# Postoperative hospital costs after anatomic and reverse total shoulder arthroplasty: A retrospective, United States hospital billing database analysis


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## OBJECTIVES

- To estimate hospital cost of post-operative revisits, revision, and complications by type of total shoulder arthroplasty (TSA).
- To evaluate patient characteristics associated with hospital cost of post-operative revisits, revision, and complications by type of TSA.

## METHODS

**Study Design:** Retrospective, noncomparative cohort study of Anatomic TSA (ATSA) and Reverse TSA (RTSA) patients.

**Data Source:** Premier Healthcare Database, a US-based hospital database, October 1, 2015 to December 31, 2021.

**Study Population:**

- ***Inclusion:*** Adult (18+ years) primary, elective ATSA or RTSA cases, with primary diagnosis of shoulder osteoarthritis or rotator cuff tear
- ***Exclusion:*** Fracture/trauma, infection or cancer of the upper arm/shoulder at index; OR evidence of shoulder revision one-year prior or at index; OR contralateral TSA, both RTSA/ATSA concurrently or bilateral surgery at index/follow-up

**Outcomes:** **One**-year post-operative hospital costs of all-cause revisits, complications (including infection, mechanical failure, cardiac, respiratory, neural injury), and revision procedures - inflation adjusted to year 2022.

**Statistical Analysis:**

- RTSA and ATSA cohorts were analyzed separately.
- Generalized linear models (GLM) with gamma distribution and log link were used to evaluate associations between patient characteristics and hospital cost such as age, gender, comorbidities; this model also included surgical and hospital characteristics as covariates.

## RESULTS

- **Table 1** presents patient characteristics of the ATSA and RTSA cohorts.

**Table 1. Baseline characteristics of patients undergoing TSA**

| Patient Characteristic | Overall | RTSA | ATSA |
|---|---|---|---|
| **N** | **86,237 (100.0%)** | **51,557 (100.0%)** | **34,680 (100.0%)** |
| **Age, n (%)** | | | |
| Age 18 to 54 | 4,274 (5.0%) | 1,240 (2.4%) | 3,034 (8.8%) |
| Age 55 to 64 | 18,121 (21.0%) | 8,284 (16.1%) | 9,837 (28.4%) |
| Age 65 to 74 | 37,933 (44.0%) | 22,935 (44.5%) | 14,998 (43.2%) |
| Age 75 Plus | 25,909 (30.0%) | 19,098 (37.0%) | 6,811(19.6%) |
| **Gender, n (%)** | | | |
| Female | 46,368 (53.8%) | 29,431 (57.1%) | 16,937 (48.8%) |
| **Race, n (%)** | | | |
| Asian | 374 (0.4%) | 234 (0.5%) | 140 (0.4%) |
| Black | 4,572 (5.3%) | 2,903 (5.6%) | 1,669 (4.8%) |
| Other | 3,445 (4.0%) | 1,969 (3.8%) | 1,476 (4.3%) |
| Unable to Determine | 915 (1.1%) | 536 (1.0%) | 379 (1.1%) |
| White | 76,931 (89.2%) | 45,915 (89.1%) | 31,016 (89.4%) |
| **Payor Category, n (%)** | | | |
| Medicare | 63,035 (73.1%) | 41,046 (79.6%) | 21,989 (63.4%) |
| Commercial | 16,326 (18.9%) | 6,621 (12.8%) | 9,705 (28.0%) |
| Medicaid | 2,559 (3.0%) | 1,291 (2.5%) | 1,268 (3.7%) |
| Other | 4,317 (5.0%) | 2,599(5.0%) | 1,718(5.0%) |
| **Elixhauser Comorbidity Index, mean (SD)** | 2.5 (1.9) | 2.7 (1.9) | 2.3 (1.8) |
| **Select Comorbidities, n (%)** | | | |
| Hypertension | 62,484 (72.5%) | 38,909 (75.5%) | 23,575 (68.0%) |
| Diabetes | 20,188 (23.4%) | 13,085 (25.4%) | 7,103 (20.5%) |
| Rheumatoid Arthritis | 5,763 (6.7%) | 4,011 (7.8%) | 1,752 (5.1%) |
| Tobacco Use | 34,618 (40.1%) | 21,270 (41.3%) | 13,348 (38.5%) |
| **Indication, n (%)** | | | |
| Osteoarthritis (OA) | 73,033 (84.7%) | 38,517 (74.4%) | 34,516 (99.5%) |
| Rotator Cuff Tear (RC Tear) | 13,204 (15.3%) | 13,040 (25.3%) | 164 (0.5%) |
| **Index Hospital Costs, mean (SD) /median** | $19,843 ($8,552)/$18,617 | $20,956 ($8,632) /$19,624 | $18,188 ($8,155)/$ 17,082 |

- **Table 2** presents one-year adjusted incidences (95% confidence intervals) of all-cause revisits, revisions, and complication-related readmissions.

| Revisit | | Revision | | Complications | |
|---|---|---|---|---|---|
| ATSA | RTSA | ATSA | RTSA | ATSA | RTSA |
| 42.3% (41.8%, 42.9%) | 45.0% (44.6%, 45.5%) | 2.1% (2.0%, 2.3%) | 2.3% (2.1%, 2.4%) | 10.1% (9.8%, 10.5%) | 12.4% (12.1%, 12.7%) |

- **Figure 1** presents outcome hospital costs **for only patients with the outcome**.
- **Figure 2** presents outcome hospital costs **on a per patient basis for the entire cohort.**

**Figure 1. One-year mean (SD), median post-operative hospital costs of patients that had all-cause revisits, revisions or complications outcomes.**

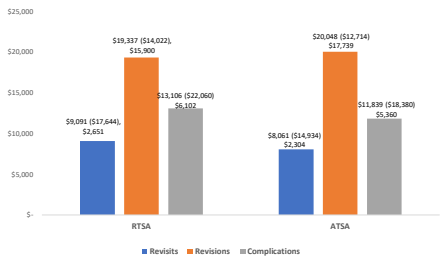
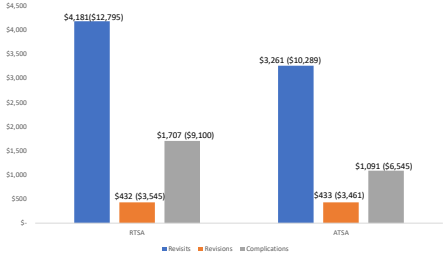



**Figure 2. One-year mean (SD) post-operative hospital costs of the entire cohort by outcome.**




- The significant associations with hospital cost of outcomes related to shoulder arthroplasty were noncommercial insurance, diabetes, and rheumatoid arthritis. **Table 3** presents the significant and nonsignificant predictors of higher or lower hospital cost.

**Table 3. GLM output indicating associations between patient variables and outcome costs expressed as a percent with 95% confidence intervals. Significant costs in orange. (+) indicates higher cost and (–) lower costs versus the reference category.**

| Characteristic | Revision | | Complications | |
|---|---|---|---|---|
| | ATSA | RTSA | ATSA | RTSA |
| Age 55 to 64 vs. 18 to 54 | (+) 10% (-4.8%, +27.2%) | (+) 13.1% (-9.3%, +39.6%) | (+) 18.6% (-3.5%, +44.7%) | (-) 8.8% (-31.3%,+17.5%) |
| Age 65 to 74 vs. 18 to 54 | (+) 7.5% (-8.8%, +26.4%) | (+) 2.4% (-18.2%, +27.0%) | (+) 19.6% (-4.4%, +48.7%) | (-) 16.5% (-36.1%, +7.2%) |
| Age 75 Plus vs. 18 to 54 | (+) 3.1% (-15.3%, +25.7%) | (-) 5.1% (-24.8%, +18.7%) | (+) 25.6% (-1.2%, 58.8%) | (-) 10.8% (-31.9%, +15.0%) |
| Male vs. Female | (+) 3.5% (-5.5%, +13.5%) | (-) 2.0% (-10.3%, +7.0%) | (-) 0.7% (-10.5%, +10.3%) | (+) 4.2% (-4.0%, +13.1%) |
| White vs. Black | (+) 3.0% (-15.0%, +23.6%) | (+) 16.8% (-3.2%, +39.7%) | (-) 10.4% (-28.0%, +10.2%) | (+) 10.5% (-6.5%, +29.8%) |
| Other vs. Black | (-) 3.6% (-25.3%, +24.7%) | (+) 18.0% (-10.4%, +56.1%) | (+) 16.5% (-15.6%, +62.2%) | (+) 1.5% (-20.9%, +30.7%) |
| Medicaid vs. Commercial | (+) 35.0% (+10.2%,+66.4%) | (-) 0.7% (-21.5%, +26.9%) | (+) 16.0% (-10.5%, +52.3%) | (+) 12.2% (-12.6%, +45.6%) |
| Medicare vs. Commercial | (+) 13.9% (-0.2%, +29.2%) | (+) 6.4% (-6.8%, +21.1%) | (+) 23.8% (+5.7%, +44.9%) | (+) 8.9% (-6.0%, +29.7%) |
| Other vs. Commercial | (+) 9.7% (-9.3%, +33.5%) | (+) 14.3% (-4.9%, +37.9%) | (+) 24.6% (-3.3%, 62.6%) | (+) 20.3% (-3.4%, +50.5%) |
| Diabetes Yes vs. No | (+) 0.06% (-10.2%, +11.7%) | (+) 0.5% (-8.5%, +10.9%) | (+) 12.7% (0.0%, 26.9%) | (+) 18.5% (+8.6%, +29.3%) |
| Hypertension Yes vs. No | (+) 1.8% (-7.8%, +12.2%) | (+) 2.1% (-8.0%, +13.1%) | (+) 5.1% (-7.1%, +18.7%) | (+) 11.4% (0.0%, +23.8%) |
| Rhem Arthritis Yes vs. No | (+) 10.3% (-5.8%, +30.1%) | (-) 6.2% (-20.2%, +10.9%) | (+) 15.9% (-3.7%, +40.6%) | (+) 19.7% (+5.1%, +37.0%) |
| Tobacco use Yes vs. No | (-) 6.9% (-14.9%, +1.8%) | (+) 0.2% (-7.8%, +9.0%) | (-) 1.9% (-11.5%, +8.7%) | (+) 4.8% (-3.2%, +13.5%) |
| OA vs. RC tear | (+) 11.3% (-29.2%, +65.3%) | (+) 2.7% (-6.1%, +12.2%) | (+) 19.8% (-33.5%, +96.8%) | (+) 6.1% (-2.7%, +15.7%) |

ATSA, anatomic total shoulder arthroplasty; RTSA, reverse total shoulder arthroplasty

## CONCLUSIONS

- Postoperatively, the most expensive revisits to the hospital after TSA were for revision procedures, generating mean hospital costs of approximately $20,000 per patient.
- As the demand for TSA rises, there is a need for surgical approaches/techniques that minimize post-surgical complications.


ISPOR Annual International Meeting
May 7–10, 2023 | Boston, MA, USA