Research Paper E-ISSN NO : 2455-295X | VOLUME : 3 | ISSUE : 11 | NOV 2017

ANTIMICROBIAL SUSCEPTIBILITY OF ESCHERICHIA COLI ISOLATES FROM BLOOD IN RELATION TO AGE, SEX AND MONTHS

FAISAL ALMAJED [1] | YASSER BADER S. SWAILEM [1] | FEDA ALJASER [2] | HAZEM AQEL [1] | SAMEERA AL-JUHANI [1] | SHOEB QURESHI [3]

[1] CLINICAL LABORATORY SCIENCES DEPARTMENT, COLLEGE OF APPLIED MEDICAL SCIENCES, KING SAUD BIN ABDULAZIZ UNIVERSITY FOR HEALTH SCIENCES, P.O. BOX 3660; RIYADH 11481; MAIL CODE: 3129; SAUDI ARABIA.

[2] CLINICAL LABORATORY SCIENCES DEPARTMENT, COLLEGE OF APPLIED MEDICAL SCIENCES, KING SAUD UNIVERSITY,P. O. BOX 10219; RIYADH 11433; SAUDI ARABIA.

[3] RESEARCH UNIT, COLLEGE OF APPLIED MEDICAL SCIENCES, KING SAUD BIN ABDULAZIZ UNIVERSITY FOR HEALTH SCIENCES, P. O. BOX 3660; RIYADH 11481; MAIL CODE: 3129; SAUDI ARABIA.

ABSTRACT

Objectives: *Determination of antibiotic susceptibility in reports of Escherichia coli (E. coli) pathogens isolated from blood in 2013 from January to December at King Abdulaziz Medical City (KAMC), King Fahd Hospital, Riyadh, Saudi Arabia.*

Design: *Description of bacterial blood isolates, evaluation of their clinical significance by microbiology staff, andcommunication with the Communicable Disease Surveillance Centre.*

Setting: *Clinical Microbiology Department at King Abdulaziz Medical City (KAMC), King Fahd Hospital, Riyadh, Saudi Arabia.*

Subjects: *Patients yielding clinically significant E. coliisolate from blood.*

Results: *Data on 181 isolates of E. coli, corresponding to the same number of patients, were reported, including 86 (47.5%) male patients and 95 (52.4%) female patients. All isolates were collected from blood. Of the total number of isolates, 17 (9.3%) were from patients <20 years of age, 30 (16.5%) were from patients 20-45 years of age, 72 (39.7%) were from patients 46-71 years of age and 62 (34.2%) were from patients >71 years of age. Patients with E. coli infection showed highly increased sensitivity to amikacin (92.8%), while they displayed declined sensitivity to ampicillin (18.2%). The antibiotics showed variation in sensitivity against bacteria in different months, e.g. amikacin showed high sensitivity in September and June (100%), whereas gentamicin was high in sensitivity in February (100%). For ceftriaxone, it showed high sensitivity among patients in July and December (77.7% and 72.7%). Patients of age >70 years showed high sensitivity to amikacin (94.9%) followed by patients of age 46-71 years (93.1%). Non-extended-spectrum beta-lactamases (NESBL) producers increased in patients attending the KAMC hospital in August and September (12.2%), and they were higher in patients 46-76 years old (45.8%).*

Conclusions: *Reports from microbiology laboratory provided valuable information on antibiotic susceptibility in bacteremia cases and showed a worrying decrease in susceptibility to some of the important antibiotics.*

Keywords: E. coli, Susceptibility; Blood culture; Antibiotics, Antimicrobial.

INTRODUCTION

Bacteremia remains one of the most important causes of morbidity and mortality around the world. Approximately 200,000 cases of bacteremia occur annually with mortality rates ranging from 20-50% worldwide [1, 2]. Bacteremia accounts for 10-20% of all nosocomial infections and is the eighth leading cause of mortality (17%) in the United States [3].One of the most common pathogens among gram-negative bacilli that could cause bacteremia is E. coli [4]. European Antimicrobial Resistance Surveillance System reported in a study that the frequency of bacteremia due to E. coli increased by 8.1% per year from 2002 to 2008, with the additional caseload attributed to increasing antimicrobial resistance [5].Moreover, it wasshownthat the most prevalent microorganism with resistance data reported bythe Gulf Corporation Council (GCC) countries from 1990 to 2011 was E. coli, followed by Klebsiella pneumoniae and others. The report demonstrated the proportion of E. coli resistance, which was 7.6% in Saudi Arabia compared to the other Gulf countries [6].The importance of that study is to aid clinicians to facilitate the empiric treatment and management of patients with symptoms of bacteremia. Moreover, their data would also help authorities to formulate antibacterial prescription policies.The aim of the present study is to highlight the bacterial etiology of bacteremia and determine the sensitivity pattern of E. coli isolates.

Methods

This study was carried out at the Clinical Microbiology Department in King Abdulaziz Medical City (KAMC), King Fahd Hospital, Riyadh, Saudi Arabia. A total of 181 non-duplicate *E. coli* isolated from blood culture during the

period of the study from January to December 2013 were reviewed.

Antimicrobial Susceptibility Studies

The protocol for *E. coli* susceptibility testing included the different antimicrobial agents such as ampicillin, aminoglycosides (gentamicin, tobramycin, and amikacin), fluoroquinolones (ciprofloxacin), third-generation cephalosporins (cefotaxime, ceftazidime and ceftriaxone), and fourth-generation cephalosporin (cefepime).

AccordingtoNational Committee for Clinical Laboratory Sta ndard (NCCLS) criteria, a consensus guideline for detecting ESBL production was recommended by the European Antimicrobial Resistance Surveillance System (EARSS) to all participants [7]. Non-ESBL producers were considered sensitive to cefotaxime, ceftazidime, ceftriaxone, and cefepimeapart from their minimum inhibitory concentration (MIC) in accordance with NCCLS criteria [7].

Statistical Analysis

Differences in the prevalence of antimicrobial resistance between different groups were assessed by Fisher exact test. Association was determined by calculation of the odds ratio (OR) with 95% confidence intervals (CI). The null hypothesis was rejected for values of $P<0.05$. Statistical analysis was performed using IBM SPSS version 20 software.

Results

Patient Data

Data of 181 *E. coli* blood isolates, corresponding to the same number of patients, were reported, including 86 (47.5%) male patients and 95 (52.4%) female patients. Of the total number of isolates, 17 (9.3%) were from patients <20 years of age, 30 (16.5%) were from patients 20-45 years of age, 72 (39.7%) were from patients 46-71 years of age, and 62 (34.2%) were from patients >71 years of age. The peak of isolates was in August and September (11.0%). A total of 174 (81.2%) isolates were implicated in nosocomial infections; 14.3% from surgery, 9.3% from ICU and oncology, 8.8% from medical centers and emergency care center, 7.1% from trauma intensive care, 6.6% from cardiology and hepatobiliary sciences, 4.4% from liver step down and transitional care unit, 3.8% from organ transplantation, 2.7% from pediatric, 0.5% from obstetrics,8.8% from other departments, and 7 (3.8%) isolates were associatedwith community-acquired infections (Table 1).

Antimicrobial Sensitivity

The antimicrobial sensitivity of the *E. coli* isolates studied in relation to sex is shown in Table 2. The sensitivity of *E. coli* to ciprofloxacin was highly significant among female than male (61.2%; *P*-value 0.016, OR 51.38, and CI 95% 22.88-79.88). The sensitivity of test *E. coli*isolates to tobramycin was also higher among female (56.8%) but not in male (43.16%;*P*-value 0.006, OR 50.83, and CI 95% 33.47-68.19). The peak of antimicrobial sensitivity for those isolates was increased for amikacin (92.8%) followed by gentamicin (75.6%). However, the peak of sensitivity was decreased for ampicillin (18.2%).

Monthly prevalence of antimicrobial sensitivity for the studied *E. coli* blood isolates is shown in Table 3. Out of 9 used antibiotics amikacin was the highest in sensitivity at all months (>85%), while gentamicin was higher in sensitivity (100%) in patients infected in February than amikacin (88.89%). On the other hand, ampicillin showed lowest sensitivity to for all months (<45%).

The sensitivity of *E. coli* blood isolates to antimicrobial agents in relation to age is shown in Table 3. There was a variation in sensitivity of different antibiotics with regard to age. Amikacin was the highest in sensitivity in patients >71 years old (94.9%), while gentamicin was for patients 46-71 years old (78.3%), and ciprofloxacin showed the highest sensitivity in patients between 20 and 45 years old (61.2%).

Non-ESBL (NESBL) producing*E. Coli*

The NESBL *E. coli* producers were higher among female in January (75%), May (58.3%), November (60%), and December (60%), whereasthey were high among male in February (62.5%), March (60%), July (60%), and August (56.3%). It was noted that the 181 *E. coli* blood isolates showed a high level of NESBL producers in August and September (12.2% for both months; Table 4).

The NESBL producing*E. coli*in blood isolates in relation to age are shown in Table 4. The non-ESBL producers were increased in male patients >71 years old (80%), however in female patients were increased in those aged 20-45 years (65%). From the total number of isolates, the highest incidence of NESBL producers was observed in patients 46-71 years old (45.8%).

Discussion

The decrease in antibiotic sensitivity is a major public health concern globally. Varying frequencies of low number of NESBLs among *Enterobacteriaceae* have been reported from many parts of the world [8-10]. Bacteremia due to gram-negative rods is a significant problem in hospitalized and community-dwelling patients. *E. coli* strains are the most commonly reported gram negative bacteria that cause bacteremia in the last 20 years in the developed and developing countries[11].In our study, the ratio of the male patients to female patientswas roughly equal (1.1:1.2), in contrast to previous studies in which they reported a male or female predominant [12, 13].The highest incidence of bacteremia due to *E. coli* comes from patients who had surgery (14.3%), then those admitted to ICU and oncology (9.3%),followed by those from medicine and emergency care centers (8.8%). In the United States, according to 2003 data from the National Nosocomial Infection Surveillance (NNIS) system, the number of bacteremic patients infected with *E. coli* due to surgery (17.6%) and ICU (13.6%) [14].

The aforementioned data suggested that the susceptibility *E. coli* to different antibiotics in male and female patient was not equaland affected by sex.*E. coli* blood isolates

were highly sensitive to ciprofloxacin and tobramycin among female isolates (61.2% and 56.8%) but not in male.Our results suggested that surgery, intensive care units, and emergency care centers were the risk factors that play role in nosocomial infection due to the decline in antimicrobial sensitivity. This result was not consistent with other result [12].

Previously, theuse of cephalosporin has been identified as a risk factor for reducingNESBL producing bacteria as well as ampicillin [12, 15, 16]. This study showed an increased frequency of sensitivity to amikacin (92.8%) and gentamicin (75.6%), however the sensitivity toampicillin was decreased (18.2%). The sensitivity according to age was also variable. Patients over 70 years old were highly sensitive to amikacin (94.9%). On the other hand, gentamicin was highly sensitive in the patients 46-71 years old (78.3%), while ciprofloxacin was highly sensitive in patients aged 20-45 years (61.2%). The findings of the present study showed a significantincrease in frequency of NESBLs (12.2%) over one year. This might not be applicable to the whole community, as the study focused on a single hospital's experience.The highest frequency of NESBL producers was seen in male patients over 71 years (80%),whereas in female patients were in 20-45 years old(65%).The reports from microbiology laboratory in KAMC, Riyadh, provided valuable information on antibiotic susceptibility in bacteremia and showed a worrying decrease in susceptibility to important antibiotics.

Table 1. Patient demographic characteristics for 181 Escherichia coli blood isolates in 2013.

	Sex		
	Male (%)	**Female (%)**	**Total (%)**
Number of patients	86 (47.51)	95 (52.49)	181 (100)
Age			
<20	9 (52.94)	8 (47.06))	17 (9.39)
20-45	13 (43.33)	17 (56.67)	30 (16.57)
46-71	29 (40.28)	43 (59.72)	72 (39.78)
>71	35 (56.45)	27 (43.55)	62 (34.25)
Months			
January	7 (41.18)	10 (58.82)	17 (9.39)
February	5 (55.56)	4 (44.44)	9 (4.97)
March	8 (57.14)	6 (42.86)	14 (7.73)
April	7 (53.85)	6 (46.15)	13 (7.18)
May	3 (21.43)	11 (78.57)	14 (7.73)
June	6 (40.00)	9 (60.00)	15 (8.29)
July	11 (61.11)	7 (38.89)	18 (9.94)
August	10 (50.00)	10 (50.00)	20 (11.05)
September	11 (55.00)	9 (45.00)	20 (11.05)
October	10 (58.82)	7 (41.18)	17 (9.39)
November	4 (33.33)	8 (66.67)	12 (6.63)
December	4 (36.36)	7 (63.64)	11 (6.08)
Wards			
Inpatients			
Surgery	14 (53.85)	12 (46.15)	26 (14.36)
ICU	12 (70.59)	5 (29.41)	17 (9.39)
Oncology	6 (35.29)	11 (64.71)	17 (9.39)
Nephr/Grn Med/Kidney Trans	1 (14.29)	6 (85.71)	7 (3.87)
Cardiology	7 (58.33)	5 (41.67)	12 (6.63)
Liver Step Down	6 (75.00)	2 (25.00)	8 (4.42)
Hepatobiliary Sciences	4 (33.33)	8 (66.67)	12 (6.63)
Pediatric	3 (60.00)	2 (40.00)	5 (2.76)
Transitional Care Unit	1 (12.50)	7 (87.50)	8 (4.42)
Medical Centres	10 (62.50)	6 (37.50)	16 (8.84)
Trauma Intensive Care	12 (92.30)	1 (7.69)	13 (7.18)
Emergency Care Centre	2 (12.50)	14 (87.50)	16 (8.84)
Obstetrics High Risk	0 (00.00)	1 (100)	1 (0.55)
Others	7 (43.75)	9 (56.25)	16 (8.84)
Outpatients	1 (14.29)	6 (85.71)	7 (3.87)

Table 2. Prevalence of antimicrobial sensitivity in blood isolates of E. coli in relation to patient sex.

Antimicrobial agents	Antimicrobial Sensitivity			Statistical Analysis	
	Sex				
	Male (%)	Female (%)	Total (%)	*p*-value	OR (CI 95%)
Ampicillin	20.93	45.45	18.23	0.083	28.20 (-9.05-65.46)
Gentamicin	46.72	53.28	75.69	0.022	58.56 (20.83-96.30)
Tobramycin	43.16	56.84	52.49	0.006	50.83 (33.47-68.19)
Amikacin	48.21	51.79	92.82	0.046	64.27 (2.70-125.84)
Ciprofloxacin	38.78	61.22	54.14	0.016	51.38 (22.88-79.88)
Cefotaxime	45.74	54.26	51.93	0.003	50.64 (39.70-61.58)
Ceftazidime	51.52	48.48	54.70	0.001	51.57 (43.84-59.29)
Cefepime	52.53	47.47	54.70	0.002	51.57 (42.35-60.78)
Ceftriaxone	47.92	52.08	53.04	0.001	51.01 (44.25-57.77)

Table 3. Prevalence of antimicrobial sensitivity in blood isolates of *E. coli* in relation to age and months

	Antimicrobial Sensitivity (%)								
	Ampicillin	**Gentamicin**	**Tobramycin**	**Amikacin**	**Ciprofloxacin**	**Cefotaxime**	**Ceftazidime**	**Cefepime**	**Ceftriaxone**
Months									
January	11.76	41.18	64.71	94.12	82.35	47.06	41.18	11.76	35.29
February	44.44	100.00	77.78	88.89	44.44	66.67	66.67	45.45	66.67
March	28.57	71.43	64.29	85.71	64.29	71.43	64.29	40.00	71.43
April	20.57	86.67	53.33	86.67	53.33	53.33	53.33	52.94	53.33
May	7.69	78.57	71.43	92.86	64.29	64.29	64.29	18.18	64.67
June	6.67	93.33	60.00	100.00	33.33	53.33	53.33	60.00	53.33
July	22.22	72.22	38.89	94.44	61.11	55.56	66.67	77.78	66.67
August	5.00	55.00	35.00	95.00	60.00	35.00	55.00	65.00	45.00
September	20.00	85.00	45.00	100.0	40.00	50.00	55.00	55.00	60.00
October	29.41	76.47	47.06	88.29	47.06	58.82	52.94	47.06	58.82
November	18.18	81.82	54.55	90.91	54.55	54.55	54.55	45.45	54.55
December	9.09	80.00	36.36	90.91	63.64	18.18	18.18	72.73	27.27
Age	11.76	76.47	58.82	76.47	47.06	41.18	47.06	52.94	47.06
<20 yrs	24.14	70.37	53.13	90.32	61.29	50.00	58.90	52.70	59.46
20-45 yrs	16.67	78.38	54.05	93.10	55.41	54.10	58.90	52.70	59.46
46-71 yrs	21.67	73.68	46.30	94.92	52.54	52.54	54.72	52.54	54.24
>71 yrs									

Table 4. Non-ESBL producers in blood isolates of *E. coli* in relation to sex, age and months.

	Antimicrobial Susceptibility		
	Sex		
	Male (%)	Female (%)	Total (%)
Months			
January	25.00	75.00	6.11
February	62.50	37.50	6.11
March	60.00	40.00	7.63
April	50.00	50.00	7.63
May	41.67	58.33	9.16
June	50.00	50.00	6.11
July	60.00	40.00	11.45
August	56.25	43.75	12.21
September	50.00	50.00	12.21
October	53.85	46.15	9.92
November	40.00	60.00	7.63
December	40.00	60.00	3.82
Age			
<20 yrs	60.00	40.00	8.30
20-45 yrs	35.00	65.00	16.67
46-71 yrs	45.45	54.55	45.83
>71 yrs	80.00	20.00	29.17

REFERENCES

1. Suárez CJ, Lolans K, Villegas MV, Quinn JP. Mechanisms of resistance to beta-lactams in some common Gram-negative bacteria causing nosocomial infections. Expert Rev Anti Infect Ther 2005; 3:915.

2. Bailey and Scott's Diagnostic microbiology: A textbook for isolation andidentification of pathogenic microorganisms. In 11th edition Edited by Forbes BA, Sahm DF, Weissfeld AS. St. Louis: The Mosby Company; 2002:378–422.

3. Diekma DJ, Beekman SE, Chapin KC, Morel KA, Munson E, Deorn GV: Epidemiology and outcome of nosocomial and community onset bloodstream infection. J ClinMicrobiol 2003, 41:3655–3660.

4. Biedenbach DJ, Moet GJ, Jones RN. Occurrence and antimicrobial resistance pattern comparisons among bloodstream infection isolates from the SENTRY Antimicrobial Surveillance Program (1997-2002). DiagnMicrobiol Infect Dis. 2004; 50:59-69.

5. de Kraker ME, Jarlier V, Monen JC, Heuer OE, van de Sande N, Grundmann H. The changing epidemiology of bacteraemias in Europe: trends from the European Antimicrobial Resistance Surveillance System. ClinMicrobiol Infect. 2013; 19:860-8.

6. Mahmoud Aly and Hanan H. Balkhy. The prevalence of antimicrobial resistance in clinical isolates from Gulf Corporation Council countries. Antimicrobial Resistance and Infection Control 2012, 1:26.

7. National Committee for Clinical Laboratory Standards. 2007. Performance standards for antimicrobial disk susceptibility testing; Seventh Informational Supplement. Approved standard M100-S17. National Committee for Clinical Laboratory Standards, Wayne, Pa.

8. Bonfiglio G, Perilli M, Stefani S, Amicosante G, Nicoletti G (2002) Frequency of extended spectrum β-lactamases among Enterobacteriaceae: an Italian survey. Int J Antimicrob Agents 19: 213-217.

9. Peirano G, van der Bij AK, Gregson DB, Pitout JD (2012). Molecular epidemiology over an 11-year period (2000 to 2010) of extended-spectrum β-lactamase-producing Escherichia coli causing bacteremia in a centralized Canadian region. J ClinMicrobiol 50: 294-299.

10. Hawser SP, Bouchillon SK, Hoban DJ, Badal RE, Hsueh PR, Paterson DL (2009) Emergence of high levels of extendedspectrum-β-lactamase-producing gram-negative bacilli in the Asia-Pacific region: data from the Study for Monitoring Antimicrobial Resistance Trends (SMART) Program, 2007. Antimicrob Agents Chemother 53: 3280-3284.

11. Kumar A, Roberts D, Wood KE, et al. Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. Crit Care Med 2006; 34:1589.

12. Onur Kaya, FusunZeynepAkcam, IbakGonen, OnurUnal, TennureCeylan. Risk factors for bacteremia due to extended-spectrum beta-lactamase producing Escherichia coli in a Turkish hospital. J Infect DevCtries 2013; 7(7):507-512.

13. Ali M Somily, Hanan A Habib, Muhammad M Absar, Muhammad Z Arshad, KutubuManneh, Sarah S Al Subaie, Mogbil A Al Hedaithy, Samina B Sayyed, Zahid Shakoor and Thomas S Murray. ESBL-producing Escherichia coli and Klebsiella pneumoniae at a tertiary care hospital in Saudi Arabia. J Infect DevCtries2014; 8(9):1129-1136.

14. Gaynes R, Edwards JR, National Nosocomial Infections Surveillance System. Overview of nosocomial infections caused by gram-negative bacilli. Clin Infect Dis 2005; 41:848.

15. Doernberg SB, Winston LG (2012) Risk factors for acquisition of extended-spectrum beta-lactamase-producing Escherichia coli in an urban county hospital. Am J Infect Control 40: 123-127

16. Freeman JT, McBride SJ, Nisbet MS, Gamble GD, Williamson DA, Taylor SL, Holland DJ (2012) Bloodstream infection with extended-spectrum beta-lactamase-producing Enterobacteriaceae at a tertiary care hospital in New Zealand: risk factors and outcomes. Int J Infect Dis 16: e371-374.