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ICD-9-CM Diagnosis Codes vs. Wound Cultures for the Diagnosis of Surgical Site Infection after Mastectomy and Breast Reconstruction

Margaret A. Olsen, Ph.D., MPH and Victoria J. Fraser, MD

Division of Infectious Diseases, Washington University School of Medicine, St. Louis, MO, USA

Abstract

We compared surveillance of surgical site infection after major breast operations using a combination of ICD-9-CM diagnosis codes to microbiology-based surveillance. The sensitivity was 87.5% for the coding algorithm and 78.1% for wound cultures. Our results suggest that SSI surveillance can be reliably performed using claims data.

Surveillance for hospital-acquired infections using administrative claims data is increasing, because the data are easily accessible, complete for virtually all patients, and facilitates comparisons across institutions. The major problem with use of administrative data for surveillance is the uncertain accuracy of the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis codes for infectious complications. In the case of surgical site infection (SSI), accuracy of ICD-9-CM procedure codes to identify the surgical procedures is also important to reliably establish SSI rates for specific procedures.

We previously performed a retrospective case-control study of SSI after major breast operations.¹ We used data from this study to determine the accuracy of ICD-9-CM diagnosis codes to identify SSI compared to surveillance based on microbiology culture results.

METHODS

The nested case-control subset was derived from a cohort of all mastectomy and breast reconstructive operations (ICD-9-CM procedure codes 85.41 – 85.48, 85.53, 85.54, 85.7, 85.85, and 85.95) performed at Barnes-Jewish Hospital (BJH), a 1251-bed, tertiary care hospital affiliated with Washington University School of Medicine, from January 1, 1998 through June 30, 2002, as described previously.²

Potential SSI were identified by ICD-9-CM diagnosis codes consistent with SSI and/or positive microbiology wound cultures during the original operative admission or any readmission (inpatient, outpatient surgical, or emergency department) within 180 days after operation. The ICD-9-CM diagnosis codes included specific SSI codes (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, and 682.2, 682.3; cellulitis of the axilla and trunk). All administrative and microbiology data were obtained by querying the BJH Medical Informatics database. The relevant medical records were

CORRESPONDING AUTHOR: Margaret Olsen, Ph.D., MPH Division of Infectious Diseases Campus Box 8051 Washington University School of Medicine 660 S. Euclid Ave. St. Louis, MO 63110 Phone: (314)-454-8320 Fax: (314)-454-5392 molsen@im.wustl.edu.

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reviewed for all patients with positive wound microbiology cultures or ICD-9-CM diagnosis codes suggestive of SSI to determine signs and symptoms of SSI. The gold standard for detection of SSI was complete review of the medical record, including microbiology and pharmacy data, to identify SSI meeting the CDC/National Healthcare Safety Network (NHSN) definition.³

Sensitivity, specificity, positive predictive values (PPVs), and likelihood ratios were calculated for SSI and individual breast surgical procedures. All data management and analyses were done in SPSS 15.0 (SPSS Inc., Chicago, IL). Approval for the study was obtained from our institutional Human Studies Committee.

RESULTS

During the 4.5 year time period of the study, 1200 hospital admissions were coded for mastectomy and/or breast reconstruction. Of the 280 patients in the case-control subset, 236 admissions (84.3%) were coded for mastectomy, but on review 239 had a mastectomy performed (sensitivity = 98.7%, PPV = 100%). Seventy-eight of 78 admissions were coded correctly for implant placement (sensitivity = 100%, PPV = 100%). Seventy admissions were coded for a transverse rectus abdominus myocutaneous flap reconstruction, although only 67 actually had the procedure performed (sensitivity = 100%, PPV = 95.7%). Twelve admissions were coded correctly for latissimus dorsi flap reconstruction, but 4 admissions in which the procedure was performed were not given the ICD-9-CM procedure code for the reconstruction (sensitivity = 75%, PPV = 100%).

Ninety original surgical or hospital readmissions within 180 days after the procedure in 73 patients met the coding and/or microbiology criteria for potential SSI. Two additional surgical admissions had an admitting ICD-9-CM diagnosis code consistent with SSI and were excluded, since the surgical procedures were performed due to pre-existing SSI in both patients.

The number of patients with SSI identified by ICD-9-CM diagnosis codes and/or wound cultures is shown in Table 1. The sensitivity of the coding algorithm for identification of SSI was 87.5%, compared to 78.1% for wound cultures. Forty-two of the 64 patients with SSI (65.6%) were identified by both ICD-9-CM diagnosis codes and wound cultures, 14 were identified by ICD-9-CM diagnosis codes only (21.9%), and 8 were identified by only wound cultures (12.5%). The specificity of the coding and wound cultures algorithms were 99.3% and 99.6%, respectively. The positive likelihood ratio was 125 for the coding algorithm vs. 195 for the wound culture algorithm, while the negative likelihood ratio was .126 for the coding algorithm compared to .220 for the wound culture surveillance method.

Table 2 lists the reasons for miscoding for the 13 patients with admissions flagged in error. Two of the 6 patients with positive wound cultures had SSI after a subsequent breast surgical procedure, and one had infection following adjuvant radiation therapy. Three of the 6 had positive wound cultures with rare skin flora and no other indicators of SSI. Three of the 7 patients with admissions flagged in error without positive wound cultures had either SSI after another surgical procedure or central venous catheter-related infection. The remaining patients were diagnosed with noninfectious wound complications (hematoma, fat necrosis, epidermolysis, dehiscence) by their surgeon, without signs or symptoms of SSI.

Of the 90 admissions with indicators of SSI, 79 were assigned ICD-9-CM diagnosis codes consistent with SSI, and 59 had positive wound cultures from the breast or donor site (for patients with autologous flap reconstruction). The patient met CDC/NNIS criteria for SSI in 77 of the 90 flagged admissions. Forty-four of the 77 admissions with confirmed SSI had both ICD-9-CM diagnosis codes suggestive of SSI and positive wound cultures (57.1%), 24

had only ICD-9-CM codes consistent with SSI (31.2%), and 9 admissions had positive wound cultures but no ICD-9-CM diagnosis codes suggestive of SSI (11.7%).

DISCUSSION

We found that surveillance of SSI after mastectomy and breast reconstruction using ICD-9-CM diagnosis codes was highly sensitive and had a high PPV compared to identification of SSI 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-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 operations had high accuracy, with the exception of the sensitivity for latissimus dorsi flap reconstruction. The sensitivity of ICD-9-CM procedures codes for identification of mastectomy was previously reported to be 100% with a PPV of 94%.⁴ We believe our study is the first to compute estimates for the PPVs of ICD-9-CM procedures 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, resulting 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. Sherman⁵ and Stevenson⁶ included diagnosis codes for a number of potentially noninfectious wound complications (e.g., dehiscence, non-healing wound, postoperative fistula, open wound), and infections unlikely to be associated with SSI (e.g., 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 authors 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 used the 998.5 code to identify SSI after major noncardiac operations in the Department of Veterans Affairs National Surgical Quality Improvement Program database.⁷ This single code had a sensitivity of 21.3% and PPV of 34.7% compared to SSI surveillance performed by trained surgical nurses. In a small study, Hebden and Roghmann found that the 998.5 code was 100% sensitive and had a PPV of 62% to identify sternal SSI after coronary artery bypass surgery.⁹ In the multicenter study by Yokoe,⁸ the sensitivities of the 998.5, 998.51, and 998.59 codes to identify SSI compared to routine infection control surveillance were 54–61% following coronary artery bypass surgery and 50–70% following breast operations, with PPVs ranging from 58–86%.

Additional diagnosis codes have been used to tailor SSI surveillance to individual surgical procedures, including 996.6 to identify SSI after knee and hip arthroscopy,^{10–12} and 670 and 674.3 for endometritis and SSI after cesarean section.^{8,13} The sensitivity of these codes in combination with 998.5 were 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 based on the CDC/NHSN definitions was only performed for individuals who met the coding and/or wound algorithm, plus a random subset of control individuals without indicators of infection. Thus our calculations of the sensitivity and specificity for the coding and wound culture algorithms 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 and individuals diagnosed with SSI 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 post-discharge surveillance for these cases, since 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. BJH is a tertiary care hospital with a large referral population of breast surgical patients, and our hospital coders may be more familiar with their care and treatment than coders at small hospitals or institutions with fewer breast surgical procedures. 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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Table 1

Comparison of ICD-9-CM Diagnosis Codes and Positive Wound Cultures to Identify SSI within 180 Days after Mastectomy and Breast Reconstruction at the Surgical Level

Indicator of SSI		Surgical Site Infection	
		Yes	No
ICD-9-CM Algorithm	Yes	56	8
	No	8	1128
	Sensitivity	87.5%	
	PPV	87.5%	
Wound Culture	Yes	50	4
	No	14	1132
	Sensitivity	78.1%	
	PPV	92.6%	

Table 2

Summary of Errant Flags in 13 Admissions without Confirmation of SSI

Number of Admissions	ICD-9-CM Diagnosis Code for SSI	Positive Wound Culture	Reason for Discrepancy
2	Yes	Yes	True SSI attributable to other surgical procedure
1	Yes	Yes	Infection attributed to adjuvant radiation therapy
1	Yes	Yes [*]	Noninfectious wound complication
4	Yes	No	Noninfectious wound complication
2	Yes	No	Central venous catheter-associated infection
1	Yes	No	True SSI attributable to other surgical procedure
2	No	Yes [*]	Noninfectious wound complication

^{*} Cultures positive for rare skin flora with no other indications for SSI