Cost Drivers Associated With Anterior Shoulder Stabilization Surgery

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Background: Arthroscopic Bankart repair, open Bankart repair, and the Latarjet procedure are common treatments for anterior shoulder instability; however, little is known of costs by patient- and surgeon-specific factors. This study aimed to identify areas where cost reduction may be achieved.

Hypothesis: Increased total charges will be associated with low-volume surgeons and surgical facilities, hospital-owned facilities, open surgical techniques, and patients with at least 1 comorbidity.

Study Design: Economic and decision analysis; Level of evidence, 3.

Methods: The 2014 State Ambulatory Surgery and Services Databases from 6 states were utilized. There were 3 Current Procedural Terminology codes (23455, 23462, 29806) used to identify open Bankart repair, the Latarjet procedure, and arthroscopic Bankart repair, respectively. Patient demographic and surgical variables were evaluated on a univariate basis, and all significant factors were then included in the multiple linear regression to determine which factors had the largest effect on cost. Total charges billed for the encounter were used as a proxy for cost of surgery.

Results: For open Bankart repair, arthroscopic Bankart repair, and the Latarjet procedure, longer operative times increased costs, and high-volume surgical facilities had decreased charges. For the arthroscopic Bankart group, additional factors that increased charges included postoperative hospital admission (US\$11,516; $P < .001$), patient residence in a ZIP code with a below-median income (US\$2909; $P < .001$), presence of a comorbidity (US\$1982; $P < .001$), male sex (US\$1545; $P = .003$), Hispanic race (US\$2493; $P = .005$), and use of regional anesthesia (US\$1898; $P = .025$). Additional cost drivers for the Latarjet procedure included postoperative hospital admission (US\$7028; $P = .022$) and older age (US\$187/y; $P = .039$).

Conclusion: Postoperative admission to the hospital was the largest cost driver for arthroscopic Bankart repair and the Latarjet procedure. Low-volume facilities were the largest cost driver for open Bankart repair. High-volume surgery centers had lower costs when compared with low-volume surgery centers. Regional anesthesia increased costs in the arthroscopic Bankart group. These findings may help to show where cost savings can be achieved, particularly considering increasing trends toward bundled health care payments.

Keywords: shoulder instability; glenoid labrum; general sports trauma; economic and decision analysis

Anterior shoulder instability is a common problem, with shoulder dislocations occurring at a rate of 23.9 per 100,000 person-years.[31] The most common surgical techniques used to address anterior shoulder instability consist of arthroscopic Bankart repair, open Bankart repair, and the Latarjet procedure. The treatment of shoulder instability depends on many factors including patient demographics, number of dislocations, and associated injuries to the glenoid and/or humerus. Over the past 2 decades, there has been a significant trend toward arthroscopic stabilization, with arthroscopic surgery accounting for nearly 90% of procedures from a 2009 national database.[23,32]

Several studies have previously compared the costs of arthroscopic and open techniques of anterior shoulder stabilization.[1,21,26,30] Min et al[21] found arthroscopic Bankart repair was a more cost-effective method of treating primary shoulder instability than was the Latarjet procedure. This contrasts with the findings of Uffmann et al,[29] who found that Bankart repair was more costly because of higher implant costs. However, sufficient data were not available to draw conclusions regarding specific patient-, surgery-, and center-derived variables at a national level within these studies. As bundled payments become more of the norm in medicine, having the ability to identify specific factors associated with the increased cost of these procedures may help physicians and payers decrease the overall monetary burden on society. Kuye et al[15] noted a lack of high-quality economic analyses regarding shoulder injuries, despite their high prevalence in the general population.

In the current study, the State Ambulatory Surgery and Services Databases (SASD) were utilized to examine patient and surgical data relating to the cost of anterior shoulder stabilization. We hypothesized that increased costs would be associated with low-volume surgeons and surgical facilities, hospital-owned facilities, open surgical techniques, and patients with at least 1 comorbidity. We also sought to identify additional variables that may be associated with increased costs for anterior shoulder stabilization procedures. Our objective was to show where cost savings can be achieved, particularly considering increasing trends toward bundled health care payments.

METHODS

Data Source

This study utilized the 2014 SASD, a part of the Healthcare Cost and Utilization Project (HCUP). The HCUP is a well-validated data source for a number of medical procedures.[2,4,8,11,28] The SASD consist of encounter-level data for outpatient surgical procedures performed in both hospital-owned and freestanding ambulatory surgery centers. The databases collect >200 data points on patient demographics, surgical variables, and procedure details for every encounter. This study utilized databases from the states of Florida, Kentucky, Iowa, Maryland, Nevada, and New York. These states were selected in an effort to provide a geographically representative sample. This geographic subset has been previously validated in studies assessing cost data in orthopaedic procedures.[3,17]

Data Collection

All cases with Current Procedural Terminology (CPT) codes 23455 (capsulorrhaphy, anterior, with labral repair), 23462 (capsulorrhaphy, anterior, any type; with coracoid process transfer), and 29806 (arthroscopy, shoulder, surgical; capsulorrhaphy) were selected. Unique physician and surgical facility identifiers were used to calculate the caseload. Any cases that also included CPT codes 29827 (arthroscopy, shoulder, with rotator cuff repair) or 29826 (arthroscopy, shoulder, subacromial decompression) were excluded, as were cases with missing or incomplete charge data.

Total charges in 2014 US dollars were used as a primary outcome variable in this study to approximate the cost of surgery, as previous HCUP database studies have demonstrated total charges as a useful proxy measure for estimating costs.[3,16,17] Moreover, utilizing total charge data allows for the analysis of trends that may be identified in how

surgery centers bill for different demographic groups and for different surgical methods. These trends may show areas where there is a potential for cost savings. This approach has been validated in several recent publications.[3,16,17]

Statistical Analysis

A number of patient demographic and surgical variables were tested for significance. Demographic variables included patient age, sex, race, presence of at least 1 medical comorbidity, type of insurance, and income quartile of the patient's ZIP code. Income quartiles were based off of the median household income of residents in the patient's ZIP code. The first quartile was from $1 to $39,999, the second quartile was from $40,000 to $50,999, the third quartile was from $51,000 to $65,999, and the fourth quartile was $66,000 or greater. Surgical variables included type of anesthesia, postoperative admission to the hospital, surgery center ownership (hospital vs privately owned), physician volume, and facility volume. These variables were first tested on a univariate basis using single linear regression, independent-samples t test, and 1-way analysis of variance as applicable. Significant variables based on univariate analysis ($P < .05$) were then included in the multiple linear regression to model the cost of individual anterior stabilization techniques while controlling for all significant factors. Additionally, a comparison of operative times between low- and high-volume surgical facilities was performed. All P values $<.05$ were considered significant (SPSS Statistics Version 25.0; IBM Corp).

Both surgeon and facility volume were divided into high- and low-volume categories. Receiver operating characteristic analysis was performed to determine the cutoffs. As has been previously described, cutoff values were identified by finding the maximum of the sum of sensitivity and specificity.[12] For arthroscopic Bankart repair, receiver operating characteristic analysis resulted in a physician volume cutoff of 11 cases per year and a facility volume cutoff of 39 cases per year. For both open Bankart repair and the Latarjet procedure, the physician volume cutoff was 5 cases, and the facility volume cutoff was 8 cases.

RESULTS

After exclusions, there were 6498 arthroscopic Bankart cases, 318 open Bankart cases, and 287 Latarjet cases. The mean costs of surgery were $18,842 ± $12,746 for the arthroscopic Bankart group, $20,690 ± $15,540 for the open Bankart group, and $20,275 ± $13,800 for the Latarjet group. The difference between arthroscopic and open

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TABLE 1
Univariate Analysis of Patient Age for Cost
of 3 Procedures[a]

Surgery Type	Constant (SE), $	B Coefficient (SE), $	P Value
Arthroscopic Bankart	16,832 (378)	72 (12)	**<.001**
Open Bankart	16,087 (2037)	156 (62)	**.013**
Latarjet	13,629 (2268)	231 (74)	**.002**

[a]Bolded P values indicate statistically significant difference (P < .05). B coefficient indicates added cost per year of increasing age. SE, standard error.

Bankart repair was significant (P = .013), but there was no significant difference between arthroscopic Bankart repair and the Latarjet procedure (P = .063) or between open Bankart repair and the Latarjet procedure (P = .730).

Patient Demographic Variables

Increasing patient age added cost for all 3 treatment methods (Table 1). Each additional year of age added from $72 (arthroscopic Bankart: P < .001) to $231 (Latarjet: P = .002). Patient race was also significant for arthroscopic Bankart repair, with Hispanic patients having 20% higher costs than non-Hispanic white patients (P < .001) (Table 2). This same trend was also present for the Latarjet procedure but only approached statistical significance (P = .084). Male patients had 12% higher costs than female patients in the arthroscopic Bankart group (P < .001) (Table 2). The presence of at least 1 comorbidity was a significant cost driver in all 3 groups (Table 2). Patients with comorbidities had 15% higher costs in the arthroscopic Bankart group (P < .001), 23% higher costs in the open Bankart group (P = .016), and 26% higher costs in the Latarjet group (P = .005). Patients with public insurance had higher costs than patients with private insurance in the arthroscopic Bankart group (Table 3). Patients with Medicaid had 12% higher costs, and patients with Medicare had 26% higher costs (both P < .001). Patients living in lower-income ZIP codes also had higher costs across all 3 treatment methods (Table 3). Compared with patients in the highest-income ZIP codes, patients living in the lowest-income ZIP codes had 23% higher costs in the arthroscopic Bankart group (P < .001), 6% higher costs in the open Bankart group (P = .009), and 41% higher costs in the Latarjet group (P = .002).

Surgical Variables

Several surgical variables were found to be cost drivers. Each additional minute in the OR added from $71 (Latarjet: P < .001) to $98 (open Bankart: P < .001) (Table 4). Patients receiving regional anesthesia had higher costs than patients receiving general anesthesia alone, with 29% higher costs in the arthroscopic Bankart group (P < .001) and 18% higher costs in the Latarjet group (P = .007) (Table 5). Postoperative admission to the hospital was a

TABLE 2
Univariate Analysis of Demographic Variables for Cost
of 3 Procedures[a]

Variable	Patients, %	Cost, Mean ± SD, $	P Value
Race			
Arthroscopic Bankart			**<.001**
White	72.6	18,860 ± 12,398	
Black	9.6	19,415 ± 12,690	
Hispanic	7.2	22,704 ± 13,367	
Asian	1.5	16,182 ± 8885	
Native American	0.2	15,592 ± 13,284	
Other	8.8	18,738 ± 15,848	
Open Bankart			.433
White	73.5	21,935 ± 15,719	
Black	9.2	20,044 ± 16,240	
Hispanic	5.3	24,819 ± 22,138	
Asian	2.5	29,761 ± 27,613	
Other	9.5	18,350 ± 9932	
Latarjet			.084
White	71.6	19,839 ± 13,173	
Black	8.0	19,513 ± 13,188	
Hispanic	5.1	31,224 ± 17,913	
Asian	1.1	20,478 ± 5273	
Other	14.2	22,479 ± 15,373	
Sex			
Arthroscopic Bankart			**<.001**
Female	25.9	17,353 ± 12,518	
Male	74.1	19,362 ± 12,785	
Open Bankart			.377
Female	78.6	21,092 ± 15,789	
Male	21.4	19,210 ± 14,604	
Latarjet			.789
Female	83.6	20,371 ± 13,500	
Male	16.4	19,782 ± 15,392	
Comorbidities			
Arthroscopic Bankart			**<.001**
None	57.0	17,679 ± 12,160	
At least 1	43.0	20,383 ± 13,330	
Open Bankart			**.016**
None	66.7	19,206 ± 12,952	
At least 1	33.3	23,658 ± 19,460	
Latarjet			**.005**
None	64.1	18,555 ± 12,058	
At least 1	35.9	23,347 ± 16,072	

[a]Bolded P values indicate statistically significant difference (P < .05).

large cost driver in the arthroscopic Bankart and Latarjet groups, adding $15,765 and $10,016, respectively (both P < .001) (Table 5). Privately owned surgery centers had lower costs across all 3 treatment methods (Table 5). At privately owned facilities, costs were 18% lower for the arthroscopic Bankart group (P < .001), 40% lower in the open Bankart group (P < .001), and 45% lower in the Latarjet group (P < .001). Across all 3 treatment methods, increased costs were found for low-volume physicians and low-volume surgical facilities (Table 6). Low-volume physicians had 5% higher costs in the arthroscopic Bankart group (P = .04), 50% higher costs in the open Bankart group (P = .016), and 53% higher costs in the Latarjet group (P =

TABLE 3
Univariate Analysis of Economic Variables for Cost
of 3 Procedures[a]

Variable	Patients, %	Cost, Mean ± SD, $	P
Insurance			
Arthroscopic Bankart			**<.001**
Medicare	2.4	23,402 ± 16,434	
Medicaid	10.2	20,773 ± 13,135	
Private insurance	69.4	18,568 ± 11,758	
Other	18.0	18,202 ± 15,180	
Open Bankart			.609
Medicare	3.1	26,763 ± 24,664	
Medicaid	17.3	20,797 ± 17,276	
Private insurance	65.4	20,646 ± 14,545	
Other	14.2	19,413 ± 15,615	
Latarjet			.295
Medicare	3.5	26,722 ± 16,192	
Medicaid	12.9	21,949 ± 15,138	
Private insurance	73.9	19,490 ± 12,930	
Other	9.8	21,701 ± 17,078	
Income quartile of patient's ZIP code			
Arthroscopic Bankart			**<.001**
1	17.1	20,799 ± 14,094	
2	23.8	20,935 ± 14,511	
3	24.3	18,168 ± 11,858	
4	34.8	16,904 ± 10,914	
Open Bankart			**.009**
1	16.2	19,117 ± 11,238	
2	22.0	25,810 ± 23,129	
3	26.8	21,490 ± 15,385	
4	35.0	17,995 ± 10,018	
Latarjet			**.002**
1	22.3	25,927 ± 17,336	
2	18.8	18,501 ± 10,740	
3	22.7	18,755 ± 15,259	
4	36.2	18,452 ± 9987	

[a]Bolded P values indicate statistically significant difference (P < .05).

TABLE 4
Univariate Analysis of Operative Time for Cost
of 3 Procedures[a]

Surgery Type	Constant (SE), $	B Coefficient (SE), $	P Value
Arthroscopic Bankart	10,672 (528)	80 (5)	**<.001**
Open Bankart	6624 (1946)	98 (14)	**<.001**
Latarjet	5961 (2217)	71 (14)	**<.001**

[a]Bolded P values indicate statistically significant difference (P < .05). B coefficient indicates added cost per minute of additional time.

.006). The same trends were true for low-volume facilities, which had 17% higher costs in the arthroscopic Bankart group (P < .001), 28% higher costs in the open Bankart group (P = .015), and 26% higher costs in the Latarjet group (P = .024).

TABLE 5
Univariate Analysis of Surgical Variables for Cost
of 3 Procedures[a]

Variable	Patients, %	Cost, Mean ± SD, $	P
Anesthesia			
Arthroscopic Bankart			**<.001**
General anesthesia	55.1	15,399 ± 9998	
Regional anesthesia	21.3	19,807 ± 9919	
Other	23.6	15,287 ± 10,501	
Open Bankart			.224
General anesthesia	61.7	18,612 ± 12,293	
Regional anesthesia	27.8	21,870 ± 7619	
Other	10.5	17,264 ± 4510	
Latarjet			**.007**
General anesthesia	44.2	16,928 ± 10,202	
Regional anesthesia	36.2	19,914 ± 8170	
Other	19.6	12,944 ± 8003	
Postoperative hospital admission			
Arthroscopic Bankart			**<.001**
Not admitted	98.0	18,514 ± 12,268	
Admitted	2.0	34,279 ± 21,724	
Open Bankart			.112
Not admitted	86.1	20,171 ± 15,331	
Admitted	13.9	24,188 ± 16,613	
Latarjet			**<.001**
Not admitted	88.4	19,079 ± 12,634	
Admitted	11.6	29,095 ± 18,951	
Surgery center ownership			
Arthroscopic Bankart			**<.001**
Hospital owned	73.6	16,437 ± 9543	
Privately owned	26.4	13,493 ± 11,403	
Open Bankart			**<.001**
Hospital owned	75.7	18,863 ± 10,886	
Privately owned	24.3	11,367 ± 4731	
Latarjet			**<.001**
Hospital owned	86.2	17,800 ± 9618	
Privately owned	13.8	9780 ± 4799	

[a]Bolded P values indicate statistically significant difference (P < .05).

Comparison of Operative Times

Operative times were shorter at high- than low-volume facilities for the arthroscopic Bankart group, requiring 6 fewer minutes (P < .001) (Table 7). There was no significant difference between high- and low-volume groups for open Bankart repair or the Latarjet procedure. Both open Bankart repair and the Latarjet procedure required longer operative times when compared with arthroscopic Bankart repair (P < .001).

Multivariate Analysis of Cost Drivers

Using multiple linear regression, we identified several variables that affected the cost of each type of anterior instability repair procedure. For the arthroscopic Bankart group, time in the OR, postoperative admission to the hospital, income quartile of the patient's ZIP code, surgery center ownership, presence of a comorbidity, facility volume, sex, race, and type

TABLE 6
Univariate Analysis of Physician and Surgical Facility
Volume for Cost of 3 Procedures[a]

Variable	Cases, %	Cost, Mean ± SD, $	P
Physician volume			**.04**
Arthroscopic Bankart			
Low volume (<11 cases)	53.5	22,014 ± 16,089	
High volume (≥11 cases)	46.5	20,937 ± 12,643	
Open Bankart			**.016**
Low volume (<5 cases)	72.5	24,394 ± 21,389	
High volume (≥5 cases)	27.5	16,251 ± 9918	
Latarjet			**.006**
Low volume (<5 cases)	71.0	26,702 ± 18,962	
High volume (≥5 cases)	29.0	17,488 ± 7646	
Facility volume			
Arthroscopic Bankart			**<.001**
Low volume (<39 cases)	49.6	20,329 ± 14,439	
High volume (≥39 cases)	50.4	17,382 ± 10,629	
Open Bankart			**.015**
Low volume (<8 cases)	64.4	21,975 ± 17,913	
High volume (≥8 cases)	35.6	17,208 ± 11,145	
Latarjet			**.024**
Low volume (<8 cases)	72.0	21,355 ± 16,396	
High volume (≥8 cases)	28.0	16,999 ± 3856	

[a]Bolded P values indicate statistically significant difference ($P < .05$).

of anesthesia all affected cost (Table 8). The largest cost driver of these was postoperative admission to the hospital, adding \$11,516 ($P < .001$). Living in a ZIP code with a below-median income added \$2909 ($P < .001$), and use of regional anesthesia added \$1898 ($P = .025$). Undergoing surgery at a high-volume facility decreased costs by \$2077 ($P < .001$).

For the open Bankart group, operative time and facility volume both significantly affected costs (Table 8). Each additional minute in the OR added \$147 ($P < .001$), and undergoing surgery at a high-volume facility decreased costs by \$6146 ($P = .010$).

For the Latarjet group, operative time, surgery center ownership, facility volume, postoperative admission to the hospital, and patient age were significant cost drivers (Table 8). As with the arthroscopic Bankart group, the largest cost driver was postoperative hospital admission, adding \$7028 ($P = .022$). Each additional minute in the OR added \$96 ($P < .001$), and each year of age added \$187 ($P = .039$). Privately owned surgery centers and high-volume surgical facilities both provided cost savings. High-volume facilities decreased costs by \$6015 ($P = .008$).

DISCUSSION

This study used large geographically representative databases to determine the cost drivers of common anterior shoulder instability procedures in the United States. Previous studies have aimed to determine the least expensive or most cost-effective surgical method of addressing

instability.[1,21,26,29,30] This study adds several findings to the previous literature about specific cost drivers within each procedure on a national level. We found that patient age, presence of comorbidities, income quartile of a patient's ZIP code, surgery center ownership, operative time, physician volume, and surgical facility volume were significant factors in determining the cost of all 3 surgical procedures assessed. Additionally, patient race, sex, insurance, type of anesthesia, and postoperative hospital admission affected costs in at least 1 type of treatment method.

Similarly, our analysis found that high-volume surgical facilities provided substantial cost savings to patients undergoing all 3 procedures. These savings ranged from \$2077 in the arthroscopic Bankart group to \$6146 in the open Bankart group. Facility volume has been previously investigated for several inpatient orthopaedic procedures; patients at high-volume facilities have lower mortality rates and shorter lengths of stay than have patients at low-volume facilities.[7,9,24] Additionally, patients undergoing anterior cruciate ligament reconstruction have been shown to have a higher risk of requiring revision anterior cruciate ligament reconstruction when surgery was performed at a low-volume facility.[18] It is possible that these high-volume facilities are able to provide both superior patient outcomes and lower costs because of greater experience of the physicians and support staff with the procedure. It should be noted that high-volume surgeons provided cost savings for all 3 treatment methods in the univariate analysis but did not have a significant effect in the multivariate regression. This may have been as a result of controlling for several surgeon-modifiable factors, such as anesthesia type and operative time. Cost savings may also be more prominent at the facility level because savings from multiple surgeons may aggregate.

In both univariate and multivariate analyses, privately owned surgery centers were able to deliver cost savings to patients undergoing arthroscopic Bankart repair and the Latarjet procedure. The univariate analysis showed that privately owned surgery centers delivered 18% lower costs for the arthroscopic Bankart group and 45% lower costs for the Latarjet group, although the difference was not clinically significant in the multivariate analysis (\$3 and \$15 in savings, respectively). It is possible that these savings were statistically significant but not clinically important in the multivariate analysis because of an association between higher facility volume and private ownership. Although previous orthopaedic studies have investigated how surgery center ownership affects procedure utilization and time efficiency in the OR, this is the first to show evidence of cost savings for outpatient procedures performed in privately owned ambulatory surgery centers.[25,27] This finding is consistent with other recent literature showing that physician-owned hospitals provided cost savings for patients undergoing posterior lumbar fusion.[19]

The comparison of operative times showed an association between high facility volume and shorter operative time for arthroscopic Bankart repair. Just as high-volume facilities had lower costs, they also had shorter average operative times, again implying familiarity with the equipment and procedures when performed in larger numbers. This also

TABLE 7
Comparison of Operative Times for 3 Procedures[a]

Surgery Type	Operative Time, min	95% CI	P Value (Within Group)	P Value (Across Groups)
Arthroscopic Bankart			**<.001**	**<.001**
Low-volume facilities	105.79	102.68-108.90		
High-volume facilities	99.60	97.33-101.86		
Open Bankart			.308	
Low-volume facilities	122.87	109.22-136.52		
High-volume facilities	132.75	119.73-145.77		
Latarjet			.929	
Low-volume facilities	152.71	143.09-162.33		
High-volume facilities	153.55	136.26-170.83		

[a]Bolded *P* values indicate statistically significant difference (*P* < .05).

TABLE 8
Multivariate Analysis of Cost Drivers for 3 Procedures[a]

	B (SE), $	P	95% CI for B, $
Arthroscopic Bankart			
Constant	11,540 (721)	<.001	10,125 to 12,954
Operative time	69 (5)	<.001	60 to 78
Postoperative admission to hospital	11,516 (1633)	<.001	8313 to 14,719
Lower-income ZIP code	2909 (464)	<.001	1999 to 3819
Privately-owned surgery center	−3 (1)	<.001	−4 to −1
Presence of comorbidity	1982 (455)	<.001	1089 to 2875
High-volume facility	−2077 (461)	<.001	−2981 to −1173
Female sex	−1545 (513)	.003	−2551 to −540
Hispanic race	2493 (890)	.005	747 to 4239
Regional anesthesia	1898 (847)	.025	236 to 3559
Open Bankart			
Constant	4148 (2846)	.147	−1482 to 9777
Operative time	147 (20)	<.001	108 to 187
High-volume facility	−6146 (2349)	.010	−10,791 to −1501
Latarjet			
Constant	4512 (4556)	.324	−4495 to 13,518
Operative time	96 (19)	<.001	59 to 134
Privately owned surgery center	−15 (4)	<.001	−24 to −7
High-volume facility	−6015 (2240)	.008	−10,443 to −1587
Postoperative admission to hospital	7028 (3038)	.022	1022 to 13,034
Age	187 (90)	.039	9 to 365

[a]Bolded *P* values indicate statistically significant difference (*P* < .05). B coefficient indicates added cost for each factor.

indicates that there may be a learning curve for performing arthroscopic Bankart repair.

Surgeon-controllable factors offer the best opportunity to provide cost savings. Operative time was a significant cost driver across all 3 procedures, ranging from $69 to $147 per minute. It is important for surgeons to be cognizant of their time efficiency in the OR. Additionally, longer operative times have been found to be a risk factor for postoperative hospital admission, which itself was the largest cost driver in the arthroscopic Bankart and Latarjet groups.[6] The use of regional anesthesia over general anesthesia was also found to increase costs in the arthroscopic Bankart and Latarjet groups in the univariate analysis. It was also a cost driver for arthroscopic Bankart repair in multivariate

regression. This contrasts with the results of Gonano et al,[10] who found that interscalene block was actually associated with decreased total anesthesia costs primarily because of a decrease in OR and postanesthesia care unit (PACU) time. Several studies have also found decreased hospitalization rates with the use of peripheral nerve blockade for orthopaedic procedures, which may offset its up-front cost by preventing unexpected postoperative admission in some patients.[5,13] Our multivariate results for arthroscopic Bankart repair controlled for the cost of postoperative admission and still found regional anesthesia added to the cost. A possible reason for this is that regional anesthesia may decrease time spent in the PACU, and this may not have been fully accounted for in our analysis because we did not have data on PACU time. Although providers should be cognizant of the additional up-front cost, they may still choose to use regional anesthesia for arthroscopic Bankart repair because of its previously shown utility in the prevention of readmission.[5,13]

We also identified several patient demographic groups that experienced higher costs. Hispanic patients had higher costs in the arthroscopic Bankart group, even when controlling for all other significant factors. This has been noted in several previous studies of outpatient orthopaedic procedures.[3,17] Patients living in a ZIP code with a below-median income also had higher costs. It is unclear why Hispanic patients and patients with a lower income level had higher costs, but it is possible that social determinants of health or provider biases play a role. A previous study analyzed patients living in communities of low socioeconomic status and found a higher risk of developing postoperative complications, higher readmission rates, and higher costs of surgery.[20] The presence of at least 1 comorbidity was also an independent cost driver in the arthroscopic Bankart group likely because of the added medical complexity underlying patients with comorbidities. Other studies have also found that patients with more comorbidities have higher costs for orthopaedic procedures.[14,22]

There are several limitations inherent in this study. We did not have data on longer-term outcomes, such as revision rates, so we were unable to adjust costs for the long-term quality of the surgical procedures. As we were using claims-based databases, there was a risk of misclassification or

miscoding of data elements when they were collected. We also were using total charges as a proxy for the cost of surgery, and a further breakdown of charges was not available. Total charges may not be the same as the reimbursement that a provider receives or the true cost of a procedure. Billing practices may also vary across sites. We studied a large sample size from 6 states to mitigate the effects of any billing variations, and this methodology has been accepted in several previous orthopaedic publications.[2-4,16-18] Our selection of 6 states provided a geographically representative sample. However, there still may have been differences between these states and those not included in the study with regard to surgical and billing practices. Finally, the calculation of total charges did not account for postoperative care including physical therapy and out-of-work status. While these may have differed among the procedures, our goal was to identify surgery- and patient-specific factors associated with increased cost, and further studies may seek to identify these additional cost factors. Despite the limitations inherent in our data set, this study can better inform surgeons when counseling patients. The trends identified can also prove useful to surgeons looking for ways to achieve cost savings.

CONCLUSION

This study identified a number of demographic and surgical variables that influence the cost of 3 methods of anterior shoulder stabilization. Postoperative admission to the hospital was the largest cost driver for arthroscopic Bankart repair and the Latarjet procedure. Low-volume surgical facilities were the largest cost driver for open Bankart repair. Privately owned and high-volume surgery centers both had lower costs when compared with hospital-owned and low-volume surgery centers. Longer operative times increased costs across all 3 procedures, and use of a nerve block increased costs in the arthroscopic Bankart and Latarjet groups. Surgeons may find these trends useful for reducing costs in their practices, particularly considering increasing trends toward bundled health care payments.

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