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Inpatient surgical site infection after shoulder arthroplasty

Mia Smucny, MD[a], Mariano E. Menendez, MD[b], David Ring, MD, PhD[b], Brian T. Feeley, MD[a], Alan L. Zhang, MD[a,*]

[a]*Department of Orthopaedic Surgery, University of California–San Francisco, San Francisco, CA, USA*
[b]*Hand and Upper Extremity Service, Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA*

Background: Surgical site infection (SSI) after joint arthroplasty is associated with prolonged hospitalization, reoperation, inferior outcomes, and substantial resource utilization. As the number of shoulder replacements performed in the United States continues to rise, measuring the incidence of inpatient SSI after hemiarthroplasty (HSA) and total shoulder arthroplasty (TSA), and associated risk factors for infection is worthwhile.

Methods: Using the Nationwide Inpatient Sample (NIS), we reviewed 241,193 patients undergoing TSA or reverse TSA and 159,795 undergoing HSA between 2002 and 2011 and identified patients with an associated diagnosis of SSI during the admission. Demographic characteristics, preoperative diagnoses, further surgical procedures, associated comorbidities, and in-hospital events associated with SSI were sought in multivariable logistic regression analysis.

Results: An in-hospital SSI developed in 0.08% of patients undergoing TSA or reverse TSA and in 0.11% of patients undergoing HSA. Independent risk factors for inpatient SSI included TSA vs HSA (odds ratio [OR], 1.83), Medicaid insurance vs private insurance (OR, 3.93), diagnosis of fracture nonunion (OR, 5.76), avascular necrosis (OR 2.71), or proximal humeral fracture (OR, 2.62) vs primary osteoarthritis, comorbidities, in-hospital events (blood transfusion, pneumonia, and acute renal failure), and increased duration of hospital stay.

Conclusions: The small percentage of SSI that occurs during the initial inpatient stay after shoulder arthroplasty is related to diagnoses other than primary osteoarthritis in more infirm patients with low-income government insurance (Medicaid). Patients considering shoulder arthroplasty can use this information to help decide between the potential improvement in comfort and function of the shoulder and the potential for major adverse events such as infection.

Level of evidence: Epidemiology Study, Database Analysis.

Keywords: Shoulder arthroplasty; acute infection; perioperative infection

Institutional Review Board approval was not required for this study because the data used were sufficiently deidentified.

*Reprint requests: Alan L. Zhang, MD, Department of Orthopaedic Surgery, University of California–San Francisco, 1500 Owens St, Box 3004, San Francisco, CA 94158, USA.

E-mail address: alan.zhang@ucsf.edu (A.L. Zhang).

Surgical site infection (SSI) accounts for 20% to 31% of health care-associated infections in hospitalized patients.[16] SSI can prolong hospital stay by 7 to 20 days, and the median cost per admission was 367% that of an uninfected patient ($24,344 vs $6,636).[25] Reducing SSI is a national

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priority, as reflected in the U.S. Department of Health and Human Services National Action Plan to Prevent Healthcare-Associated Infections. This plan strongly emphasizes research focused on the epidemiology of health care-associated infections.[5]

Prosthetic infection can cause pain and disability, implant failure, and occasionally, septicemia, and has an approximate incidence of 1.5% for total shoulder arthroplasty (TSA), hemiarthroplasty (HSA), and reverse total shoulder arthroplasty (RTSA).[1,21-24] A recent study found infection was the most common surgical cause of readmission after shoulder arthroplasty and that these readmissions incurred an average hospital cost of $11,000.[22]

Most prosthetic infections are diagnosed after patients are discharged. In studies of hip and knee arthroplasty, inpatient infections account for approximately one-third of all infections. Perioperative SSI rates were 0.36% for total hip arthroplasty and 0.31% for total knee arthroplasty in a recent study using a national database.[19]

An estimated 47,000 HSA and TSA were performed in 2008 compared with 19,000 a decade earlier.[11] This 2.5-fold increase may be attributed to an aging population, higher prevalence of shoulder and elbow surgeons, increased familiarity with shoulder replacement, expanded indications, and increased patient and surgeon expectations.[22] As the number of shoulder replacements continues to increase, identifying risk factors for infection to inform quality improvement efforts is worthwhile.

Using a national database, we aimed to (1) determine the incidence of in-hospital SSI, including wound infections, wound dehiscence, and deep prosthetic infections after HSA and TSA, and (2) identify factors associated with inpatient SSI. Our primary null hypothesis was that no factors are associated with inpatient prosthetic shoulder infection.

Materials and methods

Nationwide Inpatient Sample (NIS) discharge data for 2002 to 2011 were obtained from the Hospital Cost and Utilization Project and analyzed for this retrospective population-based study. The NIS is the largest all-payer inpatient care database in the United States.[8] Each data set year contains records on approximately 7 to 8 million discharges from more than 1000 randomly selected hospitals to approximate a 20% stratified sample of institutions across the country.[2] Sampling weights are provided to produce statistically valid national estimates. The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes are used in this database. Additional information collected in the sample includes patient-related and provider-related characteristics and inpatient outcomes such as discharge disposition and length of stay.[14] The NIS is useful for studies of inpatient care.[3,9,10,17]

Discharges with a procedure code (ICD-9-CM) for total (81.80, 81.88) or partial (81.81) shoulder arthroplasty were identified and included in the analysis. Surgical indications included osteoarthrosis, proximal humeral fracture, avascular necrosis, fracture nonunion, rheumatoid arthritis, and rotator cuff arthropathy. Patients were stratified into 2 groups: (1) patients with an in-hospital diagnosis of SSI (ICD-9-CM diagnosis codes 998.5 and 996.6), and (2) patients without a diagnosis of SSI.[19] Concomitant comorbidities and other postoperative complications were determined using the ICD-9-CM codes described by Elixhauser et al[6] and Memtsoudis et al,[13] respectively.

Explanatory variables evaluated for each group consisted of age (as a continuous variable), sex, race/ethnicity (white, black, Hispanic, and other), insurance status (Medicare, Medicaid, private, and other), comorbidities, primary diagnosis (osteoarthrosis, proximal humeral fracture, avascular necrosis, rheumatoid arthritis, nonunion of humeral fracture, and rotator cuff arthropathy), year of surgery (2002-2005, 2006-2008, and 2009-2011), and length of hospitalization. Approximately 25% of entries in the race category were not available and were imputed as ''white,'' based on an approach previously described and the observation that facilities with increased rates of missing data for race served populations with higher than average white/black patient ratios.[12,15,19] Rates of SSI (per 1000 discharges) were calculated for all explanatory variables (Table I).

Assuming normal distribution of the data on the basis of the large sample size, we used the Pearson χ^2 test for analysis of categoric data and the independent-samples t test for continuous data. Multivariable binary logistic regression analysis was performed to determine factors associated with an in-hospital diagnosis of SSI (our primary response variable). Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). The area under the receiver operating characteristic curve quantified the ability of our regression model to assign a high probability of infection to those patients who actually had an in-hospital SSI. Values can range from 0.50 to 1.0, with 0.50 indicating no ability to discriminate and 1.0 indicating perfect discrimination. We also assessed global model performance by using the Nagelkerke pseudo R^2, a measure of the proportion of variance explained in the response variable. Statistical significance was set for all analyses to $P < .05$. SPSS 22.0 software (IBM Corp, Armonk, NY, USA) was used for statistical analyses and data modeling.

Results

During the 10-year study period, we identified an estimated 241,193 patients undergoing TSA and 159,795 patients undergoing HSA. Of those, 0.08% (0.8 events per 1000 TSAs) and 0.11% (1.1 events per 1000 HSAs) developed perioperative SSI (Table I). Bivariate analysis showed factors associated with in-hospital diagnosis of SSI included longer hospital stay, TSA, Medicaid insurance, and certain comorbidities and adverse hospital events (Tables II and III). Hospital events associated with SSI included longer hospital stay, nonroutine discharge, pneumonia, blood transfusion, mechanical ventilation, acute renal failure, and gastrointestinal complications (Table III).

After minimizing confounding using multivariable modeling (Table IV), factors associated with inpatient SSI included TSA, specific comorbidities (coagulopathy, renal failure, fluid and electrolyte disorders, and congestive heart