

Evaluation of nosocomial infections following cardiovascular surgery

Kardiyovasküler cerrahi sonrası gelişen nozokomiyal enfeksiyonların değerlendirilmesi

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ABSTRACT

Objective: To evaluate nosocomial infections (NI) following cardiovascular surgery (CVS), and to share the first seven-year experience of the infection control commission in a private medical center.

Methods: Active prospective and laboratory based surveillance program of the hospital from January 1999 to December 2005 was used and all patients who were found to have NIs after CVS during their stay or readmission were included.

Results: A total of 14502 cardiovascular operations were performed and 416 (2.9%) patients had 494 NIs. The most prevalent infections were surgical site infections (42%) and urinary tract infections (22%). The most frequently isolated microorganisms were coagulase-negative staphylococci (19%), Escherichia coli (16%) and Staphylococcus aureus (16%). A total of 99 patients (24%) died. The mortality rates were high in patients with blood-stream infections (58%) and lower respiratory tract infections (37%). The 2003 was the year with the lowest NI rate when compared to 2000, 2001, 2002, 2004, and 2005 ($p < 0.005$).

Conclusion: This study allowed an evaluation of NIs, including incidence and distribution, following CVS. While carrying on the studies to prevent NIs that are responsible for serious morbidity and mortality, risk factors also need to be identified in order to take preventive measures, other than the ones present. (*Anadolu Kardiyol Derg 2007; 7: 164-8*)

Key words: Nosocomial infections, cardiovascular surgery

ÖZET

Amaç: Kardiyovasküler cerrahi sonrası gelişen nozokomiyal enfeksiyonların (NE) değerlendirilmesi ve özel bir hastanede enfeksiyon kontrol komitesinin ilk yedi yıllık çalışma sonuçlarının paylaşılması.

Yöntemler: Aktif prospektif ve laboratuvara dayalı sörveyans çalışmaları ile, Ocak 1999-Aralık 2005 tarihleri arasında, kardiyovasküler cerrahiye takiben, yatışları sırasında ve taburcu edildikten sonra kontrole gelen hastalarda gelişen NE olguları dahil edilmiştir.

Bulgular: Toplam 14502 operasyon gerçekleştirilmiş, 416 hastada (%2.9) 494 NE gelişmiştir. En sık rastlanılan enfeksiyonlar cerrahi alan enfeksiyonları (%42) ve üriner sistem enfeksiyonları (%22), en sık rastlanılan bakteriler de koagülaz negatif stafilokoklar (%19), Escherichia coli (%16) ve Staphylococcus aureus (%16) olarak bulunmuştur. Nozokomiyal enfeksiyon gelişen hastaların %24'ü eksitus olmuştur. Mortalite oranı dolaşım sistemi enfeksiyonlarında %58, alt solunum yolları enfeksiyonlarında %37 olarak bulunmuştur. 2003 yılı, 2000, 2001, 2002, 2004 ve 2005 yılları ile karşılaştırıldığında NE oranı en düşük yıl olmuştur ($p < 0.005$).

Sonuç: Bu çalışma ile, insidans ve dağılım dahil, kardiyovasküler cerrahi sonrası gelişen nozokomiyal enfeksiyonlar değerlendirilmiştir. Ciddi morbidite ve mortaliteye yol açan NE önleme çalışmalarına devam edilmesi, mevcut olanlar dışında gerekli önlemlerin alınabilmesi amacıyla risk faktörlerinin de ortaya konulmasının uygun olacağı kanaatine varılmıştır. (*Anadolu Kardiyol Derg 2007; 7: 164-8*)

Anahtar kelimeler: Nozokomiyal enfeksiyonlar, kardiyovasküler cerrahi

Introduction

Nosocomial infections (NI) are the major problem in health care facilities, resulting in extended length of stay, substantial morbidity and mortality, and excess cost (1,2).

Surveillance of NIs is a recommended practice and is a part of quality assurance program. Each institute must know its NI rate, distribution profile of NIs and microorganisms, and also

antimicrobial resistance patterns and evaluate the results in order to take preventive measures, when needed.

Cardiovascular surgery (CVS) is a high-technology medical care. However, post-operative infections are important cause of morbidity and mortality after CVS. The data of surveillance of NIs following CVS is limited.

In this study, we aimed to evaluate NIs, including the rates and distribution profiles, following CVS, and share our first seven-year experience.

Methods

Setting

Florence Nightingale Hospital is an university affiliated 300-bed private medical center, where approximately two thousand cardiovascular operations are performed each year, in Istanbul, Turkey.

Infection Control Studies

Infection control commission (ICC) was instituted in January 1998 and there is an active prospective and laboratory based surveillance program since January 1999. The surveillance results are discussed monthly by the ICC and the doctors working in the hospital are informed by results related with themselves.

Some important studies of ICC included: education of the hospital staff about hospital hygiene and hand washing (first in February 1998), and repetition of education in every six months; standardization of prophylactic antibiotic usage and updating with certain intervals (first in February 1998); commencement of surveillance (January 1999); periodical education of doctors about rational antibiotic usage (first in April 1999); selective reporting of antibiotic susceptibility test results (since April 1999); preparing guidelines for hand washing and providing liquid soap (February 2000); standardization of disinfection and sterilization methods (April 2000); preparing guidelines for intravascular catheter indwelling and care, urinary catheter indwelling and care, preventing decubitus ulcers (April 2000); updating the guidelines when needed; survey of *Staphylococcus aureus* nasal carriers among hospital staff and treatment of carriers with intranasal antibiotic ointment and repeating the survey in every eight months (first in January 2001); usage of intranasal antibiotic ointment three times in a day for three days for the patients before cardiovascular surgery (since January 2001); educating all new staff about prevention of nosocomial infections (first in June 2001); full-time working of the part-time infection control doctor (March 2002); restriction of antibiotic usage (since March 2002); isolation of all patients coming from other settings till getting nasal culture results (since September 2003); testing of all new staff for *S.aureus* nasal carriage (since December 2003).

Cardiovascular Surgery

The patients referred to CVS were hospitalized one day before the surgery. All patients had pre-operative infectious disease consultation. Routine urine analysis and culture were completed especially for the patients undergoing valve procedures. Hyperglycemia was regulated in diabetic patients. Hematologic and metabolic deficiencies were substituted.

Patients received preoperative antibacterial soap showers and hair removal and had skin preparation with povidone-iodine. Hair removal was performed with a disposable razor the night before operation. Cefazolin or cefuroxime was given as perioperative antibiotic prophylaxis, according to the current guidelines of the hospital: cefazolin, 1g 30 minutes before surgery followed by 1g doses thereafter with six-hour intervals, or cefuroxime, 1.5g 30 minutes before surgery followed by 1.5 g doses thereafter with twelve-hour intervals, for maximum 48 hours, until all chest and mediastinal drain tubes were removed (3). All sternotomy operations were performed by one of three surgeons, and all saphenous vein harvests were performed by one of the specially trained physician assistants. Entrance to operation room was limited as possible.

Follow-up of Patients

At our hospital, all patients who develop NI have "NI Follow-up Form"s other than their routine hospital reports. This form includes the following information: name, age, sex, date of hospitalization, department, underlying disorders; risk factors; type of operation, day of operation, operating team; interventions; type(s) of NI, date of NI, isolated microorganism(s), antimicrobial susceptibilities of isolated microorganism(s); name, dose, and duration of antibiotics used; daily follow-up notes; date of discharge and outcome.

All the patients having NI following CVS were selected from NI follow-up forms and included in the study. The patients were discharged on the 10th day of the operation if there was no problem requiring extra hospitalization. There was no a formal post-discharge surveillance. The patients who referred back to the hospital with a NI after discharge were included in the inpatient surveillance system. In recent two years, the patients were advised and encouraged to come back to the hospital when they come across with a problem including infection, and this was free of charge for one month.

Definitions

Center for disease control and prevention definitions were used in the diagnosis of NIs (4, 5). Infections related with the skin of sternum were considered superficial sternal surgical site infections (SSSI), where infections of sternum and mediastinum were considered as deep sternal surgical site infections (DSSSI). Computerized tomography or magnetic resonance imaging techniques were used to differentiate deep sternal infection from superficial in case of any suspicion. Surgical site infections (SSI) other than sternal area were considered "other SSIs".

Rates

The rates of NI were calculated as follows:

Rate: Number of patients with NI following CVS / Number of patients operated.

Microbiological Studies

Conventional methods were used in the isolation of microorganisms. Conventional methods or Sceptor (Becton Dickinson, USA) was used in the identification of isolated microorganisms. Methicillin resistance of isolated staphylococci was tested by using oxacillin disks on 4% NaCl added Mueller-Hinton agar plates.

Statistical Analysis

Chi-square and Kruskal-Wallis tests were used in the statistical analysis for comparison of discrete variables between groups.

Results

Characteristics of Patients

A total of 416 patients (2.9%) had 494 NIs between 1999-2005 following CVS. Among them 244 (59%) of the patients were male and 172 (41%) were female. Of 494 patients 392 (94%) were adults and 24 (6%) were infants or children. The mean age of adults was 62.8 ±9.7 years (range: 35-92). The ages of infants or children ranged from 5 days to 5 years.

Type of operations were; coronary artery bypass grafting (CABG) in 232 (56%) patients, valve operations in 60 (14%) patients, CABG and valve operations in 46 (11%) patients, operations because of congenital heart diseases in 23 (6%) patients, other vascular operations (OVO) in 26 (6%) patients, CABG and OVO in 20 (5%) patients, valve and OVO in five (1%) patients, and CABG, valve and OVO in four (1%) patients.

Rates and Distribution of NIs

Rates and distribution of NIs in years from 1999 through 2005 are shown in Table 1.

Mortality rates

A total of 99 patients (24%) died. These 99 patients had 122 NIs. The mortality rate in children was %38 (9/24), and in adults was 23% (90/392). The mortality rates among female and male patients were 19% (32/172) and 27% (67/244), respectively.

The mortality rate in patients with blood-stream infections (BSI) was 58% (42/73), and lower respiratory infections (LRTI) was 37% (37/99). The mortality rates in patients with DSSSIs, urinary tract infections (UTI), other SSIs, and SSSSIs were 21% (21/100), 11% (12/110), 4% (1/27), and 3% (2/79), respectively.

Statistical Results

The NI rate in 1999 was lower than in 2001 and 2002 and this was statistically significant ($p < 0.005$). The 2003 was the year with the lowest NI rate when compared to years 2000, 2001, 2002, 2004, and 2005, and this was statistically significant ($p < 0.005$).

The mortality rate in men was statistically higher than in women ($p < 0.05$). The mortality rate in children was not statistically different than in adults ($p > 0.05$).

The mortality rates in BSI and LRTI were higher than the mortality rates in SSSSI, other SSI, UTI, and this was statistically significant ($p < 0.005$). The mortality rate of BSI was statistically higher than that of DSSSI ($p < 0.005$), and the mortality rate of DSSSI was statistically higher than that of SSSSI ($p < 0.005$).

Microbiological Results

Overall, 478 microorganisms were isolated from 474 NIs, where there were two isolates in four infections; and no microorganism was isolated from 20 of the NIs.

The distribution of microorganisms by site of infection is shown in Table 2.

Discussion

In this study, the overall NI rate following CVS in a seven-year period was 2.9%. This was lower than reported values, varying

between 5.6% and 21.7% in the English literature (6-9) and a Turkish study with a rate of 6.6% (10). In some other Turkish studies performed in the whole hospital, NI rates in cardiovascular surgery departments changed between 2.8% and 10.0 (11-15). Our rate for DSSSI was largely consistent with the rates of 0.5%-2.3%, but that of SSSSI was lower than reported (1.9%-5.5%) in other studies (16-19). We had previously explained low rate of SSSSIs on the basis of both the strict preventive measures and lack of an outpatient surveillance system in previous years (20). Patients were discharged on the 10th day of the operation if there was no problem requiring rehospitalization. Some cases may occur after discharge and those patients may not refer back to the hospital. If so, true incidence of infection may be higher than that, we found. The BSI rate in this study was consistent with the study of Rebello et al. (9), who found a rate of bacteremia as 0.7%. On the other hand, the UTIs and LRTIs rates in our study were lower than those reported in other studies (7-9, 21). Type of hospital, type of surveillance, type of operation, characteristics of patients, infection control strategies, prophylactic antibiotic usage, study period, all affect NI rates in different settings. The major deficiency in that study was the lack of a post-discharge surveillance system, as in most other studies. But, in recent two years, doctors are compulsory to advise and encourage the patients to come back to the hospital in case of a problem, including infection and that was free of charge. Although we believe that most of the patients who have a NI after discharge refer back to us and we include them in our in-patient surveillance system, there needs to be a formal post-discharge surveillance system in this kind of studies.

The mortality rate in patients with NI was 24% in our study. According to hospital reports, the overall mortality rate in patients 5. Although the rates of BSIs and LRTIs were low in this study, the mortality rates in these infections were high. Gross et al. (22) also found that, when a NI was related or contributed to death, infection of lower respiratory tract was dominant. On the other hand, the mortality rate in male patients was higher than that of the female, in the study. Although not studied, this may be resulted from the risk factors present in the men.

Table 1. Rates and distribution of nosocomial infections between 1999-2005 in cardiovascular surgery

YEAR	No of patients operated n	Patients with NI n (%)	TYPE OF NOSOCOMIAL INFECTION							n of NIs n
			DSSSI	SSSSI	Other SSI	UTI	LRTI	BSI	OTHER	
			n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
1999	2150	50(2.3)	11(0.5)	17(0.8)	3(0.1)	7(0.3)	5(0.2)	9(0.4)	2(0.1)	54
2000	2361	71(3.0)	19(0.8)	10(0.4)	7(0.3)	10(0.4)	7(0.3)	25(1.1)	1(0.04)	79
2001	1713	76(4.4)	33(1.9)	14(0.8)	3(0.2)	23(1.3)	-	14(0.8)	-	87
2002	2174	96(4.4)	13(0.6)	19(0.9)	8(0.4)	38(1.8)	20(0.9)	10(0.5)	1(0.05)	109
2003	1981	19(1.0)	4(0.2)	4(0.2)	1(0.05)	7(0.4)	9(0.5)	3(0.15)	-	28
2004	2009	50(2.4)	10(0.4)	5(0.2)	2(0.1)	15(0.7)	24(1.2)	7(0.3)	2(0.1)	65
2005	2114	54(2.6)	10(0.5)	10(0.5)	3(0.1)	10(0.5)	34(1.6)	5(0.2)	-	72
Total	14502	416(2.9)	100(0.7)	79(0.5)	27(0.2)	110(0.8)	99(0.7)	73(0.5)	6(0.04)	494

BSI- bloodstream infection, DSSSI- deep sternal surgical site infection, LRTI- lower respiratory tract infection, NI- nosocomial infection, -SSSSI- superficial sternal surgical site infection, SSI- surgical site infection, UTI- urinary tract infection

The distribution of microorganisms found here was largely consistent with the literature (7, 10, 23). The most frequently isolated microorganisms were coagulase-negative staphylococci (CNS), *Escherichia coli* and *S. aureus*. The CNS and *S. aureus* were the most frequently isolated microorganism from SSIs and BSIs, and *E. coli* was the most frequently isolated microorganism from UTIs. Gram-negative bacilli dominated in LRTIs.

Surveillance was ongoing while preventive measures were being undertaken one after the other by our ICC. As this is our first seven-year results of surveillance, we do not have opportunity to compare these with the years before 1999, but we compared the annual rates in the seven-year study period. The NI rate in 1999 was lower when compared to 2001 and 2002. The 1999 was the first year of surveillance and our infection control doctor was working part-time with also other jobs in different settings, and our infection control nurse was not experienced enough, and all these can lead to miss some cases and obtain lower rates than expected. On the other hand, the increase in the years 2001 and 2002 can be attributed to the resignation of experienced staff, especially the nurses in order to work in state hospitals, and employing new, inexperienced staff, who were later on educated about hospital hygiene and nosocomial infections. The 2003 was the year with the lowest NI rate. In 2004 and 2005, the hospital became a more complex setting offering a wide variety of diagnostic and therapeutic service and the workload of other departments

including orthopedics, and transplantation unit increased, with parallel increase in circulation of patients and staff. Patients were also encouraged to come back to the hospital in case of a suspicious infection after discharge. These can cause an increase in the rates. Thus, all the factors mentioned above are thought to be responsible for the undulations in NI rates in this seven-year study.

Besides the studies of ICC, quality assurance studies began in June 2001. Although, there seems to be a big list of preventive measures, it was difficult to educate and convince the staff and standardize the procedures in the beginning, but patience, a full-time infection control nurse and a full-time infection control doctor with good relations with other departments, support of the hospital management to ICC, and presence of a quality assurance program helped a lot.

As a result, this study allowed an evaluation of NIs, including incidence and distribution, following CVS. Studies of ICC must be carried on. Besides this, risk factors for the current infections and risk factors for mortal cases needs be identified, in order to take preventive measures other than the ones present.

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Table 2. Microorganisms isolated from nosocomial infections following cardiovascular surgery

MICROORGANISM	TYPE OF NOSOCOMIAL INFECTION							TOTAL n (%)
	DSSSI, n	SSSSI, n	O. SSI, n	UTI, n	LRTI, n	BSI, n	Other, n	
CNS	41	25	4	-	-	25	-	95 (19.1)
<i>Escherichia coli</i>	8	3	5	49	11	1	3	80 (16.1)
<i>Staphylococcus aureus</i>	33	21	7	-	6	12	-	79 (15.9)
<i>Klebsiella spp</i>	2	2	1	22	22	9	1	59 (11.9)
<i>Pseudomonas aeruginosa</i>	4	6	3	13	19	5	1	51 (10.2)
<i>Acinetobacter spp</i>	4	8	2	8	13	12	-	47 (9.4)
<i>Enterobacter spp</i>	3	4	5	4	14	4	-	34 (6.8)
<i>Proteus spp</i>	-	1	-	3	-	1	1	6 (1.2)
<i>Serratia spp</i>	-	-	-	1	4	1	-	6 (1.2)
<i>Citrobacter spp</i>	-	-	-	4	-	1	-	5 (1.0)
<i>Enterococcus spp</i>	1	-	-	4	-	-	-	5 (1.0)
<i>Candida albicans</i>	-	-	-	-	1	2	-	3 (0.6)
<i>Streptococcus pneumoniae</i>	-	-	-	-	2	-	-	2 (0.4)
<i>Morganella spp</i>	-	-	-	-	1	-	-	1 (0.2)
<i>Streptococcus bovis</i>	1	-	-	-	-	-	-	1(0.2)
<i>Providencia spp</i>	-	-	-	1	-	-	-	1 (0.2)
<i>Stenotrophomonas maltophilia</i>	-	-	1	-	-	-	-	1 (0.2)
<i>Staphylococcus saprophyticus</i>	-	-	-	1	-	-	-	1 (0.3)
<i>Haemophilus influenzae</i>	-	-	-	-	1	-	-	1 (0.2)
None	4	10	-	-	6	-	-	20 (4.0)
TOTAL, n (%)	101(20)	80(16)	28(6)	110(22)	100(20)	73(15)	6(1)	498 (100)

BSI- bloodstream infection, CNS- coagulase-negative staphylococcus, DSSSI- deep sternal surgical site infection, LRTI- lower respiratory tract infection, NI- nosocomial infection, O.SSI- other surgical site infection, SSSSI- superficial sternal surgical site infection, UTI- urinary tract infection

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