Journal of
Pulmonology and
Intensive Care

Original Article

DOI: 10.51271/JOPIC-0003

Determination of bacteriae isolated from catheter culture and antibiotic susceptibility of patients in intensive care unit

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Cite this article: Kaya Kılıç E, Cesur S, AltınDemircan Ş, et al. Determination of bacteriae isolated from catheter culture and antibiotic susceptibility of patients in intensive care unit. J Pulmonol Intens Care 2023; 1(1): 9-12

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Submit Date: 05/02/2023 **Accept Date:** 19/02/2023

ABSTRACT

Aim: Catheter-related bloodstream infections are important causes of mortality and morbidity. In this study, it was aimed to retrospectively determine the distribution of bacterial agents isolated from intra-catheter blood culture and antibiotic susceptibility rates of patients diagnosed with catheter infection in the intensive care unit of Ankara Training and Research Hospital, Cardiovascular Surgery and Neurosurgery.

Methods: In the intensive care unit of Ankara Training and Research Hospital, Cardiovascular Surgery, and Neurosurgery, 79 bacteria isolated from intra-catheter blood cultures of patients diagnosed with catheter infection between January 1, 2021, and December 31, 2022, were included in the study.Antibiotic susceptibility of the bacteriae reproducing in catheter blood culture was obtained from the hospital information system. Antibiotic susceptibilities of bacteria isolated from intra-catheter culture were determined by the disc diffusion method or VITEK-2 automated system.

Results: The frequency of bacteriae reproducing from intra-catheter blood culture of patients hospitalized in the intensive care unit of cardiovascular surgery and neurosurgery were *Enterococcus* spp., *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, and *Escherichia coli* retrospectively. *Klebsiella pneumoniae* isolates from intra-catheter blood cultures were resistant to ceftriaxone 75%, piperacillin-tazobactam 25%, amikacin 6.25%, but not to imipenem and meropenem. Antibiotic resistance rates of *Staphylococcus aureus* isolates isolated from intra-catheter blood cultures were as follows: 100% with penicillin, no resistance to vancomycin. In *Escherichia coli* isolate isolated from intra-catheter blood cultures, resistance to ceftriaxone was 6.3%, to piperacillin-tazobactam, 12.5%, to imipenem and meropenem, 16.6%, but not to amikacin. *Acinetobacter baumannii* isolates isolated from intra-catheter blood culture showed 100% resistance to ceftriaxone, 100% to piperacillin-tazobactam, 85.7% to imipenem, 83.3% to meropenem, and no resistance to amikacin. In the *Stenotrophomonas maltophilia* isolates isolated from intra-catheter blood culture, resistance to ceftriaxone, piperacillin-tazobactam, imipenem and meropenem was 100% and levofloxacin was 25%, while no resistance to trimethoprim/sulfamethoxazole was detected.

Conclusion: Determining the antibiotic susceptibility of bacteria isolated from catheter culture will contribute to the determination of the appropriate treatment option in the empirical treatment of catheter infections in our hospital and contribute to decreasing in mortality and morbidity rates due to catheter infections.

Keywords: Catheter infection, catheter-related bloodstream infection, bacteriae, antibiotic susceptibility

INTRODUCTION

Complications such as catheter-related bloodstream infection, thrombophlebitis, endocarditis and sepsis may develop depending on the intravenous catheter use. Catheter infections have an important place in healthcare-related infections because they cause mortality and morbidity and increase the length of hospital stay and costs.[2-4]

The most common causes of catheter infections are *Staphylococcus epidermidis* and other coagulase-negative *Staphylococcus*, *Enterococcus* spp. and *Candida* spp., which are found most frequently in the skin flora and produce a glycocalyx called slime factor, respectively. Gram-negative bacilli such as *Pseudomonas aeruginosa*, *Acinetobacter baumannii* (*A. baumannii*), *Klebsiella* spp., *E. coli*, *Enterobacter* spp. and other Gram-negative bacteria are less frequently reported as factors of catheter infection.[3-6]

Determination of bacteriae isolated from catheter culture and antibiotic susceptibility rates is very important in the selection of appropriate empirical antimicrobial therapy in the treatment of catheter infections. In this study, it was aimed to retrospectively determine the microorganisms and antimicrobial resistance rates isolated from catheter blood

samples of patients hospitalized in the Intensive Care Unit, Cardiovascular Surgery and Neurosurgery Clinic of Ankara Training and Research Hospital, between January 1, 2021 and December 31, 2022.

METHODS

Seventy-nine bacteriae were isolated from intra-catheter blood cultures of patients diagnosed with catheter infection between January 1, 2021 and December 31, 2022, in the Intensive Care Unit, Cardiovascular Surgery and Neurosurgery Clinic of Ankara Training and Research Hospital, were included in the study. The study is a retrospective laboratory study, it does not contain any biological material. For that ethics committee approval is not necessary. All procedures were carried out in accordance with the ethical rules and the principles. Antibiotic susceptibility of the bacteriae reproducing in catheter blood culture was obtained from the hospital information system. Antibiotic susceptibilities of bacteria isolated from intra-catheter culture were determined by the disc diffusion method or VITEK-2 automated system (Biomerioux, France).Antibiotic susceptibility in isolated bacteria was determined by the disc diffusion method according to EUCAST recommendations.[1]

RESULTS

Fourty-eight (60.7%) Gram-positive bacteria and 31 (39.2%) Gram-negative bacteria were isolated from a total of 79 intra-catheter blood cultures. The frequency of Gram-positive bacteria isolated from intra-catheter blood culture were *Staphylococcus epidermidis*, *Staphylococcus aureus*, and *Enterococcus* spp. respectively (**Table 1**).

Gram-negative bacteria isolated from intra-catheter blood culture were *Klebsiella pneumoniae* (*K. pneumoniae*), *Escherichia coli* (*E. coli*), *Stenotrophomonas maltophilia* (*S. maltophilia*), and *A. baumannii*, respectively (**Table 2**). Antibiotic resistance rates (%) of Gram-positive bacteria isolated from intra-catheter blood culture are given in **Table 1**, and antibiotic resistance rates (%) of Gram-negative bacteria are given in **Table 2**.

DISCUSSION

Catheter infections are an important cause of mortality and morbidity, especially in patients hospitalized in the intensive care unit. The bacteriae isolated from catheter infections may vary according to factors such as the type of catheter, the location of the catheter, the immune system of the host, the unit where the patient is located, hospitals and the geographical region.[3-9] Catheter infections are reported more frequently in patients with central venous catheters hospitalized in the intensive care unit, in patients with catheters hospitalized in hematology and oncology services, and in hemodialysis patients.[2-5]

In recent years, an increase in catheter-related bloodstream infections (CRBSI) rates has been reported due to the multidrug resistance of Gram-negative bacilli. However, while coagulase-negative *Staphylococcus remain* the most common cause of catheter infection, the rate of *Staphylococcus aureus* (*S. aureus*) infections is decreasing.[4]

Although the rate of catheter-related bloodstream infections in the United States decreased by 46% between 2008 and 2013, approximately 30,100 catheter-related bloodstream infections (CRBSI) are still reported in intensive care units and units providing acute support.[9]

In a study conducted in Greece in 2018, *A. baumannii* was reported to be the most common factor among the CRBSI factors. In the same study, *A. baumannii* isolates were reported to have multiple antibiotic resistance.[5]

In a study conducted in India, Pandit et al.[6] reported Serratia marcescenswas to be the most frequently isolated bacteriae in patients developing CRBSI. In the study, the rate of methicillin resistance in coagulase-negative *Staphylococcus* (CNS) was 33.3% and vancomycin resistance in *Enterococcus faeciumisolates* was 33.3%.

In this study, *Enterococcus* spp. *K. pneumoniae*, and *Staphylococcus epidermidis* (*S. epidermidis*) were the most common causative bacteriae of catheter infections in cardiovascular surgery and neurosurgery intensive care units. Unlike the literature, it was noteworthy that the microorganisms of catheter infection were *Enterococci* and *K. pneumoniae* isolates. Ceftriaxone resistance was detected in *K. pneumoniae* strains 75% percent and 4.76% penicillin resistance in *Enterococci*. In our study, 62.3% penicillin resistance was present in *S. epidermidis* and 56.25% cefoxitin resistance, which is the indicator of methicillin resistance. While all *S. aureus* isolates were resistant to penicillin, the resistance rate of cefoxitin was 9.09% and was quite low. One of the possible reasons for this may be the decrease in methicillin-resistant *S. aureus* infections in intensive care units in Turkey.

Erdem et al.[10] reported a rapid decrease in the incidence of *S. aureus* infections in intensive care units in 88 intensive care units of 36 tertiary hospitals in Turkey in 2013. Despite this significant decrease in the incidence of *S. aureus*, a significant

Table 1 Antibiotic resistance rates of gram-positive bacteria (%)

Bacteria (number, n) /Antibiotics	Penicillin	Cefoxitin	Vancomycin	Teicoplanin	Daptomycin
Enterococcus spp. (21)	4.76	0	0	0	0
Staphylococcus epidermidis (16)	62.3	56.25	0	0	0
Staphylococcus aureus (11)	100	9.09	0	0	0

Table 2. Antibiotic resistance rates of gram-negative bacteria (%)

Bacteria (number, n) / Antibiotics	Ceftriaxone	Piperacillin/ Tazobactam	Imipenem	Meropenem	Amikacin	TMP-SMZ*	LEV**
K. pneumoniae (16)	75	25	0	0	6.25	-	-
Enterobacter spp. (4)	25	0	0	0	0	-	-
E. coli (6)	46.3	22.5	16.6	16.6	0	-	-
A. baumannii (2) ***	3	3	3	3	0	-	-
S. maltophilia (3) ***	3	3	3	3	3	0%	1

TMP-SMZ*: Trimethoprim-sulfamethoxazole, LEV**: Levofloxacin***: Since the number of strains is low, the number of resistant strains is given in this line, and the percentages are given in other lines.

increase in the incidence of infections due to resistant Gram-negative bacilli has been reported in intensive care units in Turkey in recent years.[11-14]

Ergönül et al.[14] reported carbapenem resistance as 38% and colistin resistance as 6% in *K. pneumoniae* isolates in their study on patients who developed Gram-negative bloodstream infection related with health care in 17 different centers.

In our study, while carbapenem resistance was not detected in *K. pneumoniae* isolates, resistance to ceftriaxone was found to be 75% and amikacin was found to be 6.25%. In *E. coli* isolates, resistance was found to be 46.3% for ceftriaxone, 22.5% for piperacillin-tazobactam, and 16.6% for imipenem and meropenem.

Hatipoğlu et al.[15] reported that the most frequently isolated microorganisms from catheter infections in the Neurology and Neurosurgery ICU of Ankara Training and Research Hospital were methicillin-resistant coagulase-negative *Staphylococcus* (8/32; 25%), penicillin-resistant *Enterococcus* spp. (8/32; 25%) and *Candida albicans* (4/32; 12.5%).

Can et al.[2] isolated a total of 243 microorganisms from 211 catheter cultures. Isolated microorganisms were reported as coagulase-negative *Staphylococcus* (CNS), *S. aureus* and *Pseudomonas auginosa*, respectively. In the study, vancomycin and teicoplanin resistance was not detected in methicillin-resistant CNS and methicillin-resistant *S. aureus* (MRSA) isolates. In the same study, 62% penicillin resistance was reported in enterococcal bacteria. Can et al. reported that the rate of penicillin resistance in *Enterococci* was higher than the rate of 4.76% penicillin resistance found in *Enterococci* in our study. In *K. pneumoniae* isolates, Can et al. reported 53% resistance to ceftriaxone and 20% resistance to amikacin. In our study, the resistance rate (75%) we detected in *K. pneumoniae* isolates was higher than the rate reported in this study.

Öncü et al.[16] reported the distribution of microorganisms isolated in 300 patients with central venous catheter infection as 53.4% Gram-positive cocci, 44.5% Gram-negative bacilli, and 2.1% yeast in their study conducted in Istanbul.

In their study conducted in Ankara, Sarı et al.[17] found that of the 72 pathogens isolated from patients with central venous catheters, 28 were Gram-positive (28.9%), 31 were Gram-negative (43.6%), and 13 were fungal (18.5%). In the study, coagulase-negative *Staphylococcus* (22%), *Candida* spp. (18.8%) *Acinetobacter* spp. (16.6%) were reported as the most common etiological agents. Methicillin resistance was found to be 75% in coagulase-negative *Staphylococcus*and 67% in *S. aureus*. In our study, the methicillin resistance (9.09%) in *S. aureus* isolates and the methicillin resistance (56.25%) in *S. epidermidis* were lower than the methicillin resistance rates reported in this study. This difference may be due to the difference in hospital infection agents and antibiotic resistance rates between hospitals.

In their study on 201 patients diagnosed with CRBSI, Aktaş et al.[18], reported the CRBSI agents as *Acinetobacter* spp. and CNS spp. retrospectively. In the study, vancomycin and teicoplanin resistance was not detected in MRSA and MR-CNS.

Bekçibaşi et al.[19] evaluated the agents and risk factors of blood circulation infection related with central venous catheter and reported the distribution of the factors as coagulase-negative *Staphylococcus* (15.2%), *Candida* spp. (13%) and *K. pneumoniae* (13%).

In their study examining the bloodstream infections developed in patients with hematological malignancy in adult hematology and bone marrow transplantation units, Çam and Ulu Kılıç[20] reported the frequency of microorganisms isolated from blood culture as 27.6% and 17.2% in *E. coli* and *S. epidermidis*, respectively. In the study, while methicillin resistance was found to be 73% in *S. epidermidis*, they reported 9.8% meropenem, 4.5% imipenem in *K. pneumoniae*; and 37% imipenem and %41.2 imipenem in *E. coli* isolates.

CONCLUSION

As a result, determining bacteria isolated from intra-catheter blood culture and antibiotic susceptibilities in hospitals will guide clinicians in determining the appropriate treatment option in the empirical treatment of catheter infections.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study is a retrospective laboratory study, it does not contain any biological material. For that ethics committee approval is not necessary. Approval was obtained from the institution.

Informed Consent: The study is a retrospective laboratory study, it does not contain any biological material. Informed consent is not necessary.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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