Prevalence of Nosocomial Infections After Surgery in Greek Hospitals: Results of Two Nationwide Surveys •

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PREVALENCE OF NOSOCOMIAL INFECTIONS AFTER SURGERY IN GREEK HOSPITALS: RESULTS OF TWO NATIONWIDE SURVEYS

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ABSTRACT

OBJECTIVE: To determine the frequency and type of nosocomial infections (NIs) (especially surgical-site infections [SSIs]), risk factors, and the type and duration of antibiotic use among surgical patients in Greek hospitals.

DESIGN: Two point-prevalence studies.

SETTING: Fourteen Greek hospitals.

PATIENTS: Those in the hospitals during two prevalence surveys undergoing surgery during their stay.

RESULTS: In the 1999 survey, 129 of 1,037 surgical patients had developed 148 NIs (14.3%). A total of 1,093 operations were registered, and 49 SSIs (4.5%) were found. In the 2000 survey, 82 of 868 surgical patients had developed 88 NIs (10.1%). A total of 902 operations were registered, and 38 SSIs were detected (4.2%). The median length of stay (LOS) for surgical patients without SSI was 10.0 days (range, 1–19 days); for patients who developed SSI it was 30 days (range, 1–52 days; $P < .001$). The median LOS prior to surgery for patients without SSI was 1 day (range, 0–4 days); for patients who developed SSI it was 3 days (range, 0–7.5 days; $P < .001$). Among 30 possible risk factors studied, wound class, LOS prior to surgery, and central venous catheterization were independent predictors of SSI. Median durations of prophylactic antibiotic therapy were 4 days (range, 1–14 days) and 6 days (range, 1–16 days) in the 1999 and 2000 surveys, respectively.

CONCLUSION: Surgical patients in Greek hospitals suffered higher rates of SSI than did surgical patients in other developed countries while prophylactic antibiotics were used excessively (*Infect Control Hosp Epidemiol* 2004;25:319-324).

Nosocomial infections are a major public health problem worldwide. Surveillance for nosocomial infections is an important component of an effective nosocomial infection control program, as was suggested by the Study on the Efficacy of Nosocomial Infection Control (SENIC) project.[1]

Prevalence surveys constitute a rapid and inexpensive way to estimate the magnitude of nosocomial infections. Despite their limitations, point-prevalence surveys are often preferred, as they provide a feasible estimate of nosocomial infection rates when resources are limited. Additionally, nosocomial infection prevalence rates, which have been derived from repeated studies, can be compared over a period of time and can lead to the implementation of specific infection control policies.[2]

Few surveys have been undertaken for the estimation of nosocomial infection rates in Greece. A local network for the surveillance of nosocomial infections on the island of Crete developed in 1995 provides data on a regular basis.[3] Only one national study has been published.[4]

To the best of our knowledge, the frequency of surgical-site infections (SSIs) among surgical patients, as well as the frequency and distribution of other nosocomial infections in surgical wards, has never been estimated at the local level or the national level in Greece. Therefore, this study sought to (1) determine the frequency and type of nosocomial infections and SSIs among surgical patients in Greek hospitals; (2) determine the impact of potential risk factors on the occurrence of these infections; and (3) record the purpose and the duration of antibiotic use among the surgical patients.

Two nationwide studies, in which approximately

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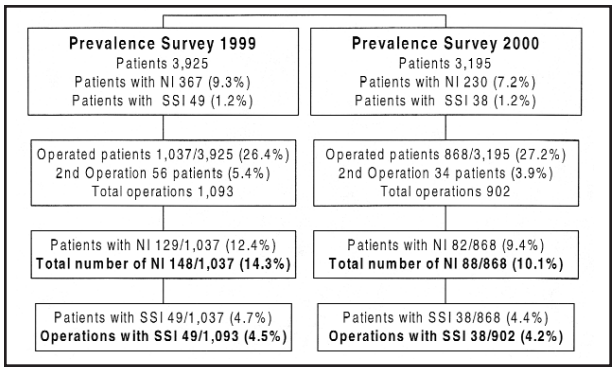

FIGURE. Rates of nosocomial infection (NI) and surgical-site infection (SSI) in the two prevalence surveys in Greek hospitals.

15% of Greek hospitals participated, were organized and a database for nosocomial infections was created. General data on the prevalence and distribution of nosocomial infections from the first study in 1999 have already been reported.[4] A second prevalence study was undertaken in 2000. Detailed information on SSIs was derived from these two surveys to better estimate the epidemiology of nosocomial infections and SSIs among surgical patients in Greek hospitals. The Hellenic Society for Nosocomial Infection Control and Healthcare Quality Assurance designed and coordinated the two studies.

METHODS

Data were collected from 14 hospitals and 3,925 patients in 1999 and from 13 hospitals and 3,195 patients in 2000. The University Hospital of Heraklion, a 700-bed, tertiary-care institution established 13 years ago, was the coordinating center for these studies. Five university and nine regional hospitals for the first study and four university and nine regional hospitals for the second study collected data on nosocomial infections and SSIs. These hospitals were widely distributed throughout Greece.

The infection control team of each hospital attended a workshop concerning definitions and methods for detecting nosocomial infections. The goal of the workshop was the uniform application of definitions, criteria, and methods for detecting nosocomial infections across all of the hospitals.[5] Criteria used for defining infections were those of the Centers for Disease Control and Prevention (CDC).[6,7]

All patients in each participating hospital were included. Physicians and nurses in charge of the patients, coordinated by a member of the infection control team, collected data derived from clinical records. At the end of the study day, all registered nosocomial infections were discussed and approved during a staff meeting in which all of the investigators participated. Cases considered doubtful during this meeting had a bedside examination to confirm the diagnosis of nosocomial infection.

Our principal focus for this study was on surgical patients (particularly those who had undergone an operation during their current hospital stay). Demographic and clinical data, use of invasive devices, wound classification, and other invasive procedures and predisposing conditions for the development of nosocomial infections and SSIs were recorded in a special database created for this study. Registration of the operations was performed according to the National Nosocomial Infections Surveillance (NNIS) System procedure categories.[8]

The prevalence of antibiotic use was recorded. The administered antibiotic regimen was considered rational if it depended on the susceptibility test of the isolated responsible microorganism, empiric if it depended on clinical or epidemiologic data, and prophylactic if it was aimed at preventing a pending infection, as in the case of surgery or invasive procedures.

Length of stay (LOS) in the hospital and LOS prior to surgery were calculated for all surgical patients.

A computer program, using the Epi-Info (version 604d; CDC, Atlanta, GA) database, was created and data were entered and analyzed. Univariate associations between nosocomial infections and possible risk factors were assessed using a chi-square test; Fisher's exact test or the Kruskal–Wallis test was also used when appropriate. Independent predictors of nosocomial infection (including SSI) and SSI were identified from multivariate logistic regression analysis with backward elimination. The model was created using SPSS software (version 10.0; SPSS, Inc., Chicago, IL) for Windows (Microsoft Corp., Redmond, WA) and all variables that had a significant or close to significant association ($P < .25$) with nosocomial infection or SSI in the univariate analysis were entered. The criterion to eliminate a variable from the model was a P value greater than .10.

RESULTS

In the 1999 survey, 367 patients with nosocomial infection (9.3%) were detected among 3,925 patients in the participating hospitals. One thousand thirty-seven patients (26.4%) had had at least one surgical procedure prior to and including the day of the survey, a total of 1,093 operations were registered, and 49 SSIs (4.5%) were found. In the 2000 survey, 230 patients with nosocomial infection (7.2%) were detected among 3,195 patients. Eight hundred sixty-eight (27.2%) of the 3,195 patients had had at least one surgical procedure prior to and including the day of the survey. A total of 902 operations were registered and 38 SSIs (4.2%) were detected (Figure). The distribution of nosocomial infections and SSIs among surgical patients, according to the NNIS System procedure categories, is presented in Table 1.

The median LOS for surgical patients without nosocomial infections was 10 days (range, 1 to 18 days), whereas patients who developed nosocomial infections had a median LOS of 27 days (range, 1 to 50 days) ($P < .001$). The median LOS for patients without SSIs was 10 days (range, 1 to 19 days), whereas it was 30 days (range, 1 to 52 days) for patients who developed SSIs ($P < .001$).

TABLE 1
DISTRIBUTION OF NOSOCOMIAL INFECTIONS AMONG SURGICAL PATIENTS ACCORDING TO THE NATIONAL NOSOCOMIAL INFECTIONS SURVEILLANCE SYSTEM PROCEDURE CATEGORIES

Procedure Category	1999 NI/Operations	1999 %	2000 NI/Operations	2000 %	SSI 1999	SSI 2000	BSI 1999	BSI 2000	LRTI 1999	LRTI 2000	PNEU 1999	PNEU 2000	UTI 1999	UTI 2000	Other 1999	Other 2000
Cholecystectomy	12/85	14.1	1/51	2.0	4	0	1	1	3	0	0	0	2	0	1	0
Colon surgery	6/30	20.0	3/37	8.1	2	2	1	1	1	0	1	1	1	0	0	0
Open reduction of fracture	12/102	11.8	7/67	10.4	6	2	0	0	1	2	1	0	4	3	0	0
Hip prosthesis	9/72	12.5	4/51	7.8	3	2	0	0	1	0	1	0	4	3	1	0
Other musculoskeletal system	9/72	12.5	8/51	15.7	5	6	1	1	1	1	0	1	1	0	2	0
Cesarean section	2/36	5.6	1/30	3.3	1	1	0	0	0	0	0	0	0	1	1	0
Other genitourinary system	2/43	4.7	2/38	5.3	1	0	0	1	0	0	0	0	1	1	0	0
Other ear, nose, mouth, or pharynx	2/62	3.2	2/54	3.7	0	0	0	0	0	0	0	0	2	0	0	2
Craniotomy	8/32	25.0	7/38	18.4	0	1	5	1	1	2	2	0	1	2	0	1
Herniorrhaphy	0/31	0.0	1/42	2.4	0	1	0	0	0	0	0	0	0	0	0	0
Other eye	2/83	2.4	0/78	0.0	1	0	0	0	0	0	0	0	1	0	0	0
Others	65/389	16.7	46/331	13.9	26	23	9	3	12	9	9	1	10	5	8	7
Total	129/1,037	12.4	82/868	9.4	49	38	17	8	20	14	14	3	27	15	13	10

NI = nosocomial infection; SSI = surgical-site infection; BSI = bloodstream infection; LRTI = lower respiratory tract infection; PNEU = pneumonia; UTI = urinary tract infection.

The median LOS prior to surgery for patients without SSIs was 1 day (range, 0 to 4 days), whereas it was 3 days (range, 0 to 7.5 days) for patients who developed SSIs ($P < .001$).

Of the 30 different invasive procedures investigated, 19 were significantly correlated with nosocomial infections and SSIs by univariate analysis (unadjusted risk ratio) among the surgical patients (Table 2). With the use of the multivariate model, 11 factors remained as predictors of the occurrence of a nosocomial infection. Clean-contaminated, contaminated, and dirty wound class; LOS prior to surgery; and central venous catheterization were significantly and independently correlated with the occurrence of SSIs among surgical patients (Table 3).

In the first survey 807 (77.8%) of 1,037 and in the second survey 629 (72.4%) of 868 surgical patients were receiving antibiotic therapy on the day of the survey. In the 1999 survey, 471 (58.4%) of 807 patients were taking one antibiotic, 267 (33.1%) were taking two antibiotics, 57 (7.1%) were taking three antibiotics, and 12 (1.5%) were taking more than three antibiotics. In the 2000 study, 371 (59.0%) of 629 patients were taking one antibiotic, 206 (32.8%) were taking two antibiotics, 51 (8.1%) were taking three antibiotics, and 1 (0.2%) was taking more than three antibiotics.

Prophylactic administration of antibiotics (64.6% and 68.0% of the patients in each survey, respectively) was most frequent, followed by empiric (28.9% and 25.6% of the patients in each survey, respectively) and rational (6.6% and 8.3% of the patients in each survey, respectively). The median time of administration of the prophylactic antibiotic therapy was 4 days (range, 1 to 14 days) and 6 days (range, 1 to 16 days) in the 1999 and 2000 surveys, respectively.

Twenty-four (2.3%) of 1,037 and 25 (2.9%) of 868 surgical patients died in 1999 and 2000, respectively. Of these deaths, 10 (41.7%) of 24 and 8 (32.0%) of 25 were directly related to the occurrence of nosocomial infections.

DISCUSSION

It has been more than 15 years since the SENIC project provided the first accurate reports on surveillance for nosocomial infections.[1]

SSIs are associated with substantial risk of morbidity, resulting in prolongation of hospital stay and increased costs.[9,10] Reports from around the world speak to important needs, and several countries have recently examined and reported their experience with nosocomial infections.[11-14] The number of countries attempting to monitor these infections is rising, and difficulties they are encountering in doing so are becoming more evident. Different countries use different approaches to collect and analyze data on SSIs.[15]

Greece is among the countries that have realized the need for surveillance. Prevalence rates of nosocomial infections found during our two previously published studies in Greece were 9.3% and 7.2%, respectively.[3,4] Similar results were found in other surveys performed worldwide.[16] In the current study, the distribution of nosocomial infections according to the site of infection indicat-

TABLE 2
RISK FACTORS FOR THE DEVELOPMENT OF NOSOCOMIAL INFECTIONS AMONG SURGICAL PATIENTS (UNIVARIATE ANALYSIS)

Risk Factor	NI			SSI		
	RR	CI_{95}	*P*	RR	CI_{95}	*P*
Foley catheter	1.98	1.54–2.55	< .001	1.15	0.75–1.76	> .10
Central IV catheter	3.65	2.83–4.71	< .001	2.29	1.41–3.73	< .01
TPN	5.87	4.24–8.14	< .001	4.09	1.80–9.30	< .01
Tracheostomy	6.07	4.61–7.99	< .001	1.99	0.76–5.20	> .10
Endotracheal intubation	3.40	2.19–5.28	< .001	2.92	1.25–6.79	< .05
Mechanical ventilation	5.13	3.81–6.91	< .001	3.06	1.48–6.30	< .01
Bronchoscopy and LBA	9.11	8.01–10.35	< .05	11.06	2.72–44.92	> .05
Upper GI endoscopy	3.53	1.75–7.11	< .01	3.42	0.94–12.46	> .10
Lumbar puncture	2.54	1.19–5.42	< .05	1.22	0.18–8.28	> .10
Abscess drainage	3.91	1.65–9.29	< .05	9.68	4.01–23.36	< .01
Hemodialysis	3.06	1.48–6.33	< .05	1.47	0.22–9.84	> .10
Bone marrow aspiration	9.11	8.01–10.35	< .05	0.0	Undefined	> .10
Thoracic puncture	4.99	2.97–8.40	< .001	1.69	0.25–11.25	> .10
Thoracic drainage	5.91	3.71–9.41	< .001	4.05	1.14–14.44	> .05
Abdominal paracentesis	6.07	2.70–13.64	< .05	14.92	6.53–34.10	< .01
Peritoneal dialysis	6.85	3.84–12.24	< .01	5.53	1.00–30.55	> .10
No. of interventions			< .001			< .01
Days before surgery			< .001			< .0001
Wound class			< .001			< .001

RR = risk ratio; CI_{95} = 95% confidence interval; NI = nosocomial infection; SSI = surgical-site infection; IV = intravenous; TPN = total parenteral nutrition; LBA = bronchoalveolar lavage; GI = gastrointestinal.

TABLE 3
RISK FACTORS FOR THE DEVELOPMENT OF NOSOCOMIAL INFECTIONS AND SURGICAL-SITE INFECTIONS AMONG SURGICAL PATIENTS (MULTIVARIATE ANALYSIS)

Term Used in the Multivariate Model	NI			SSI		
	OR	CI_{95}	*P*	OR	CI_{95}	*P*
Age	1.006	0.99–1.01	< .10	E		
Central venous catheterization	2.93	1.95–4.38	< .001	2.44	1.40–4.23	< .01
Total parenteral nutrition	3.53	1.39–8.91	< .01	E		
Tracheostomy	7.85	3.89–15.84	< .001	E		
Wound class 1*				2.40	1.39–4.16	< .01
Wound class 2*	3.07	1.91–4.95	< .001	6.92	3.65–13.10	< .001
Wound class 3*	2.52	1.28–4.95	< .001	5.96	2.60–13.66	< .001
Upper GI endoscopy	3.37	0.92–12.26	< .10	E		
Hemodialysis	2.5	0.81–8.21	< .10	E		
Thoracic puncture	5.73	1.65–19.80	< .01	E		
Thoracic drainage	6.24	1.55–25.18	< .05	E		
Length of stay prior to surgery, d	E			1.04	0.99–1.11	< .10

OR = odds ratio; NI = nosocomial infection; CI_{95}= 95% confidence interval; SSI = surgical-site infection; E = excluded; GI = gastrointestinal.
*Wound class 1= clean-contaminated operation; wound class 2 = contaminated operation; and wound class 3 = dirty operation.

ed that SSIs were the third most commonly encountered infection, accounting for 33.1% to 43.2% of all nosocomial infections (Table 4). In a similar study, SSIs were found to account for 38% of all nosocomial infections.[17]

Distribution of nosocomial infections and SSIs among the patients who underwent surgery, according to the NNIS System procedure categories, provided us a first estimate of the type of operations most frequently compli-

cated by nosocomial infections and SSIs (cholecystectomy, colon surgery, open reduction of fracture, and musculoskeletal system operations) in our hospitals (Table 1). This will help us to develop an evidence-based surveillance plan for the most common SSIs on the local and national levels and to apply control measures as needed.

The prevalence rates of SSIs in our study were found to be 4.5% and 4.2% for 1999 and 2000, respectively. These rates would have been even higher if postdischarge surveillance had been performed. Rates of SSIs in other countries vary considerably from 2.6% to 14.3%.[12,18,19]

In previous studies, approximately two-thirds of SSIs have been incisional (superficial or deep), and one-third of them involved organ spaces accessed during surgery.[20] For our patients (although the number of SSIs is too small to draw conclusions), the ratio of organ-space infections to incisional infections was found to be 1 to 5.

Central and parenteral nutrition catheters, indwelling catheters, invasive pulmonary procedures (tracheotomy, ventilation, intubation, and bronchoalveolar lavage), paracentesis (abdominal, thoracic, and lumbar puncture), drainage (thoracic and abscess), hemodialysis, peritoneal dialysis, bone marrow aspiration, number of interventions, days prior to surgery, gastrointestinal endoscopy, and wound class were found to correlate with the occurrence of nosocomial infections or SSIs. Eleven of 30 factors analyzed were found to predict the occurrence of a nosocomial infection. Clean-contaminated, contaminated, and dirty wound class; LOS prior to surgery; and central venous catheterization were significantly and independently correlated with the occurrence of SSIs among surgical patients.[21,22] Some of these were not previously "established" risk factors (eg, central venous catheter for the occurrence of SSIs or wound class for nosocomial infections), but they indicate the clinical status of the patient, which could reasonably influence the occurrence of nosocomial infections or SSIs.

In the United Kingdom, SSIs were shown to increase hospital stay by an average of 8.2 days, at a cost of £1,041.[23] A study in the United States showed that the extra hospital stay attributable to SSI was 6.5 days (95% confidence interval, 5 to 8 days) and the excess direct cost attributable to SSI was $3,089 (95% confidence interval, $2,139 to $4,163).[24] The Dutch PREZIES study found LOS increased to 8.2 days for patients with SSI.[25]

In the current study, surgical patients with infection (nosocomial or SSI) stayed in the hospital significantly longer, suggesting the additional resources being consumed by the Greek healthcare system.

Prophylactic antibiotic therapy is mostly used in surgical wards, and overuse of antibiotics is also observed in these departments.[26] It is generally recommended only for clean surgical procedures using a foreign body and in clean-contaminated procedures. A single dose of intravenous cephalosporin prior to surgery is recommended, administered by anesthesia personnel just before the incision. If the surgery lasts longer than 2 to 3 hours, additional doses are required.[26,27]

TABLE 4
PREVALENCE OF NOSOCOMIAL INFECTIONS AMONG SURGICAL PATIENTS ACCORDING TO SITE OF INFECTION

NI	1999 Survey (%)	2000 Survey (%)
SSI 1	1.25	1.38
SSI 2	2.50	2.42
SSI 3	0.96	0.57
UTI	2.60	1.73
LRTI	1.93	1.61
PNEU	1.35	0.34
BSI	1.64	0.92
Other NI	2.02	1.15
Total	14.25	10.12

NI = nosocomial infection; SSI = surgical-site infection; SSI 1= superficial incisional SSI; SSI 2 = deep incisional SSI; SSI 3 = organ-space SSI; UTI = urinary tract infection; LRTI = lower respiratory tract infection; PNEU = pneumonia; BSI = bloodstream infection.

The current study found that the median duration of prophylactic antibiotic use among surgical patients was 4 days (range, 1 to 14 days) and 6 days (range, 1 to 16 days) for 1999 and 2000, respectively. This inappropriately long use not only has an impact on the economics of our hospitals, but also could be contributing to the emergence of high rates of antibiotic-resistant pathogens in Greek hospitals.[28]

The rates of nosocomial infections and SSIs among surgical patients have been estimated in Greek hospitals for the first time. Rates seem to be high, but a sufficient number of operations must be registered and analyzed for each procedure category to create benchmarks and compare rates between hospitals. The LOS was found to be unacceptably high, as well as the duration of the prophylactic administration of antibiotics to these patients. A national plan for the surveillance and control of nosocomial infections must be developed in Greece.

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