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Identifying risk factors for 30-day readmission after outpatient total shoulder arthroplasty to aid in patient selection

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Background: A recent meta-analysis comparing inpatient and outpatient total shoulder arthroplasty (TSA) showed no statistically significant differences in complications, readmissions, revisions, and infections. However, there remains no research on the appropriate patient selection for outpatient TSA surgeries. This retrospective review seeks to aid surgeons in refining a safe patient selection algorithm by evaluating risk factors through a large database analysis of TSA surgeries.

Methods: Patients who underwent TSA between 2015 and 2020 were identified in the National Surgical Quality Improvement Program database. Patients with a hospital stay of 0 days were designated as outpatient procedures. Multivariate analyses were used to determine risk factors for 30-day readmission following outpatient TSA and whether risk factors remained significant following overnight hospital stay.

Results: A total of 2431 outpatient TSA patients were identified. The incidence of 30-day readmission was 1.8%. The majority of readmissions were due to pulmonary complications. The clinically significant risk factors for 30-day readmission were chronic steroid use (odds ratio [OR] 3.55, 95% confidence interval [CI] 1.34-9.43; $P = .011$), chronic obstructive pulmonary disease (COPD) (OR 3.11, 95% CI 1.16-8.34; $P = .024$), and current smoking status (OR 2.27, 95% CI 1.02-5.03; $P = .045$). After overnight hospital stay, chronic steroid use and current smoking status were not significant, but COPD remained significant.

Conclusion: Patients with chronic steroid use, COPD, or current smoking status are at increased risk for 30-day readmission. Inpatient hospital stay appears to benefit patients with chronic steroid use and current smoking status. Patients with COPD should be admitted for inpatient stay postoperatively but may still have high 30-day readmission rates following discharge.

The demand for total shoulder arthroplasty (TSA) is projected to grow significantly in the coming decades.[25] This development has mainly been attributed to increased utilization of reverse TSA, for which the number of procedures has almost quadrupled since 2010.[15] Consequently, the nationwide shoulder arthroplasty cost burden is an emerging economic issue. Technological and surgical advancements have allowed for TSA in the outpatient setting to become a practical alternative to inpatient procedures.[1] Changes in healthcare policy have also driven many hospital-based surgeries to the outpatient setting.[7] This is advantageous, as outpatient TSA has been shown to be more economically advantageous.[24]

Furthermore, the SARS-CoV-2 pandemic has brought increased scrutiny to the choice between inpatient and outpatient procedures. This is due to a number of factors that include stricter inpatient capacity guidelines, restrictions on inpatient elective surgeries, attempts to minimize individual transmission risk, and cost reduction measures.[19,23] Even prior to the pandemic, many inpatient procedures were already being pressured to move to the outpatient setting.[2-4,10,11,17,21]

A recent meta-analysis comparing inpatient and outpatient TSA showed no statistically significant differences in complications, readmissions, revisions, and infections.[9] Other studies have also shown similar outcomes and complication rates between outpatient and inpatient TSA, even for patients greater than 65 years of age.[5,26] Outpatient TSA can potentially decrease costs by decreasing operating room (OR) times, avoiding inpatient stays, and decreasing complication and readmission rates with proper patient selection.[16,20] Fournier et al validated their patient selection

This study was deemed exempt from approval by the authors' University's Institutional Review Board, as the NSQIP database is fully deidentified.

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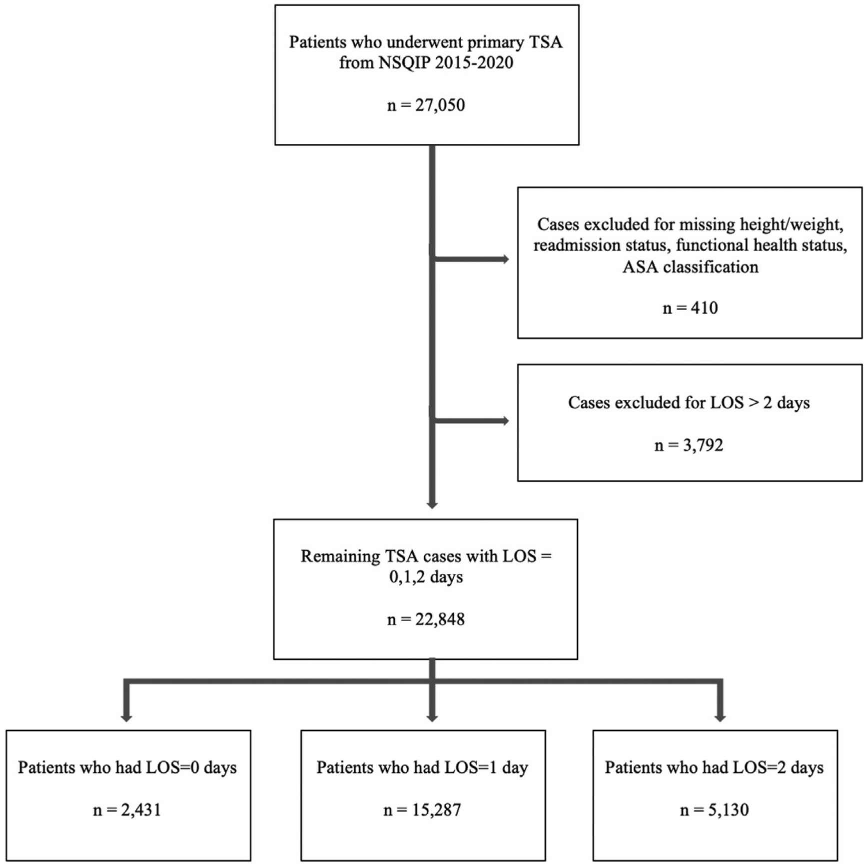

Figure 1 Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) diagram with inclusion and exclusion criteria. *TSA*, total shoulder arthroplasty; *NSQIP*, National Surgical Quality Improvement Program; *ASA*, American Society of Anesthesiologists; *LOS*, length of stay.

algorithm for outpatient TSA through a retrospective study of 61 patients. They observed zero 90-day readmissions with 7 complications and 1 revision surgery.[12] However, independent studies utilizing a large sample size for patient selection are limited.

This retrospective review seeks to aid in refining a safe patient selection algorithm for outpatient TSA based on the available data from a large national database, the National Surgical Quality Improvement Program (NSQIP). This study investigated the incidence and timing of 30-day readmission, reasons for 30-day readmission, patient risk factors associated with 30-day readmission, and the effect of overnight hospital stay on 30-day readmission rates in high-risk patients following outpatient TSA.

Methods

Patient cohort

We queried the American College of Surgeons NSQIP database for all patients who underwent TSA between 2015 and 2020. This study was rendered exempt from approval by our university's institutional review board, as the NSQIP database is fully deidentified. The data within the NSQIP database are collected by trained surgical clinical reviewers and obtained from over 600 hospitals in the United States. High fidelity is maintained through periodic auditing of the data.[22]

Current Procedural Terminology code 23472 was used to identify patients who underwent TSA, both anatomic and reverse, from 2015 to 2020. The NSQIP database automatically excludes patients younger than 18 years of age and trauma cases. Cases were also excluded if data were missing for the following variables: height/weight, readmission status, functional health status, and American Society of Anesthesiologists (ASA) classification.

The remaining cases were stratified into cohorts based on length of stay (LOS), with cohorts for LOS of 0 days, LOS of 1 day, LOS of 2 days, and LOS > 2 days. The LOS data provided in NSQIP represent the total length of hospital stay from admission to discharge. Therefore, patients with a LOS of 0 days were discharged on the same day as the procedure and were considered as outpatient procedures.

Preoperative and procedural characteristics

Patient demographics, comorbidities, surgical characteristics, preoperative laboratory values, and 30-day postoperative readmission status were collected from the database. Patient demographics included age, gender, body mass index (BMI), functional status prior to surgery, ASA classification, smoking status, and steroid use for a chronic condition. Preoperative comorbidities included insulin-dependent and non-insulin-dependent diabetes mellitus, hypertension, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), and bleeding disorders. Surgical characteristics included operative duration in minutes, categorized as 0-79 minutes (25th percentile), 80-128 minutes, and $\geq$ 129 minutes (75th percentile), based on quartile times of the entire study population. Preoperative laboratory values included measurements of hematocrit and international normalized ratio. Anemia was defined as preoperative hematocrit < 39 for

Table I
Patient characteristics for patients with length of stay = 0 d.

Characteristic	Number	Percent
Total	2431	100.0%
Age		
18-39	21	0.9%
40-64	820	33.7%
65-74	1014	41.7%
≥75	576	23.7%
Gender		
Female	1130	46.5%
Male	1301	53.5%
Body mass index (kg/m^2)		
<18.5	16	0.7%
18.5-29.9	1312	54.0%
30-34.9	667	27.4%
35-39.9	294	12.1%
≥40	142	5.8%
Functional status prior to surgery		
Independent	2422	99.6%
Dependent	9	0.4%
ASA classification		
1-2	1373	56.5%
≥3	1058	43.5%
Smoker		
No	2228	91.6%
Yes	203	8.4%
Diabetes mellitus		
No diabetes	2124	87.4%
Non-insulin-dependent diabetes	221	9.1%
Insulin-dependent diabetes	86	3.5%
Hypertension		
No	1047	43.1%
Yes	1384	56.9%
Chronic steroid use		
No	2349	96.6%
Yes	82	3.4%
Chronic obstructive pulmonary disease		
No	2349	96.6%
Yes	82	3.4%
Bleeding disorders		
No	2382	98.0%
Yes	49	2.0%
Anemia (Hct <39 for males, <36 for females)		
No	1834	75.4%
Yes	247	10.2%
Preoperative international normalized ratio		
≤1.2	819	33.7%
>1.2	63	2.6%
Operative duration (min)		
0-78	582	23.9%
79-126	1233	50.7%
≥127	616	25.3%

ASA, American Society of Anesthesiologists; *Hct*, hematocrit.

Table II
Patient characteristics for patients with length of stay = 1 d.

Characteristic	Number	Percent
Total	15,287	100.0%
Age		
18-39	84	0.5%
40-64	4469	29.2%
65-74	6709	43.9%
≥75	4025	26.3%
Gender		
Female	7693	50.3%
Male	7594	49.7%
Body mass index (kg/m^2)		
<18.5	84	0.5%
18.5-29.9	7185	47.0%
30-34.9	4212	27.6%
35-39.9	2256	14.8%
≥40	1550	10.1%
Functional status prior to surgery		
Independent	15,124	98.9%
Dependent	163	1.1%
ASA classification		
1-2	7068	46.2%
≥3	7919	51.8%
Smoker		
No	13,706	89.7%
Yes	1581	10.3%
Diabetes mellitus		
No diabetes	12,711	83.1%
Non-insulin-dependent diabetes	1965	12.9%
Insulin-dependent diabetes	611	4.0%
Hypertension		
No	5231	34.2%
Yes	10,056	65.8%
Chronic steroid use		
No	14,605	95.5%
Yes	682	4.5%
Chronic obstructive pulmonary disease		
No	14,417	94.3%
Yes	870	5.7%
Bleeding disorders		
No	14,969	97.9%
Yes	318	2.1%
Anemia (Hct <39 for males, <36 for females)		
No	11,558	75.6%
Yes	1937	12.7%
Preoperative international normalized ratio		
≤1.2	5453	35.7%
>1.2	433	2.8%
Operative duration (min)		
0-78	4043	26.4%
79-126	7746	50.7%
≥127	3498	22.9%

ASA, American Society of Anesthesiologists; *Hct*, hematocrit.

men or < 36 for women. International normalized ratio was stratified into two groups: ≤ 1.2 and > 1.2.

Reasons and timing of readmission

Reasons for readmission were extracted from the database and identified using the International Classification of Diseases, Ninth Revision (ICD-9) and Tenth Revision (ICD-10) codes. The reasons for readmission were categorized based on whether the reason was related to the surgical site and then further grouped based on complication type. The timing of readmission, in days from the procedure, was also extracted from the database.

Statistical analysis

All statistical analyses were conducted using SPSS Software version 26.0 (IBM Corp., Armonk, NY, USA). Bivariate logistic regression was used to identify significant associations with patient variables between the LOS ≤ 2 days vs LOS > 2 days cohorts. Multivariate logistic regression was used to identify significant associations between preoperative characteristics and 30-day readmission using a backward stepwise approach for the LOS 0 cohort. In this approach, all preoperative characteristics were initially included in the analysis. Variables were then removed from the analysis one at a time in a stepwise fashion, with the highest *P* values being eliminated first, until only significantly associated variables remained. Odds ratios (ORs) were reported with 95% confidence intervals (CIs). The level of statistical significance was set at $P < .05$.

After identifying the patient variables significantly associated with readmission after outpatient (LOS = 0) TSA, the significance of these risk factors following overnight hospital stay was tested using multivariate logistic regression. The significant risk factors for readmission identified in the outpatient cohort were all included in the analysis for the LOS = 1 cohort. The backward stepwise

Table III
Patient characteristics for patients with length of stay = 2 d.

Characteristic	Number	Percent
Total	5130	100.0%
Age		
18-39	22	0.4%
40-64	1389	27.1%
65-74	2109	41.1%
≥75	1610	31.4%
Gender		
Female	3220	62.8%
Male	1910	37.2%
Body mass index (kg/m^2)		
<18.5	46	0.9%
18.5-29.9	2453	47.8%
30-34.9	1317	25.7%
35-39.9	707	13.8%
≥40	607	11.8%
Functional status prior to surgery		
Independent	5023	97.9%
Dependent	107	2.1%
ASA classification		
1-2	1965	38.3%
≥3	3165	61.7%
Smoker		
No	4542	88.5%
Yes	588	11.5%
Diabetes mellitus		
No diabetes	4144	80.8%
Non-insulin-dependent diabetes	649	12.7%
Insulin-dependent diabetes	337	6.6%
Hypertension		
No	1703	33.2%
Yes	3427	66.8%
Chronic steroid use		
No	4849	94.5%
Yes	281	5.5%
Chronic obstructive pulmonary disease		
No	4724	92.1%
Yes	406	7.9%
Bleeding disorders		
No	5015	97.8%
Yes	115	2.2%
Anemia (Hct <39 for males, <36 for females)		
No	3702	72.2%
Yes	871	17.0%
Preoperative international normalized ratio		
≤1.2	2023	39.4%
>1.2	179	3.5%
Operative duration (min)		
0-78	1107	21.6%
79-126	2471	48.2%
≥127	1552	30.3%

ASA, American Society of Anesthesiologists; *Hct*, hematocrit.

Table IV
Patient characteristics for patients with length of stay > 2 d.

Characteristic	Number	Percent
Total	3792	100.0%
Age		
18-39	17	0.4%
40-64	1301	34.3%
65-74	652	17.2%
≥75	1822	48.0%
Gender		
Female	2790	73.6%
Male	1002	26.4%
Body mass index (kg/m^2)		
<18.5	50	1.3%
18.5-29.9	1762	46.5%
30-34.9	912	24.1%
35-39.9	534	14.1%
≥40	531	14.0%
Functional status prior to surgery		
Independent	3504	92.4%
Dependent	288	7.6%
ASA classification		
1-2	909	24.0%
≥3	2883	76.0%
Smoker		
No	4530	119.5%
Yes	588	15.5%
Diabetes mellitus		
No diabetes mellitus	2845	75.0%
Non-insulin-dependent diabetes	590	15.6%
Insulin-dependent diabetes	357	9.4%
Hypertension		
No	954	25.2%
Yes	2838	74.8%
Chronic steroid use		
No	3546	93.5%
Yes	246	6.5%
Chronic obstructive pulmonary disease		
No	3377	89.1%
Yes	415	10.9%
Congestive heart failure		
No	3712	97.9%
Yes	80	2.1%
Bleeding disorders		
No	3604	95.0%
Yes	188	5.0%
Anemia (Hct <39 for males, <36 for females)		
No	2327	61.4%
Yes	1198	31.6%
Preoperative international normalized ratio		
≤1.2	1718	45.3%
>1.2	168	4.4%
Operative duration (min)		
0-79	797	21.0%
80-128	1712	45.1%
≥129	1283	33.8%

ASA, American Society of Anesthesiologists; *Hct*, hematocrit.

approach was again used to eliminate variables until only significantly associated variables remained. The variables that remained significant in the LOS = 1 cohort were then included in the analysis for the LOS = 2 cohort. ORs were again reported with 95% CI and significance was at $P < .05$.

Results

A total of 27,050 patients who underwent primary TSA were identified in the NSQIP from 2015 to 2020. Cases were excluded as follows: 152 for missing height/weight, 2 for missing readmission status, 227 for missing functional health status prior to surgery, and 29 for missing ASA classification. Of the remaining 26,640 patients after application of exclusion criteria, 2431 (9.1%) patients had a LOS of 0 days, 15,287 (57.4%) patients had a LOS of 1 day, 5130 (19.3%) patients had a LOS of 2 days, and 3792 (14.2%) patients had a LOS greater than 2 days (Fig. 1). Patient demographics, comorbidities, and operative variables for each cohort are summarized in Table I, Table II, Table III, and Table IV.

Comparison of patient variables between cohorts

Of the 26,640 patients included in the study, 22,848 (85.8%) patients had a LOS ≤ 2 days and 3792 (14.2%) patients had a LOS > 2 days. Compared to the LOS ≤ 2 days cohort, the LOS > 2 days cohort had significantly higher rates of age ≥ 75 ($P < .001$), female gender ($P < .001$), BMI < 18.5 ($P < .001$), BMI ≥ 40 ($P < .001$), dependent functional status ($P < .001$), ASA ≥ 3 ($P < .001$), diabetes mellitus ($P < .001$), hypertension ($P < .001$), chronic steroid use ($P < .001$), COPD ($P < .001$), CHF ($P < .001$), bleeding disorder ($P < .001$), preoperative anemia ($P < .001$), and INR (International Normalized

Table V
Comparison of patient demographics between LOS ≤ 2 d and LOS > 2 d.

Characteristic	LOS ≤ 2 d		LOS > 2 d		*P* value
	Number	Percent	Number	Percent	
Total	22,848	100.0%	3792	100.0%	
Age					
18-39	127	0.6%	17	0.4%	.968
40-64	6678	29.2%	1301	34.3%	–
65-74	9832	43.0%	652	17.2%	**<.001**
≥75	6211	27.2%	1822	48.0%	**<.001**
Gender					**<.001**
Female	12,043	52.7%	2790	73.6%	
Male	10,805	47.3%	1002	26.4%	
Body mass index (kg/m^2)					
<18.5	146	0.6%	50	1.3%	**<.001**
18.5-29.9	10,950	47.9%	1762	46.5%	–
30-34.9	6196	27.1%	912	24.1%	**.039**
35-39.9	3257	14.3%	534	14.1%	.776
≥40	2299	10.1%	531	14.0%	**<.001**
Functional status prior to surgery					**<.001**
Independent	22,569	98.8%	3504	92.4%	
Dependent	279	1.2%	288	7.6%	
ASA classification					**<.001**
1-2	10,406	45.5%	909	24.0%	
≥3	12,142	53.1%	2883	76.0%	
Smoker					.560
No	20,476	89.6%	4530	119.5%	
Yes	2372	10.4%	588	15.5%	
Diabetes mellitus					
No diabetes mellitus	18,979	83.1%	2845	75.0%	–
Non-insulin-dependent diabetes	2835	12.4%	590	15.6%	**<.001**
Insulin-dependent diabetes	1034	4.5%	357	9.4%	**<.001**
Hypertension					**<.001**
No	7981	34.9%	954	25.2%	
Yes	14,867	65.1%	2838	74.8%	
Chronic steroid use					**<.001**
No	21,803	95.4%	3546	93.5%	
Yes	1045	4.6%	246	6.5%	
Chronic obstructive pulmonary disease					**<.001**
No	21,490	94.1%	3377	89.1%	
Yes	1368	6.0%	415	10.9%	
Congestive heart failure					**<.001**
No	22,751	99.6%	3712	97.9%	
Yes	97	0.4%	80	2.1%	
Bleeding disorders					**<.001**
No	22,366	97.9%	3604	95.0%	
Yes	482	2.1%	188	5.0%	
Anemia (Hct <39 for males, <36 for females)					**<.001**
No	17,094	74.8%	2327	61.4%	
Yes	3055	13.4%	1198	31.6%	
Preoperative international normalized ratio					**<.001**
≤1.2	8295	36.3%	1718	45.3%	
>1.2	675	3.0%	168	4.4%	
Operative duration (min)					
0-79	5985	25.1%	797	21.0%	**.013**
80-128	11,533	13.8%	1712	45.1%	–
≥129	5330	61.1%	1283	33.8%	**<.001**

ASA, American Society of Anesthesiologists; *Hct*, hematocrit; *LOS*, length of stay.
Bold *P* values indicate statistical significance with *P* < .05.

Ratio) > 1.2 (*P* < .001). The LOS ≤ 2 days cohort had significantly higher rates of age 65-74 (*P* < .001), BMI 30-34.9 (*P* = .039), and operative duration of 0-79 minutes (*P* = .013) and ≥ 129 minutes (*P* < .001) (Table V).

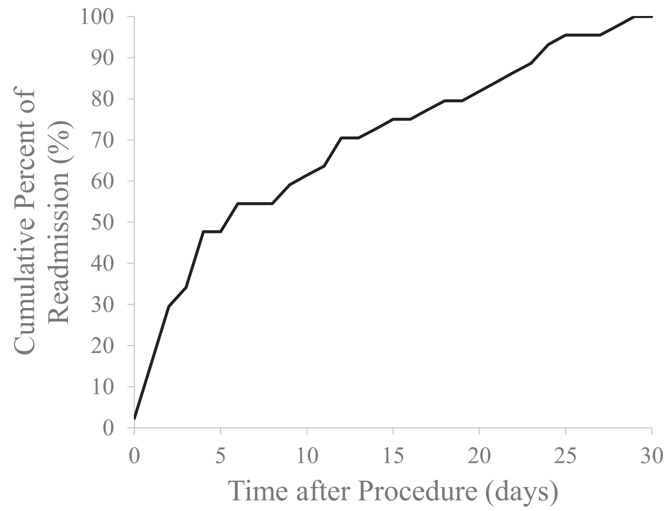

Figure 2 Timing of readmission within 30 days after total shoulder arthroplasty.

Reasons and timing of readmission after outpatient TSA

Of the 2431 patients in the outpatient TSA cohort, 44 (1.8%) patients were readmitted within 30 days after the procedure. Over half of these patients were readmitted within 6 days post-procedure. The average time from surgery to readmission was 9.6 days, with a standard deviation of 8.8 days (Fig. 2).

Of the 44 patients readmitted in the outpatient cohort, 33 (75.0%) patients were readmitted for nonsurgical site-related reasons, 5 (11.3%) patients were readmitted for surgical site-related reasons, and 6 (13.6%) patients were readmitted for other or unspecified reasons (Table VI). The most common reason for 30-day readmission was pulmonary complication (n = 10, 22.7%). Following pulmonary complications, the other common reasons for 30-day readmission included thromboembolic complications, metabolic abnormalities, neurological complications, unrelated orthopedic conditions, and wound complications (n = 4, 9.1% for each).

Risk factors for 30-day readmission after outpatient TSA

In the final multivariate model (Table VII), independent risk factors for 30-day readmission after outpatient TSA were identified to be chronic steroid use (OR 3.55, 95% CI 1.34-9.43; *P* = .011), COPD (OR 3.11, 95% CI 1.16-8.34; *P* = .024), and current smoking status (OR 2.27, 95% CI 1.02-5.03; *P* = .045).

Significance of risk factors for 30-day readmission after overnight stay

In patients who had a LOS of 1 day in the hospital, chronic steroid use (OR 1.22, 0.77-1.94; *P* = .397) and current smoking status (OR 1.30, 95% CI 0.95-1.78; *P* = .098) were no longer significant risk factors for 30-day readmission (Table VIII). However, COPD (OR 2.33, 95% CI 1.67-3.25; *P* < .001) remained a significant risk factor for 30-day readmission in patients who stayed in the hospital for 1 night.

COPD was therefore included in the analysis for patients who stayed in the hospital for 2 nights. In patients who had a LOS of 2 days in the hospital, COPD (OR 1.96, 95% CI 1.24-3.09; *P* = .004) was still a significant risk factor for 30-day readmission. Therefore, patients with COPD are at increased risk for 30-day readmission,

Table VI
Reasons for 30-d readmission after outpatient total shoulder arthroplasty.

Reason	Number	Percent
Total	44	100%
Nonsurgical site related		
Pulmonary complications	10	23%
Thromboembolic complications	4	9%
Metabolic abnormalities	4	9%
Neurological complications	4	9%
Unrelated orthopedic complications	4	9%
Sepsis	3	7%
Urinary complications	1	2%
Renal complications	1	2%
Gastrointestinal complications	1	2%
Cardiovascular complications	1	2%
Surgical site related		
Wound complications	4	9%
Pain	1	2%
Other complication/Unspecified	6	14%

Table VIII
Effect of overnight hospital stay on risk factors for 30-d readmission after total shoulder arthroplasty.

Characteristic	Odds ratio	95% CI	*P* value*
Chronic steroid use			.397
Outpatient	Reference	–	
Length of stay = 1 d	1.22	0.77-1.94	
COPD			**<.001**
Outpatient	Reference	–	
Length of stay = 1 d	2.33	1.67-3.25	
COPD			**.004**
Outpatient	Reference	–	
Length of stay = 2 d	1.96	1.24-3.09	
Current smoker			.098
Outpatient	Reference	–	
Length of stay = 1 d	1.30	0.95-1.78	

CI, confidence interval; *COPD*, chronic obstructive pulmonary disease.
Bold *P* value indicates statistical significance with $P < .05$.
*Significance at $P < .05$.

regardless of whether they undergo an outpatient procedure or stay in the hospital for 1 or 2 nights.

Discussion

In this study, we reported on clinically significant risk factors for 30-day readmission in patients who underwent outpatient TSA from 2015 to 2020 using a large national database. We also reported on the reasons for and timing of readmission. Our analysis included 26,640 patients, of which 2431 (9.1%) patients had a LOS of 0 days, 15,287 (57.4%) had a LOS of 1 day, 5130 (19.3%) had a LOS of 2 days, and 3792 (14.2%) patients had a LOS greater than 2 days. In the outpatient cohort, 44 (1.8%) patients were readmitted within 30 days. Through a multivariable model, we identified chronic steroid use, COPD, and current smoking status to be independent risk factors for 30-day readmission following outpatient TSA. Chronic steroid use and current smoking status were no longer significant risk factors for readmission for patients who stayed in the hospital overnight. However, COPD remained a significant risk factor for readmission regardless of hospital stay for 1 or 2 nights.

Rates of primary and revision shoulder arthroplasty procedures are projected to increase rapidly in the next 20 years. By 2025, the yearly incidence of TSA procedures is projected to be as high as 350,558, greatly outpacing the rise in total hip and total knee arthroplasties.[25] Consequently, policymakers and hospitals have been faced with increasing pressure to reduce costs, in light of increases in healthcare expenditure.[20] The SARS-CoV-2 (COVID-19) pandemic placed an immense burden on healthcare resources, causing the cancellation of many elective surgeries and placing even more pressure on hospitals to reduce costs.[6,18,23] Since then, many studies have found the outpatient setting to be cost-effective and safe for hip and knee arthroplasties.[2-4,11,14,17]

Table VII
Preoperative or procedural risk factors for 30-d readmission after total shoulder arthroplasty.

Characteristic	Odds ratio	95% CI	*P* value*
Chronic steroid use			.011
No	Reference	–	
Yes	3.55	1.34-9.43	
COPD			.024
No	Reference		
Yes	3.11	1.16-8.34	
Current smoker			.045
No	Reference	–	
Yes	2.27	1.02-5.03	

CI, confidence interval; *COPD*, chronic obstructive pulmonary disease.
*Significance at $P < .05$.

More recently, studies have found outpatient TSA to be safe and cost-effective in appropriately selected patients.[1,7,9,20] A meta-analysis performed by Cimino et al evaluated 26 studies and included 194,513 patients who underwent TSA, of whom 7162 underwent outpatient procedures. They reported that the overall likelihood of complications was significantly lower in outpatients compared to inpatients. Moreover, there were no significant differences in rates of readmission, reoperation, and infection between outpatients and inpatients. They concluded that outpatient TSA has comparable patient outcomes to inpatient TSA.[9] In terms of cost-effectiveness, two systematic reviews reported that outpatient TSA could result in a per procedure charge reduction of up to $53,202.[7,20] While these studies support the utilization of outpatient TSA, all stress the necessity for further research to determine a safe patient selection algorithm.[1,7,9,20]

A systematic review by O'Donnell et al, evaluated 20 studies and reported that patient selection for outpatient TSA was most often based on age < 70 years, BMI < 35 kg/m^2, absence of cardiopulmonary comorbidities, and presence of home support.[20] One study proposed a patient selection algorithm for outpatient total joint arthroplasty that considered age > 70, COPD on home oxygen, unstable cardiovascular disease, and prior cardiac surgery within 6 months to be contraindications for outpatient procedures.[12] Another study proposed a patient selection tool based on 13 patient variables that include the following: duration of surgery, age, gender, electrolyte disorder, marital status, ASA class, paralysis, diabetes, neurologic disease, peripheral vascular disease, pulmonary circulation disease, cardiac arrhythmia, and coagulation deficiency.[13] Outcomes of these screening guidelines have not been studied to our knowledge.

Our study contributes to the literature on patient selection by considering specific variables that have not been assessed in previous studies, such as current smoking status, chronic steroid use, and functional status prior to surgery. By using a large national database, we included an outpatient cohort of comparable size to previous systematic reviews and meta-analyses. Our finding that COPD is a significant risk factor for readmission after outpatient TSA is consistent with the recommendations of previously proposed algorithms.[12,13] This is also consistent with our finding that the majority of readmissions were due to pulmonary complications. Of note, we did not evaluate for the use of peripheral nerve block, which could be a potential contributing factor to the development of pulmonary complications. Our analysis showed that patients with COPD remained at elevated risk for readmission even when kept overnight compared to same-day discharge following TSA. Additionally, we identified chronic steroid use and current smoking status as significant risk factors for readmission after outpatient TSA. Patients with either of these comorbidities had lower rates of readmission after overnight hospital stay.

Of interest, we did not find age, CHF, obesity, duration of surgery, gender, ASA, or diabetes to be clinically significant predictors of readmission. However, it is possible that this is a result of selection bias as patients with some of these factors may have been screened out of ambulatory population. We compared patients with LOS $\leq$ 2 days vs LOS > 2 days to identify the characteristics that may have been screened out. We found that patients with LOS > 2 days were more likely to be over age 75 and female, with BMI < 18.5, BMI $\geq$ 40, dependent functional status, ASA $\geq$ 3, diabetes mellitus, hypertension, chronic steroid use, COPD, CHF, bleeding disorder, preoperative anemia, INR > 1.2, and operative duration 80-128 minutes. Despite screening and higher rates in the LOS > 2 days cohort, COPD and chronic steroid use remained significant predictors for readmission in the ambulatory population. This suggests that COPD and chronic steroid use should be considered more strongly as factors encouraging inpatient stay.

Other limitations of this study can be attributed to the inherent constraints of the NSQIP database. One key limitation is that postoperative complication data are only collected within the 30-day postoperative period. Therefore, reasons for readmission that are more likely to occur after a month postoperatively are not included in the analysis, such as shoulder dislocation or implant loosening.[8] An analysis that includes postoperative complication up to 90 days postoperatively would allow for better characterization of patient risk factors. However, there is currently no database that has 90-day postoperative data with a similar case volume to the NSQIP database. Another key limitation is that the database is not able to determine the etiology or severity of patient comorbidities. For example, for patients with chronic steroid use, we are unable to identify the reason for chronic steroids or the duration for which they have been taken. Additionally, for patients with current smoking status, we are unable to quantify their smoking in packs per day. Lastly, as mentioned previously, the number of patients with some of the more significant risk factors was low, possibly due to preoperative screening based on existing guidelines.

Given the recent surge in outpatient TSA, this study was able to include a large sample size using the latest files from the NSQIP database. Over 60% of the cases included in the outpatient cohort were obtained from the 2019 and 2020 NSQIP files. This study also included patient variables that have otherwise not been previously investigated with regard to outpatient TSA.

Conclusion

Overall, the 30-day readmission rate after outpatient TSA was 1.8%. A majority of readmissions were due to nonsurgical-site-related reasons, of which pulmonary complications were most common. The results of this analysis indicate that patients with a history of chronic steroid use, current smoking status, and COPD are an increased risk of 30-day readmission after outpatient TSA. Patients with chronic steroid use and current smoking status were at decreased risk of readmission following overnight hospital stay. Patients with COPD should be admitted for inpatient stay postoperatively but may still have high 30-day readmission rates following discharge. As outpatient TSA utilization increases, refined patient selection criteria will aid in minimizing adverse outcomes and mitigating unnecessary healthcare expenditures.

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