Charts versus Discharge ICD-10 Coding for Sternal Wound Infection Following Coronary Artery Bypass Grafting

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Abstract

Background: Sternal wound infection (SWI) in patients undergoing coronary artery bypass grafting (CABG) can carry a significant risk of morbidity and mortality. The objective of this work is to describe the methods used to identify cases of SWI in an administrative database and to demonstrate the effectiveness of using an International Classification of Diseases, Tenth Revision (ICD-10) coding algorithm for this purpose.

Methods: ICD-10 codes were used to identify cases of SWI within one year of CABG between April 2002 and November 2009. We randomly chose 200 charts for detailed chart review (100 from each of the groups coded as having SWI and not having SWI) to determine the utility of the ICD-10 coding algorithm.

Results: There were 2,820 patients undergoing CABG. Of these, 264 (9.4 percent) were coded as having SWI. Thirty-eight cases of SWI were identified by chart review. The ICD-10 coding algorithm of T81.3 or T81.4 was able to identify incident SWI with a positive predictive value of 35 percent and a negative predictive value of 97 percent. The agreement between the ICD-10 coding algorithm and presence of SWI remained fair, with an overall kappa coefficient of 0.32 (95 percent confidence interval, 0.22–0.43). The effectiveness of identifying deep SWI cases is also presented.

Conclusions: This article describes an effective algorithm for identifying a cohort of patients with SWI following open sternotomy in large databases using ICD-10 coding. In addition, alternative search strategies are presented to suit researchers' needs.

Keywords: ICD-10 coding algorithm, deep sternal wound infection, sternal wound dehiscence

Background

Sternal wound infection (SWI) following coronary artery bypass grafting (CABG) is a challenging complication of the median sternotomy surgical approach. A comprehensive definition of SWI is described by El Oakley and Wright.[1] They describe mediastinal wound infection as "clinical or microbiological evidence of infected presternal tissue and sternal osteomyelitis with or without mediastinal sepsis and with or without unstable sternum."[2] The incidence of SWI reported in the literature varies, generally ranging from 0.4 to 4 percent.[3–13] Despite being a relatively infrequent event, SWI following median sternotomy carries a significant risk of morbidity and mortality and is a potentially important indicator of care quality and patient safety. Defining which ICD codes accurately identify SWI cases in large administrative databases is helpful for tracking quality of care and monitoring interventions aimed at improving complication rates and patient safety.

The purpose of this report is to provide information on the accuracy of identifying cases of SWI using ICD-10 coding in large databases. SWI is a significant postoperative complication of CABG and is an important measurement of quality of care. The management of occlusive coronary artery disease is in a state of evolution, and protocols describing appropriate management strategies consisting of CABG or percutaneous intervention have recently changed and continue to change.[14–17] Therefore, an effective tool to evaluate outcomes and identify cohorts of patients in large databases with significant postoperative complications such as SWI is needed.

With this in mind, we set out to characterize the incidence of SWI in our patient population through the use of diagnosis codes available in discharge abstract data. In the last decade, our health system transitioned to using ICD-10 coding instead of ICD-9 coding for diagnosis codes. The objective of this work is to describe the methods we used to identify cases of SWI in an administrative database and to demonstrate the utility of using an ICD-10 coding algorithm for this purpose.

Methods

Study Population

This study examined a retrospective cohort of all Alberta patients undergoing CABG between April 1, 2002, and November 30, 2009. Cardiac procedures are performed at two regional cardiac centers in the province.

Data Acquisition

Demographic and clinical data on all patients undergoing procedures are gathered and managed by a provincial database research group called APPROACH (Alberta Provincial Project for Outcome Assessment in Coronary Heart Disease).[18] In addition, hospital discharge abstracts for all acute care patients in the province are reviewed, and ICD-10 codes are reviewed and coded for comorbidities. These two data sources were linked using unique patient identifiers, and comorbidities were "merged" using our method previously described elsewhere.[19] These data sources were used to identify all patients undergoing CABG (APPROACH) and to identify cases of SWI (hospital discharge abstracts). Hospital discharge abstracts were also used to identify cases of SWI up to one year following CABG.

To determine the accuracy of using discharge abstract coding to identify cases of SWI, a detailed chart review was performed on a subset of patients. Specifically, to validate the discharge abstract definition of SWI identified by ICD-10 codes, we randomly chose 100 patients coded as having SWI and 100 patients who were coded as not having SWI within one year of their CABG procedure. This chart review was limited to only one of the two cardiac sites. A detailed chart review abstraction form (see Appendix A) was then used to identify cases of SWI based on the diagnosis definition below.

Definition of Sternal Wound Infection

In 2002, our healthcare system transitioned from ICD-9 coding to ICD-10 coding for diagnostic coding of diseases. A committee of cardiac care researchers, internal medicine physicians, plastic surgeons, and cardiac surgeons met to identify which ICD-10 codes best described SWI following CABG. Using previous work with ICD-9 coding as a guide, the committee translated the codes felt to be most clinically relevant into the ICD-10 coding system.[20–22] The following codes were agreed on by the committee: T81.3, T81.4, T82.7, M86.1, M86.2, and M86.8 (see Table 1). These codes were used to search discharge abstracts for indication of SWI within one year of CABG. Codes T82.7, M86.1, M86.2, and M86.8 were included as a sensitivity measure.

A detailed chart review was then performed to identify the presence or absence of SWI in a random sample of 100 charts coded as having SWI and a random sample of 100 charts coded as not having SWI. Charts were reviewed for the dates of admission and discharge where one of the six codes (T81.3, T81.4, T82.7, M86.1, M86.2, or M86.8) was present. For the patients without SWI after CABG, the charts were searched for admissions within the year following discharge. A standardized chart review form was created to identify cases of SWI based on the definition described by El Oakley and Wright and the Centers for Disease Control and Prevention's National Healthcare Safety Network (CDC/NHSN) criteria, including isolation and culture of organisms, and documented infection by a physician based on clinical signs (erythema, pus, tenderness).[23–25] Only cases of infection at the median sternotomy incision were counted as SWI. Codes T81.3 and T81.4 denote surgical wound infections, but do not specify site; therefore, infections at the saphenous vein donor site may be captured with these codes but were not included. Our interest was to identify all cases of SWI, and therefore we included both superficial infections (El Oakley sternal wound infection subtype A, "superficial wound infections") and deep wound infections (El Oakley sternal wound infection subtype B, "deep wound infection" [mediastinitis]) in the category of SWI.[26]

The number and proportion of patients undergoing CABG who were assigned one of the above ICD-10 codes were identified. Contingency tables were created comparing the 200 randomly selected cases (100 positive for at least one criterion; 100 negative for all criteria) to calculate the positive predictive value (PPV) and the negative predictive value (NPV) of the ICD-10 coding algorithm. The PPV and NPV are, respectively, the proportions of positive and negative results in statistics and diagnostic tests that are true positive and true negative results. A high result can be interpreted as indicating the accuracy of such a statistic.[27] The kappa statistic was calculated to measure the agreement between presence of SWI and assignment of the ICD-10 codes. The kappa coefficient is a statistical measure of interrater agreement. If the raters are in complete agreement, then $\kappa = 1$. If there is no agreement among the raters other than what would be expected by chance, $\kappa = 0$.[28] Statistical analysis was performed using SAS software, version 9.3.[29] This study was approved by the institutional ethics review board of the University of Calgary.

Results

A total of 8,704 patients in Alberta underwent CABG. Of these patients, 6,258 (71.9 percent) had hospital discharge data up to one year following CABG. A total of 2,820 patients (45.1 percent) were from the regional site selected for chart review, and of those, 264 (9.4 percent) were coded as having a postoperative SWI. Using random sampling without replacement, 100 patient charts from the SWI-coded group (264 cases identified through ICD-10 codes) and 100 patient charts from the non-SWI post-CABG group (n = 2,556) were identified. Of these 200 charts, 197 records were available for review.

In total, 38 cases of SWI were identified by chart review (see Table 2). The ICD-10 coding algorithm of T81.3 or T81.4 was able to identify SWI with a PPV of 36 percent and an NPV of 97 percent (Table 3). T81.3 alone had a PPV of 60.6 percent, a NPV of 89 percent, and a kappa statistic of 0.47 (95%CI: 0.31, 0.63). Of the 38 cases of SWI identified using chart review, 35 (92.1 percent) were also identified with the ICD-10 codes of T81.3 or T81.4 and had a kappa of 0.33 (95%CI: 0.22, 0.43), a PPV of 33 percent, and an NPV of 90 percent. The additional codes of T82.7, M86.1, M86.2, and M86.8 did not change the sensitivity of detection of SWI (see Table 3), and the kappa remained fairly constant at 0.32 (95%CI: 0.22, 0.43). With respect to deep SWI, the code T81.3 identified a cohort in which 48.5 percent had a deep SWI, and T81.4 alone identified a cohort in which 31.6 percent had a deep SWI.

Discussion

As described in the methods section, the ICD-10 codes in this study were selected on the basis of a committee discussion of cardiovascular researchers, plastic surgeons, and cardiac surgeons. Two lists of codes were created. One list (not shown) was an "all-inclusive" list of more than 20 ICD-10 codes that could possibly describe SWI, similar to that described by Huang et al.[30] The other list was an "exclusive" list (Table 1), which was thought to consist of the most likely codes describing SWI based on expert opinion. A sensitivity analysis performed to compare the two lists showed that essentially the same list of patients was generated when the database was queried with each, and therefore the exclusive list was used. The additional codes are not being used in our data and likely are not used in data where fewer than 10 diagnosis codes are used. To prevent other research groups from having to undertake the task of selecting which codes best describe SWI, we present the above findings.

As shown in Table 3, the coding algorithm described has a relatively high NPV regardless of which ICD-10 code(s) are used (range, 89–97 percent). Therefore, when our algorithm is used in searching for patients in a data set, the cohort identified as not having SWI will very likely not have SWI. It is recommended that researchers include or exclude ICD-10 codes in their search on the basis of the characteristics they deem important (i.e., high NPV or PPV) as outlined in Table 3.

Additionally, note that ICD-10 codes may identify deep SWI and superficial wound infections as one group despite their being separate clinical entities as outlined by El Oakley and Wright.[31] Code T81.3 alone was able to identify the highest proportion of deep SWIs (48.5 percent), with the additional codes adding primarily superficial wound infection cases to the cohort. These codes, though not perfectly accurate at identifying deep SWI cases, can help a researcher initially flag potential cases for chart review, which in turn reduces the cost of undertaking a chart review.

Hebden describes using ICD-9-CM coding for the identification of SWI cases.[32] The ICD-9-CM code 998.59 was used to identify deep SWI cases, and the authors report 100 percent sensitivity and 98 percent specificity using this code. Huang et al. used ICD-9-CM codes through Medicare claims to track surgical site infections following CABG.[33] They report that a post-CABG surgical site infection was confirmed with chart review 40 percent of the time when cases were identified as having an infection using ICD-9-CM codes. This finding is comparable to the PPV we report using ICD-10 codes (35.7 percent using T81.3 or T81.4). We acknowledge that the lower PPV in the study by Huang et al. was due to the inclusion of a much larger set of diagnosis codes than used in this study. We feel the results described in our work serve as an update to these studies for the ICD-10 coding system. As coding practices may vary, the use of ICD-10 codes to identify SWI cases should not be used as a safety indicator unless the definition is validated with chart review. However, monitoring the incidence of SWI in the same hospital is still a useful exercise because it can identify trends and can be important in patient safety. The proposed definition also offers clinicians and researchers a method of identifying possible cases of SWI (and subtype deep SWI) with reasonable accuracy that is comparable to methods previously described for ICD-9 coding (above).

This study has limitations. Firstly, we reviewed charts only in a single teaching hospital. We acknowledge that a study of additional as well as nonteaching hospitals is also needed. Additionally, the validity of administrative data may vary across hospitals, across regions, and across countries. Therefore, our findings may not be applicable to all regions. Third, we employed chart data extracted by reviewers as a reference standard to assess the validity of ICD-10 data. Such a criterion depends on the quality of charts and can only reflect part of the validity of administrative data. Lastly, our study included chart review for samples from two different cohorts (those coded as having SWI and those coded as not having SWI), so we were only able to characterize diagnostic accuracy (PPV and NPV) and not discern sensitivity or specificity. Despite the fact that quality-of-care evaluations are limited through this detection method, ICD-10 code identification of SWI cases can be helpful in screening for positive cases. Using administrative data to identify "true" cases can save time and minimize the number of charts needed to review for quality-of-care applications. This process will provide savings of time and costs for researchers.

In conclusion, this study describes an effective algorithm for identifying a cohort of patients with SWI following median open sternotomy for CABG in large databases using ICD-10 coding. This work also serves as an update to previous work outlining search strategies using ICD-9 coding.

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Table 1

ICD-10 Algorithm to Define Sternal Wound Infection

ICD-10 Code	Definition
T81.3	Disruption of operation wound, not elsewhere classified (includes: dehiscence/rupture of wound)
T81.4	Infection following a procedure, not elsewhere classified (includes: intra-abdominal post procedural, stitch post procedural, subphrenic post procedural, wound post procedural, sepsis post procedural)
T82.7	Infection and inflammatory reaction due to other cardiac and vascular devices, implants and grafts
M86.1	Other acute osteomyelitis
M86.2	Subacute osteomyelitis
M86.8	Other osteomyelitis

Table 2

Contingency Table to Assess the Validity of the ICD-10 Algorithm (T81.3 or T81.4)

	Chart Review (*N* = 197)	
ICD-10 Code Status	**Positive Wound**	**Negative Wound**
Present (SWI)	35	63
Absent (not SWI)	3	96

Abbreviation: SWI, sternal wound infection.

Table 3

Validity of the ICD-10 Algorithm for Prediction of Sternal Wound Infection Following Coronary Artery Bypass Grafting, According to Specific ICD-10 Code

ICD-10 Code Algorithm	**Prevalence among Charts Reviewed (*N* = 197)**	**Positive Predictive Value (95% Confidence Interval)**	**Negative Predictive Value (95% Confidence Interval)**	**Cases Identified from Chart Review**
T81.3 only	(*n* = 20 + 13) 33 (16.8%)	(*n* = 20/33) 60.6 (44.8, 74.5)	(*n* = 146/164) 89.0 (75.3, 95.6)	16/33 (48.5%)
T81.4 only	(*n* = 26 + 53) 79 (40.1%)	(*n* = 26/79) 32.9 (20.2, 48.8)	(*n* = 106/118) 89.8 (76.3, 96.0)	25/79 (31.6%)
T81.3 or T81.4	(*n* = 35 + 63) 98 (49.8%)	(*n* = 35/98) 35.7 (22.5, 51.6)	(*n* = 96/99) 97.0 (85.9, 99.4)	25/98 (25.5%)
T81.3 or T81.4 or M86.1	(*n* = 35 + 64) 99 (50.3%)	(*n* = 35/99) 35.4 (22.2, 51.3)	(*n* = 95/98) 96.9 (85.9, 99.4)	25/99 (25.3%)
T81.3 or T81.4 or M86.1 or M86.2	(*n* = 35 + 64) 99 (50.3%)	(*n* = 35/99) 35.4 (22.2, 51.3)	(*n* = 95/98) 96.9 (85.9, 99.4)	25/99 (25.3%)
T81.3 or T81.4 or M86.1 or M86.2 or M86.8	(*n* = 35 + 64) 99 (50.3%)	(*n* = 35/99) 35.4 (22.2, 51.3)	(*n* = 95/98) 96.9 (85.9, 99.4)	25/99 (25.3%)
T81.3 or T81.4 or M86.1 or M86.2 or M86.8 or T82.7	(*n* = 35 + 64) 99 (50.3%)	(*n* = 35/99) 35.4 (22.2, 51.3)	(*n* = 95/98) 96.9 (85.9, 99.4)	25/99 (25.3%)

Appendix A

Dehiscence Chart Review Abstraction Form

APHN: ___________________________
RHRN: ___________________________
DOB: ____________________________
Age: ____________
Sex: ______
Weight: ___________________

Coronary Artery Bypass Procedure: Y/N
Vein Graft: Y/N
Single thoracic artery graft: Y/N
Bilateral thoracic artery graft: Y/N

Diabetes: Y/N
Diabetic medication used on admission:
Metformin: Y/N
Glyburide: Y/N
Gliclazide: Y/N
Repaglinide: Y/N
Acarbose: Y/N
Rosigliazone: Y/N
Pioglitazone: Y/N
Insulin: Y/N

Renal Status:
Creatinine level at time of diagnosis: ________________
Dialysis at time of diagnosis: Y/N

Other post-op complications:
DVT: Y/N
Noscomial infection: Y/N
Pneumonia: Y/N
C Difficile: Y/N

Dehiscence:
Leg Wound Dehiscence: Y/N
Side affected (L or R): L/R

Sternal Dehiscence: Y/N _______

Superficial (Skin & subcutaneous tissue only) Y/N

Deep (Sternum non-union) Y/N

(If no here, reviewing of chart is complete)

Dehiscence Procedures:

VAC Placement: Y/N
Duration of VAC Therapy (days): _________

Flap for coverage for defect: Y/N
Type of flap (muscle and skin or skin alone): _____________________

Plastic Surgery Consultation: Y/N
Plastic Surgeon Name: ______________________
Date of Plastic Surgery: ______________________

Infectious Disease Consultation: Y/N
Infectious Disease Physician Name: _____________________________
Date: _________________

Blood Culture Performed: Y/N
Organisms isolated: Y/N
Species of Organism: ___________________________________
Resistance Pattern: ________________________________

Bloodwork:
HbA1C: ____________
WBC: ____________
Platelets: ____________