Surgical Site Infections Occurring after Hospital Discharge

Kenneth Sands, Gordon Vineyard, and Richard Platt

Channing Laboratory and Departments of Medicine and Surgery, Brigham and Women's Hospital, and Department of Ambulatory Care and Prevention, Harvard Medical School and Harvard Pilgrim Health Care, Boston, Massachusetts

Although surgical site infections (SSIs) occurring after hospital discharge cause substantial morbidity, their epidemiology is not well understood, and methods for routine postdischarge surveillance have not been validated. Inpatient and outpatient surveillance followed 5572 nonobstetric procedures among members of a health maintenance organization with extensive automated records. Records were screened for coded diagnoses, tests, and prescriptions and, if positive, were reviewed by reading full text. Questionnaires regarding the occurrence of an SSI were sent to the same patients and their surgeons. One hundred thirty-two SSIs were documented, of which 84% occurred after hospital discharge and 63% were managed outside the surgical facility. Postdischarge SSIs led to an average of 4.6 additional ambulatory encounters. Patient and surgeon questionnaires had a sensitivity of 28% and 15%, respectively. These data suggest that most SSIs occur after discharge and are not detectable by conventional surveillance. Nonetheless, they cause substantial resource utilization.

Postoperative surgical site infections (SSIs) are among the leading nosocomial causes of morbidity and increased medical expense. An estimated 325,000 SSIs occur each year in the United States and generate additional medical costs in the range of $1–2 billion [1, 2].

Routine surveillance for SSIs is recommended by both the Centers for Disease Control and Prevention (CDC) [3] and the Surgical Infection Society [4] as a mechanism for reducing the rate of these infections, presumably by providing feedback to surgeons on their performance [4–6]. SSI surveillance has been associated with decreased infection rates of as much as 35%, [3, 7] but even if the true effect of surveillance is much less than this, it would be highly cost-effective: the cost of surveillance has been estimated to be about one-fifth the cost of treating preventable infections [4, 8]. SSI rates are thus widely used by hospitals as a quality indicator and as the basis for quality improvement efforts.

Decreasing hospital lengths of stay and increasing use of ambulatory surgery may compromise the accuracy of surveillance data [9]. Traditionally, surveillance involved inpatient follow-up only, but previous studies have reported that as many as 71% of SSIs occur after hospital discharge [10–16]. For hospitals to report accurate absolute infection rates or to make comparisons of rates between hospitals, these infections must be identified [9, 16]. However, no reliable method for routine postdischarge wound surveillance has been established. Direct wound surveillance among outpatients is extremely resource-intensive, so many hospitals doing postdischarge surveillance now rely on responses to questionnaires mailed to either patients or surgeons [17]. To our knowledge, the performance characteristics of these questionnaires have never been rigorously evaluated. At the same time, there is little published information about resource utilization associated with postdischarge SSIs.

In this study, SSIs occurring before and after discharge were identified among members of a health maintenance organization for whom detailed information was available for all post-discharge medical encounters and prescriptions. For the same cohort, we evaluated the performance of mailed patient and surgeon questionnaires for detecting postdischarge SSIs and estimated the resource utilization associated with these infections.

Methods

Study population. The study population was drawn from adult members of Harvard Pilgrim Health Care (HPHC) who underwent a nonobstetric operating room procedure at Brigham and Women's Hospital from 10 February 1992 through 7 March 1993. HPHC is a multimodel health maintenance organization that included a staff model division with ~300,000 members in the greater Boston area at the time of this study. Members pay a monthly fee, after which office visits, urgent care visits, and hospitalizations generate only nominal charges. At the time of the study, 92% of persons described above received care at centers that used an automated medical record system for both daily charting and archiving; only members with automated records were included in the study.

The automated medical record system uses standardized forms that are completed for every patient encounter at HPHC centers,

Received 27 July 1995; revised 27 November 1995.

Presented in part: American Federation for Clinical Research, April 1993, Washington, DC (Clin Res **1993**;41:235A).

This study was done in accordance with the human experimentation guidelines of Brigham and Women's Hospital and Harvard Pilgrim Health Care.

Financial support: Agency for Healthcare Policy and Research, Department of Health and Human Services (1F32 HS00057–01); Harvard Pilgrim Health Care Foundation.

Reprints or correspondence (present address): Dr. Kenneth Sands, Beth Israel Hospital, 330 Brookline Ave., Boston, MA 02215.

The Journal of Infectious Diseases 1996;173:963–70

0022–1899/96/7304–0025$01.00

including telephone calls, office visits (scheduled or unscheduled), urgent care visits, and hospitalizations. Information is recorded on forms that are customized for the type of encounter: The provider either writes in or selects from a list all coded diagnoses, tests, procedures, and prescriptions relevant to that encounter and enters additional comments as free text. All information, including free text, is entered into an automated medical encounter record. The results of diagnostic tests are entered directly into the automated record linked to the patient encounter during which they were ordered. Information about hospitalizations and emergency room visits appear in both encounter records and separate administrative records. HPHC pharmacies are also computerized and linked to the automated medical record. Ninety percent of HPHC members have prepaid coverage for pharmaceuticals and so are likely to use HPHC pharmacies for any prescriptions that have more than a nominal charge at outside pharmacies.

Brigham and Women's Hospital is the most active surgical facility for greater Boston HPHC members. HPHC patients undergoing surgery were identified within 3 weeks of their procedure from the hospital's computerized operating room log, which records information on every operation in real time, including procedure date, surgeons involved, duration of the procedure, wound class, admission status of the patient, and up to three ICD-9 procedure codes.

Identification of SSIs. Hospital-based information about SSIs was identified by review of data gathered by the hospital's infection control unit, which uses routine microbiology, nurse's notes, and surgical ward rounds for surveillance, and review of the inpatient charts of all patients receiving the ICD-9 code of 998.5 (postoperative wound infection) before discharge. Outpatient information about SSIs was identified by a two-step procedure for reviewing outpatient records that used the automated record systems described above. The first step was a computerized search of three automated data bases. Ambulatory encounter records were screened for any of 102 diagnostic, testing, or treatment codes that may have indicated an SSI. A partial list of these codes is given in figure 1. The pharmacy data base was screened for specific antibiotic prescriptions, and administrative records were searched for all rehospitalizations or emergency room visits and their corresponding ICD-9 codes for those potentially indicative of an SSI. The second step was a physician review of full-text outpatient records and relevant hospital records for the 30-day postoperative period for all patients identified by the computerized search.

All records with any documentation suggestive of an SSI were independently reviewed by 2 infectious disease physicians (K.S. and R.P.). Final classification as an SSI required agreement that documentation meeting the 1992 CDC definition of SSI [18] was present within 30 days of the procedure. For cases in which there was disagreement, a third independent review was done by a surgeon (G.V.), and the majority opinion was accepted. Because primary outpatient care was often provided by a physician's assistant, a diagnosis of SSI made by this provider was considered equivalent to physician's diagnosis; a physician would have had to review the diagnosis and findings in these cases if they involved prescription of an antibiotic.

Assessment of resource utilization. Resource utilization associated with postdischarge SSI during the 30-day postoperative period was explored by review of outpatient records for patients with a confirmed postdischarge infection. All free-text notes were reviewed, and encounters for which the principal focus was the SSI were identified. Other activities associated with the SSI, such as home care visits, prescriptions, and laboratory tests, were also identified if there was clear indication that these activities related directly to the infection.

Patient and surgeon questionnaires. Patients were mailed a single-page questionnaire between the 25th and 32nd postoperative day. A questionnaire was not sent if the patient had died or was an inpatient (either not discharged or discharged and readmitted) at the surgical facility during the time window for mailing the questionnaire. The patient questionnaire appeared in both English and Spanish and was preaddressed and stamped for return. The questionnaire provided yes-no checkboxes for questions falling within three categories: whether the patient had been treated for any problems during the postoperative period, with "infection at your surgical incision" as one of the listed choices; whether the patient had made any urgent or unplanned visits to any health care facility since the operation; and whether any new medications had been prescribed since leaving the hospital, with antibiotic listed as one of the choices. While open-ended comments were solicited, the questionnaire did not focus on the patient's subjective assessment of the wound, which has been shown to correlate poorly with physician findings [19].

Surgeons were mailed a form every 4 weeks that listed their surgical cases among the study population from 4–8 weeks earlier. The form displayed patient name, date of the procedure, and type of procedure. Adjacent to the patient name, the surgeon was asked to indicate whether an SSI occurred, with the possible responses being "definite," "possible," "no," or "don't know." The form was sent with a cover letter explaining that responses would not be used to assess individual surgeon performance and listing the CDC definition of SSI in abbreviated form. Surgeons were not notified of the concurrent chart review and patient questionnaire.

Analysis. Surgical procedures were categorized according to the National Nosocomial Infections Surveillance System (NNIS), which classifies all ICD-9 surgical codes into 44 operative categories (42 of which are nonobstetric), primarily on the basis of anatomic location of the surgery [20]. Procedures that do not qualify as operative procedures (for example, needle biopsy, transurethral prostatectomy) by the NNIS were included in the analysis as a separate nonoperative category. The NNIS categories were then collapsed into 10 new categories based on surgical specialty. SSI rates were calculated for each of the NNIS nonobstetric operative categories and for each of the 10 larger procedure categories. Attack rates were calculated for predischarge, postdischarge, and total events.

Positive questionnaire responses for procedures not identified as associated with an SSI were investigated by chart review to determine whether these were false-positive responses or true SSIs that had been missed by our case-finding methodology.

Performance characteristics of patient and surgeon questionnaires were compared with the record review procedure by calculation of sensitivity, specificity, and positive predictive value for a positive questionnaire response. Calculations were made both for procedures for which a questionnaire was returned and for the entire population, in which case an unreturned questionnaire was considered negative. In addition, for surgeon questionnaires, performance was evaluated by interpreting "possible SSI" first as a positive response and then as a negative response.

Diagnostic Codes (31)		Treatment Codes (54)	
R181	Wound infection (postoperative)	B147	Cephalexin
C150	Cellulitis	B192	Dicloxacillin
R003	Staphylococcal infection	B212	Amoxicillin clavulanate
C408	Abscess	M278	Topical antiseptic dressing
A902	Wound hematoma, postoperative	T147	Drain abscess
C182	Erythema	T693	Debridement of wound
Testing Codes (17)		Y131	Removal of hardware
B800	Wound culture	Y157	Wound care instructions
B555	Blood culture	Y907	Explore wound

Figure 1. Partial list of computer-stored ambulatory record codes used to screen postdischarge medical encounters for postoperative SSIs. Numbers in parentheses represent actual number of codes used in screening for that category.

The performance of each separate component of our automated screening strategy was also evaluated and compared with aggregate performance and with the results of hospital-based surveillance. We considered inpatient ICD-9 discharge diagnosis codes; emergency room ICD-9 diagnosis codes; ambulatory care diagnosis, test, and treatment codes as a group; obtaining wound or blood cultures in the ambulatory setting; and dispensing of the 10 principal oral antibiotic agents used to treat SSIs at HPHC.

Results

Record review. The study population consisted of 5042 HPHC members who underwent 5572 nonobstetric operative procedures. All nonobstetric NNIS categories were represented, plus 1465 procedures classified as nonoperative. Table 1 presents summary information about the patient population and procedure types.

Review of inpatient records with an SSI indicated by prospective inpatient surveillance or with discharge coding indicating an SSI identified 27 events, all of which were confirmed to meet CDC criteria for SSI. Screening of automated ambulatory encounter, pharmacy, and administrative records identified 741 procedures. Review of the relevant full-text records for this group identified 105 additional SSIs. Agreement between the two infectious disease physicians regarding the presence or absence of infection exceeded 95%. The overall attack rate for SSI was 2.4%; it was 0.7% for predischarge events (among inpatients) and 2.0% for postdischarge events. Of the total 132 SSIs identified, 111 (84%) occurred after discharge, and 70 (63%) of these were diagnosed and treated entirely outside of the institution at which the surgery was done. The median postoperative length of stay for inpatients with a postdischarge SSI was 4 days; all occurred among patients with a postoperative length of stay of ≤14 days.

Table 1. Characteristics of 5572 nonobstetric surgical procedures.

Variable	Ambulatory (n = 2479)	Inpatient (n = 3093)	Total (n = 5572)
Patient age in years, median	41	43	42
Procedure length in minutes, median	35	105	65
% female	65	60.5	63
Postoperative length of stay in days, median (range)	NA	4 (0–121)	NA
Wound classification (%)			
Clean	71.0	62.1	66.1
Clean-contaminated	25.0	29.2	27.5
Contaminated	3.1	5.5	4.4
Dirty	0.5	3.2	2.0

NOTE. NA, not applicable.

There were 53 positive patient responses and 44 positive surgeon responses relating to procedures not identified as complicated by an SSI by our methodology. Review of inpatient and outpatient records for these patients identified 1 postoperative event meeting criteria for an SSI. This event qualified as an SSI on the basis of a physician's diagnosis (in free text only, on a single visit) after noting wound erythema, which was not treated with antibiotics. The majority of false-positive responses from patients represented minor wound complications that were documented in the ambulatory record but did not meet NNIS criteria for SSI. The majority of false-positive responses from surgeons related to procedures done on sites that were infected preoperatively.

Figure 2 shows pre- and postdischarge SSI attack rates within 10 procedure categories, derived from collapsing the more specific NNIS classification scheme. Attack rates ranged from 0 (0/204) for neurosurgical procedures to 10.3% (27/261) for cardiothoracic procedures. Pre- and postdischarge SSI attack rates within these 10 categories and each of the 42 NNIS nonobstetric procedure categories are summarized in table 2.

Resource utilization. During the 30-day postoperative period, the 111 procedures complicated by a postdischarge SSI

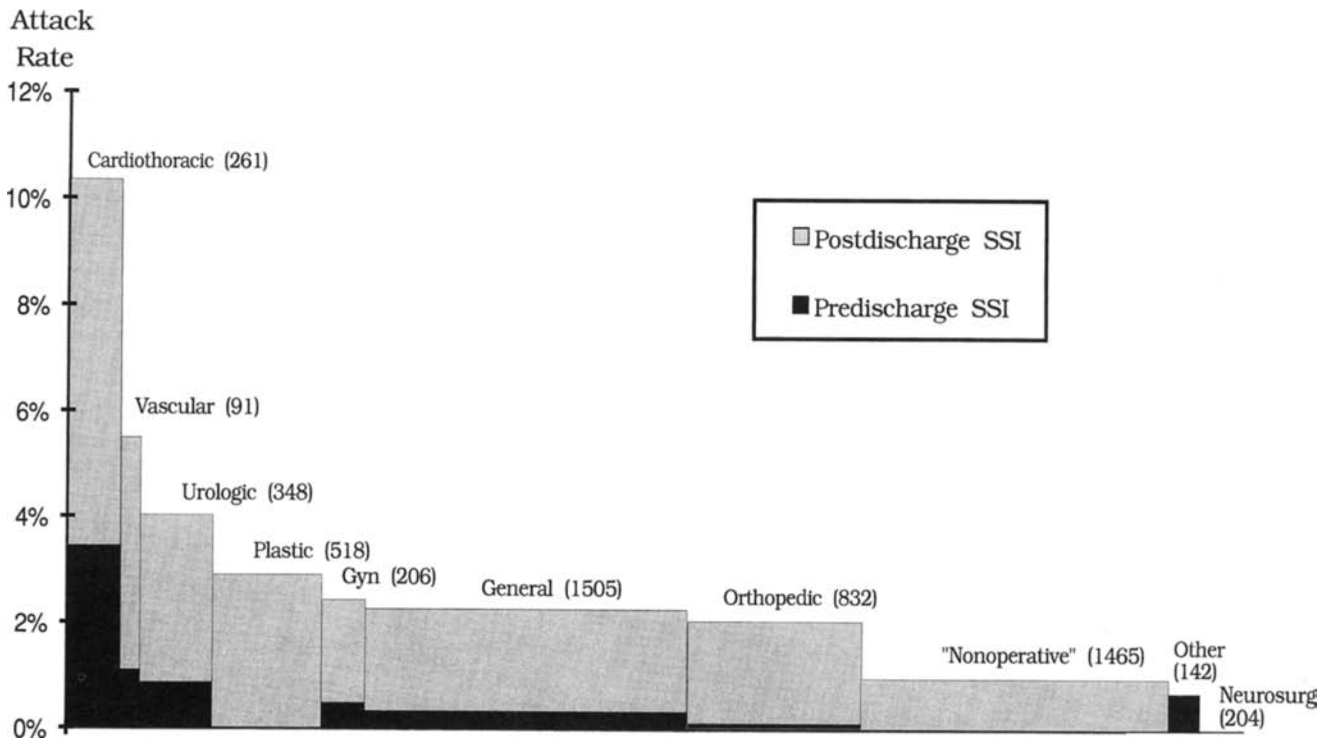

Figure 2. Predischarge (solid) and postdischarge (shaded) SSI rates within 10 surgical procedure categories. Numbers in parentheses are total number of procedures in category; width of each column is proportional to total number of procedures. Thus, area of each column reflects proportion of total SSIs occurring within that category.

necessitated 37 emergency room visits, 37 hospitalizations, 202 scheduled clinical appointments at HPHC (mean, 1.8; range, 0–8), 117 home care visits (mean, 1.1; range, 0–20), and 155 nonappointment encounters (mean, 1.4; range, 0–6), such as telephone calls or visits for laboratory tests, that could be verified as directly attributable to the infection. The average number of additional ambulatory or emergency room encounters was 4.6 (511/111). The 70 procedures that necessitated no SSI-related rehospitalizations or emergency room visits accounted for 147 scheduled clinical appointments, 41 home visits, and 48 nonappointment encounters verified as attributable to their infection. In other words, 50% (236/474) of SSI-related outpatient encounters occurred among patients diagnosed and treated without a revisit to the institution where surgery was done. These figures are likely to be underestimates, since no attempt was made to include services that were partly attributable to the infection or services that occurred after the 30th postoperative day.

Questionnaire information. Questionnaires were mailed to patients regarding 5388 procedures. They were not sent to 184 patients who either had died or were inpatients at the surgical facility at the time of the mailing; these 184 included 6 with SSIs, 2 of whom had never been discharged and 4 who had been readmitted for treatment of their infection. All 5572 procedures were represented on the monthly forms sent to surgeons. Patient questionnaires were returned for 1799 procedures (33.4%) and surgeon questionnaires for 4420 procedures (79%).

Table 3 shows the results of patient and surgeon responses in relation to the actual occurrence of SSI, excluding the 21 predischarge SSIs. The sensitivity of a positive patient response was 28% and the positive predictive value was 36%. The sensitivity of a positive patient response rose to 68% if the unreturned questionnaires were excluded. For surgeon questionnaires, if a response of possible SSI was interpreted as negative, the sensitivity was 15% and the positive predictive value was 28%. If possible SSI was considered a positive response, these figures were 24% and 19%, respectively.

Performance characteristics of selected automated screening criteria. The performance characteristics of separate components of our automated screening are shown in figure 3, along with the performance of patient and surgeon questionnaires. Coded diagnoses, tests, and treatments in the ambulatory medical record identified 84% of infections (93/111), with a positive predictive value of 17% (93/533). Dispensing of an antibiotic commonly used to treat soft tissue infections was next best, with a sensitivity of 50% (56/111) and a positive predictive value of 19% (56/289). No other single component had a sensitivity >40%. A hospital-based surveillance program that reviewed all emergency room visits and hospital readmissions would have had a sensitivity of 39% (43/111) and a

Table 2. Predischarge and postdischarge SSI rates within specific National Noscocomial Infection Surveillance (NNIS) procedure categories.

Operative category	NNIS code	n (% of total)	No. of predischarge SSIs	Predischarge SSI rate (%)	No. of postdischarge SSIs	Postdischarge SSI rate (%)	% of SSIs occurring after discharge	% of postdischarge SSIs
Coronary bypass/leg incision	cbgb	96 (1.7)	7	7.3	13	13.5	65	11.7
Coronary bypass/single incision	cbgc	6 (0.1)	1	16.7	0	0.0	0.0	0.0
Cardiac valve and septum	card	31 (0.6)	1	3.2	2	6.5	66.7	1.8
Thoracic surgery	thor	83 (1.5)	0	0.0	0	0.0	NA	0.0
Other cardiovascular	ocvs	45 (0.8)	0	0.0	3	6.7	100	2.7
All cardiothoracic		261 (4.7)	9	3.4	18	6.9	67	16.2
Vascular	vs	91 (1.6)	1	1.1	4	4.4	80	3.6
Nephrectomy	neph	27 (0.5)	0	0.0	0	0.0	NA	0.0
Organ transplant	tp	5 (0.1)	0	0.0	1	20.0	100	0.9
Prostatectomy*	prst	23 (0.4)	0	0.0	1	4.3	100	0.9
Other genitourinary system	ogu	293 (5.3)	3	1.0	9	3.1	75	8.1
All urology		348 (6.2)	3	0.9	11	3.2	58	9.9
Skin graft	skgr	19 (0.3)	0	0.0	2	10.5	100	1.8
Other integumentary system	oskn	499 (9.0)	0	0.0	13	2.6	100	11.7
All plastic surgery		518 (9.3)	0	0	15	2.9	100	13.5
Abdominal hysterectomy	hyst	151 (2.7)	1	0.7	3	2.0	75	2.7
Vaginal hysterectomy	vhys	55 (1.0)	0	0.0	1	1.8	100	0.9
All gynecologic		206 (3.7)	1	0.5	4	1.9	80	3.6
Mastectomy	mast	471 (8.5)	0	0.0	12	2.5	100	10.8
Splenectomy	sple	18 (0.3)	0	0.0	1	5.6	100	0.9
Appendectomy	appy	132 (2.4)	1	0.8	2	1.5	67	1.8
Bile duct/liver/pancreatic	bili	10 (0.2)	0	0.0	1	10.0	100	0.9
Cholescystectomy	chol	292 (5.2)	0	0.0	7	2.4	100	6.3
Gastric surgery	gast	23 (0.4)	0	0.0	0	0.0	NA	0.0
Small bowel surgery	sb	24 (0.4)	1	4.2	0	0.0	NA	0.0
Colon surgery	colo	83 (1.5)	3	3.6	1	1.2	25	0.9
Herniorrhaphy	her	279 (5.0)	0	0.0	3	1.1	100	2.7
Laparotomy	xlap	72 (1.3)	0	0.0	1	1.4	100	0.9
Other digestive system	ogit	101 (1.8)	0	0.0	1	1.0	100	0.9
All general surgery		1505 (27)	5	0.3	29	1.9	85	26.1
Open reduction fracture	fx	124 (2.2)	1	0.8	2	1.6	67	1.8
Limb amputation	amp	23 (0.4)	0	0.0	1	4.3	100	0.9
Hip prosthesis	hpro	58 (1.0)	0	0.0	0	0.0	NA	0.0
Knee prosthesis	kpro	38 (0.7)	0	0.0	2	5.3	100	1.8
Other joint prosthesis	opro	43 (0.8)	0	0.0	0	0.0	NA	0.0
Spinal fusion	fusn	9 (0.2)	0	0.0	0	0.0	NA	0.0
Other musculoskeletal	oms	537 (9.6)	0	0.0	11	2.0	100	9.9
All orthopedic		832 (14.9)	1	0.1	16	1.9	94	14.4
Craniotomy	cran	54 (1.0)	0	0.0	0	0.0	NA	0.0
Laminectomy	lam	58 (1.0)	0	0.0	0	0.0	NA	0.0
Ventricular shunt	vshn	5 (0.1)	0	0.0	0	0.0	NA	0.0
Other neurosurgical	ons	87 (1.6)	0	0.0	0	0.0	NA	0.0
All neurosurgery		204 (3.7)	0	0.0	0	0.0	NA	0.0
Head and neck surgery	hn	7 (0.1)	0	0.0	0	0.0	NA	0.0
Other otolaryngology	oent	50 (0.9)	1	2.0	0	0.0	NA	0.0
Other hemic/lymphatic	obl	20 (0.4)	0	0.0	0	0.0	NA	0.0
Other endocrine system	oes	49 (0.9)	0	0.0	0	0.0	NA	0.0
Other eye	oeye	7 (0.1)	0	0.0	0	0.0	NA	0.0
Other respiratory system	ores	9 (0.2)	0	0.0	0	0.0	NA	0.0
All other		142 (2.5)	1	0.7	0	0.0	NA	0.0
Nonoperative		1465 (26.3)	0	0.0	14	1.0	100	12.6
Total		5572 (100)	21	0.4	111	2.0	84	100.0

Note. NA, not applicable. *Excludes transurethral resection of prostate.

Table 3. Performance of patient and surgeon questionnaires for the detection of surgical wound infection.

	Patient response				Surgeon response			
Record review	SSI	No SSI	Not returned	Not surveyed	SSI	Possible SSI	No SSI	Not returned
Postdischarge SSI (n = 111)	30	14	63	4	17	10	74	10
No SSI (n = 5440)	53	1699	3510	178	44	93	4172	1131

positive predictive value of 7% (43/622); a program that reviewed ICD-9–specific emergency room visits and hospital readmissions would have had a sensitivity of 30% (33/111) and a positive predictive value of 41% (33/81).

Discussion

The pairing of screening of automated records and review of selected full-text records was both sensitive and efficient for identifying SSI because we retrieved information about outpatient care through automated clinical, laboratory, pharmacy, and administrative data bases; we could review all full-text records of persons who met screening criteria; and patient and surgeon questionnaires identified a negligible number of additional infections.

The percentage of SSIs occurring after hospital discharge was high (84%), reflecting in part the inclusion of procedures done in the ambulatory setting or with a very short stay in the hospital. However, even for major surgical procedures (e.g., cardiac surgery), the majority of SSIs occurred after discharge.

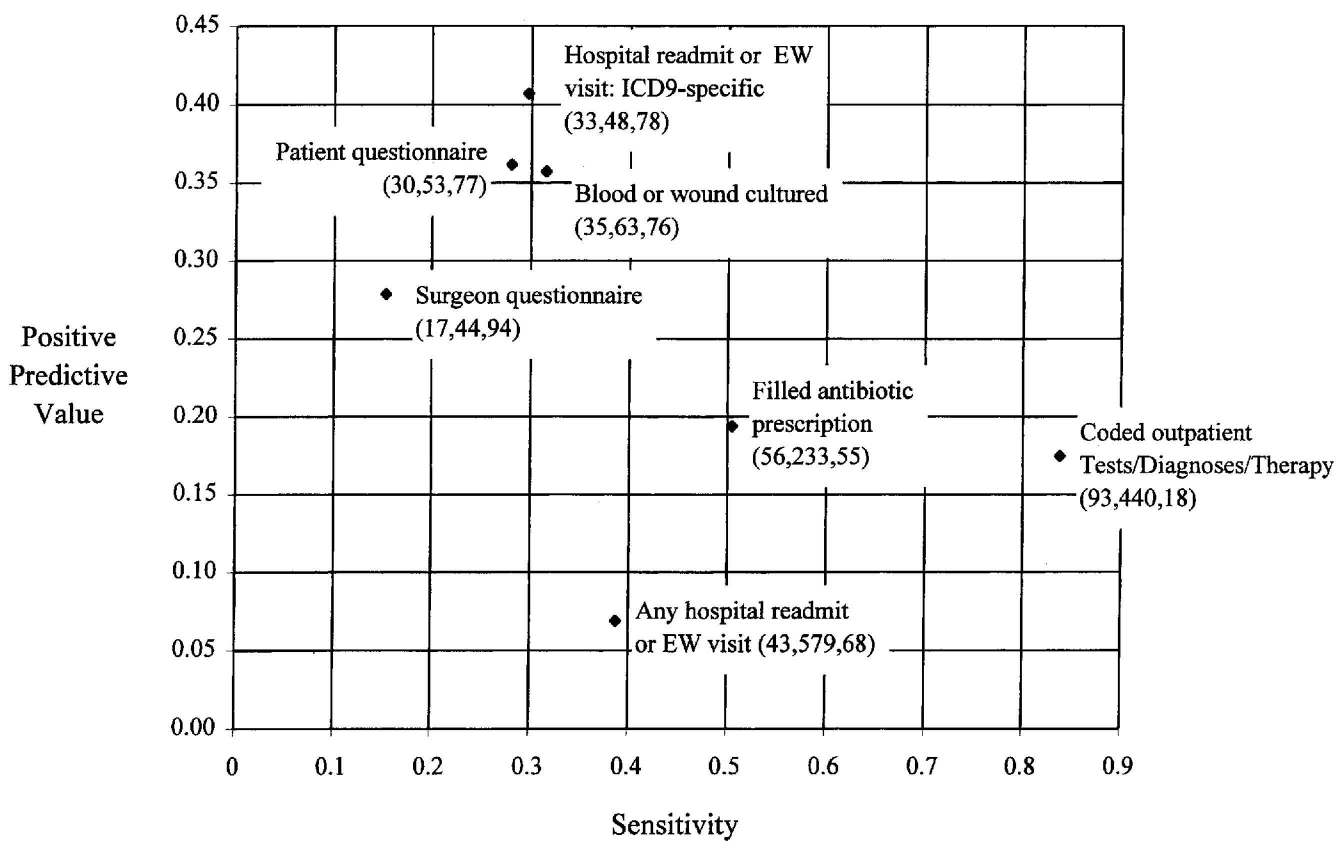

Figure 3. Strategies for screening for postdischarge SSIs. Plot shows sensitivity (x-axis) and positive predictive value (y-axis) of seven candidate methodologies. Numbers in parentheses show number of true-positive, false-positive, and false-negative responses, respectively, for given methodology. All points are based on 111 postdischarge SSIs occurring among 5551 procedures (21 procedures leading to predischarge SSIs were excluded) except "patient questionnaire." Because patient questionnaires were not sent if person was known to be deceased or in hospital at time of mailing, this point is based on 107 SSIs occurring among 5388 procedures.

Furthermore, the majority (63%) of the 84% of SSIs that occurred after hospital discharge were diagnosed and treated entirely in the ambulatory setting. In this cohort, if the institution had identified every predischarge SSI and every postdischarge SSI leading to a rehospitalization or emergency room visit, the recognized SSI attack rate would have been 1.1% (62/5572), while the actual attack rate was 2.4% (132/5572).

These postdischarge SSIs were associated with important resource utilization. There were on average 4.6 outpatient encounters attributable to the SSI and a substantial number of emergency room visits and rehospitalizations. There were a significant number of additional outpatient visits even among the 70 postdischarge SSIs that did not lead to an emergency room visit or rehospitalization: 236 encounters, or an average of 3.4 encounters/SSI for this group. This is a minimal estimate of resource utilization, as only those events occurring within 30 postoperative days and verified as primarily relating to the SSI were included. More accurate assessment of the resource utilization associated with these infections will require assessment of total utilization for those with and without infection, while controlling for important potential sources of bias.

The patient and surgeon questionnaires used in this study proved to have both low sensitivity and positive predictive value for detection of true SSIs. Patient questionnaires were insensitive largely because of the return rate of only 33.4%, a proportion similar to previous studies using a single mailed questionnaire [21]. On the other hand, surgeon questionnaires had a high return rate but were even less sensitive than patient questionnaires because many responses were falsely negative. Potential reasons for the poor sensitivity of surgeon questionnaires include lack of awareness of postdischarge infections (because postoperative follow-up was delivered by a different provider) or failure to remember such infections by the time they received the form.

The reasons for poor predictive value also differed between patient and surgeon responses. For patients, false-positive responses typically represented minor wound complications not meeting criteria for SSI. For surgeons, the majority of false-positive responses related to reporting of preoperatively infected sites, despite the fact that questionnaires included a cover letter explaining that only postoperative events should be reported.

The poor performance of patient and surgeon questionnaires (as a one-time mailing) highlights the need for further investigation of methods of postdischarge surgical site surveillance. The usefulness of patient questionnaires might be improved by strategies to improve the return rate, such as multiple mailings, telephone contacts, or discussing the questionnaire before discharge. For surgeons, other strategies would be necessary, since their response rate was satisfactory. The impact of these maneuvers is not known, but questionnaire performance would have to be dramatically better than the current findings to be a useful and efficient method for routine surveillance.

The current study used a case-finding method designed for maximal sensitivity at the expense of requiring full-text review of >10% of records. Future studies should focus on the methodology or combination of methodologies that provides the best combination of sensitivity and efficiency. We found that review of automated data bases was extremely useful as a screening methodology for SSIs. While there are currently few institutions with access to entirely automated records, these are likely to become increasingly available. An efficient mechanism for capturing emergency room visits and rehospitalizations, ideally in association with coded diagnoses, would allow a hospital to capture 39% of postdischarge SSIs. Screening outpatient antibiotic prescriptions may also be worthwhile. It should also be noted that postdischarge SSI rates varied dramatically among NNIS procedure categories. More than 75% of postdischarge SSIs fell within 17 NNIS categories, representing <50% of procedures. An efficient surveillance program may choose to focus surveillance on certain procedure groups, perhaps tailored to the case mix at that institution. Limiting surveillance to those with a postoperative length of stay of <14 days (the longest postoperative length of stay for which a postdischarge SSI was detected) would not have been an effective method since it would have eliminated the need for surveillance for only 5% of our population. Except for the few procedures with a postoperative length of stay of >14 days, the distribution of postoperative length of stay was very similar for procedures with and without an associated postdischarge SSI, including an identical median of 4 days.

Our overall SSI attack rate is lower than most previously published attack rates for SSIs [3, 5, 10, 12–14, 22–26]. There may be several reasons for this. First, the population included many low-risk procedures (clean, low anesthesiology risk scores, brief duration). Many were ambulatory procedures that have not been carefully studied before this (including >25% categorized as nonoperative by the NNIS classification scheme). Second, our protocol required written documentation of findings meeting the CDC definition of SSI. Events occurring after 30 days were not included and, unlike some studies [26], antibiotic treatment alone for a wound complication did not meet diagnostic criteria. Nonetheless, there was substantial infection-related morbidity and resource utilization. Finally, it is possible that our surveillance failed to detect a significant number of SSIs. We think this unlikely for reasons stated above, but in lieu of a true reference standard, estimates of the number of infections should be understood to be lower bounds and sensitivity measures as upper bounds.

We conclude that the majority of SSIs occur after hospital discharge and that these infections are associated with important morbidity and resource utilization. Identification of SSIs will require that hospitals, managed care organizations, and insurers perform some form of postdischarge surveillance. This investigation has demonstrated the considerable disadvantages of mailed questionnaires, which are both less accurate (lower sensitivity and lower specificity) and more resource-intensive than use of automated administrative and patient care data, which are becoming increasingly available. Additional effort is warranted to identify optimally efficient screening and confirmation methods and to better define the risk factors for postdischarge SSIs that might allow for a surveillance strategy that focuses on high-risk groups.

Acknowledgments

We thank Emily Cain, Michelle Cordeiro, Jeffrey Hansen, and James Livingston for their assistance in this study.

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