Akintunde B G, Buhari O A. Asymptomatic Urinary Tract Infection In Diabetic Patients In Ago-Iwoye, Ogun State, Nigeria. Journal of American Science. 2014;10(4s):72–78.
40. Rabindra S, Mahabouddha Kathmandu. Urinary tract infection and antibiotic sensitivity pattern among diabetics. Nepal Med Coll J. 2013;15(1):1–4.
41. Chaudhary BL, Charu C, Shukla S. Bacteriology of urinary tract infection and antibiotic susceptibility pattern among diabetic patients. Int J Bioassays. 2014;3(08):3224–3227.
42. Al-Qaseer A, Abdul-wahab B H, Abbas O K. Bacteriological finding of urinary tract infection in diabetic patients. International Journal Advanced Research. 2014;2(10):274–279.
43. Muhammad I, Saeed A, Sohaib M K, Moeez H, Imtiaz H B. Urinary tract infection in diabetic patients; causative bacteria and antibiotic sensitivity. J Med Sci. 2014;22(3):110–114.
44. Blomberg B, Olsen BE, Hinderaker SG, Langeland N, Gasheka P, Jureen R, Kvale G, Midtvedt T. Antimicrobial resistance in urinary bacterial isolates from pregnant women in rural Tanzania: implications for republichealth. Scandinavian Journal of Infectious Diseases. 2005;37(4):262–268.
45. Haider G, Zehra N, Munir AA, Haider A. Risk factors of urinary tract infection in pregnancy. J Pak Med Assoc. 2010;60(3):213–266.
46. Mathai E, Thomas RJ, Chandy S, Mathai M, Bergstrom S. Antimicrobials for the treatment of urinary tract infection in pregnancy: practices in southern India. Pharmacoepidemiol Drug Saf. 2004;13(9):645–652.
47. Mandal J, Srinivas AN, Buddhapriya D, Subhash CP. Antibiotic resistance pattern among common bacterialuropathogens with a special reference to ciprofloxacinresistant Escherichia coli. Indian J Med Res. 2012;(136):842–849.
48. Gupta N, Kundra S, Sharma A, Gautam V, Arora DR. Antimicrobial susceptibility of uropathogens in India. J Infect Dis Antimicrob Agents. 2007;(24):13–18.
49. Masinde A, Gumodoka B, Kilonzo A, Mshana SE. Prevalence of urinary tract infection among pregnant women at Bugando Medical Centre, Mwanza, Tanzania. Tanzan J Health Res. 2009;11(3):154–159.
50. Sire JM, Nabeth P, Perrier-Gros-Claude JD, Bahsoun I, Siby T, Macondo EA, Gaye-Diallo A, Guyomard S, Seck A, Breurec S, Garin B. Antimicrobial resistance in outpatient Escherichia coli urinary isolates in Dakar, Senegal. J Infect Dev Ctries. 2007;1(3):263–268.
51. Kariuki S, Revathi G, Corkill J, Kiiru J, Mwituria J, Mirza N, Hart CA. Escherichia coli from community-acquired urinary tract infections resistant to fluoroquinolones and extended-spectrum beta-lactams. J Infect Dev Ctries. 2007;1(3):257–262.
52. Gales AC, Sader HS, Jones RN. SENTRY Participants Group (Latin America): Urinary tract infection trends in Latin American hospitals: report from the SENTRY antimicrobial surveillance program (1997–2000) DiagnMicrobiol Infect Dis. 2002;44(3):289–299.
53. Williams DN, Sannes MR, Eckhoff AA, Peterson PK, Johnson JR, Sannes MR, San Román M, Mora N, Moya J. Antimicrobial resistance in Escherichia coli causing urinary tract infections in Costa Rica: a clinical dilemma. Int J Antimicrob Agents. 2003;21(1):79–81.
54. Ghenghesh KS, Elkateb E, Berbash N, Abdel Nada R, Ahmed SF, Rahouma A, et al. Uropathogens from diabetic patients in Libya: virulence factors and phylogenetic groups of Escherichia coli isolates. J Med Microbiol. 2009;58:1006–1014.
55. Albrich WC, Monnet DL, Harbarth S. Antibiotic selection pressure and resistance in Streptococcus pneumoniae and Streptococcus pyogenes. Emerging Infectious Disease. 2004;38:363–371.

Source of Support: The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.