ORIGINAL ARTICLE

Antimicrobial Resistance Pattern in *Escherichia coli* Isolates Obtained from a Specialized Women and Children Hospital in Shiraz, Iran: A Prevalence Study

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Received: 30 August 2016
Revised: 1 September 2016
Accepted: 30 September 2016

Abstract

Background: *Escherichia coli,* known as a clinically significant bacteria, can cause a wide range of infections, including urinary tract infections (UTIs), blood stream infections (BSIs), and can frequently be isolated from various clinical specimens. Evaluation of antimicrobial resistant pattern is a necessary action, especially about such bacteria which are frequent and life threatening. The aim of this study was to determine the frequency and antimicrobial resistance pattern of *E. coli* isolates obtained from various clinical specimens.

Methods: This retrospective study was performed within a seven month period from January 2015 to August 2015 at a specialized women and children hospital in Shiraz, Iran. *E. coli* isolates were obtained from various clinical specimens and identified using standard microbiological procedure. Antimicrobial susceptibility patterns were determined using disk diffusion method in accordance with CLSI recommendation.

Results: Of the total 130 positive cultures, the majority of *E. coli* isolates were obtained from urine (96=73.8%) and blood (11=8.5%) specimens. Overall, gentamicin (70.8%) was the effective antibiotic for the tested *E. coli* isolates. *E. coli* isolates obtained from urine specimens showed the highest resistance rates against ampicillin (84.4%) and nalidixic acid (61.5%); while they showed the most sensitivity to gentamicin (79.2%), nitrofurantoin (70.8%) and ciprofloxacin (66.7%). Moreover, the highest antibiotic resistance rates belonged to the isolates recovered from endotracheal tube (ETT).

Conclusion: The results showed that gentamicin was the most effective antibiotic against *E. coli* infections. However, in addition to the gentamicin, we can recommend nitrofurantoin and ciprofloxacin as the other effective agents for UTIs.

Please cite this article as: Hadadi M, Malekzadegan Y, Heidari H, Sedigh Ebrahim-Saraie H, Motamedifar M. Antimicrobial Resistance Pattern in *Escherichia coli* Isolates Obtained from a Specialized Women and Children Hospital in Shiraz, Iran: A Prevalence Study. J Health Sci Surveillance Sys. 2016;4(4):194-198.

Keywords: *Escherichia coli*, Women, Children, Nosocomial infections, Antibiotic susceptibility

Introduction

Escherichia coli, a Gram negative rod which belongs to the family of Enterobacteriaceae, causes both community acquired and nosocomial infections.[1,2] Hence, it is known as a clinical significance which can cause a wide range

of bacterial infections, including urinary tract infections (UTIs), blood stream infections (BSIs), otitis media, pneumonia, meningitis, traveler's diarrhea, and can frequently be isolated from various clinical specimens.[3,4]

The incidence of UTI is associated with gender and age; actually, it is more common among females in all age groups.[5] Pregnant women are more susceptible to different types of extra-intestinal *E.coli* which can cause several asymptomatic and symptomatic infections.[6] *E. coli* is a part of the intestinal and vaginal normal flora and may be implicated in a large number of diseases such as neonatal meningitis and septicemia which are considered as major health problems in developing countries.[7-9]

The use of β-lactam antimicrobial agents for treating infections caused by *E. coli* is more prevalence than other types of antimicrobial agents. But widespread usage of antibiotics has led to an increase in emergence and spread of antimicrobial resistant strains all over the world.[3,4,10] Nowadays, antimicrobial resistance is a serious public health problem worldwide, since the infections caused by resistant strains have been shown to be more commonly related to increased morbidity and mortality than the susceptible ones.[11-15] Also, this had led to increasing hospital stays, health care costs and cases with untreatable infections.[11,16]

According to the importance of antibiotic resistance, evaluation of antimicrobial resistant pattern is a necessary measure, especially about such bacteria which are frequent and life threatening. The aim of this study was to determine the frequency and antimicrobial resistance pattern of *E. coli* isolates obtained from various clinical specimens from a tertiary care hospital in Shiraz, Southwest of Iran.

Materials and Methods

Study Design and Setting

This retrospective cross-sectional study was performed within a seven month period from January 2015 to August 2015 at a specialized women and children hospital of Hazrat Zeinab affiliated to Shiraz University of Medical Sciences in Shiraz, the southwest Iran. *E. coli* isolates were obtained from various clinical specimens from patients referred to studied hospital.

Bacterial Isolates and Identification

In total, 130 clinical isolates of *E. coli* were collected from different specimens including urine, blood, wound, endotracheal tube (ETT) and eye, as a part of routine diagnostic microbiology services provided for the patients admitted to Hazrat Zeinab Hospital. All of the received clinical specimens were initially cultivated on blood agar and MacConkey agar, and after an overnight incubation in 37°C, *E. coli* identification was completed by gram staining as well as standard biochemical tests through sub-culturing on mediums such as triple sugar iron agar (TSI), SIM medium, and Simmons' citrate agar.

Antimicrobial Susceptibility Testing

The antimicrobial susceptibility testing was performed on Mueller-Hinton agar (Merck, Germany) by the disc diffusion method according to the procedure of Clinical Laboratory Standard Institute (CLSI) guidelines.[17] The locally available and prescribing antibiotic disks (HiMedia, India) such as cefixime (CFM), amikacin (AN), nalidixic acid (NA), ampicillin (AM), gentamicin (GM), nitrofurantoin (FM), trimethoprim-sulphamethoxazole (SXT), and ciprofloxacin (CP) were used. In our results, intermediate-resistant isolates were considered as resistant.

Statistical Analysis

Analyses were performed using SPSS™ software, version 21.0 (IBM Corp., USA). The results are presented as descriptive statistics in terms of relative frequency. Values were expressed as the mean±standard deviation (continuous variables) or percentages of the group (categorical variables).

Results

Of the total 130 positive cultures, 109 (83.8%) belonged to female subjects and 21 (16.2%) to neonates. The majority of *E. coli* isolates in the present study were obtained from urine (96=73.8%) and blood (11=8.5%) specimens. Overall, antibacterial susceptibility tests revealed that gentamicin (70.8%) was the effective antibiotic for tested *E. coli* isolates. However, based on the site of infection, antibiotic susceptibility patterns were varied. *E. coli* isolates obtained from urine specimens showed the highest resistance rates against ampicillin (84.4%) and nalidixic acid (61.5%); while they showed the most sensitivity to gentamicin (79.2%), nitrofurantoin (70.8%) and ciprofloxacin (66.7%). The highest antibiotic resistance rates belonged to the isolates recovered from ETT since it showed full resistance toward the tested antibiotics except gentamicin with 60% susceptibility. The full results of antibiotic resistance patterns according to the source of infection are presented in Tables 1.

Discussion

In the current study, we monitored a total of 130 clinical of *E. coli* isolates from various specimens collected in a specialized women and children hospital. This bacterium is the most frequent hospital-acquired infection, affecting mainly vulnerable populations including pregnant women and neonates.[18,19] The results of the current

Table 1: Antibiotic resistance patterns of *E. coli* isolates according to the source of infection

Sample (No.)	CFM No. (%)	AN No. (%)	GM No. (%)	CP No. (%)	SXT No. (%)	NA No. (%)	AM No. (%)	FM No. (%)
Urine (96)	52 (54.2)	47 (49)	20 (20.8)	32 (33.3)	53 (55.2)	59 (61.5)	81 (84.4)	28 (29.2)
Blood (11)	10 (90.9)	9 (81.8)	9 (81.8)	5 (45.5)	7 (63.6)	-	-	-
Eye (6)	4 (66.7)	4 (66.7)	3 (50)	3 (50)	4 (66.7)	-	-	-
Wound (5)	4 (80)	4 (80)	2 (40)	4 (80)	5 (100)	-	-	-
ETT [a] (5)	5 (100)	5 (100)	2 (40)	4 (80)	5 (100)	-	-	-
Secretions (5)	4 (80)	5 (100)	2 (40)	4 (80)	5 (100)	-	-	-
Cyst (2)	2 (100)	0	0	1 (50)	2 (100)	-	-	-
Total	81 (62.3)	74 (56.9)	38 (29.2)	53 (40.8)	81 (62.3)	-	-	-

[a]Endotracheal tube

survey showed that *E. coli* has been mostly isolated from urine samples, consistent with other studies that introduced *E. coli* as the most common cause of UTIs.[9,20-23] The frequency of *E. coli* in BSI was the second source of isolation after UTI in the present study. Previously, the frequency of *E. coli* as the important cause of BSIs relating to Gram-negative bacteria was noted in several studies.[24-26]

As another purpose and given the importance of antibiotic resistance which has become a worldwide concern, we investigated the trends in antibiotic resistance among the collected *E. coli* isolates from different specimens in order to make the physicians aware about the regional antibiotic resistance rates, which is important for appropriate antibiotic prescription. The used antibiotics according to the source of infection were different, but gentamicin which was tested against all collected *E. coli* isolates was the most effective antibiotic in our findings. Aminoglycosides, mainly gentamicin, are primarily used in the treatment of infections caused by gram-negative aerobic bacilli including *E. coli*.[27-29] However, recently the use of of aminoglycosides resistant isolates has been common in Iran and other parts of the world.[27,30]

Among antibiotics tested for urine isolated *E. coli,* the most effective ones were gentamicin, nitrofurantoin and ciprofloxacin, respectively. Previously published data by authors from two teaching hospitals in Shiraz (Nemazee and Dastgheib) showed some differences with the findings of the present study based on the antimicrobial stewardship used.[31,32] Nitrofurantoin and aminoglycosides were the common choices in terms of promising susceptibility in all hospitals.[31,32] However, compared to other hospitals, the rate of ciprofloxacin resistance in Nemazee hospital was remarkable.[31,32] Moreover, despite the comparable antibiotic resistance results of our urine isolated *E. coli* with other Iranian and globally conducted studies, antibiotic susceptibility patterns have a variable nature according to both time and geographical area.[33-36] The highest antibiotic resistance rates in uropathogenic *E. coli* belonged to ampicillin and nalidixic acid, which was consistent with those reports that indicated the decreasing susceptibility of *E. coli* isolates toward penicillin and quinolone family.[31,33,35,37]

As limitations of retrospective studies, we did not have access to patients to determine the related risk factors such as prior antibiotic exposure and also only access to the results of locally available antibiotics. Meanwhile, the results obtained from a tertiary care hospital cannot be generalized to whole region.

Conclusion

The results of the present study found gentamicin as the most effective antibiotic against *E. coli* infections. However, according to the importance of UTIs in healthcare settings, rational prescription of antibiotics and restricted infection control policies are required for management of infections. These findings provide significant evidence for physicians to prescribe safe and effective empiric therapies.

Acknowledgement

We thank all the personnel at Hazrat Zeinab hospital microbiology laboratory for their technical assistance. This work was supported by Department of Bacteriology and Virology, Shiraz University of Medical Sciences, Shiraz, Iran.

Conflict of Interest: None declared.

References

1 Fukushima M, Kakinuma K, Kawaguchi R. Phylogenetic analysis of *Salmonella, Shigella*, and *Escherichia coli* strains on the basis of the gyrB gene sequence. J Clin Microbiol 2002; 40(8):2779-85.

2 Toval F, Kohler CD, Vogel U, Wagenlehner F, Mellmann A, Fruth A, et al. Characterization of *Escherichia coli* isolates from hospital inpatients or outpatients with urinary tract infection. J Clin Microbiol 2014; 52(2):407-18.

3 Tayebi Z, Heidari H, Kazemian H, Ghafoori SM, Boroumandi S, Houri H. Comparison of quinolone and beta-lactam resistance among *Escherichia coli* strains isolated from urinary tract infections. Infez

Med 2016; 24(4):326-30.

4 Kazemian H, Heidari H, Ghanavati R, Mohebi R, Ghafourian S, Shavalipour A, et al . Characterization of Antimicrobial Resistance Pattern and Molecular Analysis among Extended Spectrum β-Lactamase-Producing *Escherichia coli*. Pharm Sci 2016; 22(4): 279-84.

5 Najar MS, Saldanha CL, Banday KA. Approach to urinary tract infections. Indian J Nephrol 2009; 19(4):129-39.

6 Saez-Lopez E, Cossa A, Benmessaoud R, Madrid L, Moraleda C, Villanueva S, et al. Characterization of Vaginal *Escherichia coli* Isolated from Pregnant Women in Two Different African Sites. PLoS One 2016; 11(7).

7 Simonsen KA, Anderson-Berry AL, Delair SF, Davies HD. Early-onset neonatal sepsis. Clin Microbiol Rev 2014; 27(1):21-47.

8 Motamedifar M, Sedigh Ebrahim-Saraie H, Mansury D, Nikokar I, Hashemizadeh Z. Prevalence of Etiological Agents and Antimicrobial Resistance Patterns of Bacterial Meningitis in Nemazee Hospital, Shiraz, Iran. Arch Clin Infect Dis 2015; 10(2): e22703.

9 Amiri M, Lavasani Z, Norouzirad R, Najibpour R, Mohamadpour M, Nikpoor AR, et al. Prevalence of Urinary Tract Infection Among Pregnant Women and its Complications in Their Newborns During the Birth in the Hospitals of Dezful City, Iran, 2012 - 2013. Iran Red Crescent Med J 2015; 17(8).

10 Oteo J, Perez-Vazquez M, Campos J. Extended-spectrum [beta]-lactamase producing *Escherichia coli*: changing epidemiology and clinical impact. Curr Opin Infect Dis 2010; 23(4):320-6.

11 Ventola CL. The antibiotic resistance crisis: part 1: causes and threats. P T 2015; 40(4):277-83.

12 Heidari H, Ebrahim-Saraie HS. Risk of Vancomycin-Resistant Enterococci Colonization among Cancer Patients in Iran. Austin J Infect Dis 2016; 3(3): 1028.

13 Kaveh M, Bazargani A, Ramzi M, Sedigh Ebrahim-Saraie H, Heidari H. Colonization Rate and Risk Factors of Vancomycin-Resistant Enterococci among Patients Received Hematopoietic Stem Cell Transplantation in Shiraz, Southern Iran. Int J Organ Transplant Med 2016; 7(4):197-205.

14 Seifi K, Kazemian H, Heidari H, Rezagholizadeh F, Saee Y, Shirvani F, et al. Evaluation of Biofilm Formation Among Klebsiella pneumoniae Isolates and Molecular Characterization by ERIC-PCR. Jundishapur J Microbiol. 2016; 9(1):e30682.

15 Kazemian H, Shavalipour A, Mohebi R, Ghafurian S, Aslani S, Maleki A, et al. Estimation of the Parasitic Infection Prevalence in Children With *Helicobacter pylori* Infection in Ilam City (2012-2013). Arch Pediatr Infect Dis 2014; 2(3):e15294.

16 Mulvey MR, Simor AE. Antimicrobial resistance in hospitals: how concerned should we be? Cmaj 2009; 180(4):408-15.

17 CLSI (2015). Performance Standards for Antimicrobial Susceptibility Testing; 25th Informational Supplement. M100-S25. Wayne, PA: Clinical and Laboratory Standards Institute.

18 Katouli M. Population structure of gut *Escherichia coli* and its role in development of extra-intestinal infections. Iran J Microbiol 2010; 2(2):59-72.

19 Watt S, Lanotte P, Mereghetti L, Moulin-Schouleur M, Picard B, Quentin R. *Escherichia coli* strains from pregnant women and neonates: intraspecies genetic distribution and prevalence of virulence factors. J Clin Microbiol 2003; 41(5):1929-35.

20 Ronald A. The etiology of urinary tract infection: traditional and emerging pathogens. Dis Mon 2003; 49(2):71-82.

21 Spahiu L, Hasbahta V. Most frequent causes of urinary tract infections in children. Med Arh 2010; 64(2):88-90.

22 Nozarian Z, Abdollahi A. Microbial Etiology and Antimicrobial Susceptibility of Bactria Implicated in Urinary Tract Infection in Tehran, Iran. Iran J Pathol 2015; 10(1):54-60.

23 Behzadi P, Behzadi E, Yazdanbod H, Aghapour R, Akbari Cheshmeh M, Salehian Omran D. A survey on urinary tract infections associated with the three most common uropathogenic bacteria. Maedica 2010; 5(2):111-5.

24 Tumbarello M, Spanu T, Di Bidino R, Marchetti M, Ruggeri M, Trecarichi EM, et al. Costs of bloodstream infections caused by *Escherichia coli* and influence of extended-spectrum-beta-lactamase production and inadequate initial antibiotic therapy. Antimicrob Agents Chemother 2010; 54(10):4085-91.

25 Laupland KB, Gregson DB, Church DL, Ross T, Pitout JD. Incidence, risk factors and outcomes of *Escherichia coli* bloodstream infections in a large Canadian region. Clin Microbiol Infect 2008; 14(11):1041-7.

26 Tumbarello M, Sali M, Trecarichi EM, Leone F, Rossi M, Fiori B, et al. Bloodstream infections caused by extended-spectrum-beta-lactamase- producing *Escherichia coli*: risk factors for inadequate initial antimicrobial therapy. Antimicrob Agents Chemother 2008; 52(9):3244-52.

27 Ramirez MS, Tolmasky ME. Aminoglycoside modifying enzymes. Drug Resist Updat 2010; 13(6):151-71.

28 Japoni A, Gudarzi M, Farshad S, Basiri E, Ziyaeyan M, Alborzi A, et al. Assay for integrons and pattern of antibiotic resistance in clinical *Escherichia coli* strains by PCR-RFLP in Southern Iran. Jpn J Infect Dis 2008; 61(1):85-8.

29 Ayatollahi J, Shahcheraghi SH, Akhondi R, Soluti S. Antibiotic Resistance Patterns of *Escherichia coli* Isolated from Children in Shahid Sadoughi Hospital of Yazd. Iran J Ped Hematol Oncol 2013; 3(2):78-82.

30 Soleimani N, Aganj M, Ali L, Shokoohizadeh L, Sakinc T. Frequency distribution of genes encoding aminoglycoside modifying enzymes in uropathogenic

E. coli isolated from Iranian hospital. BMC Res Notes 2014; 7(842):1756-0500.

31 Motamedifar M, Ebrahim-Saraie HS, Mansury D, Khashei R, Hashemizadeh Z, Rajabi A. Antimicrobial Susceptibility Pattern and Age Dependent Etiology of Urinary Tract Infections in Nemazee Hospital, Shiraz, South-West of Iran. Int J Enteric Pathog 2015; 3(3): e26931.

32 Motamedifar M, Zamani Kh, Hassanzadeh Y, Pashoutan S. Bacterial Etiologies and Antibiotic Susceptibility Pattern of Urinary Tract Infections at the PediatricWard of Dastgheib Hospital, Shiraz, Iran: A Three-Year Study (2009 - 2011). Arch Clin Infect Dis 2016; 11(2):e28973.

33 Khoshbakht R, Salimi A, Shirzad Aski H, Keshavarzi H. Antibiotic Susceptibility of Bacterial Strains Isolated From Urinary Tract Infections in Karaj, Iran. Jundishapur J Microbiol 2013; 6(1):86–90.

34 Amin M, Mehdinejad M, Pourdangchi Z. Study of bacteria isolated from urinary tract infections and determination of their susceptibility to antibiotics. Jundishapur J Microbiol 2009; 2(3):118–23.

35 Hryniewicz K, Szczypa K, Sulikowska A, Jankowski K, Betlejewska K, Hryniewicz W. Antibiotic susceptibility of bacterial strains isolated from urinary tract infections in Poland. J Antimicrob Chemother 2001; 47(6):773-80.

36 Daza R, Gutierrez J, Piedrola G. Antibiotic susceptibility of bacterial strains isolated from patients with community-acquired urinary tract infections. Int J Antimicrob Agents 2001; 18(3):211-5.

37 Sabir S, Ahmad Anjum A, Ijaz T, Asad Ali M, Ur Rehman Khan M, Nawaz M. Isolation and antibiotic susceptibility of E. coli from urinary tract infections in a tertiary care hospital. Pak J Med Sci 2014; 30(2):389-92.