Predictors of extended length of stay after elective shoulder arthroplasty

Mariano E. Menendez, MD[a], Dustin K. Baker, BS[b,c], Charles T. Fryberger, BS[b], Brent A. Ponce, MD[b,*]

[a]Orthopaedic Hand and Upper Extremity Service, Massachusetts General Hospital, Boston, MA, USA
[b]Division of Orthopaedic Surgery, University of Alabama at Birmingham, Birmingham, AL, USA
[c]Medical University of South Carolina, College of Medicine, Charleston, SC, USA

Background: With policymakers and hospitals increasingly looking to cut costs, length of stay after surgery has come into focus as an area for improvement. Despite the increasing popularity of total shoulder arthroplasty, there is limited research about the factors contributing to prolonged hospital stay. We sought to identify preoperative and postoperative predictors of prolonged hospital stay in patients undergoing anatomic total shoulder arthroplasty (ATSA) and reverse total shoulder arthroplasty (RTSA).
Methods: Using the 2011 Nationwide Inpatient Sample, we identified an estimated 40,869 patients who underwent elective total shoulder arthroplasty (62.5% ATSA; 37.5% RTSA) and separated them into those with normal length of stay (<75th percentile) and prolonged length of stay (>75th percentile). Multivariate logistic regression modeling was performed to identify factors associated with prolonged length of stay.
Results: Patient-level factors associated with prolonged length of stay common to patients undergoing ATSA or RTSA included increasing age, female sex, congestive heart failure, renal failure, chronic pulmonary disease, and preoperative anemia. Provider-related factors were lower volume and location in the South or Northeast. Postoperative complications showed a significant influence as well.
Conclusion: Our data can be used to promptly identify patients at higher risk of prolonged hospitalization after elective shoulder arthroplasty and to ultimately improve quality of care and cost containment.
Level of Evidence: Level III, Cross Sectional Design, Database Analysis, Epidemiology Study.
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With health policy placing an increased focus on shifting risk to hospitals and physicians, hospitals are increasing efforts to reduce excessive resource use such as extended length of stay after surgery.[25] Length of stay is often used as an indicator of efficiency in surgery.[9,22] In the United States, the average cost of a single day in the hospital is more than $4,000, so there is little wonder that hospitals have taken aim at this measure to reduce costs.[39]

Furthermore, longer length of stay has been shown to correlate with a greater risk of readmission, another frequent target of hospitals for cost reduction.[18,21,27]

Shoulder arthroplasty is a procedure that is increasing in incidence in the United States, particularly in the last 10 years.[24] Numerous studies have examined the functional outcomes of the different forms of shoulder arthroplasty, proving it to be an effective treatment for the degenerative shoulder.[6,33,37,41,42] Several large database studies have also examined postoperative outcomes of shoulder arthroplasty using cost or length of stay as a metric.[11,17,35] However, no study has fully examined patterns of resource utilization among patients undergoing shoulder arthroplasty.

This study used nationally representative data to identify preoperative and postoperative predictors of prolonged hospital stay in patients undergoing anatomic total shoulder arthroplasty (ATSA) and reverse total shoulder arthroplasty (RTSA).

Materials and methods

The Nationwide Inpatient Sample (NIS), the largest publicly available inpatient database, was the source for all diagnostic data used in this study.[2] Updated yearly since 1988, when the Agency for Healthcare and Quality first sponsored it, the survey is a random 20% sample of data from the State Inpatient Databases and has been deemed statistically valid.[2,30] Up to 25 medical diagnoses and 15 procedural diagnoses can be identified in the NIS by using the International Classification of Disease, Ninth Addition, Clinical Modification (ICD-9-CM) codes, allowing an accurate method of reporting comorbid conditions. In addition, the NIS database was used to gather all demographic, hospital characteristic, and clinical data used in our analysis. The NIS database is a widely recognized resource for its utility to answer clinical questions requiring large, representative sample sizes.[5,7,10,14,30,32]

Our study population consisted of adults (aged ≥18 years) undergoing elective ATSA or RTSA between January 1, 2011, and December 31, 2011. Discharges with an ICD-9-CM procedure code for TSA (81.80) and RSA (81.88) were included in the sample. The analysis excluded nonelective shoulder arthroplasty cases (eg trauma) to have a more homogeneous sample. As described previously, prolonged hospital stay was defined as a length of stay greater than the 75th percentile for each procedure.[12,32,35] Postoperative complications and preoperative comorbidities were codified and aggregated with the use of ICD-9-CM codes and Clinical Classifications Software (Healthcare Cost and Utilization Project) categories.[16,20,31,35] The Clinical Classifications Software categories allow practical statistical analysis and reporting by aggregating large numbers of individual ICD-9-CM codes into discrete diagnostic groups.

Three groups of explanatory variables were studied: (1) patient demographics and comorbidities, (2) hospital characteristics, and (3) postoperative complications. Specifically, patient demographics included age (continuous and categorically discrete groups: ≤64, 65-74, 75-84, and ≥85 years), sex, race/ethnicity, household income based on zip code analysis (≤$38,999, $39,000-$47,999, $48,000-$62,999, and ≥$63,000), insurance status, and primary diagnosis. Comorbid conditions included hypertension, congestive heart

failure, diabetes mellitus, peripheral vascular disorders, chronic pulmonary disease, obesity, hypothyroidism, liver disease, renal failure, depression, and deficiency anemia. Hospital characteristics studied were volume of procedures done at hospitals based on a previously outlined technique to determine patient-based tertiles (low, intermediate, high: <12, 12-27, ≥28 cases for RTSA, respectively, and <18, 18-40, ≥41 cases for ATSA, respectively), hospital teaching status, and hospital geographic region (Northeast, Midwest, South, West).[36] Finally, postoperative complications were defined as surgical (perioperative hemorrhage/hematoma, surgical site infection, acute postoperative anemia) and medical (acute renal failure, acute myocardial infarction, pneumonia, pulmonary embolism) complications. Among an estimated 40,869 patients, 15,313 (37%) underwent RTSA and 25,556 (63%) underwent ATSA.

Normal distribution of data was assumed on the basis of the large sample size. In bivariate analysis (Tables I-III), the groups with normal length of stay and prolonged length of stay were compared by Pearson χ^2 test for categoric data and the independent samples t test for continuous data. Multivariable binary logistic regression analyses (Table IV) were performed to identify factors associated with extended length of stay after ATSA and RTSA. Results are reported as odds ratios with 95% confidence intervals. A P value of <.05 was deemed to be statistically significant in all analyses. The area under the receiver operating characteristic (ROC) curve and the Hosmer-Lemeshow test were used to evaluate model discrimination and calibration, respectively. SPSS 22.0 software (IBM Corp, Armonk, NY, USA) was used for all statistical analyses and data modeling.

Results

After controlling for confounding effects in multivariable analysis, among the patient-level factors associated with extended length of stay common to patients undergoing ATSA or RTSA were advanced age, female sex, and several comorbidities, including as congestive heart failure, chronic pulmonary disorders, renal failure, and deficiency anemia. Hospital-level factors associated with extended length of stay common to patients undergoing ATSA or RTSA included low and intermediate surgical volume and hospital region (Northeast and South). Postoperative complications, reported as ≥1 surgical complication and ≥1 medical complication, were also highly associated with extended length of stay. A primary diagnosis of avascular necrosis was associated with extended length of stay in RTSA, whereas a primary diagnosis other than osteoarthritis, rheumatoid arthritis, avascular necrosis, or cuff arthropathy was a risk factor in ATSA. These results, with P values, odds ratios, and 95% confidence intervals, are reported in Table IV.

Discussion

Length of stay is an important measure for assessing efficiency in surgical procedures.[9,22] Previous studies have examined risk factors for increased length of stay related to