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concise communication

Use of Diagnosis Codes and/or Wound Culture Results for Surveillance of Surgical Site Infection after Mastectomy and Breast Reconstruction

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We compared surveillance of surgical site infection (SSI) after major breast surgery by using a combination of *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis codes and microbiology-based surveillance. The sensitivity of the coding algorithm for identification of SSI was 87.5%, and the sensitivity of wound culture for identification of SSI was 78.1%. Our results suggest that SSI surveillance can be reliably performed using claims data.

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Administrative claims data are increasingly being used for surveillance of hospital-acquired infections, because the data are easily accessible, are complete for virtually all patients, and facilitate comparisons across institutions. The major problem with the use of administrative data for surveillance is the uncertain accuracy of the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnosis codes for infectious complications. In the case of surgical site infections (SSIs), the accuracy of *ICD-9-CM* procedure codes to identify specific types of surgical procedures is also important for reliably establishing specific surgical procedure SSI rates.

We previously performed a retrospective case-control study of SSI after major breast surgery.[1] We used data from this study to determine the efficacy of using *ICD-9-CM* diagnosis codes to identify SSI, compared with surveillance based on microbiologic culture results.

methods

The case-control study was nested in a cohort of patients who underwent a mastectomy or breast reconstructive surgery (*ICD-9-CM* procedure codes 85.41–85.48, 85.53, 85.54, 85.7, 85.85, and 85.95) at Barnes-Jewish Hospital (a 1,251-bed, tertiary care hospital affiliated with Washington University School of Medicine) during the period from January 1, 1998, through June 30, 2002, as described elsewhere.[1,2] Potential cases of SSI were identified by use of *ICD-9-CM* diagnosis codes consistent with SSI and/or by use of wound cultures performed during hospitalization or during rehospitalization within 180 days after surgery (for inpatient or outpatient surgical care or emergency department care). The *ICD-9-CM* diagnosis codes included specific SSI codes (ie, 998.5, 998.51, and 998.59) and infection codes unique to breast surgery (996.69, infection and inflammatory reaction due to breast prosthesis; 611.0, inflammatory disease of breast; 682.2, cellulitis of the trunk; and 682.3, cellulitis of the axillae). All administrative and microbiology data were obtained from the Barnes-Jewish Hospital Medical Informatics database. The relevant medical records were reviewed for all patients with positive wound culture result(s) or *ICD-9-CM* diagnosis code(s) suggestive of SSI, to determine signs and symptoms of SSI. The gold standard for detection of SSI was a complete review of the medical records, including microbiology and pharmacy data, to identify cases of SSI meeting the criteria provided by the Centers for Disease Control and Prevention's National Healthcare Safety Network.[3]

The sensitivity, specificity, positive predictive value (PPV), and likelihood ratio were calculated for the SSI diagnosis code algorithm and the wound culture SSI algorithm, and for the surgical procedure codes for each type of breast surgical procedure. All data management and analyses were done with the use of SPSS, version 15.0 (SPSS). Approval for the study was obtained from our hospital's Human Studies Committee.

results

During the 4.5-year study period, 1,200 surgical procedures were given a code or codes for mastectomy and breast reconstruction during hospitalization. Of the 280 patients in the nested case-control study, 236 (84.3%) underwent a mastectomy that was coded; however, after a review of the medical records, it was determined that 239 patients (85.4%) had actually undergone a mastectomy (sensitivity, 98.7%; PPV, 100%). Seventy-eight (27.8%) of the 280 patients had undergone a breast implant insertion that was correctly coded during hospitalization (sensitivity, 100%; PPV, 100%). Seventy patients (25.0%) underwent a procedure that was given the code for transverse rectus abdominus myocutaneous flap reconstruction; however, only 67 (23.9%) patients actually underwent the procedure (sensitivity, 100%; PPV, 95.7%). Twelve patients (4.3%) underwent a latissimus dorsi flap reconstruction that was correctly coded; however, another 4 patients (1.4%) underwent a latissimus dorsi flap reconstruction that was not given the correct *ICD-9-CM* procedure code (sensitivity, 75%; PPV, 100%).

Ninety hospital admissions within 180 days after surgery in 73 patients met the coding and/or microbiologic criteria for potential SSI. Surgical admissions in 2 additional patients were given an admitting *ICD-9-CM* diagnosis code that was consistent with SSI; these 2 cases were excluded, because the surgical procedures were performed on patients with a preexisting SSI.

The number of patients with an SSI that was identified by

TABLE 1. Comparison of the Use of Diagnosis Codes and the Use of Positive Wound Culture Results to Identify Surgical Site Infection (SSI) within 180 Days after Mastectomy and Breast Reconstruction at the Surgical Level

Surveillance method	Patients with SSI (n = 64)	Patients without SSI (n = 1,200)
ICD-9-CM diagnosis codes		
Identified	56	8
Not identified	8	1,128
Wound culture		
Identified	50	4
Not identified	14	1,132

NOTE. The sensitivity of the coding algorithm for identification of SSI was 87.5% (positive predictive value, 87.5%), and the sensitivity of wound culture for identification of SSI was 78.1% (positive predictive value, 92.6%). *ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification.*

use of *ICD-9-CM* diagnosis code(s) and/or wound culture(s) is shown in Table 1. The sensitivity of the coding algorithm for identification of SSI was 87.5%, and the sensitivity of wound culture for identification of SSI was 78.1%. Of the 64 patients with SSI, 42 (65.6%) were identified by use of both *ICD-9-CM* diagnosis code(s) and wound culture(s), 14 (21.9%) were identified by use of *ICD-9-CM* diagnosis code(s) only, and 8 (12.5%) were identified by use of wound culture(s) only. The specificity of the coding algorithm for identification of SSI was 99.3%, and the specificity of wound culture for identification of SSI was 99.6%. The positive likelihood ratio was 125 for the coding algorithm and 195 for wound culture, whereas the negative likelihood ratio was 0.126 for the coding algorithm and 0.220 for the wound culture surveillance method.

Table 2 lists the reasons for miscoding in 13 patients during hospitalization. Two of the 6 patients with positive wound culture results developed an SSI after a subsequent breast surgery, and another patient developed an SSI after adjuvant radiation therapy. Three of the 6 patients identified in error by a positive wound culture result had only rare skin flora isolated in the wound culture and no other indications of SSI. Three of the 7 patients identified in error by the diagnosis code algorithm without positive wound culture results developed either an SSI after another surgical procedure or a central venous catheter–related infection. The diagnosis in the remaining patients identified in error by the diagnosis code algorithm was noninfectious wound complication (hematoma, fat necrosis, epidermolysis, or dehiscence), which was made by their surgeon, without signs or symptoms of SSI.

Of the 90 hospital admissions with an indication of SSI, 79 admissions were given *ICD-9-CM* diagnosis codes consistent with SSI, and patients in 59 admissions had positive wound culture results from tissue samples obtained from the breast or donor site (for patients with autologous flap reconstruction). Patients in 77 of the 90 admissions that met the coding or wound culture algorithm for SSI had an infection that met the criteria for SSI provided by the Centers for Disease Control and Prevention's National Healthcare Safety Network. For these 77 admissions in which the patient had a confirmed SSI, patients in 44 admissions (57.1%) had positive wound culture results, and the admission was given an *ICD-9-CM* diagnosis code suggestive of SSI; 24 admissions (31.2%) were given only an *ICD-9-CM* diagnosis code suggestive of SSI; and patients in 9 admissions (11.7%) had a positive wound culture result, but the admission was not given an *ICD-9-CM* diagnosis code suggestive of SSI.

DISCUSSION

We found that surveillance of SSI after mastectomy and breast reconstruction by using *ICD-9-CM* diagnosis codes was highly sensitive and had a high PPV, compared with surveillance of SSI by using microbiology data. This high sensitivity may be due in part to the use of an expanded group of *ICD-9-CM* codes as SSI indicators, including both specific codes for SSI and infection codes unique to breast surgery. Our results suggest that a combination of operation-

TABLE 2. Reasons for Miscoding in 13 Patients during Hospitalization without Confirmation of Surgical Site Infection (SSI)

Reason for discrepancy	No. of admissions	Admission given *ICD-9-CM* diagnosis code for SSI?	Positive wound culture result?
True SSI attributable to other surgical procedure	2	Yes	Yes
Infection attributed to adjuvant radiation therapy	1	Yes	Yes
Noninfectious wound complication	1	Yes	Yes[a]
Noninfectious wound complication	4	Yes	No
Central venous catheter–related infection	2	Yes	No
True SSI attributable to other surgical procedure	1	Yes	No
Noninfectious wound complication	2	No	Yes[a]

NOTE. *ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification.*

[a] Cultures positive for rare skin flora with no other indications of SSI.

specific *ICD-9-CM* diagnosis codes can be used with a high degree of accuracy to perform SSI surveillance.

We also found that the coding of breast surgeries resulted in a high degree of accuracy to perform SSI surveillance, with the exception of the sensitivity for latissimus dorsi flap reconstruction. The sensitivity of *ICD-9-CM* procedure codes for identification of mastectomy was previously reported to be 100%, with a PPV of 94%.[4] To our knowledge, our study is the first to compute estimates for the PPVs of *ICD-9-CM* procedure codes for breast reconstruction procedures. Determining the validity of coding of individual operative procedures is important for investigators using administrative data to study variation in SSI rates after individual surgical procedures.

Undercoding of infections, which results in low sensitivity, is thought to be the major deterrent to use of *ICD-9-CM* diagnosis coding algorithms to identify SSI. To compensate for the potential for low sensitivity, some investigators have used a very comprehensive list of *ICD-9-CM* diagnosis codes to perform surveillance for SSI. Sherman et al[5] and Stevenson et al[6] included diagnosis codes for a number of potentially noninfectious wound complications (eg, dehiscence, nonhealing wound, postoperative fistula, and open wound) and infections unlikely to be associated with SSI (eg, cryptococcal and trypanosomiasis meningitis) to identify SSI after 9 different surgical procedures. Not surprisingly, the PPVs of the combination of codes used for identification of SSI were low in both studies.

In contrast, other studies have used a more restricted set of *ICD-9-CM* diagnosis codes to identify SSI, primarily 998.5, 995.51, and 998.59 (postoperative infection).[7-9] Best et al[7] used the 998.5 code to identify SSI after major noncardiac operations in the Department of Veterans Affairs National Surgical Quality Improvement Program database. This single code had a sensitivity of 21.3% and a PPV of 34.7%, compared with the sensitivity of SSI surveillance performed by trained surgical nurses. In a small study, Hebden and Roghmann[9] found that the 998.5 code was 100% sensitive and had a PPV of 62% to identify sternal SSI after coronary artery bypass surgery. In the multicenter study by Yokoe et al,[8] the sensitivity of using the 998.5, 998.51, and 998.59 codes to identify SSI, compared with the sensitivity of using routine infection control surveillance, was 54%–61% after coronary artery bypass surgery and 50%–70% after breast operations, with PPVs ranging from 58% to 86%.

Additional diagnosis codes have been used to tailor SSI surveillance to individual surgical procedures, including the use of code 996.6 to identify SSI after knee and hip arthroscopy,[10-12] and the use of codes 670 and 674.3 to identify endometritis and SSI after cesarean section.[8,13] The use of these codes in combination with code 998.5 to identify SSI resulted in a sensitivity of 88%–89% after total joint replacement surgery[10-12] and 48%–89% after cesarean section.[8,13]

There are some limitations to our study. Complete review of the medical record to identify SSI on the basis of definitions provided by the Centers for Disease Control and Prevention's National Healthcare Safety Network was performed only for individuals whose case of infection was identified by use of *ICD-9-CM* diagnosis codes consistent with SSI and/or by use of wound culture, as well as a random subset of control patients who showed no indications of infection. Thus, our calculations of the sensitivity and specificity of the coding algorithm and wound culture surveillance method assume that no additional infections would have been identified in the remaining population without medical record review. In addition, our surveillance methods would not have identified individuals with SSI who were seen in follow-up at another institution or individuals in whom SSI was diagnosed in outpatient clinics, if cultures were not obtained and the visits were not coded for SSI. Thus, our methods likely underestimate the incidence of superficial incisional SSI diagnosed in outpatient settings and treated empirically with oral antibiotics. It would be prohibitively expensive to perform postdischarge surveillance for these cases, because identification of these infections would require manual review of all clinic records.

The relatively small sample size resulted in a low prevalence of some operations, making it difficult to estimate the accuracy of coding for these procedures. Barnes-Jewish Hospital is a tertiary care hospital with a large referral population of patients who underwent breast surgery, and our hospital coders may be more familiar with their care and treatment than are coders at small hospitals or institutions with fewer breast surgeries. Despite these limitations, our results suggest that administrative data can be reliably used to perform surveillance for SSIs after some types of surgical procedures. Our results also suggest that a combination of microbiology and administrative data can improve the sensitivity of SSI surveillance.

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