Original Article

Investigating the prevalence of vascular catheter related bloodstream infections in ICU units of Shiraz Namazi Hospital

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ABSTRACT

Introduction: Nowadays, catheter related bloodstream infections are considered as one of the serious problems of the health system. In addition to many complications, they impose many economic burdens on the health system. They also increase the odds of death in patients. The objective of this study was to investigate the prevalence of these infections in ICUs of Namazi hospital, as the largest hospital in the south of Iran. Methods: This study was conducted in the ICU units of Shiraz Namazi Hospital during the 12 months period (April 2015 to April 2016). A total of 178 patients were included into study and 253 catheters inserted in them were examined. Results: out of 253 catheters, 47.4% of the catheters had positive culture (120 catheters) and 52.6% of the catheters had negative culture (133 catheters). The most common microorganisms causing catheter related bloodstream infections were gram-negative bacteria (50%). Among the gram-negative bacteria, Acinetobacter (51.7%) and Klebsiella (25%), and among the gram-positive bacteria, Staphylococcus epidermidis (66.7%) and Enterococcus (Streptococcus group D) (23%) were the most common causes of infection. Colistin (90% sensitivity) and amikacin (33.3sensitivity) were the most sensitive antibiotics in gram-negative bacteria and chloramphenicol (87.5%) and vancomycin (75%) were the most sensitive antibiotics in gram-positive bacteria. Conclusion: this study revealed that the prevalence of catheter related bloodstream infections was 47.4% in the patients hospitalized in ICUs of Namazi Hospital. Therefore, the odds of having a catheter related bloodstream infection is higher in these patients than that in others. In addition to increasing the rate of death, it imposes high costs on the patient and the hospital. In this study, it was also found that , increasing the duration of hospitalization in ICUs increased the odds of catheter related bloodstream infections. In this study, the most antibiotic sensitivity among gram-negative bacteria was colistin (90%) and the most antibiotic sensitivity among gram-positive bacteria was chloramphenicol (87.5%) and vancomycin (75%), and all isolated bacteria, without considering that they were gram-positive or gram-negative, were resistant to meropenem, ampicillin, azithromycin, ofloxacin, piperacillin, ceftriaxone, ceftazidime, amoxicillin, oxacillin, and rifampin.

Keywords: Infection, catheter, antibiotics, patients hospitalized in ICU.

Introduction

The presence of bacteria in the bloodstream is seen in two ways: bacteremia: the presence of bacteria in the blood without clinical symptoms. Septicemia: The presence of bacteria in the body associated with clinical symptoms such as fever, increased heart rate and increased respiratory rate [1]. Different bacteria cause bloodstream infections. In this regard, the gram-positive bacteria, especially staphylococci, streptococci and enterococci, play a major role [2]. Gram-negative bacteria also accounts for 24% of nosocomial infections and 45% of the infections are acquired from the community [3], which are most commonly seen in the older population (65 years and older) and associated with a higher mortality rate [4]. Various risks factors cause bacterial infections, including diabetes, immune deficiency (such as AIDS), organ transplantation, the use of certain drugs such as glucocorticoids, liver failure, spleen removal, and having long-term vascular catheters (for example, long-term dialysis). In general, bacteremia caused by intravascular catheters is one of the four main causes of nosocomial infection [5]. The use of a catheter can cause infection and transmit infection to the bloodstream. The catheter related bloodstream infections (CRBIs) refer to all infections caused by the use of intravascular catheters [6] CRBIs are one of the main causes of

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nosocomial infections, which their prevalence are estimated to be 250,000 cases per year [7]. In this regard, 80,000 cases are related to the patients hospitalized in ICU [8]. The mechanism of creation of a blood infection by the catheter is in this way that immediately after inserting the catheter, its tip is covered by plasma proteins, especially fibrin, then, the bacteria on surfaces of the skin or bacteria that are already at the catheter tip are placed in this as a protein plate. This process is called colonization. Electromicroscopic studies have shown that this process begins several hours after the catheter insertion. For many years, it was believed that colonization occurs only outside the catheter, while more recent studies suggest that colonization can occur within the catheter lumen [9]. Therefore, in the new classification, the catheter related infections are classified into intra-lumen and extra-lumen infections. If the infection is caused by microorganisms colonized at the tip of the catheter, the term intra-lumen is used, and if the infection is caused by microorganisms present in the skin around the site of the catheter, the term extra-lumen is used [10].

According to various studies, the most common microorganisms that cause catheter related bloodstream infections are coagulase negative staphylococcus, S.aureus, gram negative bacilli and Candida albicans [11]. Catheter related blood infections impose high economic burden on the health system. It has been estimated that vascular catheter related blood infections increase the patient's hospitalization costs by $ 4,000 to $ 56,000 [12]. In addition, catheter related infections increase the patients' hospitalization in ICU by 2.4 days and increase the general hospitalization by 7.5 days [13]. In general, ICU patients are more likely to use central vascular catheters than other hospitalized patients. Therefore, the odds of catheter related blood infections is higher in these patients than that in other patients [14]. In a study conducted in 2011-2009 by Deepti and Sanjeev Sinha et al under the title of bloodstream infections caused by central vascular catheters in CIU hospitalized patients in a referral center in India, the prevalence of nosocomial infections was 38.7%, which catheter related infections accounted for 6.7% of the infections. The most common isolated microorganisms included klebsilla pneumonia, S. aureus, beta lactamase positive and acintobacter spp [15]. A study was conducted under the title of "Catheter related blood infections" in two teaching hospitals in northwest of Iran. This study was conducted on all patients admitted to all ICU units of Beheshti and Valiasr hospitals in Zanjan in 2016. In this study, no significant relationship was found between the duration of hospitalization, the type of hospitalization, the type of catheter and its location and the prevalence of catheter related infections. They also found that the rate of these infections was significantly higher in patients who received chemotherapy than that in other patients [16]. A study was conducted under the title of "The prevalence of catheter related infections in cardiovascular patients hospitalized the hospital" during the period of 2011-2012 in Tehran Rajaee Hospital. Antibiotic sensitivity test showed that gram-positive bacteria are more sensitive to vancomycin and linezolid, while gram-negative bacteria showed sensitivity to amikacin, gentamicin, tobramycin and imipenem [17]. Given what was stated above and the great importance of catheter related bloodstream infections and their complications and the high economic burden on the health system, it is necessary to conduct a study on its prevalence as well as the involved microorganisms and their appropriate antibiotics in our health care facilities, in order to gain more knowledge on it and take steps to prevent it. Thus, the objective of this study was to evaluate the prevalence of these infections in ICU units of Namazi Hospital, as the largest hospital in the south of Iran.

Methodology

This cross-sectional descriptive study was conducted at the ICU units of Namazi Hospital in Shiraz during the 12-month period since April 2016 to April 2017. Namazi Hospital is the largest and first referral center for patients in the south of Iran. The hospital has internal, surgical, pediatric, ICU units. There are several ICU units, but only adult ICU units that include central ICU, internal ICU, surgical ICU, emergency ICU, and neurological ICU were studied (1, 2). The inclusion criteria of study included the patients hospitalized in ICU, no central venous catheter at the time of admission, patients received catheter during hospitalization in ICU, patients who had intravenous or arterial catheter for more than two days, and patients without fever or any systematic infection before inserting catheter. General information of patients such as age, gender, underlying diseases, ICU of hospitalization place and duration of hospitalization were recorded in the ICU. The catheters were inserted by specialist surgery, anesthesiology, and intensive care assistants. The blood culture and catheter site culture were sent from the patients who had fever 48 hours after the catheter insertion. Some of the catheters were also replaced and the tip of the catheter suspected of infection was sent to the laboratory for culture. All blood samples were taken under disinfection conditions and after cleaning the sample site with alcohol and other disinfectants and sent to the laboratory in sterile tubes. For culturing, Macconkey agar culture medium and Blood Agar 5% were used. In the first 24 hours and the first 48 hours, and the first 5 days, the culture media were examined in terms of growth or non-growth of the bacteria. To examine the antibiotic resistance and sensitivity of microorganisms based on the guidelines of the National Institute of Laboratory Standards (CSLI 1999), Kirby Bauer Disk diffusion method in the Hinton Agar medium was used [18]. Antibiotic disks include vancomycin (V, 30mcg), ciprofloxacin (CIP, 5mcg), clindamycin (CD, 2mcg), trimethoprim-sulfamethoxazole (SXT, 30mcg), gentamicin (GM, 10mcg), ofloxacin (OFX, 5 mcg), penicillin G (P, 10 mcg) oxacillin (OXA, 5mcg), amikacin (AMK, 30mcg), cefotaxime (CTX, 30mcg), ceftazidime (CAZ, 30mcg), ceftriaxone (CTR, 30mcg), cefazolin (30mcg CZ), chloramphenicol (CHL, 30mcg), piperacillin (PIP, 100mcg), ampicillin (IPM, 10mcg), nitrofurantoin (FM, 50mcg),

ampicillin (AM, 10mcg) and rifampin RIF, 5mcg). The data were analyzed using SPSS software.

Results

In this study, 178 people were included. Some of them had one catheter and some others had more than one catheter. A total of 253 catheters were inserted in patients. Among these participants, 43.9% were female (78 people) and 56.1% were male (100 people). Out of all female subjects, 34.6% had positive culture and out of total male subjects, 41% had positive culture. In addition 65.4% of females and 59% of males had negative culture. Chi square test did not show a significant difference between two genders in terms of the prevalence of infection. Therefore, gender is not considered as a risk factor for positive culture in the current study. The mean age of the participants in the study was 50.9 ± 19.3, which was not statistically significant in those who had positive culture and those who had negative culture (51.97 years in positive culture people and 50.3 in negative culture people). Based on the results of this study, age is not a risk factor for positive culture. Using the statistical tests, total mean duration of hospitalization in ICU was 33.2 ± 36.5 days. Non-parametric Mann-Whitney test was used due to the high dispersion for measuring the negative culture and positive culture groups in terms of duration of hospitalization in ICU duration. The results of this test showed that the median of duration of hospitalization was 26 days for those who had positive culture and 16.5 days for those who had negative culture, which is statistically significant. Therefore, it can be concluded that the longer hospitalization in ICU can increase the odds of catheter related bloodstream infections. The frequency of underlying diseases is shown in Table 1. Using chi square test, it was found that among all underlying diseases, thyroid disease may had a relationship with catheter related bloodstream infections. 66.7% of patients with thyroid problems had positive culture. while other diseases do not have a significant relationship with catheter related bloodstream infections.

Table 1: Underlying diseases and their prevalence

Underlying disease	The number of people involved	percentage of prevalence
hypertension(HTN)	57	32.00%
heart diseases(IHD)	31	17.40%
Drug use	24	13.50%
cancer	22	12.40%
Hyperlipidemia (HLP)	21	11.80%
stroke(CVA)	18	10%
Thyroid diseases	12	6.70%
HIV patients	8	4.50%
Transplant patients	8	1.60%
Other disease	86	48.30%

Out of 253 catheters inserted in the study, 47.4% of the catheters had positive culture (120 catheters) indicating their infection and 52.6% of the catheters had negative culture (133 catheters) (Figure 1).

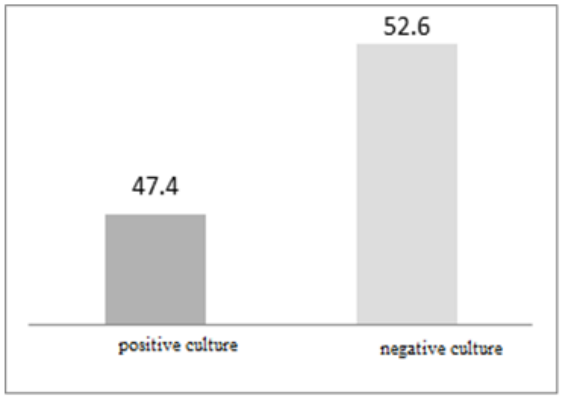

Diagram 1: The prevalence of catheter related bloodstream infections in patients hospitalized in ICU

The share of any type of microorganisms in positive culture is given in Table 2.

Table 2: Frequency of different groups of microorganisms in people with positive culture

type of microorganisms	Percentage of prevalence	n
Gram-positive bacteria	40%	48
negative-positive bacteria	50%	60
Fungi (candida albicans and non-candida albicans)	10%	12

Among the gram-negative and –gram positive bacteria, the most common cases are listed in Table 3.

Table 3: Frequency of gram negative and gram-positive bacteria

Bacteria	Type of microorganism	Percentage of frequency	(N=60)
gram negative bacteria	Acinetobacter	51.70%	31
	Klebsiella	25%	15
	Pseudomonas aeruginosa	1.70%	1
	E.coli	10%	6
	NFB	8.20%	5
	Enterobacter	1.70%	1
	Proteus	1.70%	1
gram-positive bacteria	S.aureus	2%	1
	Staphylococcus epidermidis	66.70%	32
	Group D Streptococcus)Enterococcus(	23%	11
	Diphtheroid	2%	1
	MRSA	2%	1

S.aureus	2%	1

Namazi Hospital has several ICEUs, of which 8 adult ICEs were studied. The number of catheters inserted in these ICUs is different, and each one has different levels of infection. The frequency of cultures sent from each ICU and the number of positive cultures are shown in Table 4. The highest number of catheters (41.8% of the total catheters) was inserted in the general ICU, followed by central ICE and emergency (each of them with 18.35%).

Table 4: The frequency of catheters used in each ICU and the level of infection of the catheters inserted in each ICU

ICU name	The percentage of catheters inserted in the ICU relative to total catheters inserted	Number of inserted catheters	positive culture percentages	number of positive cultures	Negative culture percentage	Number of negative cultures
general	41.80%	106	57.50%	61	42.40%	45
Central	18.35%	46	34.70%	16	65.30%	30
Neurology 1	8.50%	21	28.50%	6	71.50%	15
Neurology 2	1.50%	4	50%	2	50%	2
Emergency	18.35%	46	30.40%	14	69.60%	32
Surgical	1%	3	100%	3	0.00%	0
Internal 1	5%	13	61.50%	8	38.50%	5
Internal 2	5.50%	14	71.40%	10	28.50%	4

Emergency ICs with positive culture of 100% was the most infected ICU, followed by internal ICU 2 with 71.4% and internal ICI 1 with 61.5% (Figure 2).

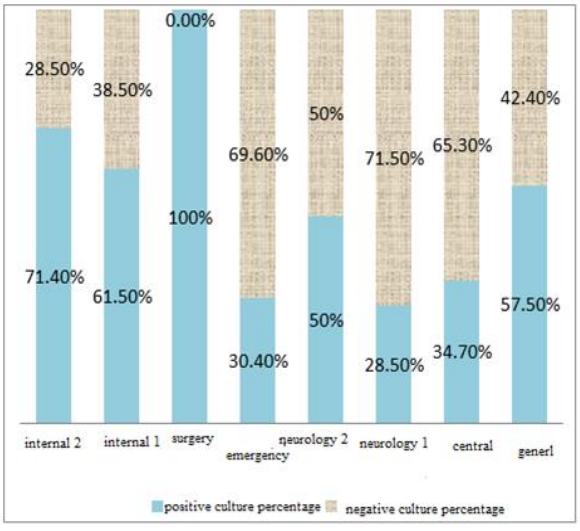

Figure 2: Positive and negative number of cultures sent to each ICU

In each ICU, different microorganisms grow. Table 5 shows the common microorganisms in each ICU, separately.

Table 5: Frequency of microorganisms in Central ICU, General ICU, Neurology 1 ICU, Neurology 2 ICU, Surgery ICU, Internal 1 ICU, Internal 2 ICU, and Emergency ICU

n	Percentage of prevalence	Microorganism name	ICU name
1	6.25%	E.coli	central
1	6.25%	Klebsiella	
5	31.25%	Acinetobacter	
6	37.5%	Staphylococcus epidermidis	
3	18.75%	NFB	
4	7%	E.coli	general
7	12%	Klebsiella	
14	23%	Acinetobacter	
18	30%	Staphylococcus epidermidis	
2	3.5%	NFB	
1	2%	MRSA	
7	12%	Non-albicans Candida	
1	2%	Diphtheroid	
2	3.5%	DNAse negative Staphylococcus	
3	5%	Group D(Enterococcus) Streptococcus	
1	16.7%	Group D (Enterococcus)Streptococcus	Neurology 1
1	16.7%	Klebsiella	
1	16.7%	Candida albicans	
3	50%	Staphylococcus epidermidis	
1	50%	S.aureus	Neurology 2
1	50%	Non-albicans Candida	
1	33.5%	Staphylococcus epidermidis	Surgery
2	66.5%	Group D(Enterococcus) Streptococcus	
1	12.5%	Acinetobacter	Internal 1
4	50%	Klebsiella	
1	12.5%	Pseudomonas aeruginosa	
2	25%	Staphylococcus epidermidis	
5	50%	Group D (Enterococcus)Streptococcus	Internal 2
4	40%	Acinetobacter	
1	10%	Enterobacter	
1	7.2%	E.coli	Emergency
2	14.2%	Klebsiella	
7	50%	Acinetobacter	
2	14.2%	Staphylococcus epidermidis	
1	7.2%	Non-albicans Candida	
1	7.2%	Proteus	

Table 6 shows the sensitivity pattern of gram-negative and gram-positive bacteria and Table 7 shows the antibiotic resistance pattern. The lowest drug resistance to the gram-negative bacteria was related to colistin, with only 10% resistance to it. In addition, about 90% of the gram-negative bacteria are sensitive to it. Hence, it can be a good choice for the treatment of catheter related bloodstream infections caused by gram-negative bacteria. Gram-positive bacteria are resistant to the most antibiotics. The lowest antibiotic resistance belongs to chloramphenicol (12.5%) and vancomycin (25%).

Table 6: Frequency of antibiotic sensitivity in gram-negative and gram-positive bacteria

Bacteria	Antibiotic name	Percentage of sensitivity	Number of sensitive cases (n=60)

	Imipenem	20%	12
	Ceftizoxime	6.60%	4
	Tetracycline	21.60%	13
	Trimethoprim sulfamethoxazole	6.60%	4
Gram-negative	Gentamicin	30%	18
	Cephalexin	1.60%	1
	Ciprofloxacin	10%	6
	Colistin	90%	54
	Chloramphenicol	15%	9
	Cefixime	6.60%	4
	Amikacin	33.30%	20
Bacterium	Antibiotic name	Percentage of sensitivity	Number of sensitive cases (n=48)
	Trimethoprim sulfamethoxazole	27.10%	13
	Gentamicin	37.50%	18
	Cephalexin	14.50%	7
	Ciprofloxacin	16.60%	8
	Chloramphenicol	87.50%	42
Gram-positive	Amikacin	2.08%	1
	Vancomycin	75%	36
	Clindamycin	16.60%	8
	Erythromycin	10.50%	5
	Lincomycin	16.60%	8
	Cloxacillin	12.50%	6
	Linezolid	2.08%	1

Table 7: Frequency of antibiotic resistance in gram-negative and gram-positive bacteria

Antibiotic name	Resistance percentage		Number of resistant cases	
	Gram-negative	Gram-positive	Gram-negative (n=60)	Gram-positive (n=48)
Imipenem	80%	100%	48	48
Ceftizoxime	93.40%	100%	56	48
Tetracycline	78.40%	100%	47	48
Trimethoprim sulfamethoxazole	93.40%	72.90%	56	35
Gentamicin	70%	62.50%	42	30
Cephalexin	98.40%	85.50%	59	41
Ciprofloxacin	90%	83.40%	54	40
colistin	10%	100%	6	48
Chloramphenicol	85%	12.50%	51	6
Cefixime	93.40%	100%	56	48
Amikacin	66.70%	97.92%	40	47
Meropenem	100%	100%	60	48
Ampicillin	100%	100%	60	48
Azithromycin	100%	100%	60	48
Vancomycin	100%	25%	60	12
Ofloxacin	100%	100%	60	48
Clindamycin	100%	83.40%	60	40
Erythromycin	100%	89.50%	60	43
Lincomycin	100%	83.40%	60	40
Cloxacillin	100%	87.50%	60	42
Piperacillin	100%	100%	60	48
Ceftriaxone	100%	100%	60	48
Ceftazidime	100%	100%	60	48
Linezolid	100%	97.92%	60	47
Amoxicillin	100%	100%	60	48
Oxacillin	100%	100%	60	48
Rifampin	100%	100%	60	48
Cefoxitin	100%	100%	60	48

Tables 8 and 9 show the antibiotic sensitivity and resistance separately in terms of types of bacteria

Table 8: Frequency of antibiotic sensitivity in a variety of bacteria

Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=6)
	Imipenem	83.40%	5
	Ceftizoxime	33.40%	2
	Tetracycline	50%	3
	Trimethoprim sulfamethoxazole	33.40%	2
E.coli	Gentamicin	100%	6
	Ciprofloxacin	33.40%	2
	Colistin	83.40%	5
	Chloramphenicol	50%	3
	Cefixime	33.40%	2
	Amikacin	83.40%	5
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=32)
	Trimethoprim sulfamethoxazole	37.50%	12
	Gentamicin	53.20%	17
	Cephalexin	18.75%	6
	Ciprofloxacin	25%	8
	Chloramphenicol	91%	29
S.epidermidis	Amikacin	3.10%	1
	Vancomycin	100%	32
	Clindamycin	25%	8
	Erythromycin	15.60%	5
	Lincomycin	25%	8
	Cloxacillin	15.60%	5
	Linezolid	3.10%	1
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=31)
	Tetracycline	25.90%	8
	Gentamicin	9.70%	3
Acintobacter	Colistin	96.80%	30
	Amikacin	6.50%	2
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=1)
	Gentamicin	100%	1
	Cephalexin	100%	1
S.aureus	Chloramphenicol	100%	1
	Vancomycin	100%	1
	Cloxacillin	100%	1
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=15)
	Imipenem	13.40%	2
	Tetracycline	6.70%	1
	Gentamicin	20%	3
Klebsiella	Colistin	93.40%	14
	Chloramphenicol	33.40%	5
	Amikacin	40%	6

Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=5)
NFB	Imipenem	60%	3
	Ceftizoxime	40%	2
	Tetracycline	20%	1
	Trimethoprim sulfamethoxazole	40%	2
	Gentamicin	80%	4
	Cephalexin	20%	1
	Ciprofloxacin	60%	3
	Colistin	60%	3
	Amikacin	80%	4
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=1)
Pseudomonas aeruginosa	Imipenem	100%	1
	Ciprofloxacin	100%	1
	Colistin	100%	1
	Amikacin	100%	1
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=1)
	Imipenem	100%	1
	Ceftizoxime	100%	1
	Trimethoprim sulfamethoxazole	100%	1
	Gentamicin	100%	1
	Cefixime	100%	1
	Amikacin	100%	1
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=1)
Proteus	Imipenem	100%	1
	Ceftizoxime	100%	1
	Trimethoprim sulfamethoxazole	100%	1
	Gentamicin	100%	1
	Cefixime	100%	1
	Amikacin	100%	1
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=1)
Enterobacter	Gentamicin	100%	1
	Colistin	100%	1
	Chloramphenicol	100%	1
	Cefixime	100%	1
	Amikacin	100%	1
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=11)
Group D Streptococcus	Trimethoprim sulfamethoxazole	9.10%	1
	Chloramphenicol	81.80%	9
	Vancomycin	9.10%	1
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=1)
MRSA	Chloramphenicol	100%	1
Bacterium name	Antibiotic name	Percentage of sensitivity	Number of resistant cases (n=2)
DNAse negative staphylococcus	Chloramphenicol	100%	2
	Vancomycin	100%	2

Table 9: Frequency of antibiotic resistance in bacteria

Bacterium / Antibiotic name	Percentage of resistance/ number of resistant bacteria						
	E.coli (N=6)	S.epidermidis(N=32)	Acintobacter(N=31)	S.aureus(N=1)	Klebsiella(N=15)	NFB(N=5)	Pseudomonas aeruginosa(N=1)
Imipenem	16.60% (1)	100%(32)	100%(31)	100%(1)	86.60%(13)	40%(2)	-
Ceftizoxime	66.60% (4)	100%(32)	100%(31)	100%(1)	100%(15)	60%(3)	100%(1)
Tetracycline	50% (3)	100%(32)	74.10%(23)	100%(1)	93.30%(14)	80%(4)	100%(1)
Trimethoprim sulfamethoxazole	66.60%(4)	62.50%(20)	100%(31)	100%(1)	100%(15)	60%(3)	100%(1)
Gentamicin	-	46.80%(15)	90.30%(28)	-	80%(12)	20%(1)	100%(1)
Cephalexin	100%(6)	81.25%(26)	100%(31)	-	100%(15)	80%(4)	100%(1)
Ciprofloxacin	66.45%(4)	75%(24)	100%(31)	100%(1)	100%(15)	40%(2)	-
Colistin	16.60%(1)	100%(32)	3.20%(1)	100%(1)	6.60%(1)	40%(2)	-
Chloramphenicol	50%(3)	9.40%(3)	100%(31)	-	66.60%(10)	100%(5)	100%(1)
Cefixime	66.60%(4)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Amikacin	16.60%(1)	96.90%(31)	93.50%(29)	100%(1)	60%(9)	20%(1)	-
Meropenem	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Ampicillin	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Azithromycin	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Vancomycin	100%(6)	100%(32)	100%(31)	-	100%(15)	-	100%(1)

Ofloxacin	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Clindamycin	100%(6)	75%(24)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Erythromycin	100%(6)	84.40%(27)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Lincomycin	100%(6)	75%(24)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Cloxacillin	100%(6)	84.40%(27)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Piperacillin	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Ceftriaxone	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Ceftazidime	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Linezolid	100%(6)	96.60%(31)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Amoxicillin	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Oxacillin	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Rifampin	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)
Cefoxitin	100%(6)	100%(32)	100%(31)	100%(1)	100%(15)	100%(5)	100%(1)

Continuation of Table 9: The frequency of antibiotic resistance in bacteria

Bacterium / Antibiotic name	Resistance percentage/number of resistant bacteria					
	Proteus(N=1)	Enterobacter (N=1)	Group D Streptococcus (N=11)	MRSA (N=1)	DNAse negative staphylococcus (N=2)	Diphtheroid (N=1)
Imipenem	-	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Ceftizoxime	-	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Tetracycline	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Trimethoprim sulfamethoxazole	-	100%(1)	90.90%(10)	100%(1)	100%(2)	100%(1)
Gentamicin	-	-	100%(11)	100%(1)	-	100%(1)
Cephalexin	100%(1)	100%(1)	100%(11)	100%(1)	-	100%(1)
Ciprofloxacin	100%(1)	100%(1)	100%(11)	-	100%(2)	100%(1)
Colistin	100%(1)	-	100%(11)	100%(1)	100%(2)	100%(1)
Chloramphenicol	100%(1)	-	18.20%(2)	-	-	100%(1)
Cefixime	-	-	100%(11)	100%(1)	100%(2)	100%(1)
Amikacin	-	-	100%(11)	100%(1)	100%(2)	100%(1)
Maropenem	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Ampicillin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Azithromycin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Vancomycin	100%(1)	100%(1)	90.90%(10)	100%(1)	-	100%(1)
Ofloxacin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Clindamycin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Erythromycin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Lincomycin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Cloxacillin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Piperacillin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Ceftriaxone	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Ceftazidime	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Linezolid	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Amoxicillin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Oxacillin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Rifampin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)
Cefoxitin	100%(1)	100%(1)	100%(11)	100%(1)	100%(2)	100%(1)

Discussion and Conclusion

Over the past years, the use of vascular catheters has increased in outpatient and hospitalized patients [19]. The use of a catheter

can cause infection and transmit infection to the bloodstream. Catheter related bloodstream infections impose many health burdens on the health system and increase the duration of hospitalization [13]. Catheter related bloodstream infections also increase the odds of death. They are nowadays considered as one of the most important health system problems. In this study, the prevalence of catheter related bloodstream infections in patients hospitalized in ICUs in Namazi Hospital since April 2016 to April 2017 was evaluated. A total of 178 patients and a total of 253 inserted catheters were studied according to predetermined conditions. Majority of participants were male (56.1%) with a mean age of 50.9. Similar studies have been conducted in this regard. For example, in the project performed during years 2009-2011 by Deepti et al in India, the mean age of the patients was 50.1 and most of the patients (54%) had age over 50 years and were male [15]. In a study conducted at Shariati Hospital in Tehran, most of the patients had age over 50 years (61%) and were men (53.3%) [20].

In the present study, the median of duration of hospitalization was 26 days in those with positive culture and 16.5 days in those with negative culture, which this difference is statistically significant. Therefore, it can be concluded that the longer hospitalization in ICU increases the odds of catheter related bloodstream infections. However, in a study conducted under the title of catheter related bloodstream infections at two teaching Shariati and Valiasr hospitals in Zanjan, there was no significant relationship between the duration of hospitalization and type of hospitalization and prevalence of catheter-related bloodstream infections [16]. In the present study, the underlying diseases such as hypertension, hyperlipidemia, types of cancers, drug use, thyroid diseases, kidney problems, cardiovascular problems, stroke and other diseases and their association with bloodstream infections were investigated. Among all above-mentioned diseases, patients with thyroid disease showed higher range of catheter related bloodstream infection (66.7% of patients with thyroid problems had positive culture).

Out of 253 catheters inserted in the present study, 47.4% of the catheters had positive culture (120 catheters) indicating their infection and the presence of catheter related infections, and 52.6% of the catheters had negative culture (133 catheters), which its rate is higher in comparison with similar studies. In the study conducted by Deepti and Sanjeev Sinha in India, the prevalence of the hospitalized infections was 38.7%, which nosocomial infections account for 6.7% of catheter related bloodstream infections [15]. In a study conducted on catheter related bloodstream infectious in two teaching hospitals in northwest of Iran, 12.1% of the cultures were positive, which the share of catheter related bloodstream infections was 6% [16]. However, the rate of catheter related bloodstream infectious in the present study was less than of the study conducted on the cardiovascular patients hospitalized in Tehran Rajaei Hospital. In the mentioned study conducted at the heart center of Rajaei Hospital, 44 (73.3%) people had positive culture of microorganisms [17].

Based on the different studies, the most common microorganisms that cause catheter related bloodstream infections are coagulase negative staphylococci S.aureus, gram negative bacilli and Candida albicans [11]. In the present study, most of the microorganism that caused catheter related bloodstream infections was gram-negative bacteria (50%), followed by gram-positive bacteria (40%) and fungi (10%), respectively. Acinetobacter among the gram-negative bacteria and Staphylococcus epidermidis among the gram-positive bacteria were the most common cause of catheter related bloodstream infections. However, in general and without positive-gram and negative-gram bacteria, the most common bacteria caused catheter related bloodstream infections included Staphylococcus epidermidis with 26.6%, Acinetobacter with 25.8%, Klebsiella with 12.5%, and Enterococcus with 9.5%. Staphylococcus epidermidis is one of the normal bacteria of skin. It can lead to the catheter infection through the skin of the patient or the skin of the individual who is inserting the catheter [21]. Therefore, in order to prevent the onset of these complications, it is recommended to make some actions before the catheterization to minimize the level of bacteria on the surface of the skin at the entry site of the catheter [22]. Acinetobacter is also the most common germ-negative organism found on the skin of the hospital staff. This opportunistic bacterium produces no toxin [23]. The prevalence of the clinical form of infection with Acinetobacter is different in each country, depending on the site of sampling [24]. In a study conducted by Songlin Peng and Yan Lu under the title of bloodstream infections caused by central vascular catheters in ICU in China, the prevalence of gram-negative microorganisms (42.8%) such as Enterobacteriae and pseudomonas was more. The prevalence of gram-positive bacteria including enterococcus faecium and methicillin-resistant Staphylococcus epidermidis (MRCON) was estimated to be 33.3% and the prevalence of fungal infections was 33% [25].

In a study conducted by Deepti and Sanjeev Sinha in India, the most common microorganisms isolated from patients hospitalized in ICU were klebsilla pneumonia, S.aureus, beta-lactamase positive, and Acinetobacter [15]. In the study conducted at Loghman Hakim Hospital in Tehran, the most common isolated microorganisms were Acinetobacter (75%) and Staphylococcus epidermidis (38.2%) [26]. In this study, the most antibiotic sensitivity to gram-negative bacteria was seen in colistin (90%), amikacin (33.3%) and gentamicin (30%). The bacteria of this family were completely resistant to meropenem, ampicillin, azithromycin, vancomycin, ofloxacin, clindamycin, erythromycin, cloxacillin, piperacillin, ceftriaxone, ceftazidime, linezolid, amoxicillin, oxacillin, rifampin and cefoxitin. Moreover, in the present study, gram-positive bacteria showed the highest sensitivity to chloramphenicol (87.5%) and vancomycin (75%).

They were also resistant to imipenem, ceftizoxime, tetracycline, colistin, cefixime meropenem, ampicillin, azithromycin, ofloxacin, piperacillin, ceftriaxone, ceftazidime, amoxicillin, oxacillin, rifampin and cefoxitin. In general, it can

be stated that all isolated bacteria in this study, regardless of their gram-positive or gram-negative nature, are completely resistant to meropenem, ampicillin, azithromycin, ofloxacin, piperacillin, ceftriaxone, ceftazidime, amoxicillin, oxacillin, rifampin and cefoxitin. In the study conducted at Valiasr and Beheshti hospitals in Zanjan, microorganisms showed the highest antibiotic sensitivity to amikacin (83.3%), ciprofloxacin (33.3%), cephalexin (33.3%), ceftizoxime (26.7%), ceftriaxone (30%), and cefazolin (30%) [16]. In a study conducted in Tehran Rajaei Hospital, investigating the antibiotic sensitivity showed that gram-positive bacteria were more sensitive to vancomycin and linezolid, whereas gram-negative bacteria were sensitive to amikacin, gentamicin, Tobramycin and imipenem [17]. Therefore, in this study, the rate of catheter related bloodstream infections in ICUs of Namazi Hospital is significantly higher than that of other centers. Patients hospitalized in ICU have a weaker prognosis than other normal hospitalized patients and have lower health status. In addition, they use central vascular catheters for longer time. Therefore, the odds of having a catheter related bloodstream infection is higher in these patients than that of others. In addition to increasing the rate of mortality, it imposes much cost on the patient and the hospital. Using simple prevention methods such as limited use of catheter, observing the hygiene of hands by the nurse when inserting the catheter, cleaning and sterilizing the catheter insertion site, using gloves and mask and sterilization equipment, avoiding inserting the catheter in the femoral vein, removing the catheter as soon as possible, not using systemic antibiotics as prophylaxis in any condition, providing appropriate training for the relevant staff, etc. [27] as well as proper use of antibiotics and limiting the use of intravascular catheter can be helpful in prevention and treatment of catheter related bloodstream infections.

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