The incidence of nosocomial bloodstream infections in our cardiac surgical intensive care unit during a three-year period

Üç yıllık bir dönemde kardiyak cerrahi yoğun bakım ünitemizde kan yoluyla yayılan nozokomiyal infeksiyonların sıklığı

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Objectives: Nosocomial bloodstream infections (BSI) cause significant morbidity and mortality worldwide. These infections occur two to seven times more often in intensive care unit (ICU) patients than in ward patients. The aim of this study was to determine the frequency of nosocomial BSI pathogens among patients admitted to our 18-bed cardiac surgical ICU (SICU).

Study design: We investigated SICU-acquired BSIs and associated pathogens in 1316 patients (886 adult, 430 pediatric) admitted to the cardiac SICU following cardiac operations between January 2000 and December 2002.

Results: A total of 93 microorganisms of nosocomial BSIs were identified in 60 patients (4.6%), including both primary (38.3%) and secondary BSIs. Of these, 36 were adult patients (60%), and 24 were pediatric patients (40%). Secondary BSIs were due to intravascular devices (23.3%), lower airway tract infections (20%), surgical wound infections (8.4%), urinary tract infections (5%), and other causes (5%). The most frequently isolated species were coagulase-negative staphylococci (30%), *Pseudomonas aeruginosa* (8.4%), and *Acinetobacter baumannii* (6.7%). The most common cardiac surgical procedures associated with BSI were congenital cardiac operations (40%), followed by coronary artery bypass grafting procedures (33.3%). The overall mortality rate was 4.5% (59 patients). Mortality was six-fold higher in patients with BSI (14 patients, 23.3%) than those without BSI.

Conclusion: Our study emphasizes the importance of infection prevention and identification of pathogens leading to BSIs in cardiac SICU patients.

Key words: Bacteremia/epidemiology/microbiology; cross infection/microbiology; intensive care units.

Amaç: Kan yoluyla yayılan nozokomiyal infeksiyonlar tüm dünyada önemli bir morbidite ve mortalite nedenidir. Bu infeksiyonlar, yoğun bakım hastalarında servis hastalarından 2-7 kat daha fazla görülür. Bu çalışmada, 18 yataklı kardiyak cerrahi yoğun bakım ünitesine (CYBÜ) yatan hastalarda kan yoluyla yayılan nozokomiyal infeksiyon etkeni patojenlerin belirlenmesi amaçlandı.

Çalışma planı: Ocak 2000-Aralık 2002 tarihleri arasında, kalp ameliyatı sonrasında kardiyak CYBÜ'ye yatırılan 1316 hastada (886 erişkin, 430 çocuk) gelişen kan yoluyla yayılan nozokomiyal infeksiyonlar ve etkenleri araştırıldı.

Bulgular: Kan yoluyla yayılan nozokomiyal infeksiyon etkeni olarak 60 hastada (%4.6) 93 mikroorganizma izole edildi. Bunların %38.3'ü primer infeksiyondu. Bu olguların 36'sı erişkin (%60), 24'ü çocuk (%40) hastaydı. Sekonder infeksiyonlar intravasküler cihaz kullanımına (%23.3), alt solunum yolu (%20), cerrahi yara (%8.4) ve üriner sistem (%5) infeksiyonlarına ve diğer nedenlere (%5) bağlıydı. En sık izole edilen mikroorganizma koagülaz negatif stafilokok (%30) idi; bunu *Pseudomonas aeruginosa* (%8.4) ve *Acinetobacter baumannii* (%6.7) izlemekteydi. Kan yoluyla yayılan nozokomiyal infeksiyonlar en sık doğumsal kalp hastalıkları nedeniyle yapılan kalp ameliyatları (%40) ve koroner arter baypas greftleme ameliyatlarını takiben görüldü (%33.3). Genel ölüm oranı %4.5 (59 hasta) bulundu. Mortalite oranı nozokomiyal infeksiyon gelişen hastalarda yaklaşık altı kat yüksekti (14 hasta, %23.3).

Sonuç: Çalışmamız, kardiyak CYBÜ hastalarında kan yoluyla yayılan nozokomiyal infeksiyonları önlemenin ve etkenlerini belirlemenin önemini vurgulamaktadır.

Anahtar sözcükler: Bakteriyemi/epidemiyoloji/mikrobiyoloji; çapraz enfeksiyon/mikrobiyoloji; yoğun bakım ünitesi.

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Nosocomial bloodstream infections (BSI) are serious complications of critically ill patients. However, it is uncertain that the acquisition of BSI in intensive care units increases the risk of death.[1] These patients are at high risk of suffering from BSI due to the severity of their illnesses and their need for invasive procedures such as mechanical ventilation, urinary catheter and central venous catheter insertions.[2] Several studies have reported that BSIs are associated with crude case fatality rates of approximately 40% in intensive care units.[1,3] The most common pathogens isolated from blood cultures are *Staphylococcus aureus*, *Escherichia coli*, coagulase-negative staphylococci (CNS), *Klebsiella pneumoniae* and enterococci.[4,5] Gram-positive organisms currently account for approximately two-thirds of nosocomial BSIs and Gram-negative bacteria are responsible for 20%.[4,5] In recent years, CNS have emerged as the most common pathogens associated with nosocomial BSIs.[6] *S. epidermidis* is an important cause of infection by implanted medical devices such as intravascular catheters, prosthetic heart valves, pacemakers, continuous ambulatory peritoneal dialysis catheters, and orthopedic devices.[7]

The aim of this study was to determine the frequency of nosocomial BSI pathogens among patients admitted to our cardiac surgical intensive care unit during a three year period.

PATIENTS AND METHODS

This study was conducted from January 2000 to December 2002 in the surgical intensive care unit (SICU) of our 150-bed clinic. The SICU is an 18-bed unit (10 adult, 6 pediatric, 2 isolated patient beds). During this period, a total of 1316 patients (886 adult, 430 pediatric) were admitted to the cardiac SICU following cardiac operations listed in Table 1. There were 433 females and 883 males with a median age of 38.8 years.

Patients undergoing open heart operations routinely received perioperative prophylactic antibiotics (either cefazolin or vancomycin for penicillin allergic patients or methicillin-resistant staphylococci). Prophylactic antibiotics were routinely given in the operating room by the anesthesiologist and continued for 48 hours postoperatively.

Bloodstream infections were characterized by bacteriemia and the following clinical signs: chills, (temperature >38 °C, hyperthermia or <35.6 °C hypothermia), pulse >90 min, tachypnea (>20 breaths/min), left-shifted leukocytosis (>12,000 mm^3, >10% immature forms) and/or leukopenia (<4000 mm^3) and inflammatory markers (e.g. C-reactive protein, interleukins). A repeat positive blood culture for the same organism was considered as a BSI. A primary BSI was defined as a bloodstream infection without an identified source. The BSI was considered to be polymicrobial if more than one microorganism was isolated from the same blood culture.

Bloodstream infections were confirmed using an automated system (Bactec 9050, Becton Dickinson, Sparks, Maryland, USA). Enterobacteriaceae were identified using the API 32E (BioMeriéux, Lyon, France), Gram-negative nonfermenters by the API 32GN, staphylococci by the API 32Staph, streptococci and enterococci by the API 32Strep systems, and using standard microbiological procedures.[8]

RESULTS

A total of 93 microorganisms of nosocomial BSIs were identified in 60 patients (4.6%; 25 females, 35 males; median age 35.1 years), including both primary and secondary BSIs. Of these, 36 were adult patients (60%), and 24 were pediatric patients (40%). The most frequently isolated species were CNS (30%), *Pseudomonas aeruginosa* (8.4%), and *Acinetobacter baumannii* (6.7%). The most common cardiac surgical procedures associated with BSI were congenital cardiac operations (40%), followed by coronary artery bypass grafting (CABG) procedures (33.3%) (Table 2).

Mortality occurred in 59 patients (4.5%), including 31 pediatric (7.2%) and 28 adult patients (3.2%). Of

Table 1. Distribution of cardiac surgical procedures

	2000		2001		2002		Total	
	Female	Male	Female	Male	Female	Male	n	%
Congenital heart operations*	94	99	60	77	47	53	430	32.7
Coronary artery bypass grafting (CABG)	42	163	49	155	36	127	572	43.5
Valve repairs or replacements	31	45	35	32	21	22	186	14.1
Valve repairs or replacements and CABG	11	12	4	5	1	6	39	3.0
Others**	13	7	18	22	11	18	89	6.8

*Atrial septal defect; Ventricular septal defect; Patent ductus arteriosus; Transposition of great arteries; Tetrology of Fallot; Pulmonary stenosis; Total anomalous pulmonary venous connection; Aortic coarctation; Aortopulmonary window; Aortic coarctation and shunt procedures. **Pericardial tube insertions.

Table 2. Distribution of culture-positive patients according to cardiac surgical procedures

	Female	Male	n	%
Congenital heart operations*	10	14	24	40.0
Coronary artery bypass grafting (CABG)	5	15	20	33.3
Valve repairs or replacements	6	3	9	15.0
Valve repairs or replacements and CABG	2	1	3	5.0
Others**	2	2	4	6.7
Total	25	35	60	100

*Atrial septal defect; Ventricular septal defect; Patent ductus arteriosus; Transposition of great arteries; Tetrology of Fallot; Pulmonary stenosis; Total anomalous pulmonary venous connection; Aortic coarctation; Aortopulmonary window; Aortic coarctation and shunt procedures. **Pericardial tube insertions.

these, seven pediatric (29.2%) and seven adult (19.4%) patients had BSI (Table 3).

Nosocomial BSIs were primary in 38.3%. Secondary BSIs were due to intravascular devices (23.3%), lower airway tract infections (20%), surgical wound infections (8.4%), urinary tract infections (5%), and other causes (5%) (Table 4).

Coagulase-negative staphylococci (in particular *S. epidermidis*) were responsible for the largest number of primary BSIs, and secondary BSIs associated with intravascular catheters and wounds (Table 4). *A. baumannii* accounted for the largest number of secondary BSIs caused by lower respiratory tract infections (Table 4).

DISCUSSION

In this study, mortality rate among pediatric and adult cardiac patients admitted to the cardiac SICU was 4.5%, being higher in pediatric patients (7.2% *vs* 3.1%). This rate is higher than those reported in other studies.[9-12] Mortality was 23.3% among patients with BSI. Many studies reported a mortality rate of approximately 40% in acquired BSIs.[1,3-6,9-11] Some studies reported a lower ICU mortality rate.[13,14]

Coagulase-negative staphylococci were the most common pathogens seen in 18 patients and were associated with CABG procedures (n=9), congenital operations (n=5), valve repair (n=3), and valve repair with CABG (n=1).

About one-fourth of nosocomial BSIs are caused by CNS and several factors may contribute to this increase,[9-12] including increased use of invasive intravascular devices and intra-aortic balloon pumps.[15] In recent years, the frequency of CNS (especially *S. epidermidis*) has increased among intravascular catheter-related BSIs, which account for 10% to 20% of all nosocomial infections. The microorganisms involved most frequently are acquired from cutaneous microflora, and Gram-positive cocci (especially CNS and *S. aureus*) are responsible for at least two-third of infections.[6,7,16-21] In our study, most of the secondary infections were due to intravascular catheters. Most of the CNS infections were caused by *S. epidermidis* (13/18; 72.2%). Several studies reported CNS as the cause of infective endocarditis.[22-26] In our unit, two patients with BSI (CNS, *S. epidermidis*) developed infective endocarditis. Furthermore, *S. epidermidis* was the pathogenic source in most of the secondary wound infections (4/5; 80%). The role of wound infections in the development of BSIs was also reported in other studies.[27,28]

P. aeruginosa has been identified as the cause of polymicrobial endocarditis.[29] In our study, *P. aeruginosa* was the second most common microorganism. *A. baumannii* has become a significant pathogen in severe nosocomial infections, including BSI and ventilator-associated pneumonia.[30] This was also the case in our SICU (3/4;75%).

We found *Enterobacter cloacae* as the cause of primary BSI in a patient undergoing reoperative aortic valve replacement. Thomas et al.[31] reported an outbreak of *E. cloacae* septicemia among seven postoperative cardiothoracic patients.

Stenotrophomonas maltophilia was isolated as a cause of infective endocarditis from a prosthetic mitral valve patient who died postoperatively. *S. maltophilia* endocarditis is a rare disease, carrying high mortality

Table 3. Mortality rates among patients admitted to the intensive care unit (ICU) following cardiac operations

	2000		2001		2002		Total	
	Female	Male	Female	Male	Female	Male	n	%
Patients admitted to the surgical ICU	12	18	6	11	7	5	59	4.5
Patients with bloodstream infections	1	4	2	2	5	0	14	23.3

Table 4. Pathogens and sources of bloodstream infections in the surgical intensive care unit

Pathogens	n	%	Sources of infection					
			Primary	Pneumonia	Intravenous catheter	Urinary tract infection	Wound	Other
Coagulase-negative staphylococci	18	30.0	3	0	7	0	4	3
Staphylococcus epidermidis	13	72.2	4	0	5	0	4	0
S. haemolyticus	4	22.2	0	0	2	0	0	2
S. hominis	1	5.6	0	0	0	0	0	1
S. aureus	2	3.3	1	0	1	0	0	0
Pseudomonas aeruginosa	5	8.3	2	2	1	0	0	0
Acinetobacter baumannii	4	6.7	0	3	0	1	0	0
Klebsiella pneumoniae	3	5.0	2	1	0	0	0	0
Enterobacter aerogenes	2	3.3	1	1	0	0	0	0
E. cloacae	1	1.7	1	0	0	0	0	0
Escherichia coli	1	1.7	0	0	0	1	0	0
Stenotrophomonas maltophilia	2	3.3	1	1	0	0	0	0
Candida spp.	2	3.3	0	0	2	0	0	0
C. albicans	1	50.0	0	0	1	0	0	0
C. tropicalis	1	50.0	0	0	1	0	0	0
Brucella spp.	2	3.3	2	0	0	0	0	0
Enterococcus faecium	1	1.7	1	0	0	0	0	0
Polymicrobial	17	28.3	8	4	3	1	1	0
Total (n)	60		23	12	14	3	5	3
Total (%)			38.3	20.0	23.3	5.0	8.3	5.0

and morbidity. Prosthetic valve cases are more commonly affected than patients with a native valve. A total of 21 cases of *S. maltophilia* endocarditis have been reported in the literature. Of these, 11 cases had prosthetic valve endocarditis and the others had native valve endocarditis.[32]

Brucella endocarditis is a rare, but serious complication of brucellosis. It is still an important cause of morbidity especially in countries of the Mediterranean and of the Middle East. Some studies reported Brucella endocarditis from aortic and mitral valves.[33-35] We identified Brucella endocarditis in two patients having infective endocarditis (native aortic valve) and prosthetic aortic valve endocarditis, respectively.

Candida parapsilosis is an important nosocomial pathogen, causing postoperative endophthalmitis, nail and skin infections, peritonitis in patients receiving chronic ambulatory peritoneal dialysis, arthritis, catheter-related fungemia, and prosthetic valve endocarditis.[36] We identified *C. parapsilosis* as a constituent of polymicrobial infection together with *S. epidermidis* and *A. baumannii* in a patient with congenital heart disease.

In conclusion, our study emphasizes the importance of infection prevention in cardiac SICU patients. Special attention is required for the identification of pathogens leading to BSIs.

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