American Journal of Infection Control 44 (2016) 1310-4

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Use of a provincial surveillance system to characterize postoperative surgical site infections after primary hip and knee arthroplasty in Alberta, Canada

Elissa Rennert-May MD [a,*], Kathryn Bush MSc [b], David Vickers PhD [b], Stephanie Smith MD, MSc [a]

[a] Division of Infectious Diseases, Department of Medicine, University of Alberta, Edmonton, AB, Canada
[b] Alberta Health Services Infection Prevention and Control Surveillance Group, Calgary, AB, Canada

Key Words:
Surveillance
surgical site infections
infection prevention
infection control

Background: Knee and hip replacements are an effective intervention for improving quality of life. Rates of these surgeries in North America are growing, coinciding with increasing obesity and an aging population.
Methods: Alberta Health Services' infection prevention and control program collects data prospectively on surgical site infections (SSIs) after primary total hip and knee arthroplasty completed in Alberta, Canada. We reviewed all SSIs within 180 days of surgical procedures between March 1, 2012, and June 30, 2014.
Results: There were 312 SSI cases reviewed. Rates of SSI (per 100 procedures) were 1.77 and 1.26 for hip and knee arthroplasties, respectively. Seventy-nine percent of infections occurred within 30 days postoperatively. Stratified by time to infection, larger proportions of knee SSIs occurred after 30 days versus hip SSI. Colonization with methicillin-resistant *Staphylococcus aureus* (MRSA) was associated with subsequent infection (odds ratio, 40; 95% confidence interval, 10.2-154.2). We have identified important characteristics that may be helpful for determining optimal prevention strategies.
Conclusions: Intensive postoperative follow-up within 30 days of knee arthroplasty may help to identify SSI early, allowing for prompt treatment and avoiding the need for invasive therapy, such as surgery for hardware revision. Decolonization techniques may decrease subsequent MRSA SSI in colonized patients.

Knee and hip arthroplasties can enhance patient's quality of life through improved mobility and pain relief. According to the Canadian Institute for Health Information, the rate of hip and knee arthroplasties increased by 16.5% and 21.5%, respectively, in the 5 years from 2008-2013. The total number of hip and knee arthroplasties in 2013 was 47,137 and 57,718, respectively, and the most common reason for needing a joint replacement was osteoarthritis.[1] In the United States there are almost 1 million knee and hip arthroplasties performed each year.[2] As the North American population continues to age and also become more overweight, the rates of knee and hip arthroplasties are expected to increase.

In both the United States and Canada, 1%-2% of patients will develop infection after hip or knee arthroplasty.[3,4] Although this is the minority of patients, the absolute number affected is high, and these infections cause significant morbidity for the individual and also contribute substantial costs to the health care system. Patients who have a revision surgery in Canada, secondary to an infection, cost the health care system millions of dollars per year, excluding the physician costs.[3] In the United States, one report anticipates that the cost to U.S. hospitals from infected prosthetic joint revisions will exceed 1.62 billion by 2020.[5]

Postoperative surgical site infections (SSIs) are generally classified as being early (within 3 months of surgery), delayed (3 months to 2 years from surgery), and late (>2 years from surgery).[6] There are specific criteria for distinguishing superficial from deep incisional or organ space infections, including time to infection and features such as purulent drainage and fever.[7] Management options for infected primary knee and hip arthroplasties depend on the time from surgery to infection and the characteristics of the infection.[8] Antimicrobial choices are often guided by the assumption that in early infections more virulent pathogens such as *Staphylococcus aureus* tend to be culprit organisms, whereas in delayed or late infection, organisms such as coagulase-negative staphylococci (CONS) are more commonly isolated. Approximately 11% of the time no organism is found in clinically obvious infections.[6]

* Address correspondence to Elissa Rennert-May, MD, 1-124 Clinical Sciences Building, 11350-83 Ave, Edmonton, AB, Canada T6G 2G3.
E-mail address: rennertm@ualberta.ca (E. Rennert-May).
Conflicts of Interest: None to report.

0196-6553/
http://dx.doi.org/10.1016/j.ajic.2016.03.021

Considering the increasing frequency of hip and knee replacement surgeries, and the cost of infection to both the patient and health care system, to date there are relatively few population-based studies that use surveillance data to explore SSI after primary hip and knee arthroplasty. There is a lack of literature determining causative pathogens for SSI, information that is needed to guide appropriate empirical management. There is also a paucity of research comparing differences between hip and knee arthroplasty SSI, including time to infection.

This study examines data from a provincial infection prevention and control (IPC) surveillance system for SSI in Alberta after primary hip and knee arthroplasties. The primary objectives of this study are to explore similarities and differences between infection rates in hip and knee arthroplasties and look at time to infection, causative pathogens, and impact of preoperative colonization with antimicrobial-resistant organisms (AROs) on postoperative infectious pathogens.

METHODS

The Alberta Health Services' IPC group prospectively collects data on all SSI after primary total hip and knee replacements completed in the province of Alberta. This information is entered into a provincial surveillance database that was used for this research. Traditional IPC surveillance is conducted by infection control practitioners at all acute care sites in Alberta. Cases of SSI are detected by electronic review of microbiology laboratory results; review of patient charts, including observation of the incision, physician record, and pharmacy data; reoperation records; readmissions; emergency visit records; and clinic visit records. Provincial surveillance is centralized using a Web-based data entry platform, and surgical procedures in all acute care facilities are monitored so that each patient is counted only once. In April 2013, an IPC data quality working group began completing an additional review of provincial admission and disease administrative codes to ensure no cases of SSI after hip and knee arthroplasty were being missed across the province. We are confident that few cases of deep or organ space infection would be missed because all hospitals in the province participate in this surveillance. Occasionally superficial infections may be missed if the patient was only seen by their general practitioner and was treated as an outpatient.

The database contains records from surgeries originally completed at 6 urban hospitals located within Calgary or Edmonton, the 2 major cities in Alberta, and 7 nonurban hospitals located throughout the rest of the province. Any infections found within 180 days from their surgical procedure, regardless of where the patient presented in Alberta, are attributed to the original site of surgery. Nonurban sites generally have less infection control support and complete fewer surgeries; therefore, records were classified into urban and nonurban to determine if these factors impacted infection rates. Characteristics recorded were age of the patient at time of surgery, sex, hospital site of the surgery, time from the operation to infection, American Society of Anesthesiologists physical classification, and National Healthcare Safety Network (NHSN) classification. Positive preoperative screening results for the ARO methicillin-resistant *S aureus* (MRSA) and vancomycin-resistant *Enterococcus* spp were also recorded when known. This screening was not done routinely on every patient prior to surgery, but if they had been admitted to hospital in the previous 6 months, were previously colonized, or had a history of incarceration or homelessness, it would be completed. This risk stratification system results in screening approximately 5% of patients undergoing hip or knee arthroplasty in Alberta. Unscreened patients are felt to be at very low risk of preoperative colonization with MRSA. Causative pathogens of SSI were recorded in the database when identified. The number of surgical samples sent is not standardized across the province and varies hospital to hospital, but generally at least 3 samples are sent for analyses. Pathogens are identified using standard microbiologic techniques in Alberta, which are a gram stain and culture on synovial fluid and periprosthetic tissue samples and culture of any prosthetic material sent. Gram stains are completed with methanol fixation and routine staining, and cultures are done by inoculating various culture plates and liquid media. No polymerase chain reaction, histology, or sonication is routinely done.

The NHSN classification is a score index that predicts a patient's risk of acquiring an SSI. The classification ranges from low risk with a score of 0 to high risk with a score of 2 and uses the American Society of Anesthesiologists score and the duration of surgery to determine the score assigned to a patient. The types of SSI were recognized and subsequently categorized by infection control practitioners according to the NHSN and Centers for Disease Control and Prevention definitions into superficial incisional, deep incisional, and organ space infections.[7]

Cases were reviewed in the database from when the surveillance program initiated in April 2012 to June 2014. During 2012-2013, the database recorded all cases of SSI after primary hip and knee arthroplasty that occurred within 12 months of the operation. However, during 2013-2014, the surveillance period only extended for 6 months from the time of operation. Therefore, to maintain consistency across all years, cases found between 6 and 12 months were excluded from analyses. This resulted in the elimination of 9 cases. A time series regression was completed on the change in infection rates after hip and knee arthroplasty over time by year.

For most analyses, time to infection was grouped as ≤30 days, 31-90 days, and >90 days. Pathogenic organisms were organized categorically when identified. When >1 organism was known, the infection was labeled as polymicrobial, but the individual pathogens were also considered in the analyses in their respective categories (eg, if an infection had a gram-negative bacilli [GNB] and a MRSA it would be added into the polymicrobial, MRSA, and GNB categories).

An analysis of variance was used to determine if the average age of the patient had a significant impact on the time to infection. The χ^2 analyses were used for comparing differences in categorical variables between hip and knee arthroplasty. This was used for type of SSI (ie, superficial incisional vs deep incisional vs organ space) and causative pathogens. The χ^2 proportions were also used to determine the relationship between time to infection and *S aureus* versus CONS, to determine the relationship between time to infection and GNB versus all other organisms, and to determine if there was a difference in time to infection when classified by surgical site. If there were significant results, time-to-event curves were represented using a Kaplan-Meier plot. A multinomial logistic regression was used to determine if time to infection and anatomic site of surgery interacted to impact causative organisms isolated. The *t* tests were used to determine if average rates of infection varied between the urban and nonurban sites when stratified by anatomic surgical site and overall.

Odds ratios were used to establish if presurgical colonization with ARO resulted in greater likelihood of that same ARO being the causative pathogen in an SSI.

All tests of significance were performed at the 5% level using Stata 13 (StataCorp, College Station, TX). This research received ethics approval from an institutional research ethics board.

RESULTS

A total of 312 cases of SSI after primary arthroplasty were available for review with a surveillance period of 180 days after original