TÜRK PEDİATRİ ARŞİVİ
TURKISH ARCHIVES of PEDİATRİCS

Original Article

A retrospective evaluation of blood cultures in a pediatric intensive care unit: a three year evaluation

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Cite this article as: Ergül AB, Işık H, Ay Altıntop Y, Altuner Torun Y. A retrospective evaluation of blood cultures in a pediatric intensive care unit: A three year evaluation. Turk Pediatri Ars 2017; 52: 154-61.

Abstract

Aim: In this study, it was aimed to retrospectively assess the frequency and antibiotic resistance of microorganisms isolated from blood cultures of patients in a pediatric intensive care unit.

Material and Methods: The study was conducted on blood culture tests obtained from patients in a pediatric intensive care unit and sent to a microbiology laboratory between 2013 and 2016. The species and antibiotic susceptibilities were assessed in microorganisms isolated from the blood cultures.

Results: Overall, 4239 blood cultures were obtained. Growth was detected in 324 blood cultures (7.6%). Of the microorganisms isolated, 195 (60.2%) were Gram-positive bacteria, and 107 (33.0%) were Gram-negative bacteria; 22 (6.8%) were fungi. The most commonly isolated microorganisms were *Coagulase-negative staphylococci* (45.1%), followed by *Klebsiella pneumonia* (14.5%), and *Enterococcus faecalis* (6.5%). Among the fungi, the most common was *Candida albicans* (59.1%), followed by *Candida parapsilosis*. The resistance rate against methicillin was 89.9% in coagulase-negative staphylococci, and 66% in S. aureus strains. The resistance rate against vancomycin was 3.6% in Enterococci spp. There was no resistance against linezolid in Gram-positive microorganisms. The rate of extended-spectrum beta lactamase positivity was found as 34% in Klebsiella spp. and 100% in *Escherichia coli*. The resistance rate against carbapenem was 44.9% in Gram-negative bacteriae. The resistance rate against carbapenem was 100% in *Acinetobacter baumanii*. In *Candida albicans*, resistance to amphotericine B was 61.5%, and resistance to voriconazole was 7.7%.

Conclusions: To plan effective empiric antibiotic therapy against nosocomial infections in intensive care units, all units should have information about the characteristics of their own flora.

Keywords: Antibiotic, blood culture, microorganism, pediatric critical care

Introduction

The most common nosocomial infections in pediatric intensive care units (PICU) are blood stream infections. This is followed by ventilator-associated pneumonia and urinary tract infections (1). In recent years, an increase in microorganisms obtained from blood cultures has been observed because of different factors including an increase in the use of broad-spectrum antibiotics, changes in patient populations (increased numbers of patients hospitalized in intensive care units, increase in the number of patients with uimmunosuppression and underlying chronic disease), an increase in use of catheters, and intravascular fluids in treatment (2).

The most common microorganisms isolated from blood cultures in intensive care units (ICUs) are Gram-positive microorganisms, among which, coagulase-negative staphylococci (CNS) are isolated most commonly, followed by *S. aureus* and *Enterococcus spp.* (2). Gram-negative microorganisms include *Enterobacteriaceae spp., Pseudomonas aeruginosa, Acinetobacter baumannii, Stenotrophomonas maltophilia* and *Burkholderia cepacia* (3).

Antibiotic resistance in microorganisms, which leads to nosocomial infections, is becoming an important problem. Therefore, studies in which the distribution of causative agents and antibiotic resistance rates are

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Received: 18.02.2017 **Accepted:** 19.04.2017

DOI: 10.5152/TurkPediatriArs.2017.5451

specified should be conducted at certain intervals. Identification of the causative agent and antibiotic resistance will be directive for the selection of appropriate antibiotics in treatment. In this study, the pathogens identified in blood cultures in the PICU and antibiotic resistances were investigated and compared with the literature.

Material and Methods

All blood culture samples sent from patients hospitalized in the PICU between January 1st, 2013, and March 31st, 2016, were evaluated retrospectively. A total of 22 beds were present in the PICU including the secondary care ICU, which contained 10 beds and the tertiary care ICU, which contained 12 beds. Blood culture samples were obtained half an hour or just before initiation of antibiotic treatment and just before the next dose in patients who were receiving antibiotic treatment. Identification of the microorganisms found in blood cultures was made in the microbiology laboratory. Blood cultures were examined in a BACTEC 9120 (Becton Dickinson, ABD) blood culture system. Susceptibility and identification procedures were performed using the Vitek 2 (BioMérieux, France) system in 2013-2014, and with a BD Phoenix (BD Diagnostic Systems, Sparks, MD) system in 2015-2016. Susceptibility was tested according to the Clinical Laboratory Standards Institute (CLSI) in 2013-2014 and according to the European Committee Antimicrobial Susceptibility (EUCAST) in 2015-2016 (5). The microorganisms isolated and their antibiotic susceptibilities were specified. Approval was obtained from the Erciyes University, Faculty of Medicine, Clinical Researches Ethics Committee (date: 27.05.2016, number: 2016/324). Informed consent was not obtained from the patients because the study was conducted retrospectively.

Statistical analysis

The IBM SPSS Statistics for Windows (Version 21.0. Armonk, NY: IBM Corp) statistical program was used. Non-parametric data were expressed as median values (25th percentile-75th percentile). Frequency data were expressed as percentages (%).

Results

It was found that 4239 blood culture samples were sent from the PICU during the study period. Growth was found in 324 (7.6%) blood cultures. Thirty-four (10.5%) of the culture samples were obtained from central venous catheters. Among the patients who were found to have growth in blood culture, 49.4% (n=160) were females and 50.6% (n=164) were males. The median age of the patients was 12 months (range, 6-36 months). One hundred ninety-five (60.2%) of 324 microorganisms found in blood cultures were identified as Gram-positive bacteria, 107 (33%) were Gram-negative bacteria, and 22 (6.8%) were fungi. Among all the agents found, the most commonly isolated microorganism was CNS (45.7%), followed by *Klebsiella pneumoniae* (14.8%), *Enterococcus faecalis* (6.5%), *Serratia marcescens* (5.6%), *Pseudomonas aeruginosa* (4.3%), and *Candida albicans* (4%). The distribution of the microorganisms found in all blood cultures is shown in Table 1.

Among all microorganisms isolated, the most common Gram-positive bacteria was CNS (n=148, 75.9%). This was followed by *Enterococcus faecalis* (6.5%) (Table 1). The most common Gram-negative agent among all microorganisms isolated was *Klebsiella pneumoniae* (14.8%), followed by *Serratia marcescens* (5.6%), *Pseudomonas aeruginosa* (4.3%), and *Acinetobacter baumannii* (3.1%). Among all fungi isolated, *C. albicans* (59.1%) was the most common, followed by *C. Parapsilosis* (27.3%) *and Candida tropicalis* (13.6%) (Table 1).

Methicillin resistance was found with a rate of 89.2% in *coagulase-negative staphylococci*. Vancomycin and linezolid resistance were not found in any *coagulase-negative staphylococcus*. The most susceptible antibiotic for *coagulase-negative staphylococci* after glycopeptide antibiotics and linezolid was *trimethoprim-sulfamethoxazole* with a susceptibility rate of 58.1%. Methicillin resistance was found in two (66%) of three *Staphylococcus aureus* strains, and vancomycin and linezolid resistance was found in none.

Among the enterococci strains isolated, vancomycin resistance was found in only one strain (3.6%). Linezolid resistance was not found in *Enterococcus* spp. High rates of gentamicin (67.9%) and streptomycin (67.9%) resistance were found in *Enterococcus spp.* The antibiotic resistance rates for Gram-positive bacteria are shown in Table 2**.**

In Enterobacteriaceae, resistance to imipenem and meropenem was found at rates of 33,3 and 10,3% respectively. Carbapenem and amikacin resistance was found with a rate of 100%, whereas colisitin resistance was not found in *Acinetobacter spp.* among non-fermentative bacteria. A high rate of carbapenem resistance was found in *Pseudomonas spp.* (62.5% for imipenem and 43.8% for meropenem). Colistin resistance was not found in *Pseudomonas spp. Pseudomonas spp*. had the highest level of susceptibility for colistin, followed by

Table 1. Distribution of the microorganisms isolated from blood cultures (N=324).

Mikroorganizma	n	%
Gram-positive microorganisms	**195**	**60.2**
Staphylococcus spp.	**151**	**46.6**
Coagulase negative staphylococcus	148	45.7
Staphylococcus aureus	3	0.9
Enterococcus spp.	**28**	**8.6**
Enterococcus faecalis	21	6.5
Enterococcus faecium	4	1.2
Enterococcus raffinosus	2	0.6
Enterococcus durans	1	0.3
Streptococcus spp.	**5**	**1.5**
Streptococcus pneumoniae	2	0.6
Group A Streptococcus	1	0.3
Other streptococci *(Streptococcus bovis, oralis)*	2	0.6
Other	**10**	**3**
Pediococcus pentosaceus	1	0.3
Kocuria kristinae	1	0.3
Kocuria varians	1	0.3
Leuconostoc pseudomesenteroides	3	0.9
Bacillus thuringiensis	1	0.3
Corynebacterium striatum	1	0.3
Corynebacterium bovis	1	0.3
Dermacoccus nishinomiyaensis	1	0.3
Gram negative microorganisms	**107**	**33.0**
Enterobacteriaceae spp.	**78**	**24.1**
Klebsiella spp.	49	15.1
Klebsiella pneumoniae	48	14.8
Klebsiella oxytoca	1	0.3
Serratia spp.	20	6.2
Serratia marcescens	18	5.6
Serratia liquefaciens	1	0.3
Serratia funticola	1	0.3
Escherichia coli	4	1.2
Enterobacter spp.	3	0.9
Shigella spp	1	0.3
Shigella sonnei	1	0.3
Proteus spp.	1	0.3
Proteus mirabilis	1	0.3
Pseudomonas spp.	**14**	**4.3**
Pseudomonas aeruginosa	14	4.3
Streptomonas maltophilia	**2**	**0.6**
Acinetobacter baumannii	**10**	**3.1**
Alcaligenes faecalis	**2**	**0.6**
Other microorganisms	**2**	**0.6**
Sphingomonas paucimobilis	1	0.3
Bacillus thuringiensis	1	0.3
Candida spp.	22	6.8
Candida albicans	13	4
Non albicans candida	9	2.8
Candida tropicalis	6	1.9
Candida parapsilosis	3	0.9

Table 2. Antibiotic resistance rates of gram positive bacteriae (%)

Antibiotic	CNS (n=148)	*Enterococcus spp.* (n=28)	*S. aureus* (n=3)
Linezolid	0	0	0
Vancomycin	0	3,6	0
Teicoplanin	22.3	3,6	0
TMP/SMX	41.9	N/A	33.3
Clindamycin	73	N/A	0
Erythromycin	89.9	N/A	66.7
Methicillin	89.2	N/A	33.3
Ciprofloxacin	58.8	N/A	0
Ampicillin	N/A	6	N/A
Gentamicin	98	N/A	0
HLGR	N/A	67.9	N/A
HLSR	N/A	67.9	N/A

CNS: coagulase-negative staphylococcus; TMP/SMX: trimethoprim + sulfamethoxazole; HLGR: High-level gentamicin resistance; HLSR: High-level streptomycin resistance

ciprofloxacin. The most efficient antibiotic was meropenem for *Klebsiella spp*., and the most efficient antibiotics were amikacin and ciprofloxacin for *Serratia spp*. The antibiotic resistance rates of Gram-negative bacteria are shown in Table 3. Extended-spectrum beta lactamase (ESBL) positivity was found as 61.2% (n=30) for *Klebsiella spp*. and 100% (n=4) for *E. coli*. When antibiotic susceptibility was evaluated in microorganisms with ESBL positivity, meropenem susceptibility was found with a rate of 94.1%, ciprofloxacin susceptibility was found with a rate of 88.2%, gentamicin susceptibility was found with a rate of 79.4%, imipenem susceptibility was found with a rate of 76.5%, amikacin susceptibility was found with a rate of 76.5% and trimethoprim-sulfamethoxazole susceptibility was found with a rate of 70.6%.

The rate of carbapenem resistance was found as 44.9% (n=48) in Gram-negative bacteria, 100% in *Acinetobacter spp.*, 62.5% in *Pseudomonas spp*., 50% in *E. coli*, 36.7% in *Klebsiella spp*., 33.3% in *Enterobacter spp.*, and 25% in *Serratia spp*. The highest level of susceptibility was found for trimethoprim-sulfamethoxazole (76.7%), piperacillin-tazobactam (70%), ciprofloxacin (66.7%), gentamicin (58.3%), cefuroxime (39.6%), and cefepime (20.8%) in microorganisms that had carbapenem resistance.

The highest level of resistance was found for amphotericin B (61.5%), and the lowest level of resistance was found for voriconazole (7.7%) in *Candida albicans*.

Table 3. Antibiotic resistance rates of Gram-negative bacteria (%)

Antibiotic	*Klebsiella spp.* (n=49)	*Serratia spp.* (n=20)	*E. coli* (n=4)	Other *Enterobacteriaceae* (n=8)	*Pseudomonas spp.* (n=16)	*Acinetobacter spp.* (n=10)
Colistin	N/A	N/A	N/A	N/A	0	0
Meropenem	8.2	15	25	25	43.8	100
Imipenem	36.7	25	50	37.5	62.5	100
Amikacin	22.4	0	25	50	18.8	90
Gentamicin	14.3	10	50	50	37.5	90
ciprofloxacin	10.2	0	25	37.5	12.5	100
Piperacillin	N/A	N/A	N/A	N/A	25	N/A
Ceftazidim	N/A	N/A	N/A	N/A	25	N/A
Cefepim	93.9	20	100	50	18.8	N/A
Ceftriaxon	95.9	15	100	62.5	N/A	N/A
Amoxycillin—clavunalic acid	93.9	95	100	62.5	N/A	N/A
Ampicillin	100	70	100	62.5	N/A	N/A

[a]Other: Alcaligenes spp., Proteus spp., Enterobacter spp., Shigella spp.

Table 4. Antifungal resistance rates of Candida species (%)

Antifungal	*Candida albicans* (n=13)	*Non-albicans Candida* (n=9)
Voriconazole	7.7	0
Caspofungin	15.4	11.1
Fluconazole	23.1	0
Amphotericin-B	61.5	0

Voriconazole, fluconazole, and amphotericin B resistance was not found in *non-albicans Candida species*, whereas caspofungin resistance was found with a rate of 11.1%. Antifungal resistance rates for *Candida species* are shown in Table 4.

Discussion

In our study, blood cultures sent from patients hospitalized in the PICU were evaluated retrospectively. According to our results, it was found that *S. aureus* was isolated with a considerably low rate in blood cultures in our unit, *Serratia spp.* among Gram-negative bacteria were isolated with a high rate, almost the only antibiotic that could be used for Acitenobacter strains was colistin, carbapenem resistance was considerably high in Pseudomonas strains and ESBL positivity was observed with a high rate in Enterobacteriaceae, especially *E. coli*.

Growth was found in 7.6% of the cultures. In the study conducted by Gülmez et al., (6) in which blood cultures in a children's hospital were evaluated, growth of any microorganism in blood cultures was reported with a rate of 7.7%, similar to our study. Sağlam et al. (7) found positive growth in 10.3% of blood cultures in a study conducted in a NICU, and reported that 5.2% of these were clinically significant. In our study, positive growth in blood cultures was found with a rate similar to the literature.

The most common cause in nosocomial bloodstream infections is Gram-positive bacteria, followed by Gram negative bacteriae and fungi (8,9). When microorganisms isolated from blood cultures are assessed, it is observed that Gram-positive bacteria generally constitute the majority, because they include diphtheroids and CNS, which may arise from skin flora and are mostly considered contamination. In a study conducted by Gülmez et al. (6), CNS was isolated with a rate of 48.3%, *S. aureus* was isolated with a rate of 7.1%, and *Enterococcus spp.* were isolated with a rate of 4.4% in blood cultures. In our study, the most common Gram-positive bacteria isolated from blood culture was CNS, similar to the studies conducted by Edmond et al. (10) and Gülmez et al. (6). In our study, the most common Gram-positive bacteria was CNS (45.7%) among all microorganism isolated from blood cultures, followed by *Enterococcus spp.* (8.6%). In the literature, *S. aureus* has been reported as the second most common bacteria after CNS (6). The frequency of *S. aureus* in blood cultures was reported as 12.0% in the study by Bayram et al. (11), and 3.5% in the study by Sağlam et al. (7). In our study, the frequency of *S. aureus* in blood cultures (0.9%) was found considerably lower compared with the literature. In some studies, the Enterobacteriaceae family, which causes bloodstream infections, has been reported to be the most common Gram-negative bacteria (7, 12). In

some other studies, it was reported that non-fermentative bacteria caused bloodstream infections more frequently compared with Enterobacteriaceae (11). In the study by Gülmez et al. (6) in which blood cultures in a children's hospital were evaluated, the most common Gram-negative agent was reported as Enterobacteriaceae, and a gradual increase in non-fermentative microorganisms was reported to have been observed the years. In our study, the most common Gram-negative bacteria isolated from all blood cultures was Enterobacteriaeceae. Among Enterobacteriaceae, the most commonly isolated species was *K. pneumoniae*, followed by *Serratia spp.; E. coli* was isolated considerably rarely (1.2%). In the present study, it seemed that *Serratia spp.* were isolated with a higher rate compared with the literature. The high growth rate of *Serratia spp.* in our study was associated with a Serratia outbreak that occurred in 2015 in our unit. Outbreaks in NICUs caused by *Serratia spp.* have been reported in the literature (13). In our study, non-fermentative bacteria were found to be the third leading causative agent after Enterobacteriaceae. In the study by Yis et al. (12), it was reported that positive growth was found in 18.7% of blood cultures and *Stenotrophomonas maltophilia* constituted 6.35% of these microorganisms, *P.aeruginosa* accounted for 6.2%, *Acinetobacter baumannii* made up 4.28% and *Sphingomonas paucimobilis* constituted 1.9%. In the current study, the most commonly isolated non-fermentative bacteria was *Pseudomonas aeroginosa*, followed by *Acinetobacter baumanii*. The other non-fermentative bacteriae observed rarely included *Alcaligenes spp., Stenotrophomonas maltophilia*, and *Sphingomonas paucimobilis*. In recent years, Candida species have been isolated with a significantly increased rate in blood cultures because of an increase in the frequency of neutropenia, premature delivery, surgical procedures, and intravascular catheter use (6). Gülmez et al. (6) reported that the fungi isolated in their study constituted 10.8% of all microorganisms. In our study, fungi were found to be grown with a rate of 6.8%. In ICUs, *C. albicans* has generally been reported to be the most commonly isolated species among fungal agents (6, 11). In the study by Gülmez et al. (6), the most commonly isolated fungal species was *C. albicans* with a rate of 47.3%, followed by *C. parapsilosis* with a rate of 21.7%. In our study, the most commonly isolated fungal species was *C. albicans*, similar to the study of Gülmez et al. (6), followed by *C. parapsilosis* (27.3%) and *Candida tropicalis* (13.6%).

In ICUs, antibiotic resistance has become a gradually increasing problem. Gradually increasing resistance rates have been reported for Enterobacteriaceae species, non-fermentative Gram-negative bacteria (Pseudomonas, Acinetobacter), methicillin-resistant *S. aureus* (MRSA) and vancomycin-resistant enterococci (VRE). Resistance patterns for ICUs are recorded with regional and global survaillance studies. Some of these include the "Intensive Care Antimicrobial Resistance Epidemiology" (ICARE, 1994-2000), "the Meropenem Yearly Susceptibility Test Information Collection Program" (MYSTIC, 1997-2000), the "ICU Surveillance Study" (ISS, 1990-1993, 1994-2000), and the "SENTRY program" (Europe, 1997-1998) (8, 9, 14).

Gram-positive microorganisms lead to serious infections in ICUs and MRSA and VRE are being isolated with a gradually increasing frequency. The frequency of nosocomial MRSA is considered a general indicator of efficiency of infection control programs (15). A gradually increasing methicillin resistance has also been observed in *coagulase-negative staphylococci*. The rate of methicillin resistance for *S.aureus* was reported as 82% by Stryjewski et al. (15) and Bayram et al. (11), 74% by Erturk et al. (3) and 54.5% by Sağlam et al. (7). In our study, the rate of methicillin resistance for *S. aureus* was found as 82%, similar to the literature. In some studies, it has been reported that methicillin resistance for CNS is observed with a higher rate compared with *S. aureus*. Methicillin resistance for CNS was found with a rate of 98.6% by Bayram et al. (11) and 66.4% by Sağlam et al. (7), which are higher than the rates with *S. aureus*. Similarly, methicillin resistance for CNS was found with a higher rate (89.9%) compared wit *S. aureus* (66%) in our study. Increasing rates of resistance to glycopeptid antibiotics for Gram-positive microorganisms are a significant problem in ICUs. Teicoplanin resistance is observed with a higher rate compared with vancomycin resistance in coagulase- negative staphylococci (16). In our study, vancomycin resistance was not found in CNS, whereas teicoplanin resistance was found with a rate of 22.3%. In our study, vancomycin and linezolid resistance was not found in CNS and *S. aureus*. It is an important problem that *Enterococcus spp.* show a gradually increasing resistance to glycopeptides (17). In the study conducted by Kara et al. (18), the frequency of VRE was found as 1.55%. In our study, the microorganism isolated with the third leading frequency among all blood cultures was *Enterococcus spp.*, and VRE was found with a rate of 3.6%. Use of aminoglycosides in combination with penicillin may be preferred in infections caused by enterococci. Therefore, resistance developing against aminoglycosides is important. El-Kersh et al. (19). reported high- level gentamicin resitance (HLGR) (25%) and high-level streptomycin resistance (HLSR) (11%) in enterococci. Ertürk et al. (3) found HLGR and HLSR at rates of 25% and 50%, respectively. In our

study, HLSR and HLGR were found at rates of 67.9% and 67.9%, respectively, in enterococci (these rates were lower compared with the literature).

Increasing antibiotic resistance in Gram-negative bacteria is an important problem in ICUs. Increasing resistance against cephalosporins and aminoglycosides in *Enterobacterecea spp.* is a part of this problem (11). In our study, cefepim resistance was found with a rate of 90% in *Klebsiella spp*., whereas it was 20% in *Serratia sp*. In the study by Bayram et al. (11), amikacin resistance was reported as 59.4% and gentamicin resistance was reported as 81.2% in Enterobacteriaceae, whereas it was 25% in *E. coli*, 22.4% in *Klebsiella spp*., and 0% in *Serratia spp*. in our study. In our study, aminoglycoside resistance in Enterobacterecea seemed to be lower compared with the literature. According to our study, it can be stated that the most efficient antibiotics against Enterobacteriaceae are carbapenems and aminoglycosides. ESBL positivity in Enterobacteriaceae has become a gradually increasing problem in ICUs. In the study by Yetkin et al. (20), ESBL positivity in *E. coli* was found with a rate of 35.5%. Ho et al. (21) found ESBL positivity in *E. coli* and *K. pneumoniae* with rates of 11% and 13%, respectively, and Kim et al. (22) found the same rates as 20% and 24%, respectively. In our study, ESBL positivity was found with a rate of 61.2% in *Klebsiella spp*., and with a rate of 100% in *E. coli*, and these rates were considerably higher compared with the literature.

Acinetobacter baumannii is a bacteria with multiple antibiotic resistance, and it is important because it leads to infections especially in patients with immunosupression and serious underlying morbidities and receiving treatment with broad-spectrum antibiotics (8). In the study by Bayram et al. (11), imipenem resistance was reported with a rate of 63.5%, amikacin resistance was observed as 71.6%, and gentamicin resistance was 85,1% in *Acinetobacter spp*. In our study, carbapenem resistance was found with a rate of 100% and aminoglycoside resistance was found with a rate of 90% in *Acinetobacter spp.,* whereas colistin resistance was not found. Colistin and tigecycline have become important treatment options because high resistance is found against carbapenem and aminoglcosides in *Acinetobacter spp*. Therefore, it was thought that colistin, tigecycline, and netilmicin should also be included in susceptibility tests for *Acinetobacter spp*. (23). According to our results, colistin seems to be the first treatment option in Acinetobacter infections in our unit.

Strains of Pseudomonas with multiple antibiotic resistance are gradually increasing. In the study conducted by Wang et al. (24) in China between 2003 and 2008, the most efficient antibiotic against *Pseudomonas spp.* was reported as meropenem. In the study conducted by Lee et al. (25) in Korea, colistin was found to be the most efficient antimicrobial against *P. aeruginosa*. Similar to the study of Lee et al. (25), colistin was found to be the most efficient antibiotic for *P. aeruginosa* in our study. In studies conducted in our country, amikacin resistance has been reported with a rate of 3-43% and gentamicin resistance has been reported with a rate of 16-51% in *P. aeruginosa* (26). In our study, amikacin resistance was found with a rate of 7.1% and gentamicin resistance was found with a rate of 18.6% in *P. aeruginosa* in accordance with the results obatained in studies conducted in our country. The high carbapenem resistance (62.5%) observed in *P. aeruginosa* strains in our study may be related with use of inappropriate antibiotics in empiric treatment. In the study conducted by Bayram et al. (11), ciprofloxacin resistance was found with a rate of 59.2% in Pseudomonas infections. In our study, the least level of resistance (12.5%) was found against ciprofloxacin in *Pseudomonas spp*., followed by amikacin (18.8%). Accordingly, ciprofloxacin and aminoglycosides may be preferred in empiric treatment before cabapenems in patients who are thought to have Pseudomonas infection considering the resistance rates in our hospital.

Another problem is gradually increasing carbapenem resistance. In the study conducted by Sağlam et al. (7) in a NICU, carbapenem resistance was not found in Gram-negative microorganisms. In the study conducted by Bayram et al. (11), the rate of imipenem resistance was reported as 26.1% in *Pseudomonas spp,* 63.5% in *Acinetobecter spp.,* and 13.1% in *E. coli*. In a study conducted by Rhomberg et al. (27) in America, the rate of meropenem resistance was found as 14.6% in *P. aeroginosa*, 2.7% in Enterobactereceae, and 54.3% in *Acinetobacter spp.* In our study, carbapenem resistance was found with a rate of 44.9% in Gram-negative bacteriae. The highest level of resistance against carbapenems was found in Acinetobacter (100%). Carbapenem resistance was found with a rate of 2.5% in *Pseudomonas spp.* and with a rate of 26% in Enterobacteriaceae (these rate are considerably higher compared with the literature). In our study, the microorganisms with carbapenem resistance had the highest level of susceptibility against colistin, followed by trimethoprim-sulfamethoxazole. The high rate of carbapenem resistance in our unit may be related with inappropriate use of carbapenems in empiric treatment.

The limitations of our study included the facts that it was a single-center study and contamination could not

be differentiated in positive CNS growths in blood cultures because of the retrospective design. The CNS rate might have been found higher than expected because sample-based evaluation rather than patient-based or attack-based evaluation was made for the results.

Species and antibiotic resistance rates of microorganisms obtained in blood cultures show difference between hospitals. We think that specification of distribution of infectious agents and antibiotic resistance rates according to samples obtained from patients with certain intervals will be directive in planning efficient antibiotherapy in nosocomial bloodstream infections in pediatric patients and in establishing antibiotic use policies.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Erciyes University Medical Faculty Ethical Committee (27.05.2016, 2016/324)

Informed Consent: Written informed consent was not obtained from patients due to the retrospective nature of the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - A.B.E., H.I.; Design - A.B.E., H.I.; Supervision - A.B.E., Y.A.T.; Resources - H.I., Y.A.A.; Materials - H.I., Y.A.A.; Data Collection and/or Processing - H.I.; Analysis and/or Interpretation - A.B.E., H.I.; Literature Search - A.B.E., H.I.; Writing Manuscript - A.B.E.; Critical Review - A.B.E., Y.A.T.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

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