Comparative Study of Antibacterial Susceptibility Patterns of the Bacteria Isolated from Patients’ Blood Samples over Two Periods

Aziz Japoni, Mehdi Kalani, Abdolvahab Alborzi, Sara Japoni and Noradin Rafaatpour
Clinical Microbiology Research Center, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract: Problem statement: Due to continuous changes in the frequencies and antibacterial susceptibility patterns of nosocomial pathogens, periodical surveillance of these fluctuations could help the clinicians to treat hospitalized patients more efficiently whenever empirical therapies need to be considered. This study was conducted to compare the prevalence of the bacteria recovered from bloodstream samples by Bactec 9240, over the two periods of 2001-2004 and 2005-2008 and to evaluate their antibacterial susceptibility patterns. Approach: Totally, 3622 culture positive blood samples were analyzed over the periods. Antibacterial susceptibility patterns of the isolates were determined by standard disk diffusion (Kirby-Bauer) method. The data were compared in terms of quantity and quality of the pathogens and based on their distributions in three main wards. Results: Changes were observed in bacterial composition and frequencies of them, between the two periods. Compared with the first period, increased frequencies of antibiotic resistant bacteria such as S. aureus, enterococci, acinetobacter and pseudomonas were noticed in the second period. Most patients were admitted to pediatrics, followed by adults and neonates wards. Increased antibiotic resistance of the majority of the bacteria in the second period indicates the decreased efficacy of corresponding antibiotics. However, overall efficacy of some antibiotics such as ciprofloxacin and amikacin against Gram positive bacteria preserved. Conclusion: Trend of composition of the bacteria from first to second period could suggest the domination of antibiotic resistant bacteria over the sensitive ones. Appropriate strategies including strict control measures and rational prescription of the effective antibiotics may retard the trend accordingly. Vancomycin and imipenem were the most active antibiotics against Gram positive and negative bacteria. Combination of these two antibiotics is highly recommended for empirical therapy.

Key words: Comparative study, blood samples, antibiotic resistance, control measures, antibacterial susceptibility patterns, S. aureus, standard disk diffusion, Methicillin Resistant S. aureus (MRSA), Pseudomonas aeruginosa

INTRODUCTION

Rapid and reliable detection of microorganisms from the blood is one of the most critical functions of a diagnostic microbiology laboratory. It is well known that the isolation of microorganisms is a gold standard for accurate detection of etiological agents of infectious diseases (Paolucci et al., 2010). Furthermore, early detection of bloodstream infections could prevent implantation of microorganisms into vital organs such as the brain, heart or kidneys (Bakowski et al., 2008). To detect blood infections, different techniques and instruments have been innovated. One of such detection systems is bactec, which is widely accepted as a rapid and accurate method for the detection of bloodstream infections (Cermak et al., 2011). In this study, blood samples were processed in bactec 9240 (Becton Dickinson Diagnostic Instrument Systems, Sparks, Md.). This system is noninvasive and automated blood culture systems with continuous monitoring have introduced a technology that reduces the time needed to detect positive blood cultures as well as decreases the specimen handling (Kim and Han, 2010; Bert et al., 2010).

The purpose of this study was to compare the frequencies and antibacterial susceptibility patterns of the bacteria isolated from blood samples of the hospitalized patients during two four year periods, using bactec 9240. Hopefully, this comparison can help
adopt a new strategy to prevent the emerging antibiotic resistant isolates in the hospitals. Prediction of the predominant bacteria and determination of the effective clinical antibiotic therapy can help promote the treatment and save on the patient’s management.

**MATERIALS AND METHODS**

This study was conducted to compare the bacteria isolated from blood samples over the two periods, 2001-2004 and 2005-2008, at Nemazee Hospital, affiliated with Shiraz University of Medical Sciences, Shiraz, southern Iran. This hospital is a tertiary care facility with 1000 beds and located in Fars province. Suspicious patients to blood infections admitted to three main hospital wards including, neonates, pediatrics and adults were enrolled in the study. Ten and 3 ml blood samples from pediatric/neonate and adult patients were taken under the supervision of specialized physician and inoculated to bactec bottles peds plus/F or adult plus aerobic/F, aseptically. An indication for patient blood infection was confirmed by the specialized physician in each ward.

The bottles were incubated in bactec system, as recommended by the manufacturer for 7 consecutive days. The negative bottles were then removed from the instrument. During the seven day incubation, when system alerted for positive results, 3-5 drops of blood culture samples taken with 1ml sterile syringe, were inoculated on the blood and chocolate agars containing 5% whole sheep blood and then incubated aerobically at 37°C overnight. The pure cultures were then stained by Gram's method. Identification of bacteria in positive cultures was carried out according to standard biochemical tests and subculturing to appropriate media.

Sensitivity of identified bacteria to the different antibiotics was determined, according to standard disk diffusion (Kirby-Bauer) method using Mast Co (Mast Co, Merseyside, UK) or Difco (BBL, USA) disks. *E. coli* (ATCC 25922) and *S. aureus* (ATCC 25923) were used as the control for antibiotic susceptibility determination. Antibiotal susceptibility was interpreted as recommended by National Committee for Clinical Laboratory Standards NCCLS (National Committee for Clinical Laboratory Standards).

Difference in frequency of bacteria over the two periods of study was analyzed by *Chi-square* (SPSS version 15 software) and Fisher's exact tests. The significant level was defined as *p*<0.05.

**RESULTS**

During the periods 2001-4 and 2005-8, 9407 and 10400 blood specimens were received and processed, of which 1122 (11.9%) and 2500 (24%) were grown in bactec apparatus, respectively. Totally, from 19807 blood samples, 3622 (18.2%) were positive during the whole periods of the study. Seven top list isolated bacteria from the blood samples were as follows: coagulase negative staphylococci, *Staphylococcus aureus*, *E.coli*, *Pseudomonas aeruginosa*, bacillus spp, *enterobacter* spp and *acinetobacter* spp. Coagulase negative staphylococci and bacillus spp, are normal flora of the skin and the possibility of blood samples contamination with them during sampling should be considered. Fluctuation in frequencies of some important pathogenic isolates such as *Pseudomonas aeruginosa*, *acinetobacter* spp, *enterococci* spp and *brucella* spp was statistically significant. *Staphylococcus aureus* and *E.coli* were Gram positive and Gram negative true pathogenic microorganisms, isolated from the patients with the highest frequencies. As shown in Table 1, during the 8 year period of study some bacteria such as fusobacter, *Neisseria meningitidis*, peptococci, *Listeria monocytogrenes*, *campylobacter* spp and hafnia were isolated at very low quantities (1; 0.1%). Comparison of fluctuation in antibiotic resistance of the Gram negative and Gram positive bacteria indicates that in the second period (2005-8), bacteria acquired more resistance to the tested antibiotic, compared to the first period (2001-4). This finding for some bacteria such as: *acinetobacter*, *Pseudomonas aeruginosai*, *S. aureus* and *entroccocci* spp were remarkable. Table 2 and 3 present the detailed comparison of bacterial resistance patterns over the two periods. Comparison of the isolates from the patients admitted to the three above-mentioned wards, revealed that frequencies (%) of bacteria in the patients with bloodstream infections in pediatrics ward was higher, compared to the other two wards (Table 4). Changes in frequencies of some bacteria such as *S. aureus*, *E.coli*, *P. aeruginosai* and *brucella* spp were statistically significant. Reduced efficacy of the antibiotics against Gram positive bacteria was observed in the second period, while for Gram negative bacteria the efficacy of majority of antibiotics preserved. Overall reduction of *in vitro* activity of cephalaxin and clindamycin against Gram negative and cefazidime against Gram positive bacteria was considerable. Figure 1 and 2 illustrate the changes in sensitivity of Gram negative and positive bacteria to the five effective antibiotics during the periods of investigation.
Table 1: Frequencies of isolated microorganisms from bactec 9240 over the periods 2001-2004 and 2005-2008

| Microorganisms                | Total Frequency 2001-2004 (%) | Total Frequency 2005-2008 (%) | P value  |
|-------------------------------|--------------------------------|--------------------------------|----------|
| *Coagulase Negative Staphylococci* | 523 (47)                      | 1295 (51.8)                    | 0.09     |
| Staphylococcus aureus         | 132 (12)                       | 250 (10)                       | 0.15     |
| E.coli                        | 64 (6)                         | 112 (4.5)                      | 0.13     |
| Pseudomonas aeruginosa        | 52 (4.5)                       | 50 (2.0)                       | 0.00018  |
| Bacillus spp                  | 52 (4.5)                       | 60 (2.4)                       | 0.0005   |
| Enterobacter spp              | 50 (4)                         | 70 (2.8)                       | 0.012    |
| Acinetobacter spp             | 40 (3.5)                       | 165 (6.6)                      | 0.00005  |
| Streptococcus viridans        | 34 (3)                         | 45 (1.8)                       | 0.022    |
| Enterococcus spp              | 29 (2.5)                       | 115 (4.6)                      | 0.005    |
| Klebsiella spp                | 29 (2.5)                       | 55 (2.2)                       | 0.04     |
| Brucella spp                  | 28 (2.4)                       | 20 (0.8)                       | 0.00005  |
| Streptococcus pneumoniae      | 20 (1.6)                       | 23 (0.9)                       | 0.029    |
| *Diphteroid cedecia daviseae*  | 16 (1.3)                       | 70 (2.8)                       | 0.014    |
| Strepotoccus pneumoniae       | 12 (0.46)                      | NA                             |          |
| Salmonella spp                | 11 (1)                         | 5 (0.2)                        | 0.001    |
| Haemophilus influenzae        | 8 (0.8)                        | 15 (0.6)                       | 0.7      |
| Candida spp                   | 6 (0.6)                        | 30 (1.2)                       | 0.064    |
| Proteus spp                   | 5 (0.5)                        | -                              | NA       |
| Oligella spp                  | 4 (0.4)                        | 30 (1.2)                       | 0.015    |
| Morganella                    | -                              | 4 (0.16)                       | NA       |
| *Micrococcus spp              | 3 (0.3)                        | 10 (0.4)                       | 0.75*    |
| Streptococcus spp             | 3 (0.3)                        | 25 (1.0)                       | 0.02     |
| Serratia spp                  | 3 (0.3)                        | 25 (1.0)                       | 0.02     |
| Gram positive anaerobic org   | 2 (0.2)                        | -                              | NA       |
| Gram negative rod             | 2 (0.2)                        | 5 (0.2)                        | 1*       |
| Nocardia                      | -                              | 2 (0.08)                       | NA       |
| Citrobacter                   | -                              | 2 (0.08)                       | NA       |
| Morexella                     | -                              | 2 (0.08)                       | NA       |
| Fusobacter                    | 1 (0.1)                        | -                              | NA       |
| Neisseria menigitidis         | 1 (0.1)                        | -                              | NA       |
| b hemolytic strep group A&B   | 1 (0.1)                        | 2 (0.8)                        | 1*       |
| Peptococi                     | -                              | 1 (0.04)                       | NA       |
| Listeria monocytogrenes       | 1 (0.1)                        | -                              | NA       |
| Campylobacter spp             | 1 (0.1)                        | -                              | NA       |
| Hafnia                        | 1 (0.1)                        | -                              | NA       |
| Total                         | 1122 (100)                     | 2500 (100)                     | NA       |

*: Analyzed with Fisher's exact tests. Significant values are printed in bold

Table 2: Comparison of antibiotic resistance patterns of important Gram negative bacteria recovered from bactec 9240 over periods 2001-4 and 2005-8

| Bacteria                  | Percentage of antibiotic resistance | Period: a or b: | GM | CN | SXT | CXM | CRX | IMI | CIP | AK | CAZ | AP | CPM | C | CFM | CTX |
|---------------------------|------------------------------------|-----------------|----|----|-----|-----|-----|-----|-----|----|-----|----|-----|---|-----|-----|
| Acinetobacter spp         | a: 40                              | 17              | 39 | 38.00 | ND | ND | ND | 17 | 41 | 39 | ND | ND | ND | ND | ND | ND |
| E. coli                   | b: 165                             | 46              | 74.6 | 43.50 | 82 | 47 | 32.5 | 17 | 25 | 48 | 86.7 | 45.7 | 62.5 | ND | ND | ND |
| Pseudomonas spp           | a: 52                              | 24.3            | ND | 93.80 | 100 | ND | ND | 10.8 | ND | ND | ND | ND | ND | ND | ND | ND |
| E. coli                   | b: 50                              | 33.3            | 81.00 | 81.00 | 95 | 58 | 12.5 | 26 | 17 | 41.5 | 87 | 43.5 | 75 | 91 | ND | ND |
| Enterobacter spp          | a: 50                              | ND              | ND | 39.00 | 44 | ND | ND | 11 | 54 | 78 | ND | ND | ND | ND | ND | ND |
| Klebsiella spp            | a: 29                              | 23.5            | 28.6 | 26.60 | 18.2 | ND | ND | 16.7 | 9.1 | 26.8 | 54 | 36.4 | ND | ND | ND | ND |
| Salmonella spp            | a: 11                              | 11              | 0.00 | 11.00 | 80 | 56 | 0 | 33 | 24 | 58 | 95 | 38 | 55.5 | ND | ND | ND |
| Brucella spp              | b: 10                              | 10              | 80.00 | 44.50 | ND | 25 | 0 | 10 | 16.7 | 66.7 | 33.3 | ND | ND | ND | ND | ND |
| Haemophilus influenzae    | a: 8                               | 6               | 25 | 38.00 | 25 | 9 | 0 | 5.2 | 6 | 15 | 25 | 53 | 15 | 16 | 15 | 15 |
| b: 15                    | 11.1                               | 33.3            | 44.40 | 35 | 11.1 | 0 | 11.1 | 11.1 | 22.2 | 33.3 | 11.1 | ND | 22.2 | 22.2 | ND | 3 |

Period a: 2001-2004; Period b: 2005-2008; Abbreviations: GM; gentamicin, CN; cephalexin, SXT; co-trimoxazole, CXM; cefoxarime, IMI; imipenem, CIP; ciprofloxacin, Ak; amikacin, CAZ; ceftazidine, AP; ampicillin, CPM, cefepeme, C; chloramphenicol , CFM; cefixime, CTX; cefotaxime, ND; not determined
Table 3: Comparison of antibiotic resistance patterns of important Gram positive bacteria recovered from bactec 9240 over the periods 2001-4 and 2005-8

| Bacteria               | Period: a or b: frequency | Percentage of antibiotic resistance |          |          |          |          |          |          |
|------------------------|---------------------------|-------------------------------------|----------|----------|----------|----------|----------|----------|
|                        |                           | GM        | VA       | CN       | SXT      | CC       | CIP      | C        |
| S. epidermidis         | a: 523                    | 36.6      | 1.0      | 19       | 62.2     | 38.1     | 21.2     | 11.8     |
|                        | b: 1295                   | 46.7      | 1.3      | 21       | 60       | 45       | 40.2     | 18.5     |
| S. aureus              | a: 132                    | 30.6      | 0.0      | 25.9     | 34       | 18.5     | 20.5     | 6.8      |
|                        | b: 250                    | 33.5      | 0.0      | 27       | 31.6     | 28.5     | 22.4     | 6.6      |
| Entrococci Spp.        | a: 29                     | 22.0      | 1.6      | ND       | 50       | ND       | 33.0     | ND       |
|                        | b: 115                    | 73.2      | 18.5     | 70       | 76.3     | 72.4     | 56.0     | 40       |
| Streptococcus viridans | a: 34                     | 79.0      | 3.0      | ND       | ND       | ND       | 29.0     | 7.0      |
|                        | b: 45                     | 80.4      | 5.8      | 15.1     | 63.7     | 28.7     | 30.0     | 12.5     |
| Streptococcus          | a: 20                     | 86.7      | 0.0      | 0        | 62.5     | 7.7      | 0.0      | 17.8     |
| Pneumonia              | b: 23                     | 66.7      | 0.0      | 11.1     | 66.7     | 11.1     | 11.1     | ND       |

Abbreviations , Period a: 2001-2004; Period b: 2005-2008: GM; gentamicin, VA; vancomycin, CN; cephalexin, SXT; co-trimoxazole, Ap; ampicillin, CC; clindamycin, CIP; ciprofloxacin, C; chloramphenicol, ND; not determined

Fig. 1: Comparison of Gram positive sensitivity profiles to five effective antibiotics over the periods 2001-2004 and 2005-2008

Fig. 2: Comparison of Gram negative sensitivity profiles to five effective antibiotics over the periods 2001-2004 and 2005-2008
Table 4: Comparison of frequencies (%) of the bacteria recovered from bactec 9240, based on hospital wards admission over the two periods (2001-2004 and 2005-2008)

| Bacteria                      | Periods: a & b: Frequency (%) | P value | Frequency (%) in neonate ward | P value | Frequency (%) in pediatrics ward | P value | Frequency (%) in adult ward | P value |
|-------------------------------|-------------------------------|---------|-------------------------------|---------|-------------------------------|---------|-------------------------------|---------|
| *Coagulase Negative Staphylococci | a: 323 (47)                   | 0.00000 | 80 (60)                       | 0.1700  | 321 (49)                      | 0.00000 | 122 (36)                      | 0.2000  |
|                               | b: 801 (32)                   |         | 147 (18.4)                    |         | 420 (52.4)                    |         | 234 (29.2)                    |         |
| Staphylococcus aureus         | a: 132 (12)                   | 0.00000 | 11 (8.2)                      | 0.002*  | 66 (10)                       | 0.00000 | 55 (16.2)                     | 0.0700  |
|                               | b: 122 (4.88)                |         | 5 (4.0)                       |         | 27 (22.2)                     |         | 90 (73.8)                     |         |
| E. coli                      | a: 64 (6)                     | 0.00000 | 4 (3)                         | 0.470*  | 29 (4.5)                      | 0.49000 | 31 (9.1)                      | 0.0040  |
|                               | b: 64 (2.6)                   |         | 5 (7.8)                       |         | 75 (59)                       |         | 34 (53.2)                     |         |
| Pseudomonas aeruginosa        | a: 52 (4.5)                   | 0.00000 | 4 (3)                         | 0.210*  | 29 (4.5)                      | 0.00000 | 19 (5.6)                      | 0.0018  |
|                               | b: 28 (1.12)                 |         | 3 (0.7)                       |         | 10 (35.7)                     |         | 13 (53.6)                     |         |
| *Bacillus spp                | a: 52 (5.5)                   | 0.00000 | 10 (7.5)                      | 0.002*  | 17 (2.8)                      | 0.11000 | 25 (7.3)                      | 0.0000  |
|                               | b: 37 (1.48)                 |         | 4 (10.6)                      |         | 23 (62.2)                     |         | 10 (27)                       |         |
| Enterobacter spp.             | a: 50 (4)                    | 0.00000 | 8 (6)                         | 0.010*  | 25 (3.9)                      | 0.00000 | 17 (5)                        | 0.0250  |
|                               | b: 37 (1.48)                 |         | 4 (10.8)                      |         | 15 (40.5)                     |         | 18 (48.7)                     |         |
| Acinetobacter spp.            | a: 40 (3.5)                   | 0.99000 | 1 (0.7)                       | 1.000*  | 31 (4.8)                      | 0.04400 | 8 (2.3)                       | 0.0220  |
|                               | b: 893 (5.6)                 |         | 4 (4.5)                       |         | 43 (48.3)                     |         | 42 (47.2)                     |         |
| Streptococcus viridans        | a: 34 (3)                    | 0.02000 | 2 (1.4)                       | 1.000*  | 30 (4.6)                      | 0.00030 | 2 (0.7)                       | 0.1700  |
|                               | b: 45 (1.8)                  |         | 6 (13.3)                      |         | 26 (57.8)                     |         | 13 (28.9)                     |         |
| Enterococcus spp.             | a: 29 (2.5)                   | 0.67000 | 6 (4.4)                       | 0.030*  | 10 (1.5)                      | 0.97000 | 13 (3.8)                      | 0.1400  |
|                               | b: 71 (2.84)                 |         | 3 (4.2)                       |         | 22 (31)                       |         | 46 (64.8)                     |         |
| Klebsiella spp.               | a: 29 (2.5)                   | 0.00700 | 5 (3.7)                       | 0.140*  | 11 (1.7)                      | 0.02000 | 13 (3.8)                      | 0.2900  |
|                               | b: 33 (1.32)                 |         | 4 (12.1)                      |         | 9 (27.3)                      |         | 20 (60.6)                     |         |
| Brucella spp.                 | a: 28 (2.4)                   | 0.00000 | 0                             |         | 16 (2.5)                      | 0.00002 | 12 (3.5)                      | 0.0003* |
|                               | b: 100 (4.4)                 |         | 0                             |         | 66 (60)                       |         | 4 (40)                        |         |
| Streptococcus pneumoniae      | a: 20 (1.6)                   | 0.00000 | 0                             |         | 19 (2.9)                      | 0.00002 | 1 (0.3)                       | -       |
|                               | b: 90(0.36)                  |         | 0                             |         | 9 (100)                       |         | 0                             |         |
| *Diphtheroid                  | a: 16 (1.3)                   | 0.24000 | 2 (1.4)                       | 1.000*  | 5 (0.8)                       | 0.07000 | 9 (2.6)                       | 0.9900  |
|                               | b: 50(2)                    |         | 4 (8)                         |         | 26 (52)                       |         | 20 (40)                       |         |
| Salmonella spp.               | a: 11 (1)                    | 0.00020 | 0                             | 0.00200*| 7 (1)                        | 0.00200*| 4 (1.2)                       | 0.2100* |
|                               | b: 5 (0.2)                   |         | 0                             |         | 2 (40)                        |         | 3 (60)                        |         |
| Haemophilus influenzae        | a: 8 (0.8)                   | 0.0300* | 0                             | 8 (1.2) | 0.00300*                      | 0       | -                             | -       |
|                               | b: 5 (0.2)                   |         | 0                             |         | 5 (100)                       |         | 0                             |         |

*: Analyzed with Fisher's exact test, significant values printed in bold. Period a: 2001-2004; Period b: 2005-2008

DISCUSSION

It has been proposed that frequencies and antibacterial susceptibility patterns of nosocomial pathogens continuously change, which demands periodical surveillance of their fluctuations (Japonti et al., 2009; Sepehri et al., 2010).

In the present study, frequencies (%) of bacteria isolated from the blood samples of patients, changed in quality and quantity from first to the second period. Continuous changing of nosocomial pathogens has been previously reported (Starman et al., 2008). Amsterdam et al. (2010) Patients may be infected in the community and transfer these bacteria to hospitals, as happened for methicillin resistance S. aureus or vice versa (Song et al., 2011). Exchanging of resident flora in the hospital with circulating bacteria in the community, may gradually reduce the efficacy of the prescribed antibiotics in outpatients and render them ineffective (Zhang et al. 2010; Moskowitz et al., 2010). Nevertheless, this flow does not reduce the nosocomial resistance rate due to continuous emerging of resistant isolates which may happen under selective pressure of consuming antibiotics in the hospitals (Ozer et al., 2011).

Increased frequencies of some antibiotic resistant bacteria such as acinetobacter and entrococci, have been observed from first to second periods, which demands appropriate attention and action to be taken. Change in the ecology of nosocomial bacteria from antibiotic sensitive to antibiotic resistant bacteria may revert by frequent application of strong antisepsics and disinfectants along with strong control measures (Sepehri et al., 2009); Special attention should be taken to educate personnel for frequent hand washing, correct using of gloves to prevent cross-contamination of other patients, wearing gown and mask (Sepehri et al., 2009)and preventing of close contact of patients admitted to infectious wards with visitors (Xerry et al., 2010). Of course, hospital personnel are more important in cross-contamination of patients. Therefore, routine surveillance of personnel of the hospitals and suspending from duty the healthy carrier individuals, carrying antibiotic resistant bacteria such as Methicillin Resistant S. aureus (MRSA), Vancomycin Resistance Entrococci (VRE) and pseudomonas until they become decontaminated, might prove effective (March et al., 2010; Askarian et al., 2009). The data also support the hypothesis that determination of antibiotic sensitivity patterns in periodic intervals should be
mandatory in each region, for choosing appropriate antibiotic therapy (Japoni et al., 2009; Sepehri et al., 2010).

The number of positive cultures in the pediatric ward was high, compared with adults and neonates wards. This is partly due to the number of beds in pediatrics ward which admit a wide range of patients with ages ranging from 6 months to 16 years old. Moreover, children at pre or primary school ages may have not received appropriate hygienic cares, as compared with adults. Besides, neonates' hygiene is continuously supported and monitored by their mothers.

Overall efficacy of antibiotics reduced in the second study period (2005-8). Continuous prescription of antibiotics in hospitals and clinics can give rise to the emerging antibiotic resistance due to clonal selection (Velickovic-Radovanovic et al., 2011). It is documented that due to continuous emerging of resistant isolates, the efficacy of antibiotics decreases gradually, particularly those administrated for bloodstream infections (Amsterdam et al., 2010; Bakowski et al., 2008). However, in the present study, in vitro efficacy of two antibiotics (ciprofloxacin and amikacin) preserved. Present results show that imipenem and vancomycin are highly active against Gram negative and positive bacteria. These results are in concordance with other reports However, it should not be expected that this activity continues for a longtime, as it has been observed during this study and reports from other centers (Jamal et al., 2010; Grant et al., 2010). Nevertheless, ciprofloxacin and chloramphenicol are alternative antibiotics with lower efficacies.

CONCLUSION

Present findings reveal the etiology of infectious diseases of the blood over two periods. The recovered bacteria with high frequency from blood samples at pediatrics ward indicates that special attention should be paid to such wards both in prevention and treatment aspects. Vancomycin and imipenem were the most active antibiotics which could cover the majority of Gram positive and negative bacteria. Therefore, an administration of the combination of these two antibiotics is highly recommended for empirical therapy. To maintain the efficacy of a few effective antibiotics, strict control measures should be implemented.

ACKNOWLEDGMENT

We appreciate H. Khajehei for his valuable linguistic copy editing.

REFERENCES

Amsterdam, D., G. Coombs and M. Dowzicky, 2010. Antimicrobial susceptibility of bloodstream isolates of staphylococcus aureus: Global results from the tigecycline evaluation and surveillance trial, 2004-2008. Am. J. Infect. Dis., 6: 1-7. DOI: 10.3844/ajidsp.2010.1.7

Askarian, M., A. Zeinalzadeh, A. Japoni, A. Alborzi and Z.A. Memish, 2009. Prevalence of nasal carriage of methicillin-resistant Staphylococcus aureus and its antibiotic susceptibility pattern in healthcare workers at Namazi Hospital, Shiraz, Iran. Int. J. Infect. Dis., 13: e241-e247. DOI: 10.1016/j.ijid.2008.11.026

Bakowski, E., S.B. Wey and E.A. Servolo, 2008. Risk factors for bacteremia and predictors of mortality of patients with bloodstream infection with methicillin-resistant staphylococcus aureus. Am J. Infect. Dis., 4: 262-266. DOI: 10.3844/ajidsp.2008.262.266

Bert, F., B. Larroque, C. Paugam-Burtz, S. Janny and F. Durand et al., 2010. Microbial epidemiology and outcome of bloodstream infections in liver transplant recipients: an analysis of 259 episodes. Liver. Transpl., 16: 393-401. DOI: 10.1002/lt.21991

Cermak, P., S. Cermakova, A. Schwarzerova, M. Klementova and M. Urychova et al., 2011 The potential use of blood culture systems for diagnosing intravascular catheter-related infections. Clin. Lab., 57: 13-20. PMID: 21391460

Grant, D.G., T.T. Zhang, L. S. Gloyne, A. V. Perkins and M.J. Kiefel et al., 2010. Exogenous pyocyanin alters pseudomonas aeruginosa susceptibility to ciprofloxacin. Am. J. Microb., 1: 9-13. DOI: 10.3844/ajmsp.2010.9.13

Jamal, W., M. Shabin and V.O. Orotimi, 2010. Surveillance and trends of antimicrobial resistance among clinical isolates of anaerobes in Kuwait hospitals from 2002 to 2007. Anaerobe., 16: 1-5. DOI: 10.1016/j.anaerobe.2009.04.004

Japoni, A., A. Vazin, M. Hamedi, M.A. Davarpanah and A. Alborzi et al., 2009. Multidrug-resistant bacteria isolated from intensive-care-unit patient samples. Braz. J. Infect. Dis. DOI: 10.1590/S1413-86702009000200009

Kim, K.E. and J.Y. Han, 2010. Evaluation of the clinical performance of an automated procalcitonin assay for the quantitative detection of bloodstream infection. Korean. J. La. Med., 30: 153-159. DOI: 10.3343/kjlm.2010.30.2.153
March, A., R. Aschbacher, H. Dhanji, D.M. Livermore and A. Bottcher et al., 2010. Colonization of residents and staff of a long-term-care facility and adjacent acute-care hospital geriatric unit by multiresistant bacteria. Clin. Microbiol. Infect., 16: 934-944. DOI: 10.1111/j.1469-0691.2009.03024.x

Moskowitz, S.M., W. Kronish and P.C. Jeanine, 2010. Mechanisms of bacterial virulence in pulmonary infections. Curr. Opin. Crit. Care., 16: 8-12. DOI: 10.1097/MCC.0b013e3283354710

Ozer, B., B.C.O. Akkurt, N. Duran, Y. Onlen and L. Savas et al., 2011. Evaluation of nosocomial infections and risk factors in critically ill patients. Med Sci. Monit., 17: 17-22. PMID: 21358613

Paolucci, M., M.P. Landini and V. Sambri, 2010. Conventional and molecular techniques for the early diagnosis of bacteraemia. Int. J. Antimicrob. Agents, 36: S6-S16. DOI: 10.1016/j.ijantimicag.2010.11.010

Sepehri, G., H.Z. Nejad, E. Sepehri and S. Razban, 2010. Bacterial Profile and Antimicrobial Resistance to commonly used antimicrobials in intra-abdominal infections in two teaching hospitals. Am. J. Applied Sci., 7: 38-43. DOI: 10.3844/ajassp.2010.38.43

Sepehri, G., N. Talebizadeh, A. Mirzazadeh, T.R. Mirshekari and E. Sepehri, 2009. Bacterial contamination and resistance to commonly used antimicrobials of healthcare workers' mobile phones in teaching hospitals, Kerman, Iran. Am J. Applied Sci., 6: 806-810. DOI: 10.3844/ajassp.2009.806.810

Song, J.H., P.R. Hsueh, D.R. Chung, K.S. Ko and C.I. Kang et al., 2011. Spread of methicillin-resistant Staphylococcus aureus between the community and the hospitals in Asian countries: An ANSORP study. J Antimicrob. Chemother., 66: 1061-1069. DOI: 10.1093/jac/dkr024

Starnes, M.J., C.V.R. Brown, I.R. Morales, P. Hadjizacharia and A. Salim et al., 2008. Evolving pathogens in the surgical intensive care unit: a 6-year experience. J. Crit. Care, 23: 507-12. DOI: 10.1016/j.jcrc.2008.02.007

Velickovic-Radovanovic, R., J. Petrovic, B. Kocic, S. Antic and R. Mitic, 2011. Analysis of antibiotic utilization and bacterial resistance changes in a surgical clinic of clinical centre, Nis. J Clin. Pharm. Ther. DOI: 10.1111/j.1365-2710.2010.01241.x

Xerry, J., C.I. Gallimore, D. Cubitt and J.J. Gray, 2010. Tracking environmental norovirus contamination in a pediatric primary immunodeficiency unit. J. Clin. Microbiol., 48: 2552-2556. DOI: 10.1128/JCM.00666-10

Zhang, W., Y. Gu, Y. Chen, H. Deng and L. Chen et al., 2010. Intestinal flora imbalance results in altered bacterial translocation and liver function in rats with experimental cirrhosis. Eur. J. Gastroenterol. Hepatol., 22: 1481-1486. DOI: 10.1097/MEG.0b013e32833eb8b0