



Delayed hospital discharge after total shoulder arthroplasty: why, and who is at risk?



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Background: There is growing policy interest in reducing the length of stay (LOS) after discretionary orthopedic surgery but few data to guide improvement efforts. We characterized the primary reasons and predisposing factors associated with extended LOS after elective total shoulder arthroplasty.

Methods: We retrospectively identified 415 patients undergoing elective primary total shoulder arthroplasty between 2016 and 2017. Extended LOS was defined as a stay greater than the 75th percentile. Medical records were manually reviewed to ascertain the primary reason for extended LOS. Multivariable logistic regression modeling was used to determine preoperative characteristics associated with prolonged hospitalization.

Results: The most common reason for extended LOS was pain (41%), followed by medical problems (39%), limited social support (18%), and blood transfusions (2%). Only 41% of patients with delayed discharges had documented adverse events (any medical or surgical problem), all of which were minor. The top 4 medical issues were transient hypoxemia (42%), nausea and/or vomiting (13%), electrolyte abnormalities (12%), and altered mental status (10%). In decreasing order of magnitude, the predictors of prolonged LOS were greater number of self-reported allergies, female sex, unmarried patient, diabetes, lower American Shoulder and Elbow Surgeons score, depression, reverse shoulder arthroplasty, and American Society of Anesthesiologists score of 3 or greater. Operative time did not correlate with LOS.

Conclusions: Prolonged hospitalizations after shoulder arthroplasty are commonly related to pain and limited social support. Sociodemographic and psychological factors seem to have more influence than patient infirmity and technical issues. These findings support a comprehensive approach to care with attention to the physical, mental, and social determinants of health.

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With the growing policy emphasis on shifting financial risk to hospitals and providers, optimizing cost and resource allocation after discretionary orthopedic surgery has become a major priority. Postoperative length of stay (LOS) is an important driver of cost variation among surgical inpatients and is receiving considerable attention as a marker of resource use and efficiency.^{9,18} One prior study correlated increased LOS after total shoulder arthroplasty (TSA), as well as several other characteristics, with higher inpatient costs.²³ Reducing unnecessarily long stays may translate into

substantial hospital savings, but there are few data on orthopedic surgery to guide improvement efforts.

Elective TSA is an increasingly popular and highly standardized procedure typically performed in medically optimized patients,^{10,17,19} yet there is notable patient-to-patient variation in LOS, suggesting that there is opportunity for improvement. Although recent big-data studies have shown that older infirm women were at risk of delayed discharge after shoulder arthroplasty,^{2,12,24} the data sources were not granular enough to explore the role of other potentially relevant contributing factors (eg, social support or patient-reported outcome measures) and, perhaps more important, characterize the primary reasons for such prolonged stays. If our goal is to reduce LOS among surgical inpatients, it is important to know why they are staying longer; and for this purpose, the more granular the data, the more actionable they will be. Although one

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may assume that extended postoperative stays are largely attributable to patient illness or complications, a study of more than 22,000 general surgery patients across 199 hospitals showed that much of the variation in LOS remained unexplained after accounting for such factors.¹⁸

Amid the growing trend toward outpatient shoulder arthroplasty,⁶ an improved understanding of the primary reasons for and factors associated with delayed hospital discharge can inform implementation of enhanced recovery pathways and cost-saving strategies. In this context, we sought to characterize the reasons for and factors associated with extended LOS after TSA. In addition, we evaluated the relationship between operative time and LOS.

Methods

Study design

This retrospective study was carried out at an urban orthopedic specialty hospital in the United States. We used our prospectively collected registry to identify all patients who underwent elective primary TSA (anatomic [ATSA] or reverse [RTSA]) between January 2016 and November 2017 performed by a single fellowship-trained shoulder surgeon. To select a homogeneous cohort of patients at low surgical risk, we decided a priori to exclude patients whose indication for surgery was traumatic and those undergoing revision surgery.

The primary outcome of interest was extended postoperative LOS, which we defined as LOS greater than the 75th percentile.²⁴ Medical records were manually reviewed to ascertain the primary reason for extended LOS. Reasons were classified into 4 predefined major categories: (1) pain, (2) medical problems, (3) limited social support, and (4) surgical problems. We lumped insurance-related and social support-related issues into 1 category, as they were inter-related (eg, patients without adequate social support being discharged to skilled nursing facilities were required to stay in the hospital for ≥ 3 nights per Medicare's mandated 3-night hospital stay rule).²⁰ Pain management was uniform across all patients to mitigate the possibility of confounding variables involved in a patient's pain appraisal. Patients were given celecoxib, pregabalin, acetaminophen, and an interscalene block preoperatively; intravenous narcotics and ketorolac tromethamine immediately postoperatively; and narcotics, nonsteroidal anti-inflammatory drugs, and Tylenol prescribed as needed on discharge. Reasons for extended LOS that were considered to be inpatient adverse events included medical and surgical problems.

In addition, we gathered data on several patient characteristics prospectively collected in our registry that might be associated with extended LOS. Specifically, we gathered data on age; sex; insurance status; marital status; number of patient-reported allergies; history of shoulder surgery; American Society of Anesthesiologists (ASA) score; body mass index (BMI); and several comorbidities, including diabetes, preoperative chronic opioid use (defined as taking opioids daily before surgery), hypertension, hypercholesterolemia, depression, thyroid disease, and rheumatoid arthritis. We also included the preoperative American Shoulder and Elbow Surgeons (ASES) score³⁵ and Visual Analog Scale (VAS) pain score, both of which are routinely collected by our research staff during the preoperative office visit. The ASES score contains both physician-rated and patient-rated sections, and the final total score (100-point scale) is weighted 50% for pain and 50% for function, with higher scores indicating better outcomes.³⁷

Statistical analysis

Descriptive statistics were used to report the reasons for extended LOS following TSA (Fig. 1). In addition, we classified

medically related reasons into subcategories to provide a more granular analysis (Fig. 2).

To compare characteristics between patients with and without extended LOS, we used the Pearson χ^2 test or Fisher exact test (for cell sizes < 5) for categorical variables and independent-samples t tests for continuous variables. Continuous variables were presented as the mean and standard deviation (SD), and categorical variables were reported as frequencies and percentages.

To minimize confounding, variables with $P < .05$ on bivariate analysis were inserted into multiple logistic regression analysis to identify which preoperative patient characteristics were independently associated with extended postoperative LOS. We entered all variables into the model simultaneously, without further selection. Results were reported as odds ratios (OR) with 95% confidence intervals (CIs). We used the area under the receiver operating characteristic curve to evaluate model discrimination and the Hosmer-Lemeshow test to assess model calibration.

We used Pearson correlation coefficients (r) to determine the relationship between hospital LOS and operative time. Statistical tests were 2 sided, with $P < .05$ denoting statistical significance.

Patient characteristics

The 415 patients comprising our study population included 253 women (61%) and 162 men, with a mean age of 69 years (SD, 8 years) and mean preoperative ASES score of 34 (SD, 17) (Table 1). Most patients were married (66%) and had an ASA score of 2 or lower (77%). Fifty-six percent of patients had Medicare listed as their primary insurance. Nearly one-third (32%) had a history of shoulder surgery. The 3 most prevalent comorbidities were hypertension (60%), hypercholesterolemia (39%), and depression (25%). The prevalence of preoperative chronic opioid use was 16%. On average, patients reported 2 allergies. Of the patients, 71% underwent RTSA whereas the remaining 29% underwent ATSA. The mean LOS was 2.2 days (SD, 0.9 days), and the 75th percentile for the LOS was 3 days.

Results

The most common reason for prolonged LOS after TSA was pain (41%), followed by medical problems (39%), limited social support (18%), and surgical problems (2%, Fig. 1). Overall, 59% of patients with extended LOS did not have a documented inpatient adverse event (any medical or surgical problem). The 4 most common medical problems delaying hospital discharge were transient hypoxemia (42%), gastrointestinal problems (13%; nausea or vomiting), electrolyte abnormalities (12%; hyponatremia or hypokalemia), and altered mental status (10%, Fig. 2). The surgical problems were both blood transfusions for asymptomatic anemia: one for a hemoglobin level of 7.3 g/dL (down from 11.2 g/dL preoperatively) in a patient without cardiac disease and the other for a hemoglobin level of 8.2 g/dL (down from 11.7 g/dL preoperatively) in a patient with cardiac disease. No other surgery-related adverse events occurred in our sample.

Patients with extended LOS were more likely to be women (85% vs. 53%, $P < .001$), older (71 ± 9.5 years vs. 68 ± 7.9 years, $P = .001$), unmarried (58% vs. 26%, $P < .001$), Medicare insured (69% vs. 52%, $P = .010$), and preoperative daily opioid users (24% vs. 14%, $P = .013$); to have more self-reported allergies ($P < .001$), diabetes (28% vs. 9%, $P < .001$), a comorbid diagnosis of major depression (39% vs. 21%, $P < .001$), an ASA score of 3 or greater (39% vs. 17%, $P < .001$), a lower preoperative ASES score (28 ± 15 vs. 36 ± 16 , $P < .001$), and a higher BMI (33 ± 8 vs. 30 ± 6 , $P = .004$); and to have undergone RTSA rather than ATSA (85% vs. 66%, $P < .001$; Table 1). After adjustment for potential confounding effects in multivariable modeling

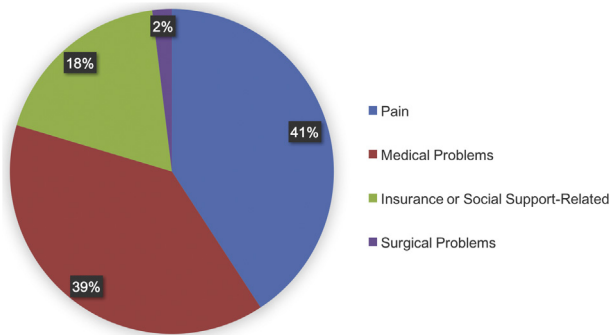


Figure 1 Reasons for delayed hospital discharge after total shoulder arthroplasty.

(Table II), the preoperative patient characteristics independently associated with extended LOS were as follows (in decreasing order of strength of association): greater number of patient-reported allergies (OR, 1.22 per 1-unit increase; 95% CI, 1.09-1.35; $P < .001$), female sex (vs. male sex; OR, 3.33; 95% CI, 1.60-6.95; $P = .001$), unmarried patient (vs. married patient; OR, 2.52; 95% CI, 1.43-4.44; $P = .001$), diabetes (OR, 2.57; 95% CI, 1.15-5.71; $P = .021$), lower ASES score (OR, 0.98 per 1-unit increase; 95% CI, 0.96-0.99; $P = .031$), comorbid diagnosis of major depression (OR, 1.91; 95% CI, 1.03-3.52; $P = .040$), RTSA (vs. ATSA; OR, 2.48; 95% CI, 1.04-5.90; $P = .040$), and ASA score of 3 (vs. ASA score ≤ 2 ; OR, 2.03; 95% CI, 1.01-4.07; $P = .046$). Our model had excellent discrimination (area under the receiver operating characteristic curve = 0.83) and was well calibrated (Hosmer-Lemeshow test = 0.91). No correlation was found between operative time and hospital LOS ($r = 0.01$, $P = .84$).

Discussion

Value increases with improved health outcomes or decreased costs. Postoperative LOS is an important driver of surgical inpatient costs, and extended LOS is correlated with higher inpatient costs.^{22,23} There is growing national interest in reducing LOS after discretionary orthopedic surgery but few data to guide improvement efforts. Because of the burgeoning demand for shoulder arthroplasty and trend toward outpatient surgery, it seems timely to explore the underlying reasons and predisposing factors for prolonged LOS after this major orthopedic procedure. This information may prove useful in the redesign of care pathways and bundling initiatives.

The principal strengths of this study include the use of granular clinical data and the relatively large sample size. The granularity of

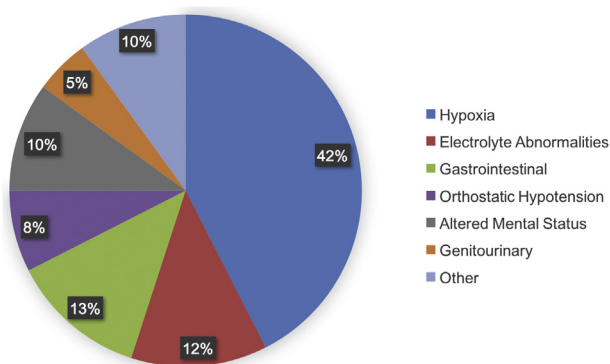


Figure 2 Medical problems delaying hospital discharge after total shoulder arthroplasty.

the data allows us to determine novel patient-level factors (social support, pain levels, ASES score, and so on) delaying hospital discharge, distinguishing the impact of this study from that of previous, larger studies (Dunn et al¹² and Menendez et al²⁴). These previous studies with larger sample sizes used superficial demographic data that cannot be validated, reducing the comprehensiveness and accuracy of their analyses. Nonetheless, our analysis was subject to several limitations that generate questions for future research. First, this study was carried out at an urban orthopedic specialty hospital serving predominantly white patients in the northeastern United States, and the results may not generalize to other practice settings.²⁹ It is possible that the decision to keep patients in the hospital is largely driven by practice-style differences between providers and hospitals.¹⁸ Some institutions may already be part of bundling initiatives that incentivize shorter postoperative stays by minimizing inefficient practice after TSA. The reader should be mindful of the inherent subjectivity of plans and decisions to keep patients in the hospital. Second, given that all procedures were performed by a single surgeon, we were unable to determine physician characteristics (eg, technical skill, case volume, or interpersonal communication skills) influencing LOS. However, having the same surgeon perform all procedures could also be viewed as a strength, as the perioperative pain management protocol was more uniform across patients. Third, because this was a retrospective review, the data collection protocol was not specifically designed for this study. Thus, we were unable to assess some potentially important patient factors affecting LOS, such as health literacy and patient activation or engagement in one's health care—two increasingly recognized concepts that have been associated with resource use.^{14,30} Finally, to achieve higher-value care for patients undergoing shoulder arthroplasty, reductions in LOS—and consequently costs—must be linked to patient experience, quality of life, and functional outcomes, which is the object of our future research.²⁸ Cost reduction without regard to the outcomes achieved can be dangerous and self-defeating, but this does not seem to be the case for our study. Recent evidence has suggested that shorter inpatient stays after TSA may actually be associated with decreased readmission risk.^{7,11,40}

We observed that pain was the most common cause of delayed hospital discharge, which is interesting considering that elective shoulder arthroplasty creates relatively uniform nociception (the pathophysiology of actual or potential tissue damage) and all patients were treated by the same surgeon, thereby eliminating variations in technical or interpersonal skills that might affect pain intensity (the cognitive appraisal and physiological experience of nociception). A previous study by Menendez et al²⁶ found that predictors of severe postoperative pain (defined as peak pain intensity > 75th percentile) were a greater number of self-reported allergies, preoperative chronic opioid use, lower ASES score, and depression. Our findings suggest ample opportunity for better alleviation of pain after shoulder arthroplasty. The answer is not more opioids: A greater intake of opioids is associated with greater (not less) pain intensity and decreased satisfaction with pain control.^{5,32} The gap between nociception and pain intensity after surgery is better accounted for by psychological and social determinants of health than by pathophysiological or technical factors.^{25,27} With the growing interest and adoption of enhanced recovery pathways for orthopedic patients, multidisciplinary efforts should optimize patients not only medically but also emotionally and socially.

We found that, among the 41% of patients with extended LOS related to a medical or surgical complication, none of these events were major adverse events (eg, death, stroke, myocardial infarction, pneumonia, pulmonary embolism, or reoperation). For instance, all patients with postoperative hypoxemia (42% of

Table I
Bivariate analysis: characteristics of study population

| Parameter | All patients | Extended length of stay (>75th percentile) | | P value |
|-----------------------------------|--------------|--|-------------|---------|
| | | Yes | No | |
| Total | 415 (100) | 103 (24.8) | 312 (75.2) | |
| Age, yr | 68.8 ± 8.4 | 71.2 ± 9.5 | 68.1 ± 7.9 | .001* |
| Sex | | | | |
| Female | 253 (61) | 87 (84.5) | 166 (53.2) | <.001* |
| Male | 162 (39) | 16 (15.5) | 146 (46.8) | |
| Insurance status | | | | |
| Private | 156 (37.6) | 29 (28.2) | 127 (40.7) | .010* |
| Medicare | 234 (56.4) | 71 (68.9) | 163 (52.2) | |
| Other | 25 (6.0) | 3 (2.9) | 22 (7.1) | |
| Marital status | | | | |
| Married | 275 (66.3) | 43 (41.7) | 232 (74.4) | <.001* |
| Unmarried | 140 (33.7) | 60 (58.3) | 80 (25.6) | |
| No. of patient-reported allergies | 2.0 ± 2.7 | 3.3 ± 3.8 | 1.6 ± 2.1 | <.001* |
| ASA score | | | | |
| ≤2 | 318 (77.4) | 62 (60.8) | 256 (82.8) | <.001* |
| ≥3 | 93 (22.6) | 40 (39.2) | 53 (17.2) | |
| BMI | 30.8 ± 6.3 | 32.6 ± 7.5 | 30.2 ± 5.8 | .004* |
| Comorbid conditions | | | | |
| Preoperative opioid use | 68 (16.4) | 25 (24.3) | 43 (13.8) | .013* |
| Diabetes | 58 (14) | 29 (28.2) | 29 (9.3) | <.001* |
| Hypertension | 247 (59.5) | 67 (65) | 180 (57.7) | .19 |
| Hypercholesterolemia | 163 (39.3) | 39 (37.9) | 124 (39.7) | .74 |
| Depression | 104 (25.1) | 40 (38.8) | 64 (20.5) | <.001* |
| Thyroid disease | 86 (20.7) | 21 (20.4) | 65 (20.8) | .99 |
| Rheumatoid arthritis | 17 (4.1) | 3 (2.9) | 14 (4.5) | .49 |
| Preoperative ASES score | 34.1 ± 16.5 | 27.8 ± 15.1 | 36.2 ± 16.4 | <.001* |
| Prior shoulder surgery | 132 (31.8) | 29 (28.2) | 103 (33) | .39 |
| Procedure type | | | | |
| Anatomic TSA | 121 (29.2) | 15 (14.6) | 106 (34) | <.001* |
| Reverse TSA | 294 (70.8) | 88 (85.4) | 206 (66) | |

ASA, American Society of Anesthesiologists; BMI, body mass index; ASES, American Shoulder and Elbow Surgeons; TSA, total shoulder arthroplasty. Data are presented as mean ± standard deviation or number of patients (percentage).

* Statistically significant ($P < .05$).

medical complications in our study) improved with nasal cannula oxygenation, and none of them had to undergo reintubation. One wonders if there is value to measuring oxygenation—perhaps it leads to more treatment but not better health. All gastrointestinal problems were either episodic nausea or vomiting. Perhaps nausea can be managed as well outside the hospital as inside the hospital. Both blood transfusions were for asymptomatic postoperative anemia, which calls into question the utility of routine daily postoperative laboratory values in the low-risk elective surgery setting—it is possible they lead to more harm than good given evidence of the association of blood transfusions with greater infection risk.³⁸

We identified several preoperative patient characteristics associated with delayed hospital discharge. Our finding that the number of self-reported allergies (a potential surrogate for psychological distress³⁴) was strongly associated with extended LOS is consistent with the growing notion regarding lower-limb arthroplasty that patients with self-reported allergies have worse postoperative functional outcomes and quality of life.^{13,15,33} In our study, the risk of extended LOS increased by 20% for every additional allergy reported. Along these lines, patients with self-reported comorbid major depression were nearly twice as likely to have prolonged postoperative stays. The observed prevalence of major depression in our sample (25%) was more than 5-fold higher than that documented in a 2014 claims-based study (4.4%); this

Table II
Multivariable regression of predictors of extended length of stay after shoulder arthroplasty

| Predictor | OR | 95% CI | | P value |
|---|------|--------|-------|---------|
| | | Lower | Upper | |
| Female sex (reference: male sex) | 3.33 | 1.60 | 6.95 | .001* |
| Age, per 1-yr increase | 1.00 | 0.95 | 1.04 | .841 |
| Insurance status (reference: private insurance) | | | | |
| Medicare | 1.52 | 0.78 | 2.93 | .217 |
| Other | 0.45 | 0.08 | 2.57 | .366 |
| Unmarried (reference: married) | 2.52 | 1.43 | 4.44 | .001* |
| Patient-reported allergies, per 1-unit increase | 1.22 | 1.09 | 1.35 | <.001* |
| ASA score ≥ 3 (reference: ASA score ≤ 2) | 2.03 | 1.01 | 4.07 | .046* |
| Preoperative opioid use | 1.30 | 0.65 | 2.58 | .455 |
| Depression | 1.91 | 1.03 | 3.52 | .040* |
| Diabetes | 2.57 | 1.15 | 5.71 | .021* |
| BMI, per 1-unit increase | 1.02 | 0.97 | 1.07 | .412 |
| Reverse TSA (reference: anatomic TSA) | 2.48 | 1.04 | 5.90 | .040* |
| Preoperative ASES score, per 1-unit increase | 0.98 | 0.96 | 0.99 | .031* |

OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists; BMI, body mass index; TSA, total shoulder arthroplasty; ASES, American Shoulder and Elbow Surgeons.

The area under the receiver operating characteristic curve equaled 0.83 (95% CI, 0.78–0.88), with Nagelkerke $R^2 = 0.40$ and $P = .48$ for the Hosmer–Lemeshow test.

* Statistically significant ($P < .05$).

difference is likely due to the known underestimation of medical conditions associated with billing data.⁴ Given that major depression is underdiagnosed and that diagnosed depression is often well treated, it would be interesting to know the influence of symptoms of depression, but these were not measured. Unmarried patients were more likely to stay longer in the hospital, possibly because they had less social support than married patients. Although the association of marital status with outcomes following TSA remains largely unexplored, a recent study reported that married patients may have better functional outcomes after total knee arthroplasty.³⁶

Our finding that lower preoperative ASES scores were predictive of prolonged LOS after surgery is particularly relevant with the growing emphasis on value, and it underscores the importance of incorporating patient-reported outcome measures in the design of care pathways. Along these lines, Jacobs et al¹⁶ recently showed that patient dissatisfaction following ATSA was linked to lower preoperative ASES scores. Women were about 3 times more likely to experience prolonged LOS, which is consistent with previous large-scale database studies.^{2,12,24} There may be nociceptive and psychosocial differences attributed to sex³⁹ that merit further research in the perioperative shoulder arthroplasty setting. We observed that greater infirmity—assessed with the ASA score—was linked to delayed hospital discharge, which is in line with previous research suggesting that the ASA score is useful in predicting readmission and resource use after shoulder arthroplasty.^{3,21} It is important to note that greater BMI was not independently associated with delayed hospital discharge. This finding may make shoulder surgeons less reluctant to operate on patients with high BMI and is consistent with findings of previous studies suggesting that BMI exerts a negligible role on outcomes after shoulder arthroplasty.^{1,31}

Although reverse shoulder arthroplasty was linked to a greater likelihood of prolonged LOS, we found that surgical duration did not correlate with length of hospitalization. This is in contrast to a 2015 study using the National Surgical Quality Improvement Program database.¹² In that study, however, a longer operative time

may have reflected surgeon experience or an intraoperative complication, neither of which could be assessed with the data source used. Although an increased operative time seems to be associated with a higher risk of post-discharge complications such as infection,⁸ its influence on hospitalization length appears more limited and warrants further research.

Conclusion

Our work provides important baseline information regarding reasons for delayed discharge after elective shoulder arthroplasty, which may, to some extent, be generalizable to other discretionary orthopedic procedures. Prolonged hospitalizations were commonly related to pain and limited social support, with socio-demographic and psychological factors playing a more influential role than patient infirmity and procedure-related characteristics. These findings support a comprehensive approach to care with attention to the physical, mental, and social determinants of health.

Disclaimer

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