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Retrospective Study on the Prevalence and Antibiotic Resistance Pattern of *Staphylococcus Aureus* and *Staphylococcus Epidermidis* Among Patients Suspicious of Bacteremia During 2006 - 2011

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Background: Staphylococci bacteria cause different diseases, varies from mild skin infections to serious bacteremia. Also they are a major cause of nosocomial and community-acquired infections globally. *Staphylococcus aureus* and *Staphylococcus epidermidis* are the two important opportunistic pathogens of the staphylococci that both can cause bacteremia.

Objectives: The aim of the present study was to investigate the prevalence and antibiotic resistance pattern of *S. aureus* and *S. epidermidis* among blood culture of patients of Ghaem Educational, Research and Treatment Center, Mashhad, Iran, during 6 years (2006 - 2011).

Patients and Methods: In this retrospective study, hospital medical records of 28000 patients referred to Ghaem Educational, Research and Treatment Center, Mashhad, Iran, who were suspicious of blood infections during 6 years (2005-2011), were extracted. The patient's blood culture with staphylococcal growth and their antibiogram results during 2006 - 2011 were collected and studied.

Results: *Staphylococcus spp.* were isolated from 600 (2.14%) out of 28000 blood cultures. Furthermore, 420 (70%), 170 (28.3%) and 10 (1.7%) out of 600 bacterial isolates identified as *S. epidermidis*, *S. aureus* and other *Staphylococcus spp*., respectively. Ampicillin, amoxicillin, cefixime, ceftazidime, penicillin, oxacillin, nalidixic acid and cephepime were the most antibiotics that the isolates were resistant against. Also vancommycin and chloramphenicol were the most effective antibiotics against *S. epidermidis* and *S. aureus*, respectively.

Conclusions: Prevalence of Staphylococcal bacteremia caused by *S. epidermidis* is fairly high comparing to *S. aureus* among patients referred to Ghaem Educational, Research and Treatment Center, Mashhad, Iran. Also the resistance rate of *Staphylococcus spp.* isolated from blood against commonly used antibiotic is high, but there are some highly sensitive antibiotic against the infection.

Keywords: Bacteremia; *Staphylococcus aureus*; *Staphylococcus epidermidis*; Drug resistance

1. Background

The staphylococci cause different diseases, varies from mild skin infections to serious bacteremia. They are a major cause of nosocomial and community-acquired infections present all over the globe (1). *Staphylococcus aureus* and *Staphylococcus epidermidis* are the two important opportunistic pathogens of the staphylococci. *S. epidermidis* is mostly common all over the cutaneous surfaces, whilst *S. aureus* is present rudimentarily on the mucosal membranes (2).

S. epidermidis can be distinguished from *S. aureus* by its inability to produce coagulase. It colonizes on the skin and mucosal membranes of the human body and represents the predominant part of the normal bacterial flora of skin. *S. aureus* is colonized in 30% to 50% of healthy adults, which is persistent in 10% to 20% (3).

Higher morbidity and mortality rates have been described in infections by organisms resistant to antibiotics comparing to antibiotic-susceptible ones (4). During last decades, infection with *S. aureus* has been increased, with mortality of 15% - 60% in patients with staphylococcal bacteremia (5, 6). The growing antibiotic resistance in staphylococcal and other bacterial infections is an emerging problem (6-8).

2. Objectives

To develop better and efficient health policies regarding treatment and control of the bacteremia, especially staphylococcal bacteremia, there is need for updated data about the prevalence of the infection and antibiotic resistance pattern in each region. This study aimed to investigate the prevalence of staphylococcal bacteremia caused by *S. aureus* and *S. epidermidis* and their antibiotic resistance pattern from patients referred to Ghaem Educational, Research and Treatment Center, Mashhad, Iran, during 6 years (2006 - 2011).

3. Patients and Methods

3.1. Blood Culture and Bacterial Isolation

In this retrospective study, hospital medical records of 28000 patients of Ghaem Educational, Research and Treatment Center, Mashhad, Iran, who were suspicious of blood infections during 6 years (2005 - 2011), were extracted. The sampling procedure was as follows; the patient's blood samples were cultured in biphasic brain heart infusion medium bottles. The cultured media were inoculated at 37˚C for 24 hours. Then they transferred to the subsequent media and biochemical tests were done for isolation of *S. aureus* and *S. epidermidis* as described before (9).

3.2. Antibiotic Susceptibility Test

The susceptibility of *S. aureus* and *S. epidermidis* isolates to 30 antibiotics (Pad Tan Teb, Iran) was carried out using disc diffusion method (10) and the test's procedure was done based on the manufacturer's construction. In brief the procedure is as follows: 1.5 × 108 CFU of bacterial emulsion, transferred to Muller-Hinton agar (Merck, Germany) and antibiogram discs were placed on the medium. The prepared media incubated for 18 hours at 35˚C. Interpretation of the results were performed using Clinical and Laboratory Standards Institute (CLSI) criteria (11). The results of antibiogram tests were reported as sensitive and resistance.

4. Results

Totally 28000 blood samples were investigated from which in 600 (2.14%) blood culture *staphylococcus spp.* were isolated. Furthermore, 420 (70%), 170 (28.3%) and 10 (1.7%) out of 600 bacterial isolates identified as *S. epidermidis*, *S. aureus* and other *Staphylococcus spp.*, respectively.

According to the antibiogram results, the highest sensitivity rates of *S. aureus* were against vancomycin (95.2%), norfloxacin (70.9%), chloramphenicol (95.7%), tobramycin (62.8%) and doxycycline (88.9%). Also *S. epidermidis* showed higher sensitivity to amikacin (84%), chloramphenicol (84.6%), cephalotin (85.1%), cefazolin (81.5%), doxycycline (72.4%), vancommycin (97.9%) and norfloxacin (69.3%).

Table 1. Antibiotic Resistance among *S. aureus* Strains Isolated from Patients with Bacteremia During 2006 – 2011 [a]

Antibiotic, µg/disc	2006	2007	2008	2009	2010	2011	6 Years		Total
							R [b]	S [b]	
Ampicillin (10)	18 (100)	9 (90)	6 (100)	11 (73)	6 (67)	5 (71)	55 (85)	10 (15)	65
Amoxicillin/clavulanic acid (20/10)	2 (100)	ND [a]	3 (60)	ND	15 (83.3)	ND	20 (80)	5 (20)	25
Cefepime (30)	ND	ND	ND	ND	3 (100)	16 (100)	19 (100)	0 (0)	19
Ceftazidime (30)	1 (100)	2 (100)	10 (100)	19 (100)	25 (96.2)	ND	57 (98.3)	1 (1.7)	58
Nalidixic acid (30)	5 (83.3)	ND	1 (100)	ND	4 (100)	ND	10 (90.9)	1 (9.1)	11
Penicillin (10)	33 (97.1)	7 (100)	15 (93.8)	21 (100)	30 (96.8)	14 (93.3)	120 (95)	4 (5)	124
Cefexime (5)	4 (100)	ND	5 (83.3)	10 (100)	10 (100)	0 (0)	29 (90.6)	3 (9.4)	32
Oxacillin (1)	3 (100)	ND	17 (94.5)	13 (100)	8 (88.9)	1 (100)	42 (97.7)	2 (2.3)	44
Amikacin (30)	2 (33.3)	1 (33.3)	0 (0)	ND	7 (46.7)	ND	10 (34.5)	19 (65.5)	29
Amoxicillin (25)	10 (58.8)	ND	6 (66.7)	1 (12.5)	2 (40)	2 (66.7)	21 (50)	21 (50)	42
Chloramphenicol (5)	0 (0)	1 (33.3)	0 (0)	ND	ND	ND	1 (4.3)	22 (95.7)	23
Cirprofloxacin (5)	4 (30.8)	0 (0)	0 (0)	ND	9 (33.3)	3 (27.3)	16 (23.9)	51 (76.1)	67
Ceftizoxime (30)	11 (34.4)	1 (12.5)	6 (40)	2 (28.6)	4 (40)	3 (42.9)	27 (34.2)	52 (65.8)	79
Cefotaxime (30)	8 (40)	3 (30)	2 (18.2)	4 (26.7)	10 (45.5)	ND	27 (34.6)	51 (65.4)	78
Cephalothin (30)	2 (33.3)	1 (20)	0 (0)	ND	2 (50)	2 (66.7)	7 (30.4)	16 (69.6)	23
Ceftriaxone (30)	8 (66.7)	ND	ND	ND	13 (54.2)	0 (0)	21 (58.3)	15 (41.7)	36
Cefazolin (30)	9 (39.1)	1 (50)	4 (26.7)	6 (35.3)	3 (23.1)	7 (53.8)	30 (36.1)	53 (63.9)	83
Cephalexin (30)	4 (20)	1 (33.3)	3 (42.9)	4 (30.8)	ND	ND	12 (27.9)	31 (72.1)	43
Gentamicin (10)	10 (30.3)	2 (25)	3 (23.1)	4 (36.4)	11 (73.3)	ND	30 (38)	49 (62)	79
Imipenem (10)	ND	2 (25)	0 (0)	5 (33.3)	9 (45)	ND	16 (35.6)	29 (64.4)	45
Kanamycin (30)	2 (33.3)	1 (100)	1 (20)	ND	4 (50)	6 (85.7)	14 (51.9)	13 (48.1)	27
Norfloxacin (10)	4 (36.4)	3 (27.3)	5 (26.3)	1 (10)	9 (34.6)	1 (50)	23 (29.1)	56 (70.9)	79
Sulfamethoxazole/Trimethoprim (23.75/1.25)	18 (52.9)	4 (33.3)	4 (30.8)	6 (75)	4 (40)	0 (0)	36 (46.8)	41 (53.2)	77
Tobramycin (10)	3 (30)	1 (50)	1 (12.5)	1 (50)	10 (47.6)	0 (0)	16 (37.2)	27 (62.8)	43
Erythromycin (15)	0 (0)	3 (37.5)	6 (40)	9 (56.3)	12 (41.4)	10 (37.5)	40 (41.2)	57 (58.8)	97
Azithromycin (15)	ND	ND	ND	ND	0 (0)	5 (41.7)	5 (33.3)	10 (66.7)	15
Doxycycline (30)	1 (100)	ND	ND	ND	0 (0)	1 (6.7)	2 (11.1)	16 (88.9)	18
Ofloxacin (5)	6 (20)	1 (50)	ND	ND	ND	ND	7 (21.9)	25 (78.1)	32
Vancomycin (30)	1 (14.3)	0 (0)	0 (0)	0 (0)	1 (4)	2 (13.3)	4 (4.8)	80 (95.2)	84
Tetracycline (30)	6 (60)	1 (50)	4 (57.1)	5 (38.5)	5 (45.5)	4 (66.7)	25 (51)	24 (49)	49

[a] All values are presented as No. (%).
[b] Abbreviations: R, Resistance; S, Sensitive; ND, No Data.

The highest rates of drug resistance among *S. aureus* isolates were seen against ampicillin (85%), amoxicillin/clavulanic acid (80%), cefixime (90.6%), ceftazidime (98.3%), penicillin (95%), oxacillin (97.7%), nalidixic acid (90.9%) and cephepime (100%). Also the highest rates of antibiotic resistance among *S. epidermidis* isolates were seen against cefixime (92.3%), ceftazidime (95.5%), penicillin (92.9%), oxacillin (88.9%), nalidixic acid (86.7%) and cephepime (87.5%). The antibiotic resistance pattern of the *S. aureus* and *S. epidermidis* during 2006 to 2011 is available in Tables 1 and 2, respectively.

Table 2. Antibiotic Resistance among *S. epidermidis* Strains Isolated from Patients with Bacteremia During 2006 – 2011 [a]

Antibiotic (μg per disc)	2006	2007	2008	2009	2010	2011	6 Years		Total
							R [b]	S [b]	
Ampicillin (10)	22 (75.9)	33 (67.3)	10 (83.3)	12 (33.3)	5 (33.3)	6 (60)	88 (55.3)	71 (44.7)	159
Amoxicillin/Clavulanic Acid ((20/10)	0 (0)	ND [b]	6 (40)	ND	17 (80.5)	1 (100)	24 (63.2)	14 (36.8)	38
Cefepime (30)	ND	ND	ND	ND	2 (100)	26 (86.7)	28 (87.5)	4 (12.5)	32
Ceftazidime (30)	4 (80)	3 (100)	23 (95.8)	45 (100)	30 (90.1)	ND	105 (95.5)	5 (4.5)	110
Nalidixic acid (30)	4 (80)	6 (100)	ND	ND	3 (75)	ND	13 (86.7)	2 (13.3)	15
Penicillin (10)	55 (96.5)	47 (95.9)	33 (80.5)	55 (98.2)	41 (93.2)	29 (87.9)	260 (92.9)	20 (7.1)	280
Cefexime (5)	9 (81.8)	ND	11 (91.7)	29 (96.7)	11 (91.7)	ND	60 (92.3)	5 (7.7)	65
Oxacillin (1)	6 (100)	ND	ND	ND	12 (100)	6 (66.7)	24 (88.9)	3 (11.1)	27
Amikacin (30)	0 (0)	6 (24)	0 (0)	0 (0)	3 (23.1)	ND	9 (17)	44 (83)	53
Amoxicillin (25)	5 (38.5)	ND	12 (41.4)	1 (4.2)	3 (37.5)	6 (27.3)	27 (28.1)	69 (71.9)	96
Chloramphenicol (5)	4 (10.5)	3 (50)	1 (12.5)	ND	ND	ND	8 (15.4)	44 (84.6)	52
Cirprofloxacin (5)	2 (10.5)	11 (23.4)	11 (29.7)	ND	6 (14.3)	10 (35.7)	40 (23.1)	133 (76.9)	173
Ceftizoxime (30)	9 (31)	18 (33.3)	16 (44.4)	12 (54.6)	18 (43.9)	13 (30.2)	86 (38.2)	139 (61.8)	225
Cefotaxime (30)	27 (55.1)	13 (31.7)	11 (32.4)	17 (42.5)	20 (50)	4 (50)	92 (43.4)	120 (56.6)	212
Cephalothin (30)	2 (33.3)	4 (20)	1 (4.5)	ND	1 (6.7)	3 (27.3)	11 (14.9)	63 (85.1)	74
Ceftriaxone (30)	ND	ND	ND	ND	21 (56.8)	8 (66.7)	29 (59.2)	20 (40.8)	49
Cefazolin (30)	8 (18.6)	4 (17.4)	5 (17.2)	11 (20)	2 (11.1)	6 (22.2)	36 (18.5)	159 (81.5)	195
Cephalexin (30)	ND	1 (2.9)	3 (17.6)	10 (23.8)	1 (100)	8 (17.8)	23 (16.4)	117 (83.6)	140
Gentamicin (10)	14 (48.3)	31 (54.4)	15 (42.9)	25 (55.6)	4 (19)	14 (48.3)	103 (47.7)	113 (52.3)	216
Imipenem (10)	ND	ND	3 (42.9)	21 (40.4)	6 (21.4)	0 (0)	30 (33.3)	60 (66.7)	90
Kanamycin (30)	12 (75)	10 (62.5)	10 (62.5)	ND	5 (71.4)	3 (60)	40 (66.7)	20 (33.3)	60
Norfloxacin (10)	12 (32.4)	13 (30.2)	15 (30.6)	4 (22.2)	12 (36.4)	3 (25)	59 (30.7)	133 (69.3)	192
Sulfamethoxazole/ Trimethoprim (23.75/1.25)	47 (79.7)	35 (70)	34 (73.9)	22 (61.1)	11 (64.7)	11 (78.6)	160 (72.1)	62 (27.9)	222
Tobramycin (10)	6 (60)	12 (48)	7 (63.6)	0 (0)	2 (12.5)	ND	27 (42.2)	37 (57.8)	64
Erythromycin (15)	6 (54.5)	33 (66)	32 (69.6)	36 (66.7)	31 (76.7)	23 (79.3)	161 (69.1)	72 (30.9)	233
Azithromycin (15)	ND	ND	ND	ND	9 (75)	11 (73.3)	20 (74.1)	7 (25.9)	27
Doxycycline (30)	ND	ND	ND	ND	5 (45.5)	3 (16.7)	8 (27.6)	21 (72.4)	29
Ofloxacin (5)	16 (30.2)	4 (23.5)	ND	ND	ND	ND	20 (28.6)	50 (71.4)	70
Vancomycin (30)	0 (0)	4 (7.7)	1 (2)	0 (0)	0 (0)	1 (3.6)	6 (2.1)	274 (97.9)	280
Tetracycline (30)	8 (34.8)	6 (60)	14 (73.7)	13 (61.9)	12 (75)	8 (40)	61 (56)	48 (44)	109

[a] All values are presented as No. (%).
[b] Abbreviations: R, Resistance; S, Sensitive; ND, No Data.

5. Discussion

S. epidermidis is a normal flora of the human skin (12). So contamination of needle during blood sampling must be considered in positive results and probably a percent of positive results may be biased in these kinds of studies. In the present study *Staphylococcus spp.* were isolated from 600 (2.14%) out of 28000 blood samples, from which 420 (70%) of the isolates were *S. epidermidis*. Only170 (28.3%) of the isolates identified as *S. aureus*. As the results shows *S. epidermidis* is much frequent in staphylococcal bacteremia than *S. aureus*.

Considering the antibiotic resistance pattern of the isolates, ampicillin, amoxicillin, cefixime, ceftazidime, penicillin, oxacillin, nalidixic acid and cephepime were the most antibiotics that the isolates were resistant against. Also vancomycin and chloramphenicol were the most effective antibiotics against *S. aureus*, and vancomycin was the most effective antibiotic against *S. epidermidis*. During 6 years increasing pattern in antibiotic resistance rate against some antibiotics can be seen. The antibiotic resistance pattern of the *S. aureus* and *S. epidermidis* during 2006 to 2011 are available in Tables 1 and 2, respectively.

As prevalence of infectious diseases have been decreasing during last decades (13), but the drug resistance became an important issue regarding the treatment of such diseases (7, 8, 14, 15). Drug resistance in *Staphylococcus spp.* is increasing in its intensity and importance in health care settings (16). In the present study the high resistant rates against eight common antibiotics were observed among the isolates.

S. epidermidis and other coagulase negative staphylococci are reported to be serious cause of many nosocomial infections during the last two decades. The adherence and growing competency of staphylococci on plastic surfaces is a fundamental phase in the pathogenesis of infections associated with polymer. Various components that may be involved in slime production and adherence of *Staphylococcus spp.* have been described (17-19).

Methicillin resistant *Staphylococcus aureus* is one of the significant nosocomial pathogen with high mortality and morbidity in patients with suppressed and deficiencies of immune system (20). Also overuse of broad spectrum antibiotics for infections is a consequently increases the risk of acquiring the infections by resistant bacteria (20, 21). High prevalence of antibiotic resistance bacterial infections can be associated to the overuse of antibiotics (22).

Lari et al. (2000) reported *S. aureus* in 5.8% of blood cultures among burned patients of Tohid Burn Center in Tehran, Iran. In their findings *S. aureus* took second place after *Pseudomonas aeroginosa* as the most common cause of bacteremia among burned patients (23).

Ekrami et al. (2007) studied bacterial infection of blood, urine and wound of 182 patients reffered to Taleghani Burn Hospital, Ahvaz, Iran. They reported *S. aureus* as the second common cause of nosocomial infection in burned patients. They noted 58 % of *S. aureus* isolates and 60% of coagulase negative *Staphylococcus spp.* as methicillin resistant, but these isolates were susceptible enough to teicoplanin and vancomycin (24).

Rahimi et al. (2009) studied antibiotic resistance and isolation of methicillin resistance gene of *S. aureus* in Tehran hospitals. They identified 54.7% of their studied isolates as *S. aureus*. They reported 66, 65, 88, 88, 100, 41, 38, 41, 0, 40, 93, 20 and 64% of isolates resistant against kanamycin, cephotaxim, methicillin, oxacillin, ampicillin, erythromycin, clindamycin, sulphamethoxazole-trimethoprime, vancomycin, chloramphenicol, ciprofloxacin, gentamicin and tetracycline, respectively. All of their studied methicillin resistance *S. aureus* and 63% of intermediate resistant isolates were carried mecA gene (25). Our *S. aureus* isolates were highly resistante against ampicillin (85%), amoxicillin/ clavulanic acid (80%), cefixime (90.6%), ceftazidime (98.3%), penicillin (95%), oxacillin (97.7%), nalidixic acid (90.9%) and cephepime (100%).

Zarifian et al. (2014) studied the pattern of antibiotic resistance among *S. aureus* clinical isolates of Mashhad from 2009 to 2011. Their isolates were highly resistant to Ceftazidime (94%), Penicillin (91%), and Ampicillin (82%). Nearly all of their studied strains were susceptible against vancomycin (26). This study showed a resistance pattern close to our findings, which is not surprising, because the two studies carried out in the same city.

There is scarce data on blood bacteremia caused by *Staphylococcus spp.* in hospitals of Iran. Mohammadi et al. (2014) studied neonatal bacteremia isolates and their antibiotic resistance pattern in Sanandaj, Iran (27). They reported 7.6% positive for bacterial growth among 355 blood cultures from which 74% were *Staphylococcus spp.* In their study, the maximum resistance rate among *Staphylococcus spp.* observed against penicillin, and ampicillin, which is similar to our findings. Also 7.5% of their isolates were sensitive to vancomycin and ciprofloxacin, but our isolates were showed high sensitivity against these two antibiotics.

Prevalence of staphylococcal bacteremia caused by *S. epidermidis* is fairly high comparing to *S. aureus* among patients referred to Ghaem Educational, Research and Treatment Center, Mashhad, Iran. Also the resistance rate of *Staphylococcus spp.* isolated from blood against commonly used antibiotic is high, but there are some highly sensitive antibiotic against the infection.

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Authors' Contributions

All authors had equally contributed in all steps of the work.

References

1. Gill SR, Fouts DE, Archer GL, Mongodin EF, Deboy RT, Ravel J, et al. Insights on evolution of virulence and resistance from the complete genome analysis of an early methicillin-resistant Staphylococcus aureus strain and a biofilm-producing methicillin-resistant Staphylococcus epidermidis strain. *J Bacteriol.* 2005;**187**(7):2426–38.
2. von Eiff C, Peters G, Heilmann C. Pathogenesis of infections due to coagulase-negative staphylococci. *Lancet Infect Dis.* 2002;**2**(11):677–85.
3. Lowy FD. Staphylococcus aureus infections. *N Engl J Med.* 1998;**339**(8):520–32.
4. Acar JF. Consequences of bacterial resistance to antibiotics in medical practice. *Clin Infect Dis.* 1997;**24**:17–8.
5. National Nosocomial Infections Surveillance (NNIS) System Report, Data Summary from January 1990-May 1999, issued June 1999. A report from the NNIS System. *Am J Infect Control.* 1999;**27**(6):520–32.
6. Cosgrove SE, Sakoulas G, Perencevich EN, Schwaber MJ, Karchmer AW, Carmeli Y. Comparison of mortality associated with methicillin-resistant and methicillin-susceptible Staphylococcus aureus bacteremia: a meta-analysis. *Clin Infect Dis.* 2003;**36**(1):53–9.
7. Safari M, Saidijam M, Bahador A, Jafari R, Alikhani MY. High Prevalence of Multidrug Resistance and Metallo-beta-lactamase (MbetaL) producing Acinetobacter Baumannii Isolated from Patients in ICU Wards, Hamadan, Iran. *J Res Health Sci.* 2013;**13**(2):162–7.
8. Safari M, Alikhani MY, Arabestani MR, Kamali Kakhki R, Jafari R. Prevalence of Metallo-β-lactamases Encoding Genes Among Pseudomonas aeruginosa Strains Isolated From the Bedridden Patients in the Intensive Care Units. *Avicenna J Clin Microb Infec.* 2014;**1**(1).
9. Schwalbe R, Steele-Moore L, Goodwin A. *Antimicrobial susceptibility testing protocols*.Boca Raton: Crc Press; 2007.
10. National committee for clinical laboratory standards.. *Methods for disk diffusion: approved standard M2-A8: performance standards for antimicrobial disk susceptibility tests.* 8th edWayne: NCCLS; 2003.
11. Clinical and Laboratory Standards Institute.. *Performance standards for antimicrobial susceptibility testing.*Wayne: CLSI; 2007.
12. Kloos WE, Bannerman TL. Update on clinical significance of coagulase-negative staphylococci. *Clin Microbiol Rev.* 1994;**7**(1):117–40.
13. Jafari R, Fallah M, Yousofi Darani H, Yousefi HA, Mohaghegh MA, Latifi M. Prevalence of Intestinal Parasitic Infections Among Rural Inhabitants of Hamadan City, Iran, 2012. *Avicenna J Clin Microb Infec.* 2014;**1**(2).
14. Petersen I, Eastman R, Lanzer M. Drug-resistant malaria: molecular mechanisms and implications for public health. *FEBS Lett.* 2011;**585**(11):1551–62.
15. Hyde JE. Drug-resistant malaria. *Trends Parasitol.* 2005;**21**(11):494–8.
16. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. *Clin Microbiol Infect.* 2012;**18**(3):268–81.
17. Christensen GD, Simpson WA, Bisno AL, Beachey EH. Adherence of slime-producing strains of Staphylococcus epidermidis to smooth surfaces. *Infect Immun.* 1982;**37**(1):318–26.
18. Vuong C, Otto M. Staphylococcus epidermidis infections. *Microbes Infect.* 2002;**4**(4):481–9.
19. Peters G, Locci R, Pulverer G. Adherence and growth of coagulase-negative staphylococci on surfaces of intravenous catheters. *J Infect Dis.* 1982;**146**(4):479–82.
20. Sheff B. VRE & MRSA–putting bad bugs out of business. *Nursing.* 1998;**28**(3):40–4.
21. Vidhani S, Mehndiratta PL, Mathur MD. Study of methicillin resistant S. aureus (MRSA) isolates from high risk patients. *Indian J Med Microbiol.* 2001;**19**(2):13–6.
22. Barbosa TM, Levy SB. The impact of antibiotic use on resistance development and persistence. *Drug Resist Updat.* 2000;**3**(5):303–11.
23. Lari AR, Alaghehbandan R. Nosocomial infections in an Iranian burn care center. *Burns.* 2000;**26**(8):737–40.
24. Ekrami A, Kalantar E. Bacterial infections in burn patients at a burn hospital in Iran. *Indian J Med Res.* 2007;**126**(6):541–4.
25. Rahimi F, Bouzari M, Maleki Z, Rahimi F. Antibiotic susceptibility pattern among Staphylococcus spp. with emphasis on detection of mecA gene in methicillin resistant Staphylococcus aureus isolates. *Arch Clin Infect Dis.* 2009;**4**(3):143–50.
26. Zarifian A, Sadeghian A, Sadeghian H, Ghazvini K, Safdari H. Antibiotic Resistance Pattern of Hospital Isolates of Staphylococcus aureus in Mashhad-Iran During 2009 - 2011. *Arch Clin Infec Dis.* 2012;**7**(3):96–8.
27. Mohammadi P, Kalantar E, Bahmani N, Fatemi A, Naseri N, Ghotbi N, et al. Neonatal bacteriemia isolates and their antibiotic resistance pattern in neonatal insensitive care unit (NICU) at Beasat Hospital, Sanandaj, Iran. *Acta Med Iran.* 2014;**52**(5):337–40.