Medical Laboratory Journal
Online ISSN: 2538-4449
Golestan University of Medical Sciences

Investigation of Antibiotic Resistance Pattern in Isolated From Urine and Blood Samples of Patients Admitted To the Intensive Care Unit of Velayat Hospital in Qazvin, Iran

Original Article

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Received: 2021/02/23
Revised: 2021/06/20
Accepted: 2021/06/21

DOI: 10.29252/mlj.15.6.31

ABSTRACT

Background and objectives: Antibiotic resistance is a global health challenge that affects both individuals and the health system in many ways. The aim of this study was to evaluate the antibiotic resistance pattern in isolates from patients admitted to the intensive care unit (ICU) of a hospital in Qazvin, Iran.

Methods: This descriptive and retrospective study was performed on urine and blood samples collected from 1318 ICU patients in the Velayat Hospital of Qazvin (Iran) during 2017-2019. Data were collected from patients' medical records. All statistical analyses were performed using SPSS software (version 25).

Results: Based on the findings, 65.2% of the samples were related to urinary tract infections and 34.7% to bloodstream infections. *Escherichia coli* (68.6%) and *Stenotrophomonas* (41.0%) were the most common bacteria isolated from urinary tract infections and bloodstream infections, respectively. Moreover, the rate of antibiotic resistance was higher among *Acinetobacter*, *Escherichia coli*, *Stenotrophomonas*, *Enterococcus* and *Pseudomonas* isolates.

Conclusion: The rate of drug resistance in isolates from ICU patients is alarmingly high and requires immediate attention. It is recommended to modify antibiotic prescriptions in the hospital based on the results of antibiotic resistance pattern, particularly for treatment of infections caused by *E. coli* and *Stenotrophomonas*.

Keywords: Drug resistance, Intensive care units, Hospitals.

INTRODUCTION

Bloodstream and urinary tract infections (UTIs) are the leading causes of death worldwide, especially in developing countries. Urinary tract infections can affect any part of the urinary tract including bladder, urethra, prostate or even kidneys (1).

Numerous studies have shown that the most common bacterial cause of UTI are gram-negative bacteria such as *Escherichia coli*, *Proteus*, *Klebsiella*, *Enterobacter* as well as gram-positive bacteria such as *Enterococcus* and *Staphylococcus saprophyticus*. *E. coli* is the most common bacteria to cause UTI (2).

Septicemia or bloodstream infection (BSI) is a major cause of death in patients admitted to hospitals. It is also a leading cause of death in the U.S female population (3). Gram-negative bacteria are more likely to cause septicemia than gram-positive bacteria. The most common bacteria isolated from blood culture of septic patients are *Acinetobacter, Klebsiella, Pseudomonas, E. coli, Enterobacter, Enterococcus,* coagulase-negative staphylococci and *Staphylococcus aureus* (4).

The prevalence of UTI and BSI is high among hospitalized patients, especially those admitted to the intensive care unit (ICU). This may be due to the severity of underlying problems, decreased mobility and increased use of invasive devices (5).

Although ICU beds make up approximately 5% of the total number of beds in each hospital, the rate of hospital-acquired infections in this ward is 5-10 times higher than other wards (6).

Infection with resistant strains in the ICU leads to increased risk of mortality and cost of care. The pattern of antibiotic resistance among pathogens isolated from ICU patients varies widely. In addition, certain types of pathogens that are common in a community can be considered as important risk factors for severe morbidity and mortality in ICU patients (7).

Investigating the pattern of antibiotic susceptibility in microorganisms isolated from ICU patients can help develop an appropriate antibiotic policy. It also prevents the unnecessary use of broad-spectrum antibiotics and the subsequent emergence of drug-resistant strains (8).

This study was performed to determine the pattern of antibiotic resistance among bacteria causing UTI and BSI in patients admitted to the ICU of a hospital in Qazvin, Iran. We believe that the results of this study can provide comprehensive information for physicians and hospital managers to reduce patient mortality and length of hospitalization by prescribing appropriate antibiotics.

MATERIALS AND METHODS

A retrospective cross-sectional study was performed using medical records of 1318 patients admitted to the ICU of Velayat Hospital in Qazvin (Iran) during 2017-2019. The study was approved by the ethics committee of Qazvin University of Medical Sciences (ethical code: IR.QUMS.REC.1399.248). All patients with a positive blood or urine culture who had history of hospitalization in the last month or less than five days have passed since their hospitalization were excluded from the study. Data including gender, culture samples, type of bacteria and the antibiotic susceptibility/resistance pattern were recorded for each patient.

Statistical analysis of data was carried out using SPSS software (version 25). Quantitative variables with normal distribution were described using mean and standard deviation (SD). Non-normal distributed data were described using mean and range. Number and percentage were used to describe the qualitative variables.

RESULTS

Among 1318 samples, 56.9% were taken from women and 43.1% were taken from men. In addition, 860 patients (65.3%) had positive urine culture, while 458 patients (34.7%) had positive blood culture. Positive urine culture was more frequent in women (64.25%) than in men (35.8%).

Moreover, 56.8% of positive blood culture samples were taken from men. The most common bacteria isolated from urine and blood cultures were *E. coli* (68.6%) and *Stenotrophomonas* (41.0%), respectively. Figure 1 shows the frequency of bacteria isolates from urine and blood cultures of ICU patients.

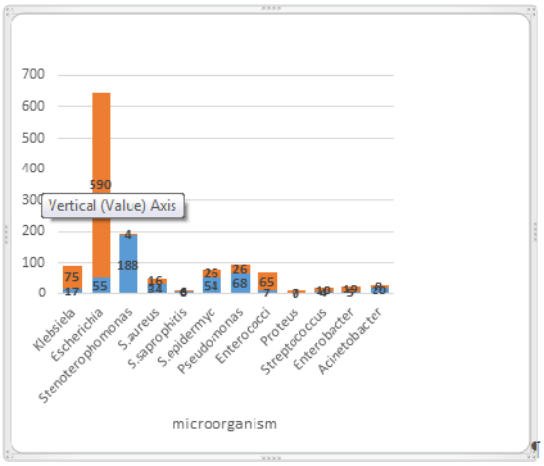

Figure 1- Frequency distribution of bacteria isolated from urine and blood culture of ICU patients

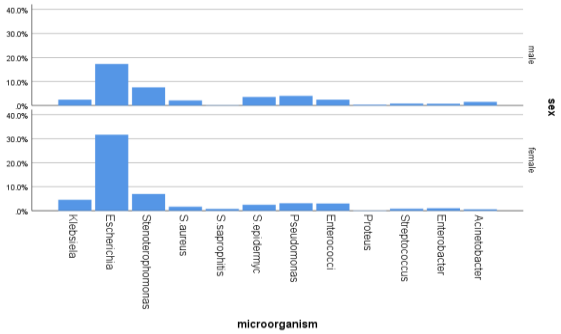

Figure 2- Frequency distribution of bacteria isolated from urine and blood culture of ICU patients according to gender

As shown in figure 2, *E. coli* was the most commonly isolated bacteria from both men and women.

The rate of antibiotic resistance was higher among *Acinetobacter*, *E. coli*, *Stenotrophomonas*, *Enterococcus* and *Pseudomonas* isolates. The most effective antibiotics against *E. coli* were meropenem (96.2%), imipenem (96.2%) and nitrofurantoin (85.7%). However, *E. coli* isolates were fully resistant against erythromycin, cefoxytin and penicillin. In case of *Stenotrophomonas* isolates, the highest susceptibility was observed to chloramphenicol (100%), levofloxacin (97.7%) and doxycycline (93.3%). However, this bacterium showed high resistance to a wide range of antibiotics including gentamicin, ampicillin, ceftriaxone, ceftazidime, nitrofurantoin, imipenem, cefepime, cefotaxime, piperacillin and amikacin (Table 1).

DISCUSSION

Urinary tract infection is an important public health problem worldwide that affect 150 million people each year (9). In our study, UTI was more common than BSI among ICU patients, which is in line with findings of a study by Ghafouri et al. in Bojnourd, Iran (10).

The frequency of UTI was higher among women, which can be due to the shortness of the urethra in women and the proximity of the urethra to the vagina and anus (11). In line with our findings, Fahimi Hamidi et al. (12) reported that the rate of UTI was higher in women.

In the present study, *E. coli* (68.6%) followed by *Klebsiella* and *Enterococcus* were the most common bacterial isolates from urine and blood cultures of ICU patients. Overall, *E. coli* has been known as the most frequent cause of UTI around the world, which could be due to the presence of this bacterium in the intestines and the risk of urethra contamination by fecal *E. coli* (13, 14).

E. coli has been also reported as one of the leading causes of BSIs in various countries such as New Zealand, Sweden, Canada, Iceland, Australia, Denmark, Finland and the USA (15).

However, the prevalence of BSIs caused by *E. coli* has decreased recently in hospitals of Brazil (16). This difference can be related to the hospital type, age of patients and geographical location.

Table 1- Antibiotic resistance pattern among bacteria isolated from urine and blood samples of ICU patients

Antibiotic / Isolates	Number of resistant isolates (%)																						
	MEM	AK	CIP	CTX	PRL	FEP	LEV	CT	C	DA	E	CN	OX	FOX	P	AM	PIP+TAZ	CRO	CAZ	DO	VA	F	IPM	TE
Klebsiella n=92	13 (26.5)	18 (24.7)	20 (43.5)	40 (54.8)	12 (60)	26 (48.1)	0	13 (54.2)	0	0	0	9 (37.5)	0	0	0	0	3 (75)	12 (70.6)	6 (85.7)	1 (20)	0	17 (47.2)	14 (21.1)	0
Escherichia n=645	12 (3.8)	48 (10.6)	220 (58)	316 (70.1)	60 (82.2)	113 (45.2)	3 (60)	130 (65)	0	0	1 (100)	57 (26.3)	0	1 (100)	1 (100)	0	1 (16.7)	94 (46.1)	67 (55.4)	3 (37.5)	0	31 (10.5)	5 (3.8)	0
Stenotrophomonas n=192	77 (93.9)	167 (90.8)	5 (20)	150 (98.7)	95 (96)	109 (99.1)	3 (2.3)	36 (22.9)	0	0	0	1 (100)	0	0	0	1 (100)	3 (50)	4 (100)	7 (100)	2 (6.7)	0	1 (100)	23 (100)	0
S. aureus n=50	0	0	9 (50)	1 (50)	1 (100)	0	0	3 (30)	8 (19.5)	19 (42.2)	17 (43.6)	5 (17.9)	5 (26.3)	9 (33.3)	29 (78.4)	0	0	0	1 (100)	0	0	0	0	1 (20)
S.saprophyticus n=12	0	0	3 (75)	0	0	0	0	1 (50)	3 (42.9)	6 (50)	9 (90)	2 (40)	1 (33.3)	6 (66.7)	6 (54.4)	0	0	0	0	0	0	0	0	0
S. epidermidis n=80	0	0	17 (54.8)	0	0	0	0	7 (70)	12 (18.5)	40 (51.9)	52 (75.4)	25 (55.6)	25 (65.8)	18 (51.4)	57 (81.4)	1 (100)	0	1 (50)	0	0	0	0	0	7 (63.6)
Pseudomonas n=94	43 (64.2)	52 (57.1)	10 (30.3)	10 (90.9)	63 (74.1)	58 (72.5)	0	2 (66.7)	0	0	0	0	0	0	0	0	41 (50)	0	7 (53.8)	1 (100)	0	3 (100)	11 (47.8)	0
Enterococcus n=72	0	3 (100)	27 (90)	0	0	0	0	0	0	0	0		0	0	21 (77.8)	36 (53.7)	0	0	0	0	52 (72.2)	10 (24.4)	0	24 (82.8)
Proteus n=7	2 (28.6)	2 (28.6)	2 (40)	6 (85.7)	2 (100)	2 (50)	0	0	0	0	0	0	0	0	0	0	0	1 (100)	1 (100)	0	0	2 (100)	0	0
Streptococcus n=22	0	0	4 (33.3)	0	0	0	0	0	0	0	0	0	0	0	2 (18.2)	15	0	0	0	0	5 (22.7)	2 (18.2)	0	5 (71.4)
Enterobacter n=24	2 (18.2)	3 (16.7)	8 (57.1)	13 (61.9)	4 (80)	6 (37.5)	0	7 (63.6)	0	0	0	4 (50)	0	0	0	0	0	6 (85.7)	4 (80)	1 (50)	0	8 (50)	1 (16.7)	0
Acinetobacter n=28	20 (92.6)	25 (92.6)	7 (70)	25 (96.2)	16 (100)	22 (95.7)	3 (100)	5 (100)	0	0	0	0	0	0	0	0	2 (100)	0	4 (100)	5 (27.8)	0	2 (100)	3 (75)	0

Meropenem: MEM, Amikacin: AK, Ciprofloxacin: CIP, Cefotaxime: CTX, Piperacillin: PRL, Cefepime: FEP, Levofloxacin: LEV, Cotrimoxazole: CT, Chloramphenicol: C, Clindamycin: DA, Erythromycin: E, Gentamicin: CN, Oxacillin: OX, Cefoxitin: FOX, Penicillin: P, Ampicillin:AM, Piperacillin and Tazobactam: PIP+TAZ, Ceftriaxone: CRO, Ceftazidime: CAZ, Doxycycline: DO, Vancomycin: VA, Nitrofurantoin: F, Imipenem: IPM, Tetracycline: TE, Staphylococcus: S.

In the present study, *Stenotrophomonas* (41%), followed by *Pseudomonas* and *S. epidermidis* were the most frequent causes of BSIs. *Stenotrophomonas* is a non-fermenting gram-negative bacillus that was previously classified as *Pseudomonas* and *Xanthomonas* (17, 18). This may justify the lower frequency of *Stenotrophomonas* in previous studies (19). However, a study by Jamali et al. (2011) in Tehran reported *Stenotrophomonas* as the most common bacterium isolated from blood culture (20). One of the reasons for the increasing prevalence of nosocomial infections caused by *Stenotrophomonas* may be due to the increasing number of patients with immunodeficiency, underlying diseases and cancer as well as transplant recipients who are significantly more susceptible to opportunistic infections (21). On the other hand, *Stenotrophomonas* is an environmental opportunistic pathogen that can be isolated from different hospital wards (22). Nevertheless, the high prevalence of this bacterium in our hospital may be due to contamination during the sampling process or the experiment procedure.

The results of the present study confirm the increased rate of antibiotic resistance among patients admitted to the ICU of Velayat hospital, especially in *Acinetobacter*, *Stenotrofomonas* and *Pseudomonas* isolates. The prevalence of resistance to carbapenems in isolates from ICUs in Qazvin was 26.6% in 2005, while in the present study, this rate increased to 95.2% (23).

The highest rate of resistance among *E. coli* isolates was observed against erythromycin, cefoxitin, penicillin and piperacillin. Whereas, resistance rates of less than 10% were recorded against imipenem, meropenem and nitrofurantoin. Similarly, two previous studies found no case of imipenem resistance among *E. coli* isolates (24, 25). Given these results, it is recommended to use carbapenem as the antibiotic of choice for the initial treatment of UTI caused by resistant *E. coli*.

In our study, *Stenotrophomonas* isolates were most sensitive to chloramphenicol, levofloxacin and doxycycline, followed by ciprofloxacin and cotrimaxazole. However, *Stenotrophomonas* isolates were highly resistant to a wide range of antibiotics including gentamicin, ampicillin, ceftriaxone, ceftazidime, nitrofurantoin, imipenem, cefepime, cefotaxime, piperacillin, meropenem and amikacin.

In line with our findings, Nikpour et al. reported a sensitivity rate of 78% to levofloxacin among *Stenotrophomonas* isolates (22). In another study in Tehran, *Stenotrophomonas* was most sensitive to cotrimaxazole (19). However, Mohammadimehr et al. reported imipenem as the most effective antibiotic for treatment of infections caused by *Stenotrophomonas* species, which is inconsistent with our findings (26). The difference in the antibiotic resistance rates can be attributed to the differences in study location, tested samples, the prevalence of microorganisms and antibiotic therapies.

It has been demonstrated that the proper administration of antibiotics is the most important factor in preventing drug resistance. About 50% of antibiotic administrations are inappropriate, which not only increases treatment costs but also increases antibiotic resistance (27). In addition, long-term use of antibiotics is another important factor that contributes to the development of antibiotic resistance (28).

We believe that the widespread use of immunosuppressive drugs in the Velayat hospital, particularly in the hematology and rheumatology wards, as well as the administration of broad-spectrum antibiotics, has led to the increased rate of antibiotic resistance. Nevertheless, transmissible resistance among pathogens has intensified the incidence of resistant hospital-acquired infection (29, 30).

CONCLUSION

Based on the results, the prevalence of antibiotic resistance is high among isolates from urine and blood samples of ICU patients in the Velayat hospital. Therefore, it is necessary to pay more attention to antibiotic prescription against these microorganisms, especially *E. coli* and *Stenotrophomonas*.

ACKNOWLEDGMENTS

The authors would like to thank the laboratory staff of the Velayat hospital for their cooperation.

DECLARATIONS

Funding

This study was financially supported by the Qazvin University of Medical Sciences, Iran.

Ethics approvals and consent to participate

The study was approved by the ethics committee of Qazvin University of Medical Sciences (ethical code: IR.QUMS.REC.1399.248).

Conflict of interest

The authors declare that there is no conflict of interest regarding publication of this article.

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How to Cite:
Bagherian F, Nikoonejad A, Allami A, Dodangeh S, Taha Yassen L, Hosienbeigi B [Investigation of Antibiotic Resistance Pattern in Isolated From Urine and Blood Samples of Patients Admitted To the Intensive Care Unit of Velayat Hospital in Qazvin, Iran]. mljgoums. 2021; 15(6): 31-37 DOI: 10.29252/mlj.15.6.31