Incidence of and Risk Factors for Surgical-Site Infections in a Peruvian Hospital

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INCIDENCE OF AND RISK FACTORS FOR SURGICAL-SITE INFECTIONS IN A PERUVIAN HOSPITAL

Katherine Hernandez, MD; Elizabeth Ramos, MD; Carlos Seas, MD; German Henostroza, MD; Eduardo Gotuzzo, MD

ABSTRACT

OBJECTIVE: To determine the incidence of and risk factors for surgical-site infections (SSIs) after abdominal surgery.

DESIGN: A cohort study was conducted from January to June 1998. CDC criteria for SSI and the NNIS System risk index were used.

SETTING: A tertiary-care hospital in Peru.

PATIENTS: Adult patients undergoing abdominal surgery who consented were enrolled and observed until 30 days after surgery. Patients who had undergone surgery at another hospital or who died or were transferred to another hospital within 24 hours after surgery were excluded.

RESULTS: Four hundred sixty-eight patients were enrolled. Their mean age was 37.2 years. One hundred twenty-five patients developed SSIs, 18% of which were identified after discharge. The overall incidence rate (IR) was 26.7%. The IR was 13.9% for clean, 15.9% for clean-contaminated, 13.5% for contaminated, and 47.2% for dirty interventions. The IR was 3.6% for NNIS System risk index 0 and 60% for index 3. Risk factors for SSI on logistic regression analysis were dirty or infected wound (RR, 3.8; CI_{95}, 1.7–8.4), drain use longer than 9 days (RR, 6.0; CI_{95}, 2.5–12.5), and length of surgery greater than the 75th percentile (RR, 2.1; CI_{95}, 1.0–4.4). Patients with SSI had a longer hospital stay than did non-infected patients (14.0 vs 6.1 days; $P < .001$).

CONCLUSIONS: SSI is a major problem in this hospital, which has a higher IR (especially for clean interventions) than those of developed countries. In developing countries, prevention of SSI should include active surveillance and interventions targeting modifiable risk factors (*Infect Control Hosp Epidemiol* 2005;26:473-477).

Nosocomial infections are a major public health problem worldwide. According to the Institute of Medicine, thousands of deaths are linked to nosocomial infections annually in the United States.[1] Surgical-site infections (SSIs) are ranked among the most common nosocomial infections, along with pneumonia, urinary tract infections, and bloodstream infections.[2] Although SSIs are not associated with a high case-fatality rate, they cause significant morbidity. Approximately 500,000 episodes of SSI occur in the United States every year, accounting for 3.7 million excess hospital days and more than 1.6 billion dollars of extra hospital charges.[3]

The Centers for Disease Control and Prevention (CDC) National Nosocomial Infections Surveillance (NNIS) System is the oldest and largest organization collecting data regarding hospital-acquired infections.[2,4] Significant reductions in hospital-acquired infections have been observed in NNIS System hospitals since it began operating, emphasizing the importance of implementing such programs.[2,5] In Peru and many other developing countries, few hospitals have established surveillance programs for nosocomial infections. This is likely due to the lack of national policies and protocols regarding this issue, scarce human and fiscal resources, and the misconception that nosocomial infections are uncommon. Consequently, reports about the incidence of and risk factors for acquiring SSI are scarce in these countries.

This study sought to evaluate the incidence of SSI at a national referral hospital in Lima, Peru, and to identify risk factors associated with the development of SSI, using the NNIS System risk index. It was thought that data from such a study would permit comparison of the incidence of SSI with that in other hospitals in the region and abroad and would help when designing intervention studies for hospitals in developing countries with scant resources.

METHODS

The study was conducted at the Hospital Nacional Cayetano Heredia, a 400-bed, tertiary-care hospital affiliated with the Universidad Peruana Cayetano Heredia. The

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TABLE 1
CHARACTERISTICS OF THE 468 PATIENTS INCLUDED IN THE COHORT STUDY

Characteristic	No. (%)
Male	280 (59.8)
Wound classification	
Clean	36 (7.7)
Clean-contaminated	69 (14.7)
Contaminated	185 (39.5)
Dirty or infected	178 (38)
ASA score > 2	78 (16.7)
Preoperative stay > 24 h	120 (25.6)
Emergency surgery	390 (83.3)
Median duration of surgery, min (25th–75th percentile)	80 (55–120)
Drain use	193 (41.2)
Surgical procedure	
Appendectomy	237 (50.6)
Gallbladder and biliary tract surgery	90 (19.2)
Liver surgery	13 (2.8)
Gastric surgery	9 (1.9)
Small bowel surgery	15 (3.2)
Colorectal surgery	34 (7.3)
Herniorrhaphy	33 (7.1)
Laparotomy	9 (1.9)
Other	28 (6.0)
Nosocomial infection other than SSI	73 (15.6)
Median length of stay, d (25th–75th percentile)	6 (3–10)

ASA = American Society of Anesthesiologists; SSI = surgical-site infection.

Hospital Nacional Cayetano Heredia has a catchment population of approximately 2 million and, along with two other hospitals, serves as a referral center for the northern part of Lima. Approximately 200 surgical interventions are performed monthly at the Hospital Nacional Cayetano Heredia. The surgery department has an emergency service, an ambulatory clinic, a surgery ward with 86 beds, and a surgical intensive care unit with 4 beds. By the time the study started, the hospital had created an infection control committee, but no active surveillance for infections was being performed on a regular basis.

An observational study was conducted between January and June 1998. Patients older than 14 years who required abdominal surgery were included in the study. Patients were excluded if they had undergone surgical interventions at another hospital or died or were transferred to another hospital within the first 24 hours after surgery. Two physicians who were specifically trained for this study interviewed and closely observed the patients during their hospitalization, searching daily for SSI and potential risk factors. Clinical charts were systematically reviewed and, if necessary, the medical staff in charge of a patient were interviewed. Data regarding SSI were obtained from all patients daily during their hospitalization and until 30 days after surgical intervention. Clinical evaluation in the outpatient clinic, telephone contact, or chart review was used when patients were discharged prior to the 30 days.

CDC definitions for SSI and other nosocomial infections were followed to detect all postoperative nosocomial infections.[6,7] The NNIS System risk index was calculated based on three risk factors, each worth one point: contaminated or dirty surgical wound, American Society of Anesthesiologists (ASA) score greater than 2, and duration of surgery greater than the 75th percentile for a specific group of surgical procedures. The NNIS System index ranges from 0 to 3.[8,9] The National Research Council operative-site classification was also used[10]; it classifies surgical wounds as clean, clean-contaminated, contaminated, and dirty. A form was devised to collect data on age, gender, presence of underlying diseases, type of surgery (elective vs emergency), preoperative stay (in hours), total length of hospitalization (in days), and ASA preoperative assessment score.[11,12] Use and duration of antibiotic prophylaxis, length of surgery (in minutes), the 75th percentile duration of every surgical procedure, number of surgical interventions per patient, and use and duration of drainage were also recorded. Surgical interventions were categorized into groups according to the injured organ. No attempt was made to isolate microbes from the surgical wounds.

Data were analyzed by a microcomputer using SPSS software for Windows (version 10.0.7; SPSS, Inc., Chicago, IL). Categorical variables were compared using chi-square with continuity correction or Fisher's exact test as needed. Continuous variables were compared using the Student's *t* test for normally distributed data; otherwise, the Mann–Whitney test was used. A P value of less than .05 was considered significant, and all tests were two-tailed. Relative risks (RRs) and 95% confidence intervals (CI_{95}) were calculated using Epi-Info software (version 6.0; CDC, Atlanta, GA). A logistic regression analysis was performed to identify independent predictors for the development of SSI; variables that attained a P value of less than .1 on univariate analysis were included in stepwise fashion in the multivariate analysis. All patients were requested to give oral consent to participate in the study. The protocol was approved by the Institutional Ethics Review Board of the hospital.

RESULTS

A total of 468 consecutive abdominal interventions were evaluated. Characteristics of the patients included in the study are summarized in Table 1. The cohort was mainly composed of young patients (mean age, 37.2 ± 18.0 years), and 59.8% were men. Most of the surgical procedures (83.3%) were classified as emergency procedures, with appendectomy being the most common surgical procedure. When cases were grouped by wound classification, there were 7.7% clean, 14.7% clean-contaminated, 39.5% contaminated, and 38% dirty procedures. There were a total of 125 SSIs, 23 (18.4%) of which were identified after discharge. One hundred eight (86.4%) occurred in patients who had undergone emergency procedures and 17 (13.6%) occurred

TABLE 2
UNIVARIATE ANALYSIS OF RISK FACTORS FOR SURGICAL-SITE INFECTIONS*

Risk Factor	No SSI (n = 343)	SSI (n = 125)	P
Mean age, y (± SD)	37.6 (18.2)	36.2 (17.6)	.5
Male	198 (57.7)	82 (65.6)	.12
Emergency surgery	282 (82.2)	108 (86.4)	.28
Preoperative stay > 24 h	83 (24.2)	37 (29.6)	.24
Wound classification			
Clean	31 (9.0)	5 (4.0)	
Clean-contaminated	58 (16.9)	11 (8.8)	
Contaminated	160 (46.7)	25 (20.0)	
Dirty or infected	94 (27.4)	84 (67.2)	< .001
Received antibiotic prophylaxis	296 (86.3)	114 (91.2)	.15
Duration of surgery > 75th percentile	71 (20.7)	55 (44.0)	.01
Use of drains	111 (32.4)	82 (65.6)	< .001
Duration of drainage ⩾ 9 d	32 (9.3)	50 (40.0)	< .001
More than one drain	25 (7.3)	21 (16.8)	.62
More than one surgical intervention	8 (2.3)	10 (8.0)	.05
Presence of comorbidities	36 (10.5)	7 (5.6)	.11
Concomitant nosocomial infection	37 (10.8)	36 (28.8)	< .001

SSI = surgical-site infection; SD = standard deviation.
*Data are number of patients (%) unless otherwise noted.

in patients who had undergone elective procedures. The overall incidence rate of SSI was 26.7%. The median time to development of SSI was 6 days (25th percentile, 4 days; 75th percentile, 10 days). Nosocomial infections other than SSI were observed in 73 patients: urinary tract infections (n = 42), pneumonia (n = 21), gastrointestinal infections (n = 5), skin and soft tissue infections (n = 3), and catheter-related infections (n = 2).

The results of univariate analysis to identify risk factors for SSI are given in Table 2. Age, gender, and emergency procedures were not associated with SSI. The incidence rate of SSI differed by wound classification: 13.9% for clean, 15.9% for clean-contaminated, 13.5% for contaminated, and 47.2% for dirty wounds ($P < .001$). The duration of the procedure had a marked effect on the incidence of SSI. The incidence of SSI for procedures lasting longer than the 75th percentile was twice as high as that for shorter procedures (43.7% vs 20.5%, respectively; $P < .001$). Additionally, compared with procedures lasting 1 hour or less, the incidence of SSI was 1.6-fold higher for procedures lasting 2 hours, 2-fold higher for procedures lasting 3 hours, and 2.8-fold higher for procedures lasting 4 hours or more.

The use of open drains in the abdominal cavity and the duration of drainage, but not the number of drains, were associated with the development of SSI. When the cutoff for the duration of drainage was 9 days, the incidence of SSI was almost 3 times higher for patients with a duration above this cutoff compared with patients with a duration below this cutoff (60.0% vs 19.4%, respectively; $P < .001$). Patients who had more than one surgical procedure performed had an incidence of SSI approximately twice as high as that of patients with only one intervention (55.6% vs 25.6%, respectively; $P = .005$). Patients who developed SSI had a longer hospital stay than those who did not develop SSI (median [25th to 75th percentiles], 12 [8 to 18] vs 4 [2 to 7] days, respectively; $P < .001$). The development of a nosocomial infection other than a SSI was associated with increased risk for SSI. Thirty-six patients with SSI (28.8%) developed another nosocomial infection. These patients had higher incidence rates of SSI than those who did not develop another nosocomial infection (49.3% vs 22.5%, respectively; $P < .001$). Other nosocomial infections found in patients with SSI were urinary tract infection (n = 18), pneumonia (n = 12), gastrointestinal infection (n = 5), and catheter-related infection (n = 1).

Dirty or infected wounds (RR, 3.8; CI_{95}, 1.7 to 8.4), use of drains for longer than 9 days (RR, 6.0; CI_{95}, 2.5 to 12.5), and length of surgery greater than the 75th percentile (RR, 2.1; CI_{95}, 1.0 to 4.4) remained independently associated with SSI on logistic regression analysis. The incidence of SSI according to the NNIS System risk index is provided in Table 3. A marked increase in the incidence of SSI and in the RR to develop SSI was observed as the NNIS System risk index increased.

TABLE 3
INCIDENCE OF SURGICAL-SITE INFECTIONS ACCORDING TO THE NATIONAL NOSOCOMIAL INFECTIONS SURVEILLANCE (NNIS) SYSTEM RISK INDEX

NNIS System Risk Index	Total No. of Procedures	No. of Patients With SSI	Incidence Rate per 100 Interventions	RR (CI_{95})
0	56	2	3.6%	1
1	277	61	22%	6.2 (1.6–24.5)
2	115	50	43.5%	12.2 (3.1–48.2)
3	20	12	60%	16.8 (4.1–68.6)

SSI = surgical-site infection; RR = relative risk; CI_{95} = 95% confidence interval.

DISCUSSION

Hospital infection control programs are an essential component of the quality of healthcare. Results from these programs are regularly used to evaluate the performance of hospitals.[13] SSIs are the second or third most common type of hospital-acquired infection, and feedback of rates has been associated with improvement. Therefore, an effective surveillance program for SSI should be a critical component of any hospital infection control program.[14] This study provided data on SSI in a place where no surveillance or feedback of SSI rates had been implemented, a common scenario in developing countries.

The overall incidence rate of SSI found in our study was 26.7%, remarkably higher than incidence rates reported from developed countries such as the United Kingdom (3.1%) and the Netherlands (4.3%)[15,16] and from other developing countries in Central and South America such as Mexico (9.7%), Brazil (8.7%), and Bolivia (12%).[17-19] The incidence rates of SSI according to wound classification were also higher in our study compared with other studies from the region,[19,20] but comparable to those reported from Spain[21] and Vietnam.[22] Differences in patient characteristics, distributions of surgical procedures, and hospital settings may help explain this, but the high incidence of SSI after clean procedures was striking. We could not identify any specific risk factor associated with this, but it certainly deserves further study. Prevalence studies of SSI had previously been conducted in Peru and showed overall rates similar to those of our study[23]; however, these studies did not investigate the development of SSI after hospital discharge and were retrospective, likely leading to underestimation of the actual rates. This prospective, longitudinal study included postdischarge surveillance, which detected 18.4% of the cases during the month of follow-up, a value that is consistent with previous international reports.[24,25]

Three independent risk factors associated with the development of SSI were identified in our study: dirty or infected wounds (RR, 3.8), length of surgery greater than the 75th percentile for the particular surgical procedure (RR, 2.1), and use of drains for 9 days or more (RR, 6.0). These risk factors are not unique to our setting and have been previously reported.[26,27] Interestingly, length of surgery and prolonged use of drains are potentially amenable to intervention.

Open drains are a well-recognized risk factor for SSI; closed-suction drains are preferred over open drains when drainage of the abdominal cavity is indicated.[28,29] Reducing the length of procedures through adequate training of the staff on proper surgical techniques, improving surgeons' skills, direct supervision of trainees by more experienced surgeons, and adherence to written protocols are clearly needed in our hospital. We found that patients with another nosocomial infection were at greater risk for developing SSI and that patients with SSI had a median excess hospital stay of 8 days.[30] We did not evaluate the bacterial etiology or costs of SSI in this study.

The NNIS System risk index is advocated as a good predictor of SSI.[9] We found a good correlation between the NNIS System risk index and the development of SSI. The RR of developing SSI increased significantly from 6.2 for patients with an NNIS System risk index of 1 to 16.8 for patients with an NNIS System risk index of 3. This correlation between the NNIS System risk index and the development of SSI is well recognized.[21] More recently, however, a study from Santa Cruz, Bolivia, did not find an association between the NNIS System risk index and SSI.[19] In that study, few patients belonged to the highest NNIS System risk index, reducing the power to detect an association with SSI. In sharp contrast to that study, we found that approximately 77% of the surgical interventions in our study were at the highest risk for SSI, belonging to the categories contaminated or dirty according to wound classification.

What are the implications of our study? First, the implementation of a surveillance program to control SSI is needed in the Hospital Nacional Cayetano Heredia. Second, regarding controlling SSI, a surveillance program in this setting should set up standards for the duration of surgical procedures and review the indications for draining the abdominal cavity with particular emphasis on the duration of drainage and the kind of drains used. Reducing the rate of SSI in our hospital will take time and significant effort from all of the individuals involved. An initiative for setting up an infection control committee in all Peruvian hospitals is being promoted by the Peruvian National Institute of Health. This initiative is not focusing on any nosocomial infection in particular. Our study emphasizes that controlling SSI should be a priority in hospitals such as ours, showing preintervention data on SSI to allow evaluation of specific interventions.

SSI is a significant problem at the Hospital Nacional

Cayetano Heredia, with incidence rates higher than previously reported in the region, especially for clean interventions. The NNIS System risk index was a good indicator of SSI. Preventing SSI in this setting is a challenge that requires implementation of routine surveillance of SSI and control measures targeting identified risk factors.

REFERENCES

1. Kohn L, Corrigan J, Donaldson M. *To Err Is Human: Building a Safer Health System*. Washington, DC: Institute of Medicine, National Academy Press; 1999.
2. National Nosocomial Infections Surveillance (NNIS) System. National Nosocomial Infections Surveillance (NNIS) System report: data summary from January 1992 to June 2002, issued August 2002. *Am J Infect Control* 2002;30:458-475.
3. Martone W, Jarvis W, Edwards J, Culver D, Haley R. Incidence and nature of endemic and epidemic nosocomial infections. In: Bennett JV, Brachman PS, eds. *Hospital Infections*. Philadelphia: Lippincott-Raven; 1998:461-476.
4. Haley RW, Shachtman RH. The emergence of infection surveillance and control programs in US hospitals: an assessment, 1976. *Am J Epidemiol* 1980;111:574-591.
5. Centers for Disease Control and Prevention. Monitoring hospital acquired infections to promote patient safety: United States, 1990-1999. *MMWR* 2000;49:149-152.
6. Society for Hospital Epidemiology of America, Association for Practitioners in Infection Control, Centers for Disease Control, Surgical Infection Society. Consensus paper on the surveillance of surgical wound infections. *Infect Control Hosp Epidemiol* 1992;13:599-605.
7. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG. CDC definitions for nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections. *Infect Control Hosp Epidemiol* 1992;13:606-608.
8. Haley RW, Culver DH, Morgan WM, et al. Identifying patients at high risk of surgical wound infection: a simple multivariate index of patient susceptibility and wound contamination. *Am J Epidemiol* 1985;121:206-215.
9. Culver DH, Horan TC, Gaynes RP, et al. Surgical wound infection rates by wound class, operative procedure and patient risk index: National Nosocomial Infections Surveillance System. *Am J Med* 1991;91(suppl 3B):152-157.
10. Horan TC, Culver DH, Gaynes RP, National Academy of Sciences–National Research Council. Postoperative wound infections: the influence of ultraviolet irradiation of the operating room and of various other factors. *Ann Surg* 1964;160(suppl 2):1-132.
11. Owens WD, Felts JA, Spitznagel EL. ASA physical status classification: a study of consistency of ratings. *Anesthesiology* 1978;49:239-243.
12. Keats AS. The ASA classification of physical status. *Anesthesiology* 1978;49:223-226.
13. Gerberding JL. Health-care quality promotion through infection prevention: beyond 2000. *Emerg Infect Dis* 2001;7:363-366.
14. Haley RW. The scientific basis for using surveillance and risk factor data to reduce nosocomial infection rates. *J Hosp Infect* 1995;30(suppl):S3-S14.
15. Communicable Disease Surveillance Centre. NINSS reports on surgical site infection and hospital acquired bacteremia. *CDR Wkly* 2000;10:213-216.
16. Geubbels EL, Mintjes-de Groot AJ, van den Berg JM, de Boer AS. An operating surveillance system of surgical site infections in the Netherlands: results of the PREZIES national surveillance network. *Infect Control Hosp Epidemiol* 2000;21:311-318.
17. Vilar-Compte D, Sandoval S, Gordillo P, de la Rosa M, Sanchez-Mejorada G, Volkow P. Surveillance of surgical wound infections: 18-month experience in the Instituto Nacional de Cancerologia. *Salud Publica Mex* 1999;41(suppl 1):S44-S50.
18. Wagner MB, da Silva NB, Vinciprova AR, Becker AB, Burtet LM, Hall AJ. Hospital-acquired infections among surgical patients in a Brazilian hospital. *J Hosp Infect* 1997;35:277-285.
19. Soleto L, Pirard M, Boelaert M, et al. Incidence of surgical site infections and the validity of the National Nosocomial Infections Surveillance System risk index in a general surgical ward in Santa Cruz, Bolivia. *Infect Control Hosp Epidemiol* 2003;24:26-30.
20. Ziliotto JA, Kunzle JE, Mendes JA, Ferreira JL. Hospital infection at a private hospital in Ribeirao Preto, Sao Paulo, Brazil. *Revista da Associacao Medico Brasileira* 1989;35:29-33.
21. Valls V, Diez M, Ena J, Gutierrez A, et al. Evaluation of the SENIC risk index in a Spanish university hospital. *Infect Control Hosp Epidemiol* 1999;20:196-199.
22. Nguyen D, MacLeod W, Phumg D, et al. Incidence and predictors of surgical-site infections in Vietnam. *Infect Control Hosp Epidemiol* 2001;22:485-492.
23. Saldias J, Villacorta J, Izquierdo G, Samanez J. Nosocomial infection in index services of internal medicine and general surgery. *Revista Medica del Instituto Peruano de Seguirdad Social* 1992;1:4-7.
24. Manian FA, Meyer L. Comprehensive surveillance of surgical wound infections in outpatient and inpatient surgery. *Infect Control Hosp Epidemiol* 1990;11:515-520.
25. Medina-Cuadros M, Sillero-Arenas M, Martínez-Gallego G, Delgado-Rodríguez M. Surgical wound infections diagnosed after discharge from the hospital: epidemiological differences with in-hospital infections. *Am J Infect Control* 1996;24:421-428.
26. Garibaldi R, Cushing D, Lerer T. Risk factors for postoperative infection. *Am J Med* 1991;91(suppl 3B):S158-S163.
27. Lizán-García M, García Caballero J, Asensio Vegas A. Risk factors for surgical-wound infection in general surgery: a prospective study. *Infect Control Hosp Epidemiol* 1997;18:310-315.
28. Alexander JW, Korelitz J, Alexander NS. Prevention of wound infections: a case for closed suction drainage to remove wound fluids deficient in opsonic proteins. *Am J Surg* 1976;131:59-63.
29. Simchen E, Shapiro M, Sacks TG, Michel J, Durst A, Eyal Z. Determinants of wound infection after colon surgery. *Ann Surg* 1984;199:260-265.
30. Kirkland KB, Briggs JP, Trivette SL, Wilkinson WE, Sexton DJ. The impact of surgical-site infections in the 1990s: attributable mortality, excess length of hospitalization, and extra costs. *Infect Control Hosp Epidemiol* 1999;20:725-730.