RESEARCH ARTICLE

The "July Effect" on Shoulder Arthroplasty: Are Complication Rates Higher at the Beginning of the Academic Year?

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Abstract

Background: The "July effect" is a colloquialism asserting an increased rate of errors at the start of the academic year in teaching hospitals. This retrospective population-based study evaluated for the presence of the July effect in performing shoulder arthroplasty.

Methods: Using the Nationwide Inpatient Sample for 2002 through 2011, a total of 178,590 patients undergoing shoulder arthroplasty at academic medical centers were identified and separated into 2 groups: 1) patients admitted during July and 2) patients admitted between August and June. Multivariable logistic regression was used to identify associations with inpatient mortality and adverse events, blood transfusion, prolonged length of stay (>75th percentile) and non-routine discharge.

Results: After adjusting for patient, procedure, and hospital characteristics in multivariable modeling, admission in July was not associated with increased risk for inpatient mortality (OR 1.6) aggregate morbidity, blood transfusion, prolonged length of stay, and non-routine discharge.

Conclusion: This nationwide database analysis shows that shoulder arthroplasty at academic medical centers is not associated with increased perioperative morbidity and resource utilization during the month of July.

Level of evidence: III

Keywords: Complications, July effect, Nationwide inpatient sample, Resident education, Shoulder arthroplasty, Teaching hospitals

Introduction

The "July Effect" is a colloquialism that implies there are more hospital errors when new surgical resident trainees begin in July, resulting in increased complications and mortality. Database studies have examined this across many specialties and found varying results when evaluating mortality rates, length of stay, and medication errors (1–8). Shoulder arthroplasty is increasingly being performed in older patients with more complex comorbidities, resulting in longer lengths of hospital stay (9–11). Because this population may be older and more infirm than those undergoing other orthopaedic surgeries, they constitute an appropriate sample for analysis. We postulate that patients undergoing total shoulder arthroplasty or reverse shoulder arthroplasty have no difference in mortality or adverse events in the month of July compared to the months of August through June.

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Materials and Methods

Data Source

We conducted a retrospective population-based study using discharge records from the Nationwide Inpatient Sample (NIS) from 2002 through 2011. The NIS is compiled by the Agency for Healthcare Research and Quality, and constitutes the largest inpatient care database in the United States. The NIS collects data from a 20% stratified sample of all acute-care hospitalizations across the nation. This amounts to nearly eight million discharges from more than 1000 short-term and non-Federal hospitals each year. Therefore, when extrapolated the data represents approximately 40 million discharges. Besides incorporating patient- and hospital-level data, the NIS collects up to 25 diagnoses and 15 procedures (standardized with the *International Classification of Diseases, 9th Revision, Clinical Modification* [ICD-9-CM] codes), and several hospitalization outcomes such as length of stay and discharge disposition. The NIS has been increasingly used for comparative health services research since its inception in 1988 (12-14). Formal approval by our Institutional Review Board was not required, as the data contained no personal identifiers.

Identification of Sample and Definitions

We considered all adult (≥18 years) patients undergoing total (ICD-9-CM codes 81.80, 81.88) or partial (81.81) shoulder arthroplasty at academic medical centers between January 1, 2002 and December 31, 2011 (15). Using data from the American Hospital Association Annual Survey of Hospitals, the NIS considers a hospital to be a teaching institution if any of the following 3 criteria are met: (1) residency-training approval by the Accreditation Council for Graduate Medical Education, (2) membership in the Council of Teaching Hospitals, or (3) a resident to beds ratio of 0.25 or more (16, 17). In order to evaluate for the presence of the "July effect" within shoulder arthroplasty, we stratified patients into two groups: (1) patients admitted in the month of July, and (2) patients admitted between August and June. Among 178,590 patients undergoing shoulder arthroplasty, 13,612 (7.6%) were admitted in July [Table 1].

Patient-level variables were age, sex, race/ethnicity (white, black, Hispanic, other), primary health insurance (private, Medicare, Medicaid, other), median household income of the patient's zip code of residence ($1-$38,999, $39,000-$47,999, $48,000-$62,999, and ≥$63,000), and baseline comorbidity status (quantified with the Elixhauser comorbidity algorithm) (18). We also collected data on the primary indication for shoulder arthroplasty: osteoarthrosis, proximal humerus fracture, avascular necrosis, rheumatoid arthritis, fracture nonunion, rotator cuff arthropathy, and other. Hospital-related variables included rural/urban location and geographic region (Northeast, Midwest, South, and West).

By use of ICD-9-CM codes, we decided *a priori* to consider the following in-hospital adverse events due to their incidence and impact in the perioperative shoulder surgery setting: myocardial infarction (410.

Table 1. Baseline characteristics of patients undergoing shoulder arthroplasty in academic teaching hospitals

Parameter	Month of Admission	
	July	August-June
Total N (%)	13,612 (7.6)	164,978 (92.4)
Age in years, mean±SD	68±12	68±12
Sex, %		
Female	63	59
Male	37	41
Race/ethnicity, %		
White	91	91
Black	4.4	3.8
Hispanic	2.1	2.5
Other	2.7	2.4
Median household income, %		
$1-$38,999	17	18
$39,000-$47,999	23	24
$48,000-$62,999	28	27
≥$63,000	32	32
Primary health insurance, %		
Private	29	29
Medicare	63	63
Medicaid	2.8	2.9
Other	5.3	4.9
Elixhauser comorbidity score, mean±SD	1.8±1.4	1.8±1.4
Primary diagnosis, %		
Osteoarthrosis	63	62
Proximal humerus fracture	15	15
Avascular necrosis	3.7	3.5
Rheumatoid arthritis	1.8	1.7
Non-union of humerus fracture	2.4	2.4
Rotator cuff arthropathy	8.9	9.6
Other	5.5	5.7
Type of arthroplasty, %		
Total	60	61
Partial	40	39
Hospital location ,%		
Rural	3.7	3.4
Urban	96.3	96.6
Hospital region, %		
Northeast	21	21
Midwest	33	34
South	26	26
West	20	19

xx), pneumonia (481, 482.x, 483.x, 484.x, 485, 486, 997.31, 997.39), deep vein thrombosis (451.11, 451.19, 451.2, 451.81, 451.9, 453.40-2, 453.8-9), pulmonary embolism (415.1, 415.11, 415.13, 415.19), surgical site infection (996.67, 998.59), acute renal failure (584.x), postoperative ileus or other gastrointestinal events (997.49, 560.1, 560.9, 560.81, 536.2, 537.3), mechanical ventilation (93.90, 96.70-72), and acute posthemorrhagic anemia (285.1) (15, 19–22).

Statistical Analysis

Multivariable logistic regression models were used to assess the association of July admission with predetermined study outcomes: inpatient mortality and adverse events, blood transfusion, prolonged length of stay (>75th percentile), and non-routine discharge (discharged to location other than home) (23). All covariates (demographics, comorbidities, surgical indication, procedure type, and hospital characteristics) were defined *a priori* and entered into the models simultaneously, without further selection. Results were reported as odds ratios (OR) with 95% confidence intervals (CI). To correct for multiple comparisons and the large sample size, statistical significance was set at *P<0.001*.

Results

After adjusting for patient, procedure, and hospital characteristics in multivariable modeling, we found that admission in July was not associated with increased risk for inpatient mortality (OR 1.6, 95% CI 1.0-2.5), aggregate morbidity (OR 0.97, 95% CI 0.92-1.0), blood transfusion (OR 0.99, 95% CI 0.94-1.1), prolonged length of stay (OR 0.97, 95% CI 0.92-1.0), and non-routine discharge (OR 1.0, 95% CI 0.96-1.1) [Table 2].

Discussion

There is a common belief that hospital errors increase during July, the first month of the academic year.[24] In this study, we compared 13,612 shoulder arthroplasty procedures performed in July at teaching hospitals to those performed in the surrounding months and did not find a statistically significant difference in mortality, adverse events, length of stay, or discharge disposition between the two groups.

The "July effect" has been studied for numerous specialties and the data can be conflicting. There are studies in the internal medicine literature that demonstrate worse patient outcomes during the month of July, while others show equivalent complication rates in high-risk patients (1, 8, 25). Liver transplantation has found no difference in complication rates during the month of July in multiple studies (26, 27).

Edelstein *et al.* looked at the orthopaedic field as a whole and found lower mortality and perioperative complication rates in cases where residents were involved (28). Within the spine literature, Nandyala *et al*. found an increased rate of surgical site infections, postoperative DVT, and dysphagia for patients undergoing anterior cervical fusion in July, but no difference in mortality or hospital costs (29). Hoashi *et al.* demonstrated similar complication rates in July compared to other months for patients undergoing

Table 2. Association between month of admission (July v. August – June) and inpatient outcomes in shoulder arthroplasty

	Month of Admission		July, OR (95% CI)†	*P*
	July	August-June		
Mortality, %	0.23	0.13	1.6 (1.0-2.5)	0.020
Combined adverse events, %	12	12	0.97 (0.92-1.0)	0.26
Myocardial infarction	0.37	0.29	1.5 (1.0-2.0)	0.007
Pneumonia	0.91	1.1	0.95 (0.79-1.1)	0.61
Deep venous thrombosis	0.15	0.25	0.62 (0.40-1.0)	0.038
Pulmonary embolism	0.32	0.26	1.4 (1.0-1.9)	0.042
Surgical site infection	0.28	0.27	0.91 (0.63-1.3)	0.61
Acute renal failure	0.84	1.2	0.79 (0.65-1.0)	0.016
Gastrointestinal complication	0.22	0.28	0.71 (0.48-1.1)	0.098
Mechanical ventilation	0.22	0.28	0.71 (0.48-1.1)	0.098
Acute posthemorrhagic anemia	10	9.9	1.0 (0.98-1.1)	0.19
Transfusion, %	8.8	8.9	0.99 (0.94-1.1)	0.95
Length of stay in days, mean±SD	2.8±2.8	2.7±2.7	0.97 (0.92-1.0)*	0.22
Non-homebound discharge, %	32	31	1.0 (0.96-1.1)	0.96

†Adjusted for age, sex, race, income, insurance, Elixhauser comorbidity, diagnosis, procedure, and hospital characteristics.

*Calculated for prolonged length of stay (>75th percentile).

corrective surgery for adolescent idiopathic scoliosis at teaching hospitals (30). Similarly, McDonald *et al.* found no difference in periprocedural outcomes for patients undergoing spine surgery in July (6).

Within the hip and knee arthroplasty literature, Haughom *et al.* found no increase in the 30-day complication rate in over 13,000 cases with resident involvement (31). Likewise, Bohl *et al*. observed no significant increase in perioperative morbidity in over 21,000 patients undergoing hip or knee arthroplasty (32).

In the shoulder arthroplasty literature, Cvetanovich et al. recently reported that resident involvement was not a risk factor for 30-day mortality in 1,382 total shoulder arthroplasty cases (33). Using a large sample size from a separate database, our data found that shoulder arthroplasty performed in July at academic medical centers had similar complication rates compared to the remainder of the year.

Despite its size and national scope, our study should be interpreted cautiously in light of limitations inherent to the use of administrative data. As a claims-based study, the accuracy and completeness of the data depend largely on the training and expertise of the coders (34). We tried to minimize the possibility of underreporting of adverse events by limiting our analysis to major postoperative complications that are likely to generate a claim. In addition, while these data represent academic medical centers, it is uncertain that trainees were involved in each case that was included in the data set. Another limitation was our inability to assess post-discharge outcomes. Finally, the rates of some complications (e.g. death, myocardial infarction) were low despite the large sample size, thus leading to larger confidence intervals and making the conclusions from these variables less reliable.

This study represents the largest investigation into the "July effect" for shoulder arthroplasty. The results support the contention that our current training model does not increase major adverse events associated with shoulder arthroplasty during transition periods of resident and fellow staff. This research adds to the growing body of literature across many orthopaedic subspecialties indicating the "July effect" may be overstated.

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