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ORIGINAL ARTICLE

Five-year surveillance of nosocomial infections following orthopedic surgery in a private medical center

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Abstract
Introduction Nosocomial infections (NI) are a major problem in health care facilities, resulting in extended length of stay, substantial morbidity and mortality, and excess cost. In this study, we aimed to know the rates, distribution profiles of NIs following orthopedic surgery, and share our first 5-year experience, in a private medical center.
Materials and methods There is an active, prospective, and laboratory-based surveillance program since January 1999 at Florence Nightingale Hospital in Istanbul, Turkey, which is a Kadir Has University affiliated private medical center, where more than 700 orthopedic operations are performed every year.
Results A total of 112 patients (3, 4%) had 125 NIs between 1999 and 2003 following 3, 249 orthopedic surgeries. The mean age was 58.2 ± 22.1 years (range 3–88). A total of 68 (61%) operations were elective and implant material was used in a total of 97 (87%) cases. The sites of operation were vertebra, hip, and knee in 44 (39.3%), 32 (28.6%), and nine (8.0%) of the operations, respectively. The changes in the annual rates of surgical site infections (SSIs) ($P < 0.05$), urinary tract infections (UTIs) ($P < 0.005$), and total of NIs ($P < 0.001$) in 5-year period were statistically significant. The changes in lower respiratory tract infections (LRTI), bloodstream infections (BSI), and other infections were not statistically significant ($P > 0.05$).
Conclusion This study allowed an evaluation of incidence and distribution of NIs following orthopedic surgery in a private medical center, and showed the effect of ICC in decreasing the rates.

Keywords Nosocomial infection · Orthopedic surgery · Surveillance analysis

Surveillance des infections nosocomiales après chirurgie orthopédique dans un centre médical privé avec un recul de cinq ans.

Résumé
Introduction Les infections nosocomiales (NI) constituent un problème majeur dans les services de soins, liées aux séjours hospitalier prolongés, entraînant une réelle morbidité, causes de mortalité et de coût excessif. Dans cette étude, nous avons voulu connaître les taux, les profils étiologiques des NI survenant à la suite d'interventions chirurgicales orthopédiques et de partager l'expérience de cinq années que nous avons acquise dans un centre médical privé.
Matériels and Méthodes Un programme de surveillance prospective basée sur un travail de laboratoire a été mis en place depuis 1999 dans l'Hôpital Florence Nightingale, qui est centre médical privé affilié à l'Université Kadir Has et qui réalise plus de 700 interventions orthopédiques par an à Istanbul, Turquie.
Résultats Un total de 112 patients (3.4%) ont présenté une NI entre 1999 et 2003 dans les suites de 3249

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interventions de chirurgie orthopédique. L'âge moyen était de 58.2 ± 22.1 ans (extrêmes : 3 à 88). Un total de 68 opérations (de 61%) étaient réglées et un implant a été employé dans un total de 97 cas (de 87%). Le site opéré était le rachis, la hanche, le genou respectivement dans 44 cas (39.3%), 32 cas (28.6%) et 9 cas (8.0%). Les changements dans les taux d'infection du site opératoire (SSIs) ($P < 0.05$), du tractus urinaire (UTIs) ($P < 0.005$), ainsi que du total des infections nosocomiales (Nis) ($P < 0.001$) durant la période de 5 années étaient statistiquement significatifs. Les changements dans le taux des infections de la partie basse du tractus respiratoire (LRTI), du réseau vasculaire (BSI) et ceux des autres infections n'étaient pas significatifs ($P > 0.05$).

Conclusion Cette étude a permis d'évaluer l'incidence et la distribution des infections nosocomiales à la suite d'opérations chirurgicales orthopédiques dans une clinique privée et a mis en évidence le rôle du ICC (CLIN) dans la diminution des taux.

Mots clés Infection nosocomiale · Chirurgie orthopédique · Analyse de la surveillance

Introduction

Nosocomial infections (NI) are a major problem in health care facilities, resulting in extended length of stay, substantial morbidity and mortality, and excess cost [8, 19].

Surveillance of NIs is a recommended practice and is a part of quality-assurance programme. Each institute must know its NI rate, distribution profile of NIs and microorganisms, antimicrobial resistance patterns and evaluate the results in order to take preventive measures, when needed.

In recent years, the insertion of implants has being widely used in modern orthopedics and traumatology. Although this is a life-saving procedure, it brings risk factors for nosocomial infections, especially for surgical site infections (SSI). Patients with orthopedic SSIs have physical limitations and significant reduction in their health related quality of life. The orthopedic patients are immobilized and hospitalized for a period of time and are also at risk of any NIs.

Infection control commission (ICC) was instituted at our hospital in January 1998 and there is an active, prospective, and laboratory-based surveillance program since January 1999.

The data of surveillance of NIs following orthopedic surgery is limited, or site-specific, generally focusing on SSIs and these are generally from university or community hospitals. In this study, we aimed to know the rates, distribution profiles of NIs following orthopedic surgery, and share our first 5-year experience, in a private medical center.

Materials and methods

There is an active, prospective, and laboratory-based surveillance program since January 1999 at Florence Nightingale Hospital in Istanbul, Turkey, which is a Kadir Has University affiliated private medical center, where more than 700 orthopedic operations are performed every year. Patients, who were considered for elective surgery, were hospitalized 1 day before the surgery. Patients with various fractures or other emergency cases were operated as soon as possible. In all cases, pre-operative blood and urine analysis were completed, and urine cultures were performed. Patients with a positive urine culture and suggestive signs of infection were treated. Hematological and metabolic deficiencies were substituted.

All patients bathed before the operation the operation area was shaved with a disposable instrument. The operations were performed in an operation room with high-efficiency particulate air (HEPA) filters. First ether, and then povidone–iodine, was used for the cleansing of the operation area. In the operations close to the gluteal region, tegaderm drape was used, and other local preparation of the patient and draping was made. Cefazolin or cefuroxime was given as perioperative antibiotic prophylaxis, according to the current hospital guideline: Cefazolin, 1 g 30 min before surgery followed by 1-g doses thereafter with 6-hour intervals, or cefuroxime, 1.5 g 30 min before surgery followed by 1, 5-g doses thereafter with 12-h intervals, for maximum 48 h, till the time drainage tubes were removed. The operation team changed the surgical gloves every 2 h and used two pairs. Entrance to operation room was restricted as much as possible and hood was used in arthroplasty operations.

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 NIs following orthopedic surgery were selected from NI follow-up forms and included in the study.

Center for disease control and prevention definitions were used in the diagnosis of Nis [5, 6].

The rates of NI were calculated as follows:

Rate: Number of patients with NI following orthopedic surgery/Number of patients operated.

Conventional methods were used in the isolation of microorganisms. Sceptor (Becton Dickinson, USA) was

used in the identification and antibacterial susceptibilities of isolated microorganisms. Methicilline resistance of isolated staphylococci was tested by using oxacilline disks on 4% NaCl added Mueller-Hinton agar plates.

Qui-square test was used in the statistical analysis. A $P < 0.05$ was regarded as statistically significant.

Results

A total of 112 patients (3.4%) had 125 NIs between 1999 and 2003 following 3, 249 orthopedic surgeries. Seventy (62.5%) of the patients were females and 42 (37.5%) were males. The mean age was 58.2 ± 22.1 years (range 3–88).

A total of 68 (61%) operations were elective and implant material was used in a total of 97 (87%) cases.

The sites of operation were: the vertebra, hip, and the knee, in 44 (39.3%), 32 (28.6%), and 9 (8.0%) of the operations, respectively. Besides these, one case (0.9%) was an operation of both vertebra and hip; one case (0.9%) was operated because of clavicular fracture; 11 (9.8%) cases were operated because of limb fractures; three (2.7%) cases were amputations; and 11 (9.8%) cases were other musculoskeletal operations.

Vertebra operations were due to degenerative vertebral diseases, deformities, vertebra fractures, and other reasons in 24 (55%), 11(25%), 5 (11%), and 4 (9%) cases, respectively. Hip operations were due to fractures and degenerative disease (coxarthrosis) in 23 (72%) and 9 (28%) patients, respectively. One case of hip and vertebra operation was due to fracture. Knee operations were due to degenerative diseases and patellar fracture in seven (78%) and two (22%) cases, respectively. Limb fractures included five cases of femur fracture, two cases of humerus fracture, two cases of revision for humerus fracture, one case of tibia, and one case of tibia with fibula fractures. Two cases of limb amputations were due to diabetes mellitus, and one was due to trauma. Other musculoskeletal operations included six cases of irrigation and debridement because of various wounds, one case of sacral chordoma excision, one case of hallux valgus operation, one case of penetrating wound of lower extremity, one case of fasciotomy after trauma, and one case of osteotomy revision.

Rates and distribution of NIs in years from 1999 through 2003 are shown in Table 1.

The changes in the annual rates of SSIs ($P < 0.05$), UTIs ($P < 0.005$), and total of NIs ($P < 0.001$) in 5-year period were statistically significant. The changes in lower respiratory tract infections (LRTI), bloodstream infections (BSI), and other infections were not statistically significant ($P > 0.05$).

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

Fifty-six percent of *Staphylococcus aureus* isolates and 92% of coagulase negative staphylococci (CNS) were methicilline resistant. All of the staphylococci were susceptible to vancomycin and teicoplanin where 100% of *S.aureus* isolates and 60% of CNS were sensitive to trimetoprim/sulphometoxazole.

The antibiotic susceptibilities of isolated gram-negative enteric bacilli were as follows: cefuroxime; 65%, ceftriaxone; 75%, gentamicin; 83%, ciprofloxacin; 85%, amikacin; 94%, imipenem; 98%.

The antibiotic susceptibilities of isolated non-fermentative gram-negative bacilli were as follows: gentamicin; 46%, ceftazidime; 48%, piperacillin; 52%, ciprofloxacin; 58%, amikacin; 73%, imipenem; 100%.

Discussion

NI remains a significant problem in modern orthopedics and traumatology. In this study, conducted in a university-affiliated private medical center in a 5-year period, the overall rate of NIs following orthopedic surgery was 3.4%, which was lower than the values obtained in other studies that varied between 5.0% and 20.7% [2, 3, 7, 10, 12, 14, 16, 20]. Type of hospital, type of surveillance, type of

Table 1 Rates and distribution of nosocomial infections between 1999 and 2003 in orthopedic surgery

Year	No. of patients operated	Patients with NI *n*(%)	Type of nosocomial infection				
			SSI *n* (%)	UTI *n*(%)	LRTI *n*(%)	BSI *n* (%)	Other[a] *n*(%)
1999	371	14 (3.8)	8 (2.2)	6 (1.6)	1 (0.2)	–	–
2000	549	37 (6.7)	20 (3.6)	18 (3.3)	–	2 (0.4)	–
2001	831	18 (2.2)	12 (1.4)	6 (0.7)	–	3 (0.4)	–
2002	732	23 (3.1)	12 (1.6)	9 (1.2)	4 (0.6)	1 (0.1)	1 (0.1)
2003	766	20 (2.6)	8 (1.0)	10 (1.3)	2 (0.3)	2 (0.3)	–
Total	3, 249	112 (3.4)	60 (1.8)	49 (1.5)	7 (0.2)	8 (0.3)	1 (0.03)

NI nosocomial infection, *SSI* surgical site infection, *UTI* urinary tract infection, *LRTI* lower respiratory tract infection, *BSI* bloodstream infection

[a] Infection of decubitis ulcers

Table 2 The distribution of microorganisms by type of infection in orthopedic surgery

Bacteria	Type of nosocomial infection					
	SSI *n*(%)	UTI *n*(%)	LRTI *n*(%)	BSI *n*(%)	Other[a] *n*(%)	Total *n*(%)
S. aureus	23 (38, 3)	–	1 (14, 3)	2 (25, 0)	–	26 (20, 8)
E. coli	4 (6, 7)	27 (55, 0)	–	1 (12, 5)	–	32 (25, 6)
Klebsiella spp.	5 (8, 3)	11 (22, 4)	3 (42, 9)	–	–	19 (15, 2)
A. baumannii	9 (15, 0)	3 (6, 1)	2 (28, 6)	2 (25, 0)	–	16 (12, 8)
CNS	7 (11, 7)	–	–	3 (37, 5)	–	10 (8, 0)
P. aeruginosa	8 (13, 3)	4 (8, 2)		–	–	12 (9, 6)
E. faecalis	2 (3, 3)	–	–	–	–	2 (1, 6)
P. mirabilis	–	2 (4, 1)	–	–	–	2 (1, 6)
S. marcescens	–	1 (2, 0)	–	–	–	1 (0, 8)
S. saprophyticus	–	1 (2, 0)	–	–	–	1 (0, 8)
S. bovis	1 (1, 7)	–	–	–	–	1 (0, 8)
Candida sp.	–	–	1 (14, 3)	–	–	1 (0, 8)
None	1 (1, 7)	–	–	–	1 (100)	2 (1, 6)
Total	60 (100)	49 (100)	7 (100)	8 (100)	1 (100)	125 (100)

SSI surgical site infection, *UTI* urinary tract infection, *LRTI* lower respiratory tract infection, *BSI* bloodstream infection

[a] Infection of decubitis ulcers

operation, characteristics of patients, infection control strategies, prophylactic antibiotic usage, study period, all affect NI rates in different settings.

SSIs were the most frequent NI with an overall rate of 1.8%, in this study. This result was largely consistent with other studies [1, 9, 13], and even lower than some others [16, 18]. Most authors studied site and operation-specific SSIs. The rate of SSI was 1.25% following total hip, knee, and elbow arthroplasties by Poss et al. [13], 1.8% following total hip and knee arthroplasties by Berbari et al. [1], 1.25% following hip and knee arthroplasties was by Lecuire et al. [9], and 5% following total hip and total knee replacements by Thomas et al. [18].

No formal post-discharge surveillance was in place at our hospital during the study period. Post-discharge infections that resulted in readmission were identified by the in-patient surveillance system. We think that the patients, who developed serious NIs, as deep SSIs, were admitted to the hospital, but the ones, who developed less serious NIs, as superficial SSIs, might have referred to other facilities and we might not have been aware of those after discharge. Martini et al. [11] found a SSI rate, following orthopedic surgery as 1.1%, but they reported that 33.3% of these had occurred after discharge. SSI rate was 1.3% after knee arthroplasty with traditional surveillance, but was found to be 4.5% with the use of electronic chart review surveillance after discharge by Friedman et al. [4]. It is pointed out that awareness should be given to the institutions' surveillance methods and intensity when comparing published rates [4]. As SSIs following orthopedic surgery, especially when implant material was used, may occur in a 1-year period, each setting needs a post-discharge surveillance system to obtain more reliable results about nosocomial infections.

The second most frequent NI was urinary tract infections (UTIs), with a rate of 1.5%, in this study. UTI rates changed between 1.5 and 5.1% in the literature [7, 16, 17]. UTIs was the most or second most frequent NI in other studies [3, 7], and was the most frequent infection when the site of operation was the hip or knee, in this study.

The distribution of microorganisms was largely consistent with the literature [9, 13, 14, 16]. The most frequently isolated microorganism in our study was *Escherichia coli*, and that was also the most frequently isolated microorganism from UTIs. *S.aureus*, the second frequently isolated microorganism was the most frequent agent causing SSIs. If we also consider CNS, staphylococci were the most frequent nosocomial microorganisms following orthopedic surgery in this study.

Every setting has its own antibacterial resistance pattern according to antibiotic usage policies. The rate of methicilline resistance in the staphylococci was high at our hospital. The most effective antibiotics to Gram-negative bacteria were imipenem and amikacin. Although we did not have enough number of Gram-negative bacilli, the resistance of the present ones was high against second and third generation cephalosporins, and fluoroquinolones. This can be explained on the basis of widespread usage of these antibiotics. But in recent years, we have restricted antibiotic usage and expect to have better results in the future.

We obtained a statistically significant change in the annual rates of SSIs, UTIs, and total of NIs. There was a

decrease in these rates in 2001 and following years, when compared to 1999 and 2000. There was no statistically significant change in the rates of LRTIs, BSIs, and other NIs, but the rates were actually were very low. All these can be explained on the basis of active studies and preventive measures of ICC, carried out since January 1998, the time it was instituted.

The preventive measures of ICC came one after the other and included; education of the hospital staff about hospital hygiene and hand washing (February 1998), repetition of education in every 6 months; standardization of prophylactic antibiotic usage and updating with certain intervals (first in February 1998); periodical education of doctors about rational antibiotic usage (first in April 1999); selective reporting of antibiotic susceptibility test results (April 1999); preparing guidelines for hand washing and providing liquid soap (Feb. 2000); standardization of disinfections and sterilization methods (April 2000); preparing guidelines for intravascular catheter indwelling and care, guidelines for urinary catheter indwelling and care, guidelines for preventing decubitis ulcers (April 2000); updating the guidelines with certain intervals; survey of *S.aureus* nasal carriers among all hospital staff and treatment of carriers with intranasal mupirocin ointment and repeating the survey in every eight months (first in January 2001); usage of intranasal mupirocin ointment three times in a day for three days for the patients before elective orthopedic surgery (January 2001); educating all new staff about prevention of nosocomial infections (June 2001); full-time working of the part-time infection control doctor (March 2002); restriction of antibiotic usage (March 2002); isolation of all patients coming from other settings till getting nasal culture results (September 2003); testing of all new staff for *S.aureus* nasal carriage (December 2003). Besides the studies of ICC, quality assurance studies began in June 2001.

The year 2002 was the year with highest rates when compared to 2001 and 2003. The only factor for this can be the changes in the hospital staff. Experienced staff especially nurses, left the hospital, and new staff began working in 2002.

The rate of SSI was the lowest in 2003 when compared to previous years and we expect to decrease or at least maintain this rate with intensive preventive measures against *S.aureus* NIs. Besides survey and treatment of *S.aureus* carriers among hospital staff and using intranasal mupirocin for all the patients undergoing elective surgery since January 2001, other preventive measures included new strategies as isolation of all patients coming from other settings till getting nasal culture results after September 2003 and testing all new staff for *S.aureus* nasal carriage after December 2003. The basis for these strategies was various other studies. It has already been documented that *S.aureus* nasal carriage was a major risk factor for SSIs and eradication of *S.aureus* was essential. Methicillin-resistant *S. aureus* (MRSA) carriage was 3.1 and 5.3% in hospitalized patients to general surgery or orthopedic wards, and previous hospitalization in the preceeding 6 months or 1 year was an important risk factor for MRSA carriage [15, 20].

As a result, the improvement in the rates of NIs over time appears to be multifactorial in this study. It was difficult to educate and convince the staff in the beginning. 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 institution of a quality assurance program, helped a lot.

This study allowed an evaluation of incidence and distribution of NIs following orthopedic surgery in a private medical center, and showed the effect of ICC to decrease the rates. So, studies of ICC must be carried on. Besides this, risk factors for the current infections needs be identified, and a formal post-discharge surveillance system needs to be put into effect, in order to achieve more reliable results, especially when implants were used. Antibiotic susceptibility test results of the future can be compared with that of today in order to see the effect of restricted antibiotic usage.

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