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Distributions and Antibiotic Resistance Rates of Bacteria Isolated from Intensive Care Units in Siirt Training and Research Hospital

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ABSTRACT

Objective: The aim of this study was to evaluate the antimicrobial resistance rates of bacteria isolated from the samples of catheter and endotracheal aspirates (ETS) of patients under mechanical ventilation in intensive care units (ICUs).

Material and Methods: We determined the antibiotic resistance rates of bacteria isolated from catheters and ETS taken from patients who underwent mechanical ventilation in the ICUs at the Siirt Training and Research Hospital between January 2018 and November 2019.

Results: While the most common Gram-positive bacteria isolated from catheters and ETS were coagulase-negative *Staphylococcus* (CNS), *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Enterococcus faecium*, and the most common Gram-negative bacteria were *Acinetobacter baumannii*, *Klebsiella* spp., *Pseudomonas aeruginosa* and *Escherichia coli*. Among Gram-positive bacteria, methicillin resistances were detected in 82.9% of CNS isolated from catheter and in 45% of *S. aureus* strains isolated from ETS. Vancomycin resistance was observed in 14.3% of *E. faecium*. Carbapenem resistance rates were 100% for *A. baumannii* in both catheter and ETS while colistin resistance rates were 16.7% and 7.7% for catheter and ETS, respectively. For *Klebsiella* spp., carbapenem resistance rates were 47.1% and 59.1% in catheter and ETS, respectively, while colistin resistance rates were 23.5% in catheter and 9.1% in ETS. For *P. aeruginosa*, carbapenem resistance rate was 58.8% and colistin resistance rate was 2.9% in ETS. Carbapenem resistance rate of *E. coli* isolated from ETS was 11.1% while 100% of *E. coli* samples were sensitive to colistin.

Conclusion: It should be noted that infections that develop in patients followed in ICUs often occur with multiple resistant microorganisms. Antimicrobial resistance patterns of the factors detected in ICUs should be monitored regularly and treatment protocols should be updated accordingly.

Keywords: Endotracheal aspirate, catheter, intensive care units, antibacterial agents

ÖZ

Siirt Eğitim ve Araştırma Hastanesi Yoğun Bakım Ünitelerinden İzole Edilen Bakterilerin Dağılımları ve Antibiyotik Direnç Oranları

Giriş: Bu çalışmanın amacı,Siirt Eğitim ve Araştırma Hastanesi yoğun bakım ünitelerinde (YBÜ) mekanik ventilasyon uygulanan hastaların kateter ve endotrakeal aspirat (ETS) örneklerinden izole edilen bakterilerin antimikrobiyal direnç oranlarını değerlendirmektir.

Gereç ve Yöntemler: Bu çalışmada, Ocak 2018-Kasım 2019 tarihleri arasında Siirt Eğitim ve Araştırma Hastanesi YBÜ'lerinde mekanik ventilasyon uygulanan hastalardan alınan kateter ve ETS'den izole edilen bakterilerin antibiyotik direnç oranlarını belirledik.

Bulgular: Kateter ve ETS'den izole edilen en yaygın Gram-pozitif bakteriler koagülaz-negatif *Staphylococcus* (CNS), *Staphylococcus aureus*, *Streptococcus pneumoniae* ve *Enterococcus faecium* iken, en yaygın Gram-negatif bakteriler *Acinetobacter baumannii*, *Klebsiella* spp., *Pseudomonas aeruginosa* ve *Escherichia coli* idi. Gram-pozitif bakteriler arasında, kateterden izole edilen CNS'lerin %82.9'unda ve ETS'den izole edilen *S. aureus* suşlarının %45'inde metisilin dirençleri tespit edildi. *E. faecium*'un %14.3'ünde vankomisin direnci gözlendi. Karbapenem direnç oranları *A. baumannii* için hem kateter hem de ETS'de %100 iken kolistin direnç oranları kateter ve ETS için sırasıyla %16.7 ve % 7.7'ydi. *Klebsiella* spp. için karbapenem direnç oranları kateter ve ETS'de sırasıyla %47.1 ve %59.1 iken, kolistin direnci oranları kateterde %23.5 ve ETS'de %9.1'di. *P. aeruginosa* için ETS'de karbapenem direnç oranı %58.8 ve kolistin direnç oranı %2.9'du. ETS'den izole edilen *E. coli* örneklerinde karbapenem direnç oranı %11.1 iken, *E. coli* örneklerinin %100'ü kolistine duyarlıydı.

Sonuç: Yoğun bakım ünitelerinde takip edilen hastalarda gelişen enfeksiyonların sıklıkla birden fazla dirençli mikroorganizma ile ortaya çıktığı unutulmamalıdır. Yoğun bakım ünitelerinde tespit edilen faktörlerin antimikrobiyal direnç paternleri düzenli olarak izlenmeli ve tedavi protokolleri buna göre güncellenmelidir.

Anahtar Kelimeler: Endotrakeal aspirat, kateter, yoğun bakım üniteleri, antibakteriyel ajanlar

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INTRODUCTION

The high frequency of antimicrobial-resistant microorganisms is a major public health problem in many countries. These resistances increase treatment failures, costs, and morbidity, especially in intensive care units (ICUs) (1,2). Approximately 5% to 10% of patients admitted to the hospital have a hospital-acquired infection. Patients treated in ICUs have a higher risk of hospital-acquired infections due to increased disease acuity, high prevalence of invasive devices, and high probability of immune suppression (3). Antimicrobial resistance is a threat to all branches of medical and public health practice. In the European Union, approximately 25.000 patients die each year from infections caused by selected multidrug-resistant bacteria, and the associated costs are estimated at approximately 1.5 billion Euros per year (4). Increased resistance to antibiotics, the emergence and spread of antimicrobial resistance in intensive care units are considered as global public health threats today (5). Patients treated in intensive care units (ICUs) make up 5-10% of hospitalized patients, and 25% of hospital infections are seen in ICUs (6). In recent years, according to the studies conducted on hospital infections and risk factors in Turkey, it has been reported that the rate of hospital infections is between 3.1% and 14.1%, and the places where hospital infections are seen the most are in ICUs (7,8). In studies conducted, it was reported that infection rates in intensive care units are in a wide range such as 5.3-56.1% (7,9).

In the last 15 to 20 years, infection control applications and the development of new antimicrobials have been focused primarily on Gram-positive bacteria. However, in recent years, the incidence of infections caused by Gram-negative bacteria has increased significantly in intensive care units, and the lack of available treatment options against some multidrug-resistant (MDR) strains is alarming. Infections caused by MDR Gram-negative organisms are also known to be associated with high morbidity and mortality. Among the pathogens of *Pseudomonas aeruginosa* and *Acinetobacter baumannii* and recently *Enterobacteriaceae* family, increased antimicrobial resistance to b-lactam antibiotics (including carbapenems) is a concern (10).

ICUs are the most common hospital units with microorganisms resistant to hospital infections and antibiotics due to long hospitalization times, elderly, neonatal patients, more frequent application of invasive procedures, frequent immunosuppression in inpatients, or patients who have undergone surgery. When the clinical status of patients hospitalized in ICUs is examined, treatment difficulties, increasing mortality rates, and cost have become an important problem in these patients (10,11). Antibiotic resistance status of these microorganisms can change from hospital to hospital over the years. For this reason, the resistance status of microorganisms, especially in intensive care units of each hospital, should be determined and monitored. In this study, it was aimed to determine the distribution and antibiotic resistance rates of microorganisms isolated from endotracheal aspirates (ETS) and catheters taken from patients who underwent mechanical ventilation in the ICUs in Siirt Training and Research Hospital.

MATERIALS and METHODS

In this study, we determined the distribution and antibiotic resistance rates of microorganisms isolated from ETS and catheters taken from patients who underwent mechanical ventilation in the ICUs at the Siirt Training and Research Hospital between January 2018 and November 2019. In samples sent from the same patient at different times, these samples were excluded when the same microorganism reproduced. Clinical samples were transferred on 5% sheep blood agar and "eosin methylene blue" (EMB) agar. Plates were incubated at 37°C for 18-24 hours; Plaques that produced ≥100,000 CFU/ml in pure culture were included in the study. Microorganisms that could not be identified by conventional methods were identified with the automated system VITEK® 2 (bioMérieux, Marcy l'Etoile, France). Antibiotic susceptibility of growing bacteria was investigated by using the disc diffusion method and VITEK® 2 (bioMérieux, Marcy l'Etoile, France). Antibiogram results were interpreted in line with the recommendations of the European Committee on Antimicrobial Susceptibility Testing (EUCAST). Bloody agar was used for streptococci and Mueller-Hinton agar (Becton, Dickinson and Company, Franklin Lakes, New Jersey, USA) was used for other microorganisms.

This study was approved by the Siirt University Non-Interventional Clinical Research Ethics Committee and Republic of Turkey Ministry of Health as well (Date: 15.01.2020, Decision No: 2020/01.02).

Statistical Analysis

Descriptive statistics for all studied variables (characteristics) were presented as count and percent. SPSS (Version 22) statistical program was used for all statistical computations.

RESULTS

In the present study, Significant growth was detected in 260 of ETS and catheter samples admitted to our laboratory in 22 months period. Ninety-nine of the samples were taken from catheters and 161 from ETS. Forty-four (44.4%) Gram-positive and 55 (55.6%) Gram-negative bacteria were isolated and identified from catheter samples and 31 (19.1%) Gram-positive and 130 (80.9%) Gram-negative bacteria were isolated and identified from ETS. In the 44 Gram-positive bacteria detected in the catheter, 35 (79.5%) samples were identified as coagulase-negative *Staphylococcus* (CNS), seven (15.9%) samples were identified as *Enterococcus faecium*, and two (4.5%) samples were identified as *Staphylococcus aureus* (Figure 1a). Twenty (64.5%) of Gram-positive bacteria isolated from ETS were found to be *Staphylococcus aureus*, five (16.1%) of *Streptococcus pneumoniae*, and three (9.7%) of CNS (Figure 1b).

It was found that 17 (30.9%) of 55 Gram-negative bacteria isolated from catheter samples were *Klebsiella* spp., 12 (21.8%) of *Acinetobacter baumannii*, nine (16.4%) of *Pseudomonas aeruginosa*, and five (9.1%) of *Enterobacter* spp. Figures 2a and 2b show the distribution of Gram-negative bacteria isolated from catheter and ETS. Among 130 Gram-negative bacteria isolated from ETS, 39 (30%) of Gram-negative bacteria were identified as *A. baumannii*, 34 (26.2%) of identified as *P. aeruginosa*, 22 (17%) of identified as *Klebsiella* spp., and 18 (13.8%) of identified as *Escherichia coli* (Figure 2a, 2b).

Table 1 shows resistance and sensitive rates of growing Gram-positive bacteria isolated from catheter samples to various antibiotics. One hundred percent of CNS were found to be sensitive to vancomycin, 94.3% of sensitive to teicoplanin and linezolid, whereas 93.8% of were found to be resistant to tigecycline, and 85.7% of resistant to ciprofloxacin.

The most common Gram-positive bacteria isolated from ETS were *S. aureus* (64.5%) and *S. pneumoniae* (16.1%). As shown in Table 2, 100% of *S. aureus* were found to be sensitive to vancomycin, teicoplanin, and linezolid and 80% of were sensitive to ciprofloxacin whereas 45% of were resistant to oxacillin and 20% of were resistant to ciprofloxacin (Table 2). All *S. pneumoniae* were found to be sensitive to all antibiotics used for Gram-positive in the present study.

In our study, methicillin resistances were detected in 82.9% (n= 35) of CNS isolated from catheter samples and in 45% (n= 20) of *S. aureus* strains isolated from ETS. Vancomycin resistance was observed in 14.3% of *E. faecium*.

As can be seen in Table 3 and 4, carbapenem resistance rates were detected as 100% for *A. baumannii* isolates for both catheter and ETS while colistin resistance were 16.7% and 7.7% for catheter and ETS, respectively. For *Klebsiella*

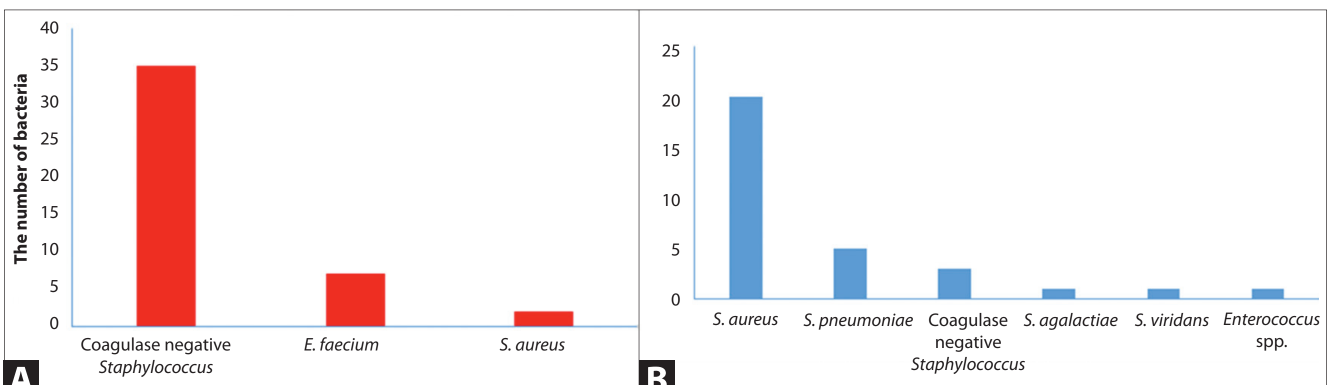

Figure 1. Distribution of Gram-positive bacteria isolated from ICUs **A.** Gram-positive bacteria from catheter samples **B.** Gram-positive bacteria from endotracheal aspirate samples.

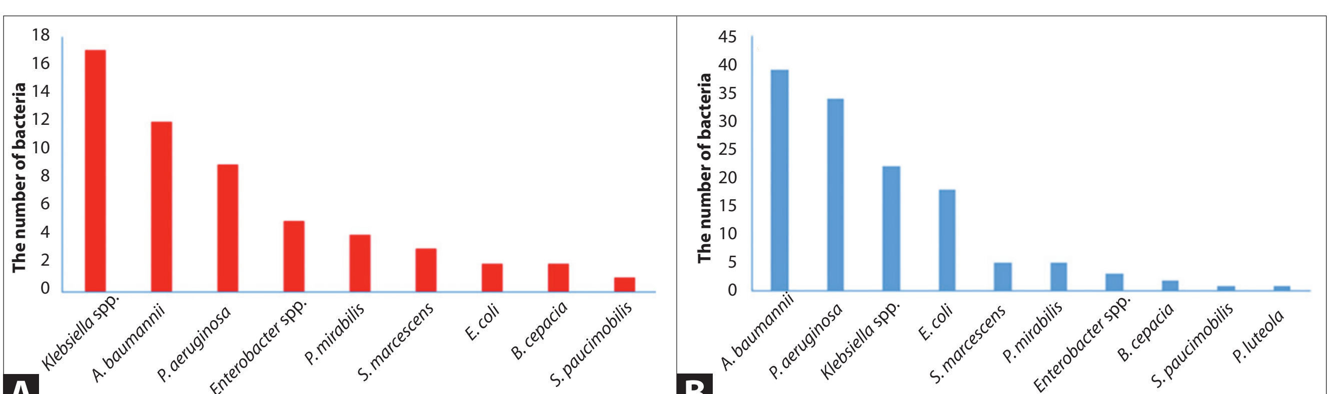

Figure 2. Distribution of Gram-negative bacteria isolated from ICUs **A.** Gram-negative bacteria from catheter samples **B.** Gram-negative bacteria from endotracheal aspirate samples

Table 1. Resistance and sensitive rates of growing Gram-positive bacteria isolated from catheter samples to various antibiotics (%)

	Antibiotics resistance and sensitivity (%)											
Bacteria	**Oxacillin**		**Vancomycin**		**Teicoplanin**		**Linezolid**		**Ciprofloxacin**		**Tigecycline**	
	+	-	+	-	+	-	+	-	+	-	+	-
Coagulase-negative *Staphylococcus* (n= 35)	82.9 (n= 29)	17.1 (n= 6)	0 (n= 0)	100 (n= 35)	5.7 (n= 2)	94.3 (n= 33)	5.7 (n= 2)	94.3 (n= 33)	85.7 (n= 30)	14.3 (n= 5)	6.3 n= 2	93.8 (n= 33)
S. aureus (n= 2)	100 (n= 2)	0 (n= 0)	0 (n= 0)	100 (n= 2)	0 (n= 0)	100 (n= 2)	0 (n= 0)	100 (n= 2)	50 (n= 1)	50 (n= 1)	0 (n= 0)	100 (n= 2)
E. faecium (n= 7)	14.3 (n= 1)	85.7 (n= 6)	14.3 (n= 1)	85.7 (n= 6)	14.3 (n= 1)	85.7 (n= 6)	0 (n= 0)	100 (n= 7)	42.9 (n= 3)	57.1 (n= 4)	0 (n= 0)	100 (n= 7)

+: Resistance, -: Sensitive.

Table 2. Resistance and sensitive rates of growing Gram-positive bacteria isolated from endotracheal aspirate samples to various antibiotics (%)

	Antibiotics resistance and sensitivity (%)									
Bacteria	**Oxacillin**		**Vancomycin**		**Teicoplanin**		**Linezolid**		**Ciprofloxacin**	
	+	-	+	-	+	-	+	-	+	-
S. aureus (n= 20)	45 n= 9	55 n= 11	0 n= 0	100 n= 20	0 n= 0	100 n= 20	0 n= 0	100 n= 20	20 n= 4	80 n= 16
S. pneumoniae (n= 5)	0 n= 0	100 n= 5	0 n= 0	100 n= 5	0 n= 0	100 n= 5	0 n= 0	100 n= 5	0 n= 0	100 n= 5
Coagulase negative *Staphylococcus* (n= 3)	33.3 n= 1	66.7 n= 2	0 n= 0	100 n= 0	0 n= 0	100 n= 0	0 n= 0	100 n= 0	33.3 n= 1	66.7 n= 2
S. agalactiae (n= 1)	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1
S. viridans (n= 1)	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1
Enterococcus (n= 1)	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1

+: Resistance, -: Sensitive.

spp., carbapenem resistance rates were found to be 47.1% for catheter samples, 59.1% for ETS while colistin resistance was determined as 23.5% in the catheter and 9.1% in ETS. For *P. aeruginosa* (n= 34), carbapenem resistance rates were found to be 58.8% in ETS, and colistin resistance was determined as 2.9%. Carbapenem resistance rates of *E. coli* isolated from ETS were found to be 11.1% while 100% of *E. coli* samples (n= 18) were sensitive to colistin.

DISCUSSION

In the present study, while the most common Gram-positive bacteria detected in the catheter samples were CNS, *E. faecium*, and *S. aureus*, the most common Gram-positive bacteria isolated from ETS were *S. aureus*, *S. pneumoniae*, and CNS. In the previous studies, Çıkman et al. (12) have reported that 57% of 124 microorganisms isolated from various clinical samples of patients hospitalized in the ICUs were Gram-positive. They have also stated that the most frequently isolated Gram-positive bacterium was CNS (16%), followed by *S. aureus* (15%) and *Enterococcus* spp. (10%). In another study, Sağmak-Tartar et al. (13) have isolated 23 (3.7%) CNS and 13 (2.1%) *S. aureus* from ETS in the ICUs. The results in our study show compatibility with previous studies. In another study from abroad, Tantracheewathorn et al. (14) have reported that *S. aureus*, CNS, and *Enterococci* were found to be the most frequently isolated Gram-positive pathogens.

In recent studies, Aydemir et al. (15) have isolated *A. baumannii* (21.2%), *K. pneumoniae* (19.8%), *P. aeruginosa* (18.4%), *E. coli* (9.9%), and *Enterobacter cloaca* (8.5%) from endotracheal aspirate samples. In another study conducted in our country, Dede et al. (16) have reported *P. aeruginosa* (29%)

Table 3. Resistance and sensitivirt rates of growing Gram-negative bacteria isolated from catheter to various antibiotics (%)

	Antibiotics resistance and sensitivity (%)															
Bacteria	**Colistin**		**Amikacin**		**Piperacillin-tazobactam**		**Meropenem**		**Ciprofloxacin**		**Tigecycline**		**Trimethoprim-sulfamethoxazole**		**Ceftazidime**	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
Klebsiella spp. (n= 17)	23.5 n= 4	76.5 n= 13	47.1 n= 8	52.9 n= 9	64.7 n= 11	35.3 n= 6	47.1 n= 8	52.9 n= 9	52.9 n= 9	47.1 n= 8	41.2 n= 7	58.8 n= 10	58.8 n= 10	41.2 n= 7	64.7 n= 11	35.3 n= 6
A. baumannii (n= 12)	16.7 n= 2	83.3 n= 1	58.3 n= 7	41.7 n= 5	100 n= 12	0 n= 0	100 n= 12	0 n= 0	91.7 n= 11	8.3 n= 1	41.7 n= 5	58.3 n= 7	66.7 n= 8	33.3 n= 4	100 n= 12	0 n= 0
P. aeruginosa (n= 9)	11.1 n= 1	88.9 n= 8	11.1 n= 1	88.9 n= 8	44.4 n= 4	55.6 n= 5	55.6 n= 5	44.4 n= 4	22.2 n= 2	77.8 n= 7	0 n= 0	100 n= 9	33.3 n= 3	66.7 n= 6	33.3 n= 3	66.7 n= 6
Enterobacter spp. (n= 5)	0 n= 0	100 n= 5	0 n= 0	100 n= 5	40 n= 2	60 n= 3	0 n= 0	100 n= 5	0 n= 0	100 n= 5	0 n= 0	100 n= 5	0 n= 0	100 n= 5	40 n= 2	60 n= 3
P. mirabilis (n= 4)	25 n= 1	75 n= 3	50 n= 2	50 n= 2	25 n= 1	75 n= 3	25 n= 1	75 n= 3	25 n= 1	75 n= 3	50 n= 2	50 n= 2	25 n= 1	75 n= 3	25 n= 1	75 n= 3
E. coli (n= 2)	0 n= 0	100 n= 2	50 n= 1	50 n= 1	0 n= 0	100 n= 2	0 n= 0	100 n= 2	50 n= 1	50 n= 1	0 n= 0	100 n= 2	0 n= 0	100 n= 2	100 n= 2	0 n= 0
B. cepacıa (n= 2)	100 n= 2	0 n= 0	0 n= 0	100 n= 2	50 n= 1	50 n= 1	0 n= 0	100 n= 2	0 n= 0	100 n= 2	0 n= 0	100 n= 2	50 n= 1	50 n= 1	50 n= 1	50 n= 1
S. paucimobilis (n= 1)	0 n= 0	100 n= 1	0 n= 0	100 n= 1	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	0 n= 0	100 n= 1	100 n= 1	0 n= 0	100 n= 1	0 n= 0

+: Resistance, -: Sensitive.

Table 4. Resistance and sensitivity rates of growing Gram-negative bacteria isolated from endotracheal aspirate samples to various antibiotics (%)

	Antibiotics resistance and sensitivity (%)															
Bacteria	**Colistin**		**Amikacin**		**Piperacillin-tazobactam**		**Meropenem**		**Ciprofloxacin**		**Tigecycline**		**Trimethoprim-sulfamethoxazole**		**Ceftazidime**	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
A. baumannii (n= 39)	7.7 n= 3	92.3 n= 36	74.4 n= 29	25.6 n= 10	100 n= 39	0 n= 0	100 n= 39	0 n= 0	100 n= 39	0 n= 0	53.8 n= 21	46.2 n= 18	79.5 n= 31	20.5 n= 8	100 n= 39	0 n= 0
P. aeruginosa (n= 34)	2.9 n= 1	97.1 n= 33	20.6 n= 7	79.4 n= 27	64.7 n= 22	35.3 n= 12	58.8 n= 20	41.2 n= 14	50 n= 17	50 n= 17	2.9 n= 1	97.1 n= 33	50 n= 17	50 n= 17	55.9 n= 19	44.1 n= 15
Klebsiella spp. (n= 22)	9.1 n= 2	90.9 n= 20	50 n= 11	50 n= 11	68.2 n= 15	31.8 n= 7	59.1 n= 13	40.9 n= 9	63.6 n= 14	36.4 n= 8	27.3 n= 6	72.7 n= 16	63.6 n= 14	36.4 n= 8	68.2 n= 15	31.8 n= 7
E. coli (n= 18)	0 n= 0	100 n= 18	27.8 n= 5	72.2 n= 13	38.9 n= 7	61.1 n= 11	11.1 n= 2	88.9 n= 16	72.2 n= 13	27.8 n= 5	5.6 n= 1	94.4 n= 17	27.8 n= 5	72.2 n= 13	50 n= 9	50 n= 9
S. marcescens (n= 5)	60 n= 3	40 n= 2	20 n= 1	80 n= 4	0 n= 0	100 n= 5	20 n= 1	80 n= 4	0 n= 0	100 n= 5	20 n= 1	80 n= 4	0 n= 0	100 n= 5	0 n= 0	100 n= 5
P. mirabilis (n= 5)	60 n= 3	40 n= 2	40 n= 2	60 n= 3	20 n= 1	80 n= 4	40 n= 2	60 n= 3	40 n= 2	60 n= 3	100 n= 5	0 n= 0	20 n= 1	80 n= 4	40 n= 2	60 n= 3
Enterobacter spp. (n= 3)	33.3 n= 1	66.7 n= 2	0 n= 0	100 n= 3	33.3 n= 1	66.7 n= 2	33.3 n= 1	66.7 n= 2	0 n= 0	100 n= 3	33.3 n= 1	66.7 n= 2	0 n= 0	100 n= 3	33.3 n= 1	66.7 n= 2
B. cepacia (n= 2)	50 n= 1	50 n= 1	0 n= 0	100 n= 2	0 n= 0	100 n= 2	0 n= 0	100 n= 2	0 n= 0	100 n= 2	0 n= 0	100 n= 2	0 n= 0	100 n= 2	50 n= 1	50 n= 1
S. paucimobilis (n= 1)	0 n= 0	100 n= 1	0 n= 0	100 n= 1	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	0 n= 0	100 n= 1	100 n= 1	0 n= 0	0 n= 0	100 n= 1
P. luteola (n= 1)	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	0 n= 0	100 n= 1	100 n= 1	0 n= 0	0 n= 0	100 n= 1	0 n= 0	100 n= 1		100 n= 1

+: Resistance, -: Sensitive.

and *A. baumannii* (26%) in tracheal aspirate samples. In our study, the most common Gram-negative bacteria isolated from catheter samples were *Klebsiella* spp., *A. baumannii*, *P. aeruginosa*, and *Enterobacter* spp. and the most common Gram-negative bacteria isolated from ETS were *A. baumannii*, *P. aeruginosa*, *Klebsiella* spp., and *E. coli*. The reason why *A. baumannii* (30% in ETS) and *P. aeruginosa* (26% in ETS) rates are higher in our study compared to other studies may be the inclusion of internal and anesthesia ICUs that provide tertiary intensive care services, where relatively heavier patients are followed, as our study year is more recent, resistance rates may have increased over the years. Although some of these factors are not true infection agents, they are a strong indicator of changing patient flora. In a more recent study, Sağmak-Tatar et al. (13) have also reported higher rates of *A. baumannii* (49%) from endotracheal aspirate samples in ICUs.

In the present study, the most effective antibiotics on CNS from catheter samples were found as vancomycin, teicoplanin and linezolid. However, bacteria were mostly resistant to tigecycline and ciprofloxacin. In previous studies, Çıkman et al. (12) and Barış et al. (17) have also reported that the most effective antibiotics on the CNS and *Enterococcus* spp. isolated from ICUs were vancomycin, teicoplanin and linezolid. In another study, Sağmak-Tatar et al. (13) have reported that 73.9% of CNS isolated from ICUs were resistant to ciprofloxacin. In the present study, while *E. faecium* was highly susceptible to most antibiotics, 57.1% of were resistant to ciprofloxacin, and 14.3% of resistant to vancomycin. In a previous study, Çıkman et al. (12) have reported that 17% of *Enterococcus* spp. were resistant to vancomycin.

In our study, the most effective antibiotics on the *S. aureus* isolated from ETS were found as vancomycin, teicoplanin linezolid, and ciprofloxacin whereas *S. aureus* strains were mostly resistant to oxacillin and ciprofloxacin. In a recent study, Çıkman et al. (12) have also reported that the most effective antibiotics on the *S. aureus* isolated from ICUs were vancomycin, teicoplanin, and linezolid.

In addition to the increasing frequency of Gram-positive bacteria in the ICUs, they have also become a serious problem due to their advanced antibiotic resistance (12). It is pointed out that methicillin and vancomycin resistance rates are increased especially in *Staphylococci* and *Enterococci* (18,19). In our study, methicillin resistances were detected in 82.9% of CNS isolated from catheter samples and in 45% of *S. aureus* strains isolated from ETS. Vancomycin resistance was observed in 14.3% of *E. faecium*. Sağmak-Tatar et al. (13) have reported that methicillin resistance was detected in all *S. aureus* strains and the frequency of methicillin resistance was reported as 86.4% in CNS isolated from ETS. In the study of Kollef et al. (20), evaluating the factors reproducing in deep tracheal aspirate in patients with ventilator-associated pneumonia, have determined methicillin resistance rate as 14.8%. While Sesli Çetin et al. (18) have determined methicillin resistance rates as 64.4% in CNS and 68.9% in *S. aureus*, Vardar-Ünlü et al. (21) have reported methicillin resistance in *S. aureus* and CNS strains isolated from various clinical samples at the rates of 53.6% and 44%, respectively. In another study, Ertürk et al. (22) have determined methicillin resistance rates as 74% for CNS and *S. aureus*.

High morbidity and mortality rates in Gram-negative bacteria due to multiple antibiotic resistance cause great concern in terms of hospital-acquired infections. Resistance problem increases due to reasons such as the suppression of immune systems of patients, excessive use of broad-spectrum antibiotics, and lack of compliance with infection control measures in ICUs (23). It is known that in carbapenems, which are the most broad-spectrum β-lactam antibiotics developed for use in highly resistant strains, the main resistance mechanism is carbapenemase production, other mechanisms are modification of penicillin-binding proteins and loss of porin (13). Especially in recent studies, high levels of carbapenem resistance have been found in *Acinetobacter*, *Pseudomonas*, *Klebsiella* species (24-26). In our study, while carbapenem resistance was found to be quite high for *A. baumannii*, *Klebsiella* spp, and *P. aeruginosa*, colistin resistance was found to be lower for all species. In addition, carbapenem and colistin resistance was found to be quite low in *E. coli*. In a recent study, Sağmak-Tatar et al. (13) have also reported that carbapenem resistance rates were quite high in Gram-negative microorganisms. They have reported that carbapenem resistance was 97.7% in *A. baumannii*, 70.9% in *P. aeruginosa*, and colistin resistance was 2.9% in *A. baumannii* while colistin resistance as 2.4% and 5% in *P. aeruginosa* and *Klebsiella* spp., respectively. No colistin resistance was reported in *E. coli*. In a previous study conducted in Turkey, Gür et al. (27) have investigated carbapenem resistance in *A. baumannii* origins between 2000-2006. They reported that imipenem sensitivity was decreased by 40.4% from the year 2000 until 2006 and the sensitivity of meropenem decreased significantly by 71.7% and 40% for the same years, respectively.

Colistin and amikacin are among the most effective antibiotics for *Pseudomonas* spp. and *Acinetobacter* spp. (28). In antibiogram susceptibility results, resistance to all antibiotics, except colistin, can be detected in both groups of bacteria. Although the side effects of ototoxicity and nephrotoxicity are well known, the only treatment option may be colistin. In some studies, in which colistin was not used, amikacin was found to be the most effective antibiotic for *Pseudomonas* spp., and tigecycline was found to be for *Acinetobacter* spp. (29,30).

In the present study, the most effective antibiotics for *A. baumannii* were found to be colistin and tigecycline while antibiotics to which bacteria were most resistant were piperacillin-tazobactam, meropenem, and ceftazidime. For *P. aeruginosa*, the most effective antibiotics were found to be colistin, tigecycline, and amikacin while antibiotics to which bacteria were most resistant were found to be meropenem and piperacillin-tazobactam. For *Klebsiella* spp., the most effective antibiotics were found to be colistin and tigecycline while antibiotics which bacteria were most resistant were found to be piperacillin-tazobactam, trimethoprim-sulfamethoxazole, and ceftazidime.

CONCLUSION

As a result, for the infections developing in patients followed in ICUs, it should be noted that it often occurs with multiple resistant microorganisms. Antimicrobial resistance patterns of the factors detected in ICUs should be monitored regularly and treatment protocols should be updated accordingly. Each center should determine the resistance status of microorganisms to antimicrobials with cumulative antibiogram studies. Surveying the antibiotic consumption within the ICUs for avoiding further selective pressure on bacteria showing increased resistance rates is important as well. The important struggle to reduce antibiotic consumption can continue safely in the ICUs If these actions are successfully implemented.

Ethics Committee Approval: This study was approved by the Siirt University Non-Interventional Clinical Research Ethics Committee and Republic of Turkey Ministry of Health as well (Date: 15.01.2020, Decision No: 2020/01.02).

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REFERENCES

1. *Pittet D, Tarara D, Wenzel RP. Nosocomial bloodstream infection in critically iii patients: Excess length of stay, extra costs, and attributable mortality. JAMA 1994;271(20):1598-601.*
2. *Geissler A, Gerbeaux P, Granier I, Blanc P, Facon K, Durand-Gasselin J. Rational use of antibiotics in the intensive care unit: impact on microbial resistance and costs. Intensive Care Med 2003;29(1):49-54.*
3. *Volkoff SJ, McCumber AW, Anderson DJ, Gunsch CK. Antibiotic-resistant bacteria on personal devices in hospital intensive care units: Molecular approaches to quantifying and describing changes in the bacterial community of personal mobile devices. Infect Control Hosp Epidemiol 2019;40(6):717.*
4. *Golli A-L, Nitu FM, Balasoiu M, Lungu MA, Dragomirescu CC, Olteanu M, et al. The characterization of antibiotic resistance of bacterial isolates from Intensive Care Unit patient samples in a university affiliated hospital in Romania. Revista De Chimie 2019;70(5):1778-83.*
5. *Núñez-Núñez M, Navarro MD, Palomo V, Rajendran N, Del Toro M, Voss A, et al. The methodology of surveillance for antimicrobial resistance and healthcare-associated infections in Europe (SUSPIRE): a systematic review of publicly available information. Clin Microbiol Infect 2018;24(2):105-9.*
6. *Çoksak A, Çelik Y, Danacı C, Sökel S. Yoğun Bakım Ünitelerinde invaziv uygulamalar ve enfeksiyon ilişkisi. MAKÜ Sag Bil Enst Derg 2017;5(1):22-31*
7. *Çelik İ, Şenol A, Karlıdağ G, İncİ N. Year 2006 surveillance results of hospital acquired infections in Firat University Hospital. Firat Tip Dergisi 2009;14(4):242-6.*
8. *Özçetin M, Saz E, Karapınar B, Özen S, Aydemir Ş, Vardar F. Pediatric nosocomial infections; incidence, risk factors. J Pediatr Inf 2009;3(2):49-53.*
9. *Dizbay M, Baş S, Gürsoy A, Şİmşek H, Maral I, Aktaş F. Invasive device-related infection surveillance in intensive care units of Gazi University Hospital in 2006-2007. Turkiye Klinikleri J Med Sci 2009;29(1):140-5.*
10. *MacVane SH. Antimicrobial resistance in the intensive care unit: a focus on gram-negative bacterial infections. J Intensive Care Med 2017;32(1):25-37.*
11. *Uğur M, Genç S. Yoğun Bakım Ünitelerinden izole edilen Acinetobacter baumannii ve Pseudomonas aeruginosa suşlarının üç yıllık direnç profili. Turk J Intens Care 2019;17(3).*
12. *Çıkman A, Gündem NS, Karakeçili F, Korkmaz E, Çıkman Ö. Yoğun bakim ünitesinde yatan hastalarin çeşitli klinik örneklerinden izole edilen mikroorganizmalar ve antibiyotik duyarliliklari. ANKEM Derg 2012;26(3):131-6.*
13. *Sagmak-Tartar A, Ozer AB, Ulu R, Akbulut A. Microbiological evaluation of the pathogens isolated from the endotracheal aspirate samples of the patients followed in the intensive care units: A One-Year Retrospective Analysis. Klimik 2018;31(1):56-60.*
14. *Tantracheewathorn T, Vititpatarapak N, Phumisantiphong U. Epidemiologic study of nosocomial bacterial infection of pediatric patients at BMA Medical College and Vajira Hospital. J Med Assoc Thai 2007;90(2):258.*
15. *Aydemir Ö, Demiray T, Köroğlu M, Aydemir Y, Karabay O, Altindiş M. Yoğun bakım ünitelerinde yatan hastaların endotrakeal aspirat örneklerinden izole edilen bakterilerin tanımlanması ve antibiyotik duyarlılıkları. OTJHS 2016;1(4):1-8.*
16. *Dede B, Kadanalı A, Karagöz G, Çomoğlu Ş, Bektaşoğlu MF, İrvem A. The evaluation of cultures of deep tracheal aspirates in intensive care unite. Haydarpasa Numune Med J 2014;54(1):15-20.*
17. *Barış A, Bulut ME, Öncül A, Bayraktar B. Distribution of clinical isolates at species level and their antibiotic susceptibilities in intensive care units patients. Turk J Intensive Care 2017;15(1):21-7.*
18. *Çetin ES, Kaya S, Pakbaş İ, Demirci M. Yoğun bakım ünitelerinde yatan hastalardan izole edilen mikroorganizmalar ve antibiyotik duyarlılıkları. İnönü Üniversitesi Tıp Fakültesi Dergisi 2007;14(2):69-73.*
19. *Ulusoy S. Yoğun Bakım Ünitesinde Gram pozitif mikroorganizma enfeksiyonları ve yaklaşım. Turkiye Klinikleri J Int Med Sci. 2006;2(46):32-40.*

20. Kollef MH, Morrow LE, Niederman MS, Leeper KV, Anzueto A, Benz-Scott L, et al. Clinical characteristics and treatment patterns among patients with ventilator-associated pneumonia. Chest 2006;129(5):1210-8.

21. Vardar G, Ünlü M, Yağmuroğlu A. Klinik örneklerden soyutlanan S. aureus ve KNS izolatlarında mupirosin direnci. ANKEM Derg 2006;20(4):222-5.

22. Ertürk A, Çiçek A, Köksal E, Köksal Z, Özyurt S. Microorganisms isolated from various clinical samples and their antibiotic susceptibilities in intensive care unit patients. ANKEM Derg 2012;26(01):1-9.

23. An Y. Yoğun bakım ünitesinde antibiyotik kullanımı ve direnç sorununa genel bakış. ANKEM Derg 2009;23(Suppl 2):136-42.

24. Gozutok F, Sariguzel F, Celik I, Berk E, Aydin B, Guzel D. Investigation of antimicrobial resistance rates of Acinetobacter baumannii strains from nosocomial infections. ANKEM Derg 2013;27(1):7-12.

25. Iraz M, Ceylan A, Akkoyunlu Y. Investigation of antibiotic resistance rates of Acinetobacter species isolated from various clinical samples. ANKEM Derg 2012;26(2):80-5.

26. Küme G, Demirci M. Yoğun bakım ünitelerindeki hastaların alt solunum yolu örneklerinden izole edilen non-fermantatif Gram-negatif bakterilerin antimikrobiyal duyarlılıkları ve alt solunum yolu enfeksiyonu ile ilişkili risk faktörleri. J DEU 2012;26(1):37-44.

27. Gur D, Korten V, Unal S, Deshpande LM, Castanheira M. Increasing carbapenem resistance due to the clonal dissemination of oxacillinase (OXA-23 and OXA-58)-producing Acinetobacter baumannii: report from the Turkish SENTRY Program sites. J Med Microbiol 2008;57(12):1529-32.

28. Arda B. Dirençli non-fermentatif Gram negatif bakteri infeksiyonlarının tedavi ve yönetimi. ANKEM Derg 2011;25:45-9.

29. Çıkman A, Parlak M, Gültepe B, Güdücüoğlu H, Berktaş M. Hastanekökenli Acinetobacter baumanıı izolatlarında tigesiklin duyarlılığının E-test yöntemiyle araştırılması. ANKEM Derg 2011;25(2):79-83.

30. Pehlivanoglu F, Yasar KK, Bilir YA, Sengoz G, Gungor N, Nazlican O. Surveillance of device-associated nosocomial infections in an intensive care unit at a 550-bed research hospital during 2009/550 yatakli bir arastirma hastanesinin yogun bakim unitesinde 2009 yili alet iliskili hastane enfeksiyonlari surveyansi. Med Bull Haseki 2011:30-4.