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Quantification of patient-level costs in outpatient total shoulder arthroplasty

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Background: Patient-level costs of inpatient and outpatient total shoulder arthroplasty (TSA) irrespective of payer status are seldom reported. The purpose of this study was to compare patient-level costs of primary elective TSA between inpatient and outpatient surgery centers.
Methods: By use of the Texas Health Care Information Collection database, inpatient and outpatient TSAs performed between 2010 and 2015 were identified according to billing codes. Patient-level costs (total charges and itemized charges) were analyzed according to type of surgery center (inpatient vs outpatient) and inpatient volume (high volume vs low volume). Statistical comparisons were performed using 1-way analysis of variance and 2-sample independent *t* tests. Mixed-model analysis of variance was used to compare the rate of cost change between inpatient and outpatient TSAs from 2010-2015. $P < .05$ represented statistical significance.
Results: A total of 21,331 inpatient TSAs and 1542 outpatient TSAs were performed from 2010-2015 in the state of Texas. Inpatient TSA costs were significantly higher than outpatient TSA costs ($76,109 [standard deviation (SD), $48,981] vs $22,907 [SD, $13,599]; $P < .001$). After exclusion of inpatient-specific charges, inpatient TSA remained 41.1% more expensive than outpatient TSA ($32,330 [SD, $24,221] vs $22,907 [SD, $13,599]; $P < .0001$). High-volume inpatient TSA was less expensive than low-volume inpatient TSA; however, high-volume inpatient TSA remained 33.4% more costly than outpatient TSA even after exclusion of inpatient-specific charges ($30,579 [SD, $23,233] vs $22,907 [SD, $13,599]; $P < .0001$).
Conclusions: In the state of Texas, the patient-level costs of primary elective inpatient TSA were significantly higher than those of the equivalent outpatient procedure. This difference persisted after exclusion of low-volume inpatient TSA centers and inpatient-specific ancillary charges.
Level of evidence: Level IV; Economic Analysis
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Keywords: Shoulder arthroplasty; cost analysis; outpatient surgery; ambulatory surgery; inpatient surgery; hospital volume

Total shoulder arthroplasty (TSA) is becoming an increasingly common procedure performed by orthopedic surgeons in the United States. The demand for TSA has risen dramatically in recent years and is largely attributable to the growing prevalence of age-related degenerative conditions that can be

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successfully treated with TSA, including glenohumeral osteoarthritis and end-stage cuff arthropathy.[5] The demand for TSA will undoubtedly continue to increase for the foreseeable future, and it is predictable that patient- and provider-level costs will follow suit.[9,10] As a result, policy makers have placed specific emphasis on reducing the cost of TSA without compromising the quality, efficiency, or safety of patient care. Quantification of patient-level itemized costs represents a direct approach to cost analysis by tracing the resources that were actually consumed rather than the traditional "top-down" allocation approach, which is inherently limited in scope.

Existing cost analyses in shoulder arthroplasty have shown a clear volume-value threshold for shoulder arthroplasty.[20] Previous database studies reported that surgical centers performing larger numbers of joint replacement surgical procedures had decreased rates of complications and readmissions relative to lower-volume centers.[4,12] These differences in care quality were presumed to reflect differences in physician and staff familiarity with these procedures relative to lower-volume surgical centers.[12,13] However, this assumption naturally conflicts with outpatient centers that employ or share ownership with high-volume surgeons who travel with their dedicated staff.

Outpatient total joint arthroplasty has been touted as an alternative to inpatient arthroplasty owing to the potential for decreased overall operating costs, enhanced profitability, and patient-provider incentivization without sacrificing care quality.[2,6,15] In addition, surgeon-staff familiarity with the procedures being performed is thought to be responsible for the improved quality of surgical care provided by higher-volume surgical centers.[11-13] Nonetheless, following the volume-value debate in previous years, the shift toward outpatient arthroplasty has generated similar concerns regarding the potential for complications, readmissions, and inadequate perioperative pain control by virtue of being performed at lower-volume outpatient surgery centers (irrespective of surgeon volume).

Previous studies relating to hip and knee arthroplasty have found no significant differences in complication or readmission rates when surgical procedures were performed at lower-volume outpatient centers compared with traditional higher-volume inpatient centers, even after accounting for differences in age, sex, and possible comorbidities that may have existed between inpatient and outpatient cohorts.[1,13,14,18] Similar results have been reported in more recent studies specifically targeting inpatient versus outpatient TSA.[2,6,7,15,19]

Although the preliminary clinical results of outpatient TSA are promising, comparative studies of patient-level costs between inpatient and outpatient TSAs irrespective of insurance coverage have infrequently been performed. It is therefore unclear how currently understood cost-volume relationships of inpatient primary elective TSA compare with those of outpatient TSA. Cost-effectiveness studies comparing inpatient and outpatient TSAs will continue to be incomplete until detailed, itemized patient-level cost data are considered.

The purpose of this study was to compare patient-level cost-volume relationships between inpatient and outpatient primary elective TSAs performed in the state of Texas between 2010 and 2015. We hypothesized that (1) patient-level costs, along with their rate of change between 2010 and 2015, would be significantly greater for inpatient TSA compared with outpatient TSA and (2) these cost differences would remain after accounting for surgery center volume.

Methods

Data acquisition

More than 6 million deidentified inpatient and outpatient records were obtained in November 2016 from the publicly available Texas Health Care Information Collection (THCIC) database through the Texas Department of State Health Services covering the interval 2010-2015 (it was in 2010 that outpatient records first became publicly available).[22,23] Created in 1995, the THCIC requires all hospitals and ambulatory surgery centers operating in the state of Texas to report a summary of data on all discharged patients. These records include billing information, demographic characteristics, and itemized cost data connected to all patient encounters irrespective of the presence or absence of health insurance coverage. All primary elective anatomic TSA or reverse TSA procedures performed between 2010 and 2015 were included in the study. All non-elective cases, such as those involving treatment for ipsilateral proximal humeral fractures and avascular necrosis, were excluded.

The following diagnostic and procedural coding systems were used in this study: *International Classification of Diseases, Ninth Revision, Clinical Modification*; *International Classification of Diseases, Tenth Revision, Procedure Coding System*; Healthcare Common Procedure Coding System; and Current Procedural Terminology (CPT) codes. Any records that included *International Classification of Diseases, Ninth Revision, Clinical Modification* codes (inpatient before October 2015); *International Classification of Diseases, Tenth Revision, Procedure Coding System* codes (inpatient after October 2015); and CPT codes (all outpatient records) for primary elective anatomic TSA and reverse TSA were extracted for analysis (Table I). Of note, the *International Classification of*

Table I Procedural and diagnostic billing codes used to identify inpatient and outpatient primary elective TSAs and reverse TSAs in this study

ICD-9-CM	ICD-10-PCS	CPT	HCPCS
81.80	0RRJ0JZ	23472	G0378*
81.88	0RRK0JZ	99231*	G0379*
	0RRJ0J6	99235*	
	0RRJ0J7		
	0RRK0J6		
	0RRK0J7		
	044J00Z		

TSA, total shoulder arthroplasty; *ICD-9-CM*, *International Classification of Diseases, Ninth Revision, Clinical Modification*; *ICD-10-PCS*, *International Classification of Diseases, Tenth Revision, Procedure Coding System*; *CPT*, Current Procedural Terminology; *HCPCS*, Healthcare Common Procedure Coding System.

* These billing codes were considered to represent inpatient procedures irrespective of database revenue codes.

Diseases, Ninth Revision, Procedure Coding System code for inpatient reverse TSA was not introduced until October 2010; therefore, reverse TSA was not included in the analyses of inpatient procedures until the first quarter of 2011. Reverse TSA was not included in the analyses of outpatient procedures because outpatient CPT codes do not delineate between anatomic TSA and reverse TSA. A total of 22,873 primary elective TSAs performed between 2010 and 2015 in the state of Texas were included in the final analysis.

Each record was categorized as inpatient or outpatient based on publicly available revenue codes included within the THCIC database. In addition, any record including CPT codes 99231 and 99235 or Healthcare Common Procedure Coding System codes G0378 and G0379 (postoperative observation) was considered to represent inpatient TSA. All inpatient and outpatient records were linked to their corresponding hospitals or ambulatory care centers to determine statewide procedural volumes at the level of each institution. Actual patient-level itemized charge data analyzed in this study included the following: total charges, insurance-covered and noncovered charges, accommodation charges, physical therapy charges, occupational therapy charges, operating room charges, anesthesia charges, laboratory charges, and radiology charges. Charges that were present in only the inpatient setting (and absent from all outpatient cases) were defined as inpatient-specific charges; these included charges related to nursing, medications, and accommodations. In addition, accommodation charges were defined as those pertaining to room and board specific to the level of postoperative care that was used as outlined by the Centers for Medicare & Medicaid Services, the categories of which include general ward, intensive care unit, cardiac care unit, and private or semi-private rooms (provided by patient request). Patient-level itemized charges were compared between inpatient and outpatient procedures, as well as between high- and low-volume inpatient centers.

Statistical analyses

All statistical analyses were performed using SPSS Statistics (version 24; IBM, Armonk, NY, USA). Procedural volumes and patient-level costs were compared between all inpatient and outpatient primary elective anatomic and reverse TSAs in the state of Texas between 2010 and 2015. Annual procedural volumes were compared using independent 2-sample *t* tests with unequal variance. Cost analyses were performed to compare baseline patient demographic characteristics and average costs between (1) inpatient and outpatient TSAs and (2) high- and low-volume TSA centers using 1-way analysis of variance. Mixed-model analysis of variance (group × time) was used to determine the change in average total costs between inpatient and outpatient TSA procedures from 2010 to 2015. Results were considered statistically significant at $P < .05$.

Results

Inpatient versus outpatient volume trends

From 2010-2015, a total of 22,873 primary elective anatomic or reverse TSAs were documented in the state of Texas (21,331 inpatient [93.3%] and 1542 outpatient [6.7%], $P < .001$). Volume comparisons between inpatient and outpatient procedures stratified by age, sex, and race for this data set are provided in Table II. Significantly more inpatient procedures were performed between 2010 and 2015 than outpatient procedures ($P < .001$). The overall volume of inpatient and outpatient procedures increased by a cumulative total of 102.6% for inpatient procedures (from 2569 procedures in 2010 to 5206 procedures in 2015, $P < .001$) and

Table II Comparisons of demographic characteristics for included study population of patients who underwent inpatient versus outpatient primary elective anatomic and reverse TSA in state of Texas between 2010 and 2015

	Inpatient		Outpatient	
	n (%)	Cost (SD), $	n (%)	Cost (SD), $
Total	21,331 (93.3)*	76,109 (48,981)*	1542 (6.7)	22,907 (13,599)
Age				
<45 yr	242 (1.1)	73,040 (42,687)*	99 (6.4)	22,327 (12,213)
45-64 yr	5540 (26.0)	73,307 (47,940)*	802 (52.0)	22,663 (12,712)
65-74 yr	8866 (41.6)	74,752 (45,217)*	408 (26.5)	23,085 (15,240)
75-89 yr	6548 (30.7)	80,053 (53,978)*	227 (14.7)	23,594 (13,961)
≥90 yr	128 (0.6)	99,355 (64,591)*	5 (0.3)	28,969 (16,595)
Sex				
Male	9000 (39.4)	72,989 (44,315)*	774 (50.2)	23,182 (14,611)
Female	1974 (56.1)	74,039 (48,082)*	745 (48.3)	22,725 (12,639)
Race or ethnicity				
White	17,575 (82.4)	75,419 (49,588)*	1203 (78.0)	22,913 (13,857)
African American	885 (4.1)	77,049 (43,654)*	88 (5.7)	21,749 (8219)
American Indian	47 (0.2)	61,139 (23,173)*	2 (0.1)	20,220 (1679)
Asian	71 (0.3)	96,057 (71,129)*	7 (4.5)	18,983 (2659)
Hispanic	1254 (5.9)	92,489 (49,357)*	73 (4.7)	26,010 (13,888)
Other	2736	79,969 (45,729)*	241	23,174 (13,504)

TSA, total shoulder arthroplasty; *SD*, standard deviation.
* Statistically significant increase compared with outpatient TSA.

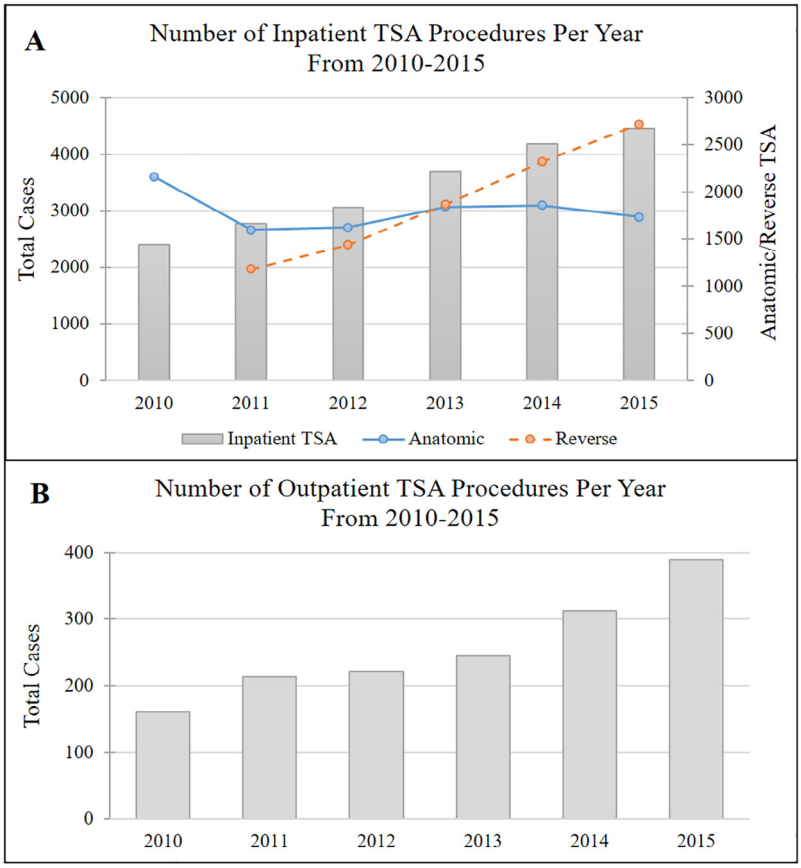

Figure 1 Graphical summaries of number of inpatient **(A)** and outpatient **(B)** total shoulder arthroplasty (*TSA*) procedures performed in state of Texas from 2010-2015.

141.6% for outpatient procedures (from 161 procedures in 2010 to 389 procedures in 2015, $P < .001$). The average annual rate of volume increase for inpatient and outpatient TSAs between 2010 and 2015 was not significantly different (inpatient, 16.8% [standard deviation (SD), 7.9%]; outpatient, 19.8% [SD, 12.2%]; $P > .05$).

Among the 18,166 inpatient TSAs performed between 2011 and 2015 (after implementation of reverse TSA procedure codes), approximately 52.4% of these cases were reverse TSAs. Reverse TSAs represented 42.5% and 61.1% of all inpatient TSAs in 2011 and 2015, respectively ($P < .001$, Fig. 1).

Inpatient versus outpatient TSA costs

Comparisons of total costs and itemized charges between inpatient and outpatient TSAs for this cohort are provided in Table III. The average overall cost of primary elective TSA from 2010-2015 was significantly greater when performed in the inpatient setting ($76,109 [SD, $48,981] vs $22,907 [SD, $13,599]; $P < .001$), reflecting an average 3-fold increased cost of inpatient procedures relative to outpatient procedures. In addition, charges for inpatient reverse TSA were significantly greater than those for inpatient anatomic TSA ($78,144 [SD, $58,336] vs $66,293 [SD, $35,552]; $P < .0001$). After exclusion of inpatient-specific charges, the cost of inpatient TSA was still found to be 41.1% higher than the cost of outpatient TSA ($32,330 [SD, $24,221] vs $22,907 [SD, $13,599]; $P < .0001$). Nearly every cost category was significantly higher for inpatient procedures (Table III).

Overall costs were found to have increased steadily for both inpatient and outpatient TSAs from 2010 to 2015 (inpatient, from $62,933 [SD, $39,385] in 2010 to $78,824 [SD, $63,728] in 2015; outpatient, from $16,642 [SD, $6325] in 2010 to $25,971 [SD, $14,280] in 2015; $P < .001$). No "group × time" interaction was found ($F = 0.758$, $P = .781$), indicating that the rate of cost increase from 2010 to 2015 was not statistically different between inpatient and outpatient TSAs or between inpatient anatomic and reverse TSAs.

High- and low-volume inpatient TSA costs

Direct comparisons of TSA total costs and itemized charges for procedures performed in high- and low-volume inpatient centers between 2010 and 2015 are given in Table IV and represented graphically in Figure 2. The average total cost was significantly less for high-volume inpatient centers than low-volume inpatient centers ($68,508 [SD, $41,932] vs $80,803 [SD, $61,003]; $P < .0001$), revealing a 17.9% cost reduction when TSA procedures were performed at high-volume inpatient centers. Furthermore, although reverse TSA

Table III Comparison of average itemized costs for inpatient and outpatient TSA centers from 2010-2015

Charge category	2010	2011	2012	2013	2014	2015	Trend
Inpatient TSA center							
Total charges, $	62,933*	67,194*	74,660*	78,648*	85,106*	78,779*	
Procedure-related charges, $	17,107*	19,403*	22,033*	23,944*	26,094*	22,688*	
Nursing-related charges, $	32,318*	34,257*	38,202*	40,014*	43,668*	33,940*	
Medication-related charges, $	3355*	3336*	3549*	3588*	3839	4891*	
Rehabilitation-related charges, $	1122*	1037*	1196*	1156*	1287	1953*	
Laboratory charges, $	1698*	1633*	1763*	1834*	1909	3548*	
Radiology charges, $	773*	799*	879*	908*	976*	2127*	
Accommodation charges, $	2978*	3094*	3217*	3304*	3440*	6019*	
Outpatient TSA center							
Total charges, $	16,642	19,025	20,925	25,020	24,723	25,971	
Procedure-related charges, $	14,770	16,805	18,071	21,488	21,343	22,562	
Nursing-related charges, $	0	0	0	0	0	0	
Medication-related charges, $	0	0	0	0	0	0	
Rehabilitation-related charges, $	357	371	325	355	348	393	
Laboratory charges, $	580	661	676	691	704	758	
Radiology charges, $	315	340	253	390	393	551	
Accommodation charges, $	0	0	0	0	0	0	

TSA, total shoulder arthroplasty.
* Statistically significant increase relative to outpatient TSA.

Table IV Trends in average itemized cost data for high- and low-volume inpatient TSA centers from 2010-2015

Charge category	2010	2011	2012	2013	2014	2015	Trend
High-volume inpatient TSA center							
Total charges, $	66,900	67,040	69,211	67,946	69,671	70,157	
Procedure-related charges, $	19,271	19,653	20,910	20,886	21,678	21,318	
Nursing-related charges, $	32,713	32,867	33,558	32,270	33,224	33,598	
Medication-related charges, $	3681	3549	3756	3623	3585	3654	
Rehabilitation-related charges, $	1151	1168	1184	1199	1250	1285	
Laboratory charges, $	1854	1834	1870	1898	1911	2031	
Radiology charges, $	1005	986	1007	1012	1018	1108	
Accommodation charges, $	3411	3379	3370	3464	3487	3639	
Low-volume inpatient TSA center							
Total charges, $	80,195*	81,660*	79,317*	84,901*	81,614*	83,597*	
Procedure-related charges, $	26,148*	26,430*	24,890*	25,906*	24,142*	26,428*	
Nursing-related charges, $	38,020*	38,454*	37,809*	42,043*	40,261*	41,073*	
Medication-related charges, $	3613*	3808*	3460*	3719*	3837	3639*	
Rehabilitation-related charges, $	1494*	1511*	1519*	1563*	1453*	1377*	
Laboratory charges, $	2465*	2572*	2588*	2690*	2727*	2510*	
Radiology charges, $	1302*	1369*	1374*	1448*	1472*	1254*	
Accommodation charges, $	4007*	4132*	4230*	4203*	4205*	3825*	

TSA, total shoulder arthroplasty.
* Statistically significant increase relative to high-volume inpatient TSA.

was associated with higher charges overall, reverse TSAs performed at high-volume inpatient centers were associated with lower charges relative to those performed at low-volume inpatient centers ($83,364 [SD, $46,850] vs $101,195 [SD, $75,975]; $P < .0001$). The 2 most important drivers of these differences were nursing- and procedure-related charges. Nursing charges were lower for high-volume inpatient TSA than for low-volume inpatient TSA ($34,143 [SD, $20,806] vs $45,637 [SD, $45,663]; $P < .001$), as were procedure-related charges ($20,312 [SD, $11,563] vs $25,375 [SD, $16,540]; $P < .001$). However, the lower cost of TSA at high-volume inpatient centers still remained 33.4% more costly than outpatient TSA even after exclusion of inpatient-specific ancillary charges ($30,579 [SD, $23,233] vs $22,907 [SD, $13,599]; $P < .0001$).

Both high- and low-volume inpatient TSA centers demonstrated significantly increased costs in 2015 relative to 2010, although the rate of cost increase was not significantly

A

High Volume Inpatient	2010		2011		2012		2013		2014		2015	
	n	Cost	n	Cost	n	Cost	n	Cost	n	Cost	n	Cost
Total	1,854	$58,645	2,119	$60,787	2,360	$68,567	2,987	$71,031	3,493	$91,722	4,688	$82,753
Nursing Charges	1,776	$31,938	2,004	$33,069	2,225	$36,244	2,854	$36,736	3,491	$38,926	4,394	$32,632
Medication Charges	1,776	$3,305	2,004	$3,169	2,225	$3,636	2,855	$3,557	3,491	$3,581	4,672	$4,621
Laboratory Charges	1,775	$1,536	1,988	$1,419	2,232	$1,625	2,856	$1,591	3,392	$1,726	4,576	$3,409
Speech Therapy Charges	9	$702	4	$937	9	$790	16	$1,177	21	$1,078	181	$1,178
MRI Charges	7	$5,317	10	$4,155	12	$6,541	16	$4,058	9	$7,565	127	$6,604
Emergency Room Charges	17	$2,190	25	$1,700	38	$2,351	52	$2,498	74	$3,129	783	$3,315
Dialysis Charges	4	$1,169	2	$8,868	5	$12,994	8	$2,802	7	$6,241	49	$9,617
Clinic Charges	25	$112	20	$224	30	$312	33	$154	36	$143	105	$373
Accommodation Charges	1,854	$2,679	2,119	$2,668	2,360	$2,948	2,987	$3,014	3,493	$3,102	4,688	$5,672
Low Volume Inpatient	**2010**		**2011**		**2012**		**2013**		**2014**		**2015**	
	n	Cost	n	Cost	n	Cost	n	Cost	n	Cost	n	Cost
Total	714	$63,627*	869	$71,089*	922	$77,318*	962	$88,641*	995	$77,883*	906	$73,688*
Nursing Charges	714	$29,502*	865	$33,323*	919	$39,449*	960	$45,173*	995	$46,786*	906	$36,794*
Medication Charges	714	$3,085*	869	$3,346*	920	$3,007*	961	$3,261*	995	$3,553	906	$4,277*
Laboratory Charges	707	$2,053*	860	$2,155*	908	$2,109*	957	$2,527*	995	$2,350*	906	$3,494*
Speech Therapy Charges	2	$720*	4	$670*	4	$713*	5	$530*	8	$604*	27	$1,010*
MRI Charges	8	$5,152*	2	$3,277*	5	$3,822*	5	$5,087*	8	$4,258*	22	$7,392*
Emergency Room Charges	21	$2,283*	35	$2,681*	33	$2,862*	43	$3,060*	48	$2,961*	155	$2,964*
Dialysis Charges	1	$58,334*	5	$4,003*	4	$2,197*	5	$3,312*	5	$7,225*	10	$4,961*
Clinic Charges	2	$219*	4	$189*	7	$457*	8	$210*	5	$239*	11	$626*
Accommodation Charges	714	$3,082*	869	$3,376*	922	$3,128*	962	$3,361*	995	$3,551*	906	$5,241*

*Indicates a statistically significant increase relative to high volume inpatient centers.

B

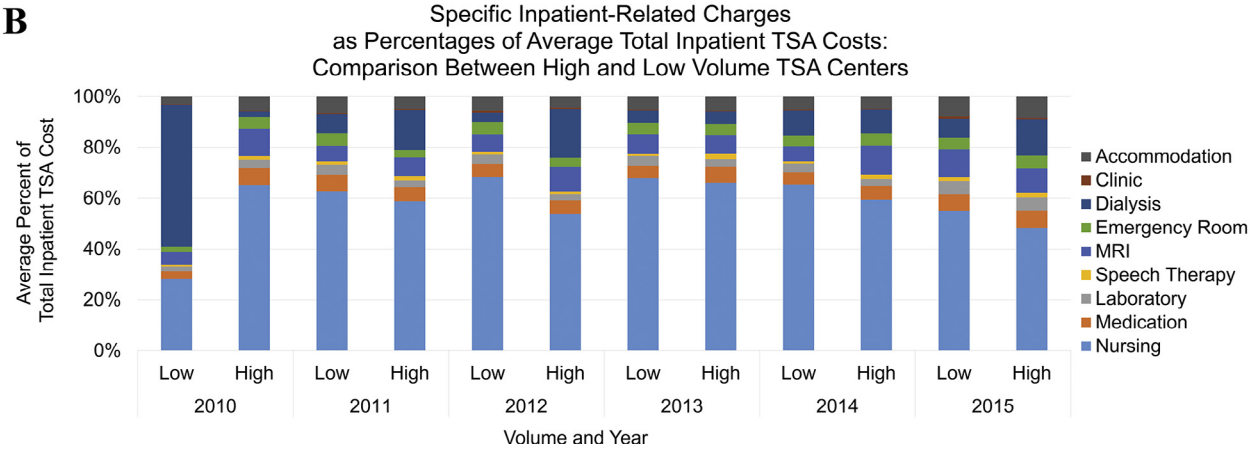

Figure 2 Tabular **(A)** and graphical **(B)** summaries of itemized charges that were only applicable to inpatient total shoulder arthroplasty (*TSA*) records (ie, these charges were absent from all outpatient TSA records). *MRI*, magnetic resonance imaging.

different (high-volume inpatient, from $69,394 [SD, $38,405] in 2010 to $72,969 [SD, $43,968] in 2015; low-volume inpatient, from $84,822 [SD, $58,770] in 2010 to $89,567 [SD, $64,408] in 2015; $P < .001$).

Discussion

In this study, our aim was to compare the patient-level cost of inpatient and outpatient TSAs and determine the rate of change for this cost over time. Using the THCIC database, we found that patient-level costs were significantly greater in inpatient settings than in outpatient settings, even when inpatient-specific ancillary costs were excluded. Although the rate of cost increase during this period was not significantly different between inpatient and outpatient TSA centers, it should be noted that the rates of cost increase for both inpatient and outpatient TSAs were nearly triple the rate of annual inflation over the same period (total 25.2% increased cost of TSA from 2010-2015 vs total 9.2% nationwide inflation from 2010-2015 [US Department of Labor, Bureau of Labor and Statistics[24]]). The cause of this remains unclear. Advances in medical technology are commonly proposed as a driver of increasing health care costs. The increasing prevalence of reverse shoulder arthroplasty over anatomic shoulder arthroplasty appears to have contributed to increased charges. In addition, it is possible that shifts in implant type or design may have contributed to the observed increase in charges. Although the volume of inpatient TSAs performed was significantly greater than that of outpatient TSAs, we found no significant difference in their respective rates of volume increase from 2010-2015. A summary of these findings is graphically presented in Figure 1.

National databases are of limited use when analyzing costs of outpatient TSA, most notably because only a select group of insured patients are included. Particular insurer-specific policies may have a large impact on cost analyses, and the results may not be generalizable beyond that specific insurance provider. A large state-level database that includes procedure information on all patients, regardless of insurance coverage

status, may be preferable for these types of analyses. For that reason, we chose to use the THCIC database to analyze patient-level costs related to inpatient and outpatient TSAs in the state of Texas.

Currently, it is well demonstrated that high-volume inpatient centers provide optimal patient-level costs of primary elective TSA owing to a combination of surgeon and staff familiarity and proficiency with the procedure, as well as facility capabilities to handle potential complications.[5] Advancements in postoperative pain management and technical efficiency have created opportunities to perform more orthopedic procedures in outpatient surgery centers.[8] As outpatient TSA still represents a relatively small percentage of overall TSA volume, not many high-volume outpatient TSA centers exist. However, there is an increasing trend for outpatient centers to contract high-volume surgeons for primary elective anatomic and reverse TSA procedures,[5] which diminishes the argument that less confident or less proficient surgeons are performing outpatient TSA. Several studies have shown that outpatient centers are an equally viable setting to perform primary elective anatomic and reverse TSA procedures and, to date, outpatient TSA has not resulted in detectable differences in complication rates compared with inpatient TSA.[2,6,7,15] The effect of this shift is felt most immediately in cost savings, which have already been demonstrated in lower-extremity arthroplasty.[1,3,7] In the state of Texas between 2010 and 2015, we found that inpatient TSA had significantly higher costs than the equivalent outpatient procedure. These findings are in alignment with the results of prior studies on this topic.[1,3,7,16]

Although it is understood that some patients may require more intensive monitoring or workups in the inpatient setting because of case complexity or medical comorbidities, it is possible that some ancillary costs may be a result of routine postsurgical orders, which could safely be eliminated by transitioning to an outpatient setting in appropriately selected patients. Our results confirmed the aforementioned assumption, specifically that inpatient-specific ancillary charges were the primary contributors to the cost difference between inpatient and outpatient TSAs (eg, additional laboratory studies, imaging studies, physical therapy, and occupational therapy); however, our results indicated that inpatient TSA was still more expensive even after exclusion of these ancillary costs. This finding should be confirmed by future studies comparing the use efficiency of operating room personnel, surgical equipment, and disposable materials, as well as other operating room resources, between inpatient and outpatient TSA centers. Granular patient-level cost data, such as those collected in this study, will provide a framework for future cost-effectiveness analyses of outpatient TSA.

One of the strengths of our study was the use of a large, statewide database to collect patient-level information. Because all inpatient and outpatient records are collected at the state level regardless of insurance coverage or payer status, we are confident that these data represent a reasonably complete picture of all outpatient and inpatient TSA procedures performed in the state of Texas during the 2010-2015 period. Databases of patients with governmental insurance, such as Medicare or Medicaid, underestimate the volume of outpatient TSA procedures because the federal government currently reimburses TSA as an inpatient procedure. National databases from private insurance companies are also limited by cost reimbursement decisions specific to those companies. The inpatient and outpatient designations in the data set used for this study were determined by the type of bill that was issued and were not subject to any other criteria.

Several limitations should be noted. First, the THCIC database is not designed to track patient-level readmissions and complications. As a result, we can only comment on patient-level cost itself and not on cost-effectiveness or clinical outcomes. However, multiple studies have found that outpatient TSA is safe for appropriately selected patients.[6,14,17,21] Second, although all retrospective studies are subject to selection bias, some degree of detection bias also exists because TSA candidates who are less healthy are much more likely to undergo their surgical procedures in the inpatient setting, thus potentially inflating the cost of inpatient TSA owing to the presence of comorbidities and the need for close observation and additional monitoring. Future studies can be performed to compare the cost-effectiveness of inpatient and outpatient TSAs through evaluation of clinical data pertaining to patient-level readmissions and complications while controlling for patient condition. Third, the THCIC database includes data submitted to the state by hospitals, and the cost information collected represents hospital charges. The charges do not reflect the direct cost of health care resources, as hospital billing practices may differ. In addition, reimbursement rates for these charges may vary depending on insurance contract, payer status, and hospital collection policies. Regardless, hospital charges serve as a valuable tool to analyze patient-level health care costs, as they represent the basis for how much patients and insurers pay for health care services. Other limitations are those consistent with other large database studies,[4,5,13,17] in that the validity of the analysis entirely depends on the accuracy and quality of coding and data entry.

Conclusion

In the state of Texas, the average patient-level cost of primary elective TSA was significantly higher when performed in the inpatient setting compared with the outpatient setting. This difference persisted even when ancillary charges specific to inpatient admissions were excluded. The cost-volume relationship between high- and low-volume inpatient centers does not account for the significantly increased inpatient TSA costs relative to those of outpatient TSA. Future studies should compare the cost-effectiveness of inpatient and outpatient TSAs through analysis of readmissions and complications while controlling for patient condition.

Disclaimer

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