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Five-Years Bacteremia Surveillance in the Intensive Care Unit
Yoğun Bakım Ünitesinde Beş Yıllık Bakteriyemi Sürveyansı

Gülten Ünlü[1], Gönül Şengöz[3], Filiz Pehlivanoğlu[3], Şemsi Nur Karabela[2], Kadriye Kar Yaşar[2]

[1] S.B.U. Kocaeli Derince Training and Research Hospital, Infectious Diseases and Clinical Microbiology Clinic, Kocaeli, Turkey.
[2] S.B.U. Bakırköy Sadi Konuk Training and Research Hospital, Infectious Diseases and Clinical Microbiology Clinic, Kocaeli, Turkey.
[3] S.B.U. Haseki Training and Research Hospital, Infectious Diseases and Clinical Microbiology Clinic, Kocaeli, Turkey.

ABSTRACT

Objective: Intensive care units are the areas where nosocomial infections and bacteremia are most common. With the surveillance study, it is aimed to determine the agents, to know their characteristics, to create the resistance profile, to prevent cross-infection and contamination, and to reduce the rates of nosocomial infections. In this study, it was aimed to examine the distributions and susceptibility rates of the agents in nosocomial bacteremia in patients followed up in the Haseki Training and Research Hospital ICU between 2009 and 2013. Our study was carried out in ICU between January 1, 2009 and December 31, 2013.

Method: Bacteremia surveillance of the patients hospitalized in the ICU was evaluated according to the surveillance follow-up form and the invasive vehicle surveillance follow-up form. Bacteria grown in blood cultures were identified from vials with positive growth signal after incubation in the BacT/Alert system using conventional methods and Vitek 2 identification device. Antibiotic sensitivities were determined according to Kirby Bauer disc diffusion method and interpreted according to CLSI criteria.

Results: In the ICU, 327 episodes of bacteremia were detected in a five-year period. Of these, 181 were peripheral blood samples, 146 were CVC-associated bacteremia, 76.2% of the isolated bacteremias were Gram-negative agents, 19.5% were Gram-positive agents, and 3.6% were fungal agents. The most frequently isolated bacteria is Klebsiella spp. (22.9%). Respectively, Acinetobacter spp. (19.8%), Pseudomonas spp. (17.7%), Enterobacter spp. (7.1%), E. coli (3.1%) were the most frequently observed Gram negative bacteria. Significant changes were found in the antibiotic susceptibility of bacteria by years.

Conclusion: Compared to total nosocomial infections in the ICU, the rate of bloodstream infections decreased significantly over the years, and an increase was observed in CVC-related bloodstream infections over the years. In bacteremia developing in the ICU, the agents are more resistant and the patients are more complicated. Surveillance studies are of great importance in controlling hospital infections.

Keywords: intensive care unit, nosocomial infection, surveillance

ÖZ

Giriş: Yoğun bakım üniteleri(YBÜ) nozokomiyal enfeksiyonlar ve bakteriyeminin en sık görüldüğü alanlardır. Sürveyans çalışması ile etkenlerin belirlenmesi, özelliklerinin bilinmesi, direnç profilinin çıkarılması, çapraz enfeksiyon, kontaminasyonun önlenmesi ile hastane enfeksiyonu oranları düşürülmesi hedeflenir. Bu çalışmada Haseki Eğitim ve Araştırma Hastanesi YBÜ'de 2009-2013 yılları arasında izlenen hastalarda gelişen nozokomiyal bakteriyemilerde etkenlerin dağılımları ve duyarlılık oranlarının incelenmesi amaçlanmıştır.

Yöntem: Çalışmamız 1 Ocak 2009 ve 31 Aralık 2013 tarihleri arasında YBÜ' de yapılmıştır. YBÜ'ye yatan hastaların bakteriyemi sürveyansı, sürveyans takip formu, invaziv araç sürveyansı izlem formuna göre değerlendirilmiştir. Kan kültürlerinde üreyen bakteriler BacT/Alert sisteminde inkübasyon sonrası pozitif üreme sinyali olan şişelerden konvansiyonel yöntemler ve Vitek 2 identifikasyon cihazında identifiye edilmiştir. Antibiyotik duyarlılıkları Kirby Bauer disk diffüzyon yöntemine göre yapılmış, CLSI kriterlerine göre yorumlanmıştır.

Bulgular: YBÜ'de beş yıllık sürede 327 bakteriyemi epizodu saptanmıştır. Bunların 181'i periferik kan örneği, 146'sı SVK ilişkili bakteriyemi, izole edilen bakteriyemilerin %76.2'si Gram negatif etkenler, %19.5'i Gram pozitif etkenler, %3.6'sı fungal etkenler olmuştur. En sık izole edilen bakteri Klebsiella spp. (%22.9) olmuştur. Sırasıyla Acinetobacter spp. (%19.8), Pseudomonas spp. (%17.7), Enterobacter spp. (%7.1), E. coli (%3.1) en sık gözlenen Gram negatif bakteriler olmuştur. Bakterilerin antibiyotik duyarlılıklarında yıllara göre anlamlı değişiklikler saptanmıştır.

Sonuç: YBÜ'de toplam nozokomiyal enfeksiyonlara göre kan dolaşımı enfeksiyonu oranı yıllara göre anlamlı oranda azalmış olup SVK ilişkili kan dolaşımı enfeksiyonunda yıllara göre artış gözlenmiştir. YBÜ'de gelişen bakteriyemilerde etkenler daha dirençli olup, hastalar daha komplikedir. Hastane enfeksiyonlarının kontrol altına alınmasında sürveyans çalışmaları büyük önem taşımaktadır.

Anahtar Kelimeler: nozokomiyal enfeksiyon, sürveyans, yoğunbakım ünitesi

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Correspondence: Gülten Ünlü, S.B.U. Kocaeli Derince Training And Research Hospital, Infectious Diseases And Clinical Microbiology Clinic, Kocaeli, Turkey.
E-mail: cicekgulten@yahoo.com

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INTRODUCTION

Significant growth in the blood culture taken 48-72 hours after the patient's hospitalization is considered as nosocomial bacteremia. According to the European intensive care unit infections study data, nosocomial bacteremia accounts for 12% of all hospital infections. Despite the antimicrobial treatment and technological developments, the mortality rate is between 12-80%, with an average of 25%. The causative microorganisms in nosocomial bacteremias change over time(1). Surveillance is defined as the continuous and regular collection, analysis and interpretation of health data, which will form the basis for the planning and development of public health practices, and feedback to the necessary places. Infected patients are identified by the surveillance of hospital infections, the frequency of infection and the factors causing the infection are determined. At the same time, surveillance results are important as a quality indicator. With regular surveillance, outbreaks can be detected in a short time and necessary control measures can be implemented (2).Impairment of host defenses are; with acute disease (trauma, surgical intervention, burns, Coagulase negative Stafilococcus (CNS) infections, Left Ventricular Hypertrophy(LVH), cardiac arrest, intoxication, head trauma), consciousness may be lost, swallowing and cough reflexes may be impaired and aspiration may develop. Mechanical ventilator may be required, nosocomial pneumonia may develop, invasive interventions (endotracheal or nasal intubation, tracheostomy, mechanical ventilation, urinary catheterization, central venous catheterization, surgical drains, nasogastric tubes) treatments (sedatives, antimicrobial therapy, immunosuppressive parenteral nutrition therapy, steroid therapy, stress ulcer prophylaxis, other pre-existing diseases of the patient (advanced age, diabetes, chronic lung disease, hypertension, alcoholism, malnutrition, smoking habit) cause deterioration of host defense (3,5). Endogenous colonization : Candida, Enterobacter, The protease enzyme released from Klebsiella, Pseudomonas species causes loss of fibronectin, which enables Gram-positive bacteria to bind in the oral flora in severely ill patients, or endogenous colonization by gaining alkaline properties due to achlorhydria, antacid use, advanced age, malnutrition, H2 receptor blockers in the stomach. Reflux formation and aspiration pneumonia may occur. Exogenous colonization ; can be transmitted by the hands or clothing of the hospital staff, infusion fluids, contaminated mechanical ventilators, nebulizers, drugs. Contaminated environment with the hands of personnel plays a role especially in the transmission of multi-resistant Staphylococci and Vancomyc in Resistance Enterococcus (VRE) (4).

MATERIAL AND METHODS

Haseki Education and Research Nosocomial bacteremia surveillance in patients hospitalized in the Intensive Care Unit, were evaluated retrospective, according to the surveillance follow-up form and the invasive vehicle surveillance follow-up form for five years. Blood culture bottles from the 25-bed ICU of our hospital Incubated and positive in a BacT/Alert automated blood culture system (BioMerieux, France). From the bottles giving a growth signal, inoculation was made on chocolate agar medium and conventional methods and on the Vitek 2 fully automated identification device (BioMerieux, France) has been identified. Antibiotic sensitivities according to Kirby Bauer disc diffusion method and interpreted according to CLSI criteria. Nosocomial bacteremia was determined according to CDC criteria. No hospital admission clinically significant blood culture after at least 48 hours in a patient without infection determination of positivity in hospital infection control as nosocomial infectioIt was accepted by the committee by applying laboratory-based active surveillance. Bacteremia due to intravascular catheter has also been accepted as nosocomial bacteria. At least two sets of blood cultures were taken in patients with suspected catheter infection. from the catheter and Simultaneous blood was taken from the peripheral vein and analyzed with an automated system.

Statistical Reviews

NCSS (Number Cruncher Statistical System) 2007&PASS (Power Analysis and Sample Size) 2008 Statistical Software (Utah, USA) program was

used for statistical analysis. While evaluating the study data, Pearson Chi-Square test, Fisher's exact test and Fisher-Freeman Halton exact test were used for comparison of qualitative data as well as descriptive statistical methods (Ratio). Significance was evaluated at $p<0.01$ and $p<0.05$ levels.

RESULTS

In the surveillance study conducted between January 2009 and December 2013 in the 25-bed capacity intensive care unit of the Ministry of Health Haseki Training and Research Hospital, 805 nosocomial ICU infections were detected. Of these, 327 (40.6%) were bacteremia. 76.7% of bacteremias are Gram-negative agents, 19.5% are Gram-positive agents, and 3.6% are fungal agents. The number of peripheral blood culture-related bloodstream infections was 181 and the number of CVC-related bloodstream infections was 146 (Table 1).

Of the isolated bacteria, 64 (19.8%) Acinetobacter spp., 57 (17.7%) Pseudomonas spp., 23 (7.1%) Enterobacter spp., 74 (22.9%) Klebsiella spp., 10 (3.1%) E. coli, 16 (4.9%) Staphylococcus spp., 12 (3.7%) Candida spp., 5 (1.5%) Serratia marcescens, 48 (14.9%) Enterococcus spp., 12 (3.7%)) Stenotrophomonas maltophilia, 6 (1.8%) are Proteus species. While the total number of nosocomial bacteremia in the ICU was 56 in 2009, it was found to be 101 in 2013. The resistance percentages of the factors by years are shown in Table 2.

In 2009, Acinetobacter spp. The ampicillin sulbactam resistance rate of strains was 14%, 64% in 2013 and has increased linearly over the years. Imipenem resistance approached 100%. Colistin resistance was not detected. Colistin and tigecycline resistance were detected in Pseudomonas strains. For Klebsiella pneumoniae strains, imipenem resistance was 7% in 2009, 4% in 2013, and tigecycline resistance was 4% in 2013. For enterococci strains, resistance rates were found to be 75% for ampicillin, 57% for gentamicin, and 8% for vancomycin in 2013.

Oxacillin resistance of Staphylococcus aureus strains was found to be 67% in 2013. No resistance to linezolid and tigecycline was detected in 2013.

Table 2: Antibiotic Resistance Percentages of Agents by Years

Isolated Pathogen		Percentages of Resistance				
		2009	2010	2011	2012	2013
Acinetobacter spp.	Ampicillin sulbactam	14	30	28	31	64
	Imipenem	71	64	76	100	92
	Piperacillin tazobactam	84	71	86	100	0
	Cefepim	60	90	94	98	50
	Cefaperazone	6	17	-	-	-
	Ceftriaxone	94	100	100	95	100
	Ciprofloxacin	79	80	97	92	90
	Colistin	-	-	0	-	0
	Tigecycline	-	-	0	31	73
Pseudomonas spp.	Amikasin	22	0	0	5	22
	Imipenem	42	8	11	56	21
	Piperacillin tazobactam	12	0	19	22	18
	Cefepim	33	18	18	56	54
	Ceftazidim	50	40	28	34	46
	Ciprofloksasin	48	9	39	20	36
	Colistin	-	-	-	25	13
	Tigecycline	-	-	-	89	56
Klebsiella pneumoniae	Imipenem	7	0	0	21	4
	Cefepim	40	67	65	48	10
	Piperacillin tazobactam	33	33	71	44	15
	Gentamisin	25	25	70	44	14
	Ciprofloksasin	64	67	64	65	13
	TMP-SMX	0	-	17	60	60
	Tigecycline	-	0	0	4	4
Enterococcus spp.	Ampicillin	80	100	100	100	75
	Gentamicin	79	100	0	50	57
	Ciprofloxacin	88	100	100	100	71
	Vancomycin	0	0	0	50	8
	Teikoplanin	0	0	0	25	0
	Tigecycline	-	-	-	0	0
Staphylococcus aureus	Oxacillin	-	100	100	100	67
	Cefazolin	-	-	100	100	33
	Ciprofloxacin	-	-	100	100	67
	Teikoplanin	-	-	0	0	0
	Vancomycin	-	-	0	0	0
	Linezolid	-	-	-	-	0
	Tigecycline	-	-	-	-	0

TMP-SMX : Trimetoprim-Sulfametoksazol

Table 1: Bacteremia Agents, Number, Percentage by Years

Yıl	2009				2010				2011				2012				2013			
	n				n				n				n				n			
Toplam	56				38				57				77				99			
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
	Pr		SVK		Pr		SVK		Pr		SVK		Pr		SVK		Pr		SVK	
Acinetobacter baumannii	-	-	-	-	-	-	-	-	-	-	-	-	3	12	1	2.1	1	3.7	11	15
Diğer Acinetobacter türleri	7	13	-	-	3	10	2	22	18	34	1	20	3	12	9	19	2	7.4	3	4
Diğer Pseudomonas türleri	15	28	1	25	7	24	1	11	9	17	2	40	5	20	5	10	1	3	3	4
Pseudomonas auroginosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	7	9
Enterobacreceae	3	5	1	25	-	-	1	11	2	3.8	-	-	1	4	-	-	-	-	1	1.3
Enterobacter cloacae	-	-	-	-	1	3	-	-	1	1.9	-	-	-	-	1	2	-	-	2	2.7
Enterobacter aerogenes	-	-	-	-	2	6	-	-	-	-	-	-	-	-	1	3	1	3	5	6.7
Klebsiella pneumoniae	10	19	-	-	2	6.9	-	-	10	19	1	20	7	29	18	39	7	25	7	9.4
Diğer Klebsiella türleri	2	3.8	-	-	5	17	1	11	2	3.8	-	-	-	-	-	-	1	3.7	1	1.3
E. coli	2	3.8	-	-	1	34	1	11	1	1.9	-	-	-	-	-	-	2	7.4	3	4
Stafilococcus aureus	-	-	-	-	-	-	1	11	1	1.9	-	-	-	-	-	-	1	0.7	2	2.7
Koagülaz negatif Stafilococcus	-	-	-	-	-	-	-	-	-	-	1	20	-	-	4	8.7	-	-	6	8
Candida albicans	-	-	-	-	-	-	-	-	2	3.8	-	-	-	-	1	2.1	1	3.7	4	5.4
Candida parapsilosis	-	-	1	25	-	-	1	3.4	-	-	-	-	-	-	-	-	-	-	1	1.3
Diğer Candida türleri	-	-	-	-	-	-	-	-	-	-	-	-	1	2.1	-	-	-	-	-	-
Serratia marcescens	-	-	-	-	-	-	1	11	-	11	-	-	-	-	1	2.1	2	7.4	1	1.3
Diğer Enterococcus türleri	9	17	1	25	3	10	-	-	4	7.6	-	-	1	4.1	9	19	5	18	12	16
Enterococcus faecium	-	-	-	-	1	34	-	-	1	1.9	-	-	1	4.1	1	2.1	-	-	-	-
Stenotrophomonas maltophilia	4	7.6	-	-	1	34	1	11	-	-	-	-	1	4.1	1	2.1	-	-	4	5.4
Proteus mirabilis	-	-	-	-	2	6.9	-	-	1	1.9	-	-	2	8.3	-	-	-	-	-	-
Proteus vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1.3

Pr: Primer, CVC: Central Venous Catheter

A significant difference was found in ampicillin sulbactam resistance in Acinetobacter strains according to years (p<0.05). While the increase in the resistance rates in 2013 compared to 2009 was found to be significant, no significant difference was observed between the resistance rates between the years 2010-13 (Table 3).

When the change in resistances over the years is examined; The resistances of 2010 and 2011 were lower than the resistances of 2009, 2012 and 2013 (p<0.05), and no significant difference was observed between the other years (p>0.05) (Table 4).

When the change in resistances over the years is examined; There was no significant difference between the other years (p>0.05), in which the resistance percentage in 2013 was lower than the resistance percentages in 2010, 2011 and 2012 (p<0.05) (Table 5).

Although the rate of use of CVCs decreased to 0.90 in 2009 and to 0.50 in 2013, the number of CVC-BDI has increased over the years. The LVMI-BDI Rate was 0.45 in 2009 and 15.69 in 2013 (Table 6).

Table 3 : Acinetobacter spp. Resistance Percentages and Ratings

Acinetobacter spp.	Resistance Rate (%)					
	2009	2010	2011	2012	2013	p
Ampicilin sulbaktam	14.29	30.00	27.78	30.95	63.64	*a0.049**
Imipenem	7.43	63.64	75.76	100.00	91.67	*b0.345*
Piperacillin tazobactam	84.21	71.43	86.36	100.00	0.00	*b0.140*
Cefepim	60.00	90.00	94.44	97.56	50.00	*b0.013**
Cefaperazon	5.56	16.67	-	-	-	*c0.446*
Ceftriakson	94.12	100.00	100.00	95.12	100.00	*b0.672*
Ciprofloxacin	78.57	80.00	97.22	92.50	90.00	*b0.119*
Colistin	-	-	0.00	-	0.00	*d*
Tigecycline	-	-	0.00	30.95	72.73	*c0.017**

a : Pearson ki-kare test, b : Fisher-Freeman-Haltonexact test, c :Fisher exact test , d : The relevant analysis could not be performed due to insufficient observations. *p<0,05

Table 4 : Pseudomonas spp. Resistance Percentages and Ratings

Pseudomonas spp.	Direnç oranları (%)					
	2009	2010	2011	2012	2013	p
Amikasin	22.22	0.00	0.00	5.13	0.00	c0.055
Imipenem	41.94	8.33	10.71	55.56	40.00	b0.006**
Piperasilin tazobaktam	12.00	0.00	19.23	22.22	0.00	b0.719
Cefepim	33.33	18.18	17.86	56.41	38.10	a0.014*
Ceftazidim	50.00	40.00	27.59	34.38	20.00	a0.216
Ciprofloxacin	47.62	9.09	39.29	20.00	14.29	b0.047*
Colistin	-	-	-	25.00	0.00	d
Tigecycline	-	-	-	88.89	100.00	c1.000

a : Pearson ki-kare test, b : Fisher-Freeman-Haltonexact test, c :Fisher exact test , d : The relevant analysis could not be performed due to insufficient observations. *p<0,05 **p<0,01

Table 5: Klebsiella Pneumoniae Resistance Percentages and Evaluations by Years						
Klebsiella pneumoniae	**Direnç oranları (%)**					
	2009	**2010**	**2011**	**2012**	**2013**	**p**
Imipenem	6.67	0.00	0.00	21.43	3.57	b0.134
Cefepim	40.00	66.67	65.22	48.48	10.00	b0.002**
Piperacilin tazobaktam	33.33	33.33	71.43	43.75	15.00	b0.016*
Gentamisin	25.00	25.00	69.57	44.12	13.79	b0.001**
Ciprofloxasin	63.64	66.67	63.64	64.52	13.33	b0.008**
TMP-SMX	0.00	-	16.67	60.00	60.00	b0.149
Tigecyclin	-	0.00	0.00	4.35	3.57	c1.000
b : Fisher-Freeman-Haltonexact test, c : Fisher exact test, *p<0,05, **p<0,01						

Table 6: Evaluation of CVC by Years				
	CVC Day	**CVCI-BSI (number)**	**CVC Kullanım Oranı**	**CVCI-BSI Rate**
2009	6.630	3	0.90	0.45
2010	6.830	8	0.84	1.17
2011	6.034	3	0.68	0.50
2012	5.352	44	0.62	8.22
2013	4.335	68	0.50	15.6

Conclusion

In studies conducted in our country, the rate of bloodstream infections among all hospital infections is between 13.4% and 26%. Nosocomial bacteremias constitute 52% of clinically significant positive blood cultures. Like other nosocomial infections, bloodstream infections are 7-8 times higher in ICU patients compared to other units, due to the risk of infection, underlying diseases, and many invasive interventional procedures. Nosocomial bacteremias occupy the top three ranks among infections seen in ICU (6). In studies conducted in our country, the rate of hospital infection varies between 5-56% and the rate of bloodstream infection varies between 15-33%. In the studies conducted, bloodstream infections are seen 3 times more frequently in patients over 65 years of age compared to young people (7).

Sacar et al. Although there was an increase in the number of inpatients in pediatrics and pediatric surgery units between 2005 and 2006, hospital infection rates were reduced by improving the physical conditions in these services and increasing the number of personnel per patient. The surveillance program enables the determination of endemic hospital infection rates and epidemics, the analysis of data and regular feedback to hospital staff, and comparisons with other hospitals(8). In a multicenter study conducted in our country in which 133 ICUs participated, pneumonia was found to be 45.5%, bloodstream infection 25.7%, and urinary system infection 17.9%. In our study, pneumonia was 50%, bloodstream infection 34.5%, urinary system infection 15.2% and central nervous system infection 0.3% in ICU in 2013 (9).

40 Consideration should be given to skin antisepsis when taking blood cultures. The positive predictive value of catheter and peripheral venous blood culture for catheter infection was 63% and 73%, respectively; the negative predictive value is 99% and 98%, respectively. When inserting a central venous catheter, extreme attention should be paid to the rules of asepsis (hand washing, long-sleeved sterile shirt, mask, cap, large sterile drape, sterile gloves) (10,11). Hands must be washed in cases such as catheter insertion or removal, daily inspection of the catheter insertion site, and before and after dressing. Water, soap, antiseptic soaps or alcohol-based gels can be used for hand washing (12). Establishment of experienced infusion therapy teams can reduce the rate of catheter-related infections 8-10 times. In the absence of

a team to monitor the incident at every level, the relevant health personnel should be trained at regular intervals (13).

Most episodes of bacteremia are primary bacteremia. The most common agents encountered in intensive care units are Gram-negative agents, especially carbapenem-resistant Acinetobacter spp., Klebsiella pneumoniae and Pseudomonas spp. It was observed that there was an increase in the strains over the years. In our study, nosocomial bacteremia agents and antibiotic susceptibility were investigated in the ICU of our hospital. With the surveillance study, it was aimed to prevent nosocomial infections and to start empirical antibiotics when necessary, accompanied by data analysis.

Conflict of Interest
There is no conflict of interest.

Funding
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Authors contributions: All investigators contributed to the study and approved the final manuscript.

Ethics Committee Approval
Since it was not affiliated with the university in the years of the study and it was a retrospective study, it was approved by the thesis advisor. And Approved 2014/05 by the medical education specialty board.

Informed Consent
This is a retrospective study.

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