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Major Article

Validity of administrative data in identifying complex surgical site infections from a population-based cohort after primary hip and knee arthroplasty in Alberta, Canada

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Background: Surgical site infections (SSIs) are a substantial burden to healthcare systems in North America. Administrative data is one method though which these may be identified, but the accuracy of using such data is uncertain.

Methods: We followed a population-based cohort of patients who received primary hip/knee arthroplasty in Alberta, Canada, for whom a comprehensive Infection Prevention and Control (IPC) prospective surveillance methodology was used to track SSIs. Patients were also followed using International Classification of Diseases, Tenth Revision (ICD-10) codes. We assessed the sensitivity/specificity and positive/negative predictive values of ICD-10 codes compared to IPC surveillance.

Results: Between April 1, 2012, and March 31, 2015, 24,512 people received hip/knee arthroplasty. Of these, 258 (1.05%) had a complex SSI found by IPC surveillance. Sensitivity and specificity of ICD-10 codes in identifying complex SSIs after hip/knee arthroplasty were 85.3% (95% confidence interval [CI] 80.3%-89.4%) and 99.5% (95% CI 99.4%-99.6%), respectively. Positive and negative predictive values were 63.6% (95% CI 58.3%-68.7%) and 99.8% (95% CI 99.8%-99.9%), respectively.

Discussion: Administrative data have reasonable testing characteristics for identifying complex SSIs after arthroplasty. For centers without prospective surveillance programs, this could be useful in identifying hospitals with frequent complex SSIs after arthroplasty.

Conclusions: A comprehensive IPC surveillance program is superior at detecting SSIs after arthroplasty.

In the United States and Canada, hospital-acquired infections (HAIs) are a substantial burden on the healthcare systems.[1,2] Although estimates of HAI rates tend to vary, over 700,000 HAIs are contracted by patients receiving medical care in the United States[3] every year, and over 200,000 HAIs are contracted by patients receiving medical care annually in Canada, with approximately 20% of these being surgical site infections (SSIs).[2] In addition to the resulting patient morbidity and mortality from HAIs, there are significant costs to the healthcare systems.[4,5]

To combat HAIs, it is important that appropriate and effective Infection Prevention and Control (IPC) methods are put into place.[5] In the most recent World Health Organization guidelines for effective IPC programs, surveillance is listed as a core component.[5]

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Administrative data are one mechanism by which IPC surveillance can be completed; however, the validity of such data has been questioned.[6] A study of central line-associated bloodstream infection surveillance looked at the use of International Classification of Diseases, Ninth Revision (ICD-9) codes to identify these HAIs compared to more comprehensive IPC surveillance methods.[6] The authors found that, compared to the IPC methods, the sensitivity of ICD-9 codes was only 14% and the positive predictive value (PPV) was only 55%.

In both the United States and Canada, hip and knee arthroplasty procedures are increasing, with approximately 100,000 surgeries performed in Canada and over 1 million surgeries performed in the United States each year.[7,8] Unfortunately, in both the United States and Canada, 1%-2% of patients will develop an SSI after arthroplasty.[9,10] Standard criteria are used to identify superficial, deep, and organ space SSIs, with the latter 2 considered complex infections.[11] Management of these infections varies depending on whether the infection is complex. Complex infections frequently require more aggressive management, including repeat surgeries and hospital admissions, causing patient morbidity and considerable healthcare costs.[12] Therefore, it is important to have accurate IPC surveillance of these infections to identify "hot spots" of infection and to determine the common causative organisms, thus enabling implementation of appropriate preventative protocols and guidelines.

After arthroplasty, many hospitals track SSIs using multifaceted IPC surveillance, including, but not limited to, ICD-9 or International Classification of Diseases, Tenth Revision (ICD-10) codes. In Alberta, approximately 10,000 hip and knee arthroplasties are performed annually, and all patients are followed postoperatively over a 3-month period by IPC professionals to monitor for the development of an SSI. The IPC surveillance team uses multiple methods, including ICD-10 codes, to track SSIs.[13]

This study compared the use of ICD-10 codes alone to the full IPC surveillance methodology using active follow-up and discrete definitions. The goal was to determine the validity of these ICD administrative codes in diagnosing and identifying complex SSIs after hip and knee arthroplasty.

METHODS

To complete this project, data were collected from several administrative databases. The Alberta Bone and Joint Health Institute collects information on all patients who undergo a primary hip or knee arthroplasty in Alberta. These data were used to create a population-based cohort of all patients who underwent a primary hip or knee replacement in Alberta from April 1, 2012, to March 31, 2015. If patients received 2 primary arthroplasties in the study timeframe, only the first surgery was counted so patients were not duplicated in the cohort. If patients developed an infection after the second surgery, this infection was not counted to ensure that the proportion of infections was not falsely elevated. All patients in the cohort had Alberta Healthcare coverage.

The Alberta Health Services (AHS) IPC program collects data prospectively on all SSIs after primary total hip and knee replacement in the province of Alberta for a 3-month period. Infection control professionals at all acute care sites in Alberta conduct traditional surveillance, including electronic review of microbiology laboratory results, patient records, physician records, pharmacy data, reoperation records, readmissions, emergency visit records, and clinic visit records. They also use 7 ICD-10 codes related to infection (Table 1) after arthroplasty.[13] Using this comprehensive approach, they identify all SSIs, categorizing them into superficial versus complex SSIs, using definitions from the Centers for Disease Control and Prevention (CDC) and the National Healthcare Safety Network (NHSN).[11] IPC surveillance for every acute care facility in the province is coordinated through a single provincial team, using a single surveillance protocol and an online data entry system with real-time data entry validation rules. IPC program staff (IPC physicians and professionals) participate in standardized education and local data quality meetings to decide surveillance cases. Additionally, in April 2013, an IPC Data Quality Working Group initiated an additional review of provincial admission and administrative codes to ensure that no cases of SSIs after hip or knee arthroplasty were being missed in the province. This group provides oversight for the entire provincial surveillance system, ensuring minimal variability in practices across the province, and confirming that all surveillance results are reliable. Effectively, IPC staff across the province work as a single surveillance unit. Any complex SSI occurring within 3 months of arthroplasty is unlikely to be missed. The vast majority of SSIs would not occur outside of this 3-month timeframe.[14] All SSIs occurring within 3 months of arthroplasty were recorded from this database.

Table 1
International Classification of Disease, Tenth Revision (ICD-10) codes used by infection control professionals to identify post-arthroplasty surgical site infections

ICD-10 code	Definition
T814	Infection after a procedure, not elsewhere classified
T8182	Persistent postoperative fistula
T847	Infection and inflammatory reaction due to other internal prosthetic devices, implants, and grafts
T8453	Infection and inflammatory reaction due to hip prosthesis
T8454	Infection and inflammatory reaction due to knee prosthesis
T857	Infection and inflammatory reaction due to other internal prosthetic devices, implants, and grafts
T8459	Infection and inflammatory reaction due to unspecified joint prosthesis

AHS Analytics, which provides healthcare data on all Alberta residents, provided discharge abstract database (DAD) information using an Excel spreadsheet on patients in the baseline cohort, including all of their subsequent hospital admissions after their arthroplasty, and the associated hospital ICD codes. We assumed that all patients with complex SSIs would be admitted to a hospital for management.

All patients with a superficial SSI were removed from the cohort to compare the group of patients with complex infections (which, as previously mentioned, are more serious and require more extensive management) to patients in the non-infected group. All remaining patients were then followed for 3 months from the time of their arthroplasty using the DAD database to determine if they had any of the "infection" ICD codes as one of their hospitalization ICD codes. Standard epidemiologic methods were used to calculate sensitivity, specificity, PPV, and negative predictive value (NPV) of the ICD codes. Comprehensive IPC surveillance was used as the "gold standard" criterion, and ICD infection codes were used as the test. This was completed to validate the use of ICD-10 codes in identifying SSIs after arthroplasty.

All statistics were calculated using Stata version 14 software (StataCorp, College Station, Texas). Ethics approval for this project was obtained from the Institutional Research Ethics Board.

RESULTS

Once the patients with a superficial SSI (n = 155) were removed from the cohort, a total of 24,512 patients underwent either a primary hip or knee arthroplasty between April 1, 2012, and March 31, 2015. Of these, 258 (1.05%) were found by IPC surveillance to have a complex SSI during the 3 months after arthroplasty (i.e., the infected cohort), leaving 24,254 patients with no SSI. In the infected cohort, 145 and 113 complex SSIs occurred after a hip and