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General

Wide Geographic Variation in Resource Utilization after Shoulder Arthroplasty

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Background

There is growing interest in optimizing cost and resource utilization after shoulder arthroplasty, but little data to guide improvement efforts.

Objective

The purpose of this study was to evaluate geographic variation in length of stay and home discharge disposition after shoulder arthroplasty across the United States.

Methods

The Centers for Medicare and Medicaid Services database was used to identify Medicare discharges following shoulder arthroplasties performed from April 2019 through March 2020. National, regional (Northeast, Midwest, South, West), and state-level variation in length of stay and home discharge disposition rates were examined. The degree of variation was assessed using the coefficient of variation, with a value greater than 0.15 being considered as "substantial" variation. Geographic maps were created for visual representation of the data.

Results

There was substantial state-level variation in home discharge disposition rates (64% in Connecticut to 96% in West Virginia) and length of stay (1.01 days in Delaware to 1.86 days in Kansas). There was wide regional variation in length of stay (1.35 days in the West to 1.50 days in the Northeast) and home discharge disposition rates (73% in the Northeast to 85% in the West).

Conclusions

There is wide variation in resource utilization after shoulder arthroplasty across the United States. Certain patterns emerge from our data; for instance, the Northeast has the longest hospital stays with the lowest home discharge rates. This study provides important information for the implementation of targeted strategies to effectively reduce geographic variation in healthcare resource utilization.

INTRODUCTION

The incidence of total shoulder arthroplasty (TSA) has risen dramatically in recent decades.[1] Currently, over 100,000 cases of TSA are performed annually with a projected increase in volume of 235% by 2025.[2] Costs associated with TSA are high and constitute a rising proportion of overall healthcare spending.[3-5] In today's economic climate, there is growing national interest in optimizing cost and resource utilization after musculoskeletal procedures.[6] However, little data is present to guide improvement efforts after TSA.

Previous studies have shown that 63% of inpatient costs associated with TSA are related to facility utilization.[7] As a result, many have attempted to increase the rate of out-

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patient TSA procedures,[8] which has been shown to reduce costs[8] without subjecting patients to increased risk of complications.[9] However, most patients undergoing TSA are insured by Medicare.[10] Most Current Procedural Terminology (CPT) codes for shoulder arthroplasty are not approved for ambulatory surgery centers (ASC) under Medicare and must be performed at a hospital.[5] Thus, current focus has shifted towards safely reducing inpatient length of stay [LOS] after TSA to reduce costs.[5]

Discharge disposition is an additional post-surgical driver of cost following TSA.[11] Recently, it has been shown that disposition to an inpatient rehabilitation facility following TSA increases 90-day reimbursements by 194% when compared to home discharge.[11] In addition, non-home discharge has been shown to increase the rate of adverse events and hospital readmission after TSA, independent of a patient's medical complexity.[12]

While several studies have identified patient and hospital-related factors associated with LOS and discharge disposition after TSA,[4,12-16] little is known about the geographic variability of these markers of resource utilization across the United States. Herein, we used the Centers for Medicare and Medicaid Services (CMS) database to identify Medicare discharges associated with shoulder arthroplasty. We hypothesized that there would be wide geographic variation in LOS and home discharge disposition rates after this procedure. Improved understanding of these differences may yield important patterns that can be used to redirect resources toward higher-value, cost-conscious care.

MATERIALS AND METHODS

Data for this retrospective analysis were obtained from the CMS Limited Data Set from April 2019 to March 2020. This de-identified database consists of a collection of billing and diagnostic codes with the goal of quality control, population monitoring and tracking procedures. The use of this database does not require institutional review board approval.

We identified Medicare discharges with the Diagnosis-Related Group (DRG) code 483 which includes both elective joint arthroplasty and arthroplasty for acute fracture.[17] The data for this study was retrieved with the technical assistance from the Dexur Research and Analytics (Miami, Florida, USA), a research organization specializing in the analysis of large datasets. The technical design involved loading the pre-selected DRG code and identifying outcomes in the claims data. Our outcomes of interest included surgeon-specific LOS (in days) and home discharge rates. This query included physicians performing at least 18 procedures annually.

Standard descriptive statistics such as the mean, standard deviation (SD), and range were used to evaluate national, regional, and state-level variation in LOS and home discharge disposition rates. Geographical regions are classified as Northeast, Midwest, South, and West as previously described.[18]

The degree of variation was assessed using the coefficient of variation (CV; ratio of the SD to the mean), with a value greater than 0.15 being considered as "substantial" variation.[19] Geographic maps were created for visual representation of the data.

RESULTS

STATE VARIATION

With regards to LOS, there was a 1.84-fold variation among U.S states: the shortest LOS was observed in Delaware (1.01 ± 0.49 days) and West Virginia (1.06 ± 0.13), and the longest in Florida (1.68 ± 0.54 days) and Kansas (1.86 ± 0.49; **Table 1**; **Figure 1**). The largest CVs were observed in Delaware (0.49), Oregon (0.46), and Georgia (0.40) (**Table 1**).

With regards to home discharge rates, there was a 1.5-fold variation among U.S states: the lowest home discharge rates were observed in Connecticut (64% ± 11) and Utah (66% ± 24), and the largest in Arkansas (92% ± 5), Minnesota (92% ± 6), and West Virginia (96% ± 3; **Table 1**; **Figure 2**). The largest CVs were observed in Louisiana (0.41), Utah (0.36), and New Hampshire (0.34) (**Table 1**).

REGIONAL AND NATIONAL VARIATION

With regards to LOS, the shortest LOS was observed in the West (1.35 ± 0.39 days), and the longest in the Northeast (1.5 ± 0.42 days; **Table 2**).

With regards to home discharge rates, the lowest home discharge rate was observed in the Northeast (73% ± 15), and the largest in the West (85% ± 15; **Table 2**).

At the national level, the mean LOS was 1.45 ± 0.42 days, and the mean home discharge rate was 81% ± 14 (**Table 1**).

DISCUSSION

We found wide geographic variability in LOS and home discharge disposition rates among Medicare-insured patients undergoing shoulder arthroplasty. Certain patterns emerge from our data; for instance, the Northeast has the longest hospital stays with the lowest home discharge rates, whereas the West has the shortest hospital stays with the greatest home discharge rates. As healthcare spending continues to increase in the United States,[20] the optimization of resource utilization associated with shoulder arthroplasty gains importance. Improved understanding of these differences may lead to the implementation of targeted strategies to lower costs and effectively reduce geographic variation.

Substantial state-level (range, 64% in Connecticut to 96% in West Virginia) and regional variation (range, 73% in the Northeast to 85% in the West) in home discharge disposition rates after TSA were present. Soley-Bori et al[21] found similar results in privately insured patients who underwent TKA and THA, as patients in the Northeast were more than twice as likely to be discharged to an extended care facility (ECF) compared to those in the South. Comparable findings were reported in those after traumatic brain injury and burns.[22,23] The direction of geographic variabil-

Table 1. National and State-Level Variation in Length of Stay and Home Discharge Disposition after Shoulder Arthroplasty

U.S. State	Surgeons	Length of Stay (days)						Home Discharge Rate (%)					
		Mean	SD	Coefficient of Variation	Range		*P*	Mean	SD	Coefficient of Variation	Range		*P*
					Min	Max					Min	Max	
AK	3	1.47	0.53	0.36	0.95	2.00		92	5	0.05	89	98	
AL	12	1.45	0.45	0.31	0.76	2.20		78	13	0.17	50	95	
AR	14	1.33	0.32	0.24	1.06	2.00		80	12	0.14	54	94	
AZ	26	1.21	0.24	0.20	0.96	1.92		90	10	0.11	60	100	
CA	48	1.53	0.53	0.34	0.64	3.53		83	14	0.17	42	100	
CO	25	1.42	0.28	0.20	1.00	2.16		76	18	0.24	35	97	
CT	10	1.52	0.38	0.25	1.04	2.38		64	11	0.18	46	75	
DC	3	1.56	0.29	0.19	1.30	1.87		77	16	0.21	67	96	
DE	5	1.01	0.49	0.49	0.16	1.43		90	9	0.10	74	96	
FL	64	1.68	0.54	0.32	0.33	3.12		75	19	0.25	33	100	
GA	22	1.36	0.55	0.40	0.53	3.33		87	8	0.09	70	100	
HI	1	1.39			1.39	1.39		79			79	79	
IA	18	1.48	0.43	0.29	1.05	2.66		84	9	0.11	61	100	
ID	12	1.29	0.25	0.19	1.00	1.81	<0.001	85	12	0.14	58	100	<0.001
IL	37	1.48	0.34	0.23	0.96	2.39		77	13	0.18	47	98	
IN	22	1.36	0.52	0.38	0.50	2.77		83	13	0.16	38	97	
KS	18	1.86	0.49	0.26	1.19	2.77		83	11	0.13	59	100	
KY	17	1.44	0.22	0.15	1.14	1.79		81	11	0.14	57	95	
LA	14	1.38	0.37	0.27	1.00	2.11		69	28	0.41	20	100	
MA	19	1.63	0.61	0.38	0.07	2.83		69	16	0.23	50	100	
MD	20	1.32	0.37	0.28	0.96	2.56		85	8	0.10	67	95	
ME	4	1.14	0.20	0.17	0.86	1.33		73	7	0.10	67	81	
MI	37	1.43	0.30	0.21	0.81	2.05		83	9	0.11	65	100	
MN	27	1.55	0.33	0.21	1.08	2.52		84	9	0.10	68	100	
MO	29	1.49	0.38	0.26	0.52	2.40		83	10	0.12	57	96	
MS	10	1.49	0.44	0.30	1.00	2.39		74	19	0.25	38	100	
MT	9	1.27	0.24	0.19	1.00	1.66		92	6	0.06	82	100	

NC	44	1.55	0.42	0.27	0.52	2.62	80	13	0.16	41	100
ND	6	1.24	0.17	0.14	1.00	1.40	89	9	0.10	78	100
NE	15	1.45	0.48	0.33	1.00	2.55	83	10	0.13	65	100
NH	6	1.47	0.47	0.32	0.86	2.00	70	24	0.34	39	95
NJ	9	1.58	0.48	0.30	0.84	2.32	80	13	0.17	63	100
NM	5	1.22	0.16	0.13	1.05	1.42	88	14	0.16	64	100
NV	11	1.27	0.37	0.29	0.57	1.76	86	24	0.28	28	100
NY	36	1.54	0.39	0.25	0.57	2.30	75	15	0.20	33	100
OH	41	1.36	0.36	0.27	0.45	2.37	81	9	0.11	47	95
OK	16	1.59	0.46	0.29	1.00	2.57	72	24	0.33	28	100
OR	15	1.27	0.58	0.46	0.50	2.74	89	7	0.08	77	100
PA	42	1.43	0.36	0.25	0.85	2.36	74	15	0.21	38	100
RI	3	1.56	0.50	0.32	1.21	2.13	75	25	0.33	46	90
SC	29	1.48	0.52	0.35	0.31	2.80	83	10	0.12	60	100
SD	10	1.34	0.31	0.23	1.00	1.85	86	6	0.07	78	96
TN	26	1.34	0.33	0.25	0.86	2.47	86	11	0.13	52	99
TX	46	1.48	0.44	0.30	0.19	2.35	78	18	0.23	20	100
UT	13	1.41	0.28	0.20	1.08	2.05	66	24	0.36	25	100
VA	31	1.32	0.23	0.17	0.55	1.75	81	14	0.18	49	100
VT	3	1.41	0.51	0.36	1.06	2.00	80	6	0.08	74	86
WA	36	1.27	0.32	0.25	0.09	1.79	90	11	0.12	52	100
WI	19	1.48	0.45	0.30	0.92	2.52	83	9	0.11	61	96
WV	5	1.06	0.13	0.13	0.85	1.20	96	3	0.03	91	100
WY	3	1.21	0.25	0.21	1.00	1.49	85	5	0.06	80	90
National	996	1.45	0.42	0.29	0.07	3.53	81	14	0.18	20	100

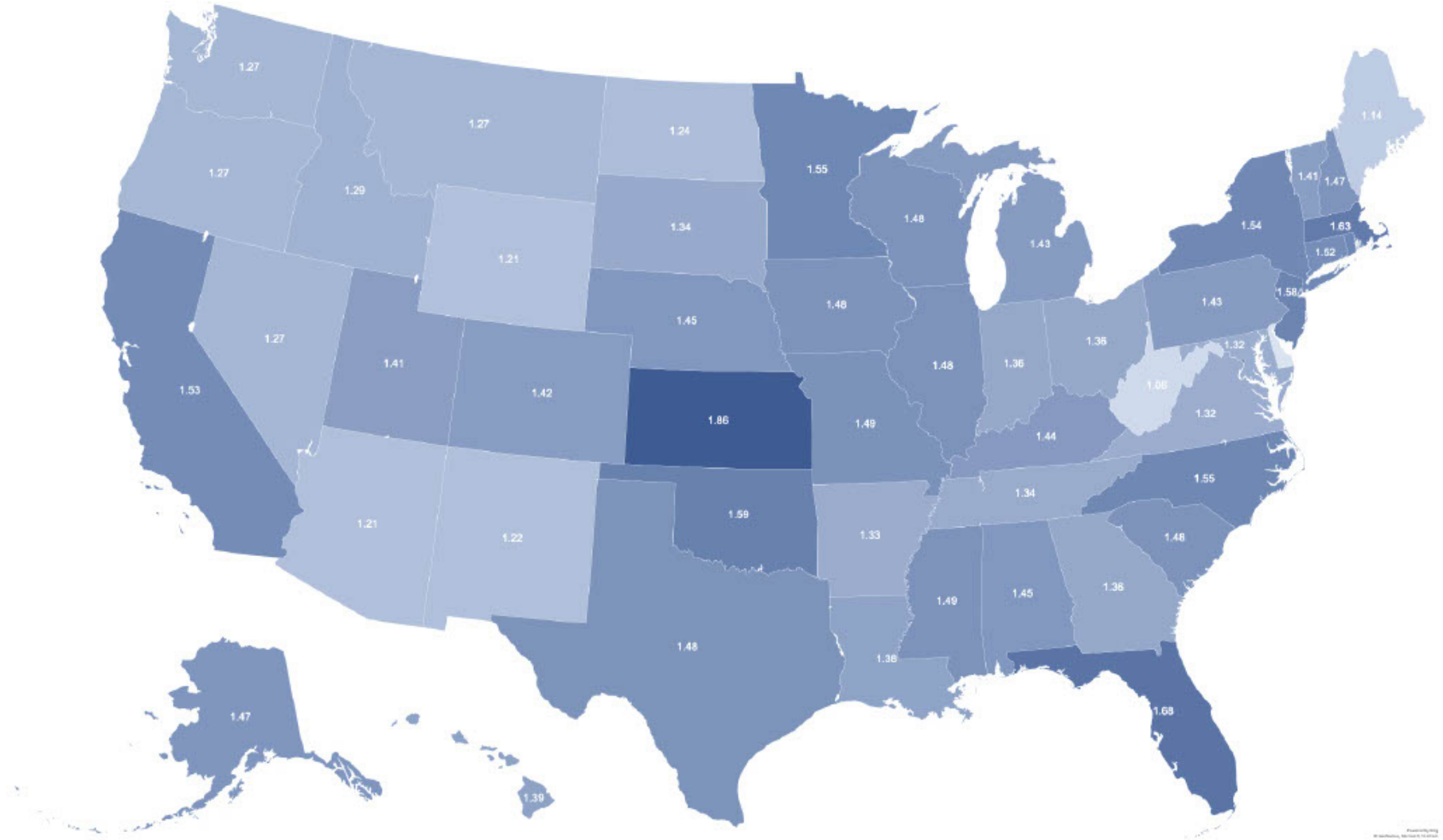

Figure 1. Length of Stay (days) after Shoulder Arthroplasty Across US States

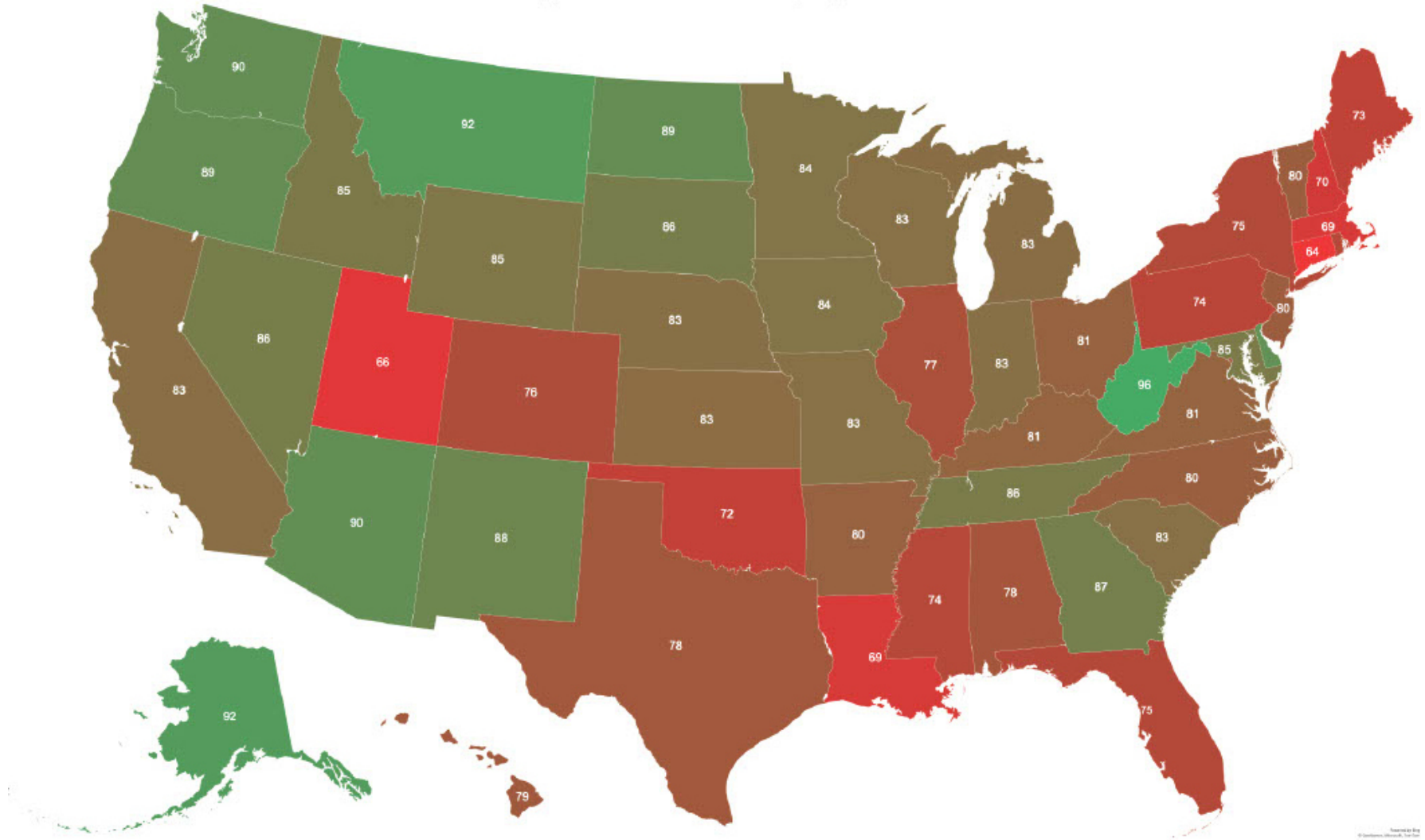

Figure 2. Home Discharge Rate after Shoulder Arthroplasty Across US States

Table 2. Regional Variation in Length of Stay and Home Discharge Disposition after Shoulder Arthroplasty

U.S. Region	Length of Stay (days)						Home Discharge Rate (%)					
	Mean	SD	Coefficient of Variation	Range		*P*	Mean	SD	Coefficient of Variation	Range		*P*
				Min	Max					Min	Max	
Northeast	1.50	0.42	0.28	0.07	2.83	0.003	73	15	0.20	33	100	<0.001
Midwest	1.47	0.40	0.27	0.45	2.77		82	10	0.13	38	100	
South	1.46	0.45	0.31	0.16	3.33		80	15	0.19	20	100	
West	1.35	0.39	0.29	0.09	3.53		85	15	0.18	25	100	

ity in health services is influenced by the prevalence of disease, price markup differences, community wealth, poverty, access to ECFs, and differences in uniform discharge patterns.[21] Within the hip and knee literature, income and residential area significantly influenced discharge disposition.[21] Patients in urban areas were 74% more likely to use an ECF, which may reflect limited access to ECF facilities or greater financial burden for those in rural areas. Furthermore, onsite inpatient rehabilitation facilities are more often implemented at high-volume hospitals,[21] which may contribute to differences observed in LOS.

Over the past 20 years, LOS following shoulder arthroplasty has declined significantly from 5.8 days in 1993 to 2.4 days in 2007.[24,25] In our study, the average LOS following TSA in Medicare patients was 1.45 days nationally. This suggests that LOS following TSA is continuing to decline. Despite this decline, wide regional variation was present and found to be greatest in the Northeast (1.5 days) and lowest in the West (1.35 days). Casp et al[5] evaluated regional variation of hospital charges and reimbursements compared with surgeon charges and reimbursements for shoulder arthroplasty in a Medicare population. Interestingly, the ratio of hospital charges to surgeon charges was greatest in the West and lowest in the Northeast. These findings are unexpected as one would expect greater hospital charges in regions with increased LOS. Furthermore, it was found that the ratio of hospital relative to surgeon charges and payments continually increased at the national level throughout the study period, despite stable patient complexity (as evidenced by the Charleston Comorbidity Index). These findings indicate that regional variation exists despite similar overall health status. Perhaps surgeon and hospital-related factors may account for the findings of our study and represent modifiable areas of improvement efforts.

Surgeon and hospital volume has been shown to effect LOS after TSA.[26,27] Hammond et al[26] showed that surgeons who performed greater than 20 TSA cases per year were three times more likely than low-volume surgeons to have patients with a hospital stay of less than six days. Jain et al[27] showed that patients undergoing shoulder arthroplasty by surgeons performing between 2 and 5 cases per year had an average LOS that was 0.3 days longer when compared with surgeons who performed 5 or more cases per year. These findings indicate that LOS may incrementally decrease with greater surgeon experience. The data presented by our study represents cases performed by surgeons who perform more than 18 TSAs annually. Therefore, our data may underestimate LOS after TSA amongst the general population. In addition, a recent study found that more than 75% and 95% of the entire population lives within 50 km and 200 km of a shoulder surgeon with high volume TSA caseloads.[28] Despite improving patient access to high volume TSA surgeons,[28] regional variation in LOS and discharge disposition still exists. Thus, it may be prudent to examine other surgical factors that may contribute to our findings.

In addition to surgeon volume, anesthesia type and the choice of postoperative pain control after TSA have been shown to affect LOS.[29-33] Specifically, general anesthesia was associated with shorter LOS when compared to regional anesthesia (2.0 and 2.3 days; $p < 0.001$).[33] With respect to postoperative pain control, peripheral nerve blocks[30] and local injection of liposomal bupivacaine combined with intravenous dexamethasone[29] significantly reduced LOS, while continuous interscalene brachial plexus blockades yield mixed results.[31,32] While surgeon treatment preferences are highly indivualized and difficult to study on a macro scale, they may represent important areas of further study.

Patient-characteristics are well-studied predictors of healthcare resource utilization after TSA[4,12-16] and may be more generalizable to region-specific study. In a recent systematic review of 22 studies, it was determined that age greater than 65 years, female sex, diabetes, and obesity were patient-related factors that contributed to increased LOS and discharge to an ECF after shoulder arthroplasty.[34] In a separate retrospective review including 40,869 patients, congestive heart failure, renal failure, chronic pulmonary disease, and preoperative anemia served as additional comorbid factors.[15] Racial and demographic discrepancies (including age, sex, income, and comorbidity index) exist regionally within the United States amongst TSA patients and may serve as important areas of further study to reduce variability in healthcare resource utilization.[18]

Our study is not without limitations. The use of administrative data like Medicare claims may be limited by inaccurate coding, potential missing data, and discrepancies between administrative data and medical records.[35,36] Furthermore, the use of only the Centers for Medicare and Medicaid Services database data limited our findings to an older, Medicare population. While TSA is commonly performed in this age-group, there has been a trend in utilization amongst younger patients.[37] In addition, lifestyles and practice styles may vary across states, which may cause patients to seek and receive treatment before the age of 65.[38] Perhaps our results may differ if data on a wider range of patient age-groups was included. Our study also lacked a measure of social support, functional status, and data on readmission rates, which may influence patient discharge preferences.[21] Moreover, patient and hospital characteristics were not accounted for.

CONCLUSION

There is wide variation in resource utilization after shoulder arthroplasty across the United States. Certain patterns emerge from our data; for instance, the Northeast has the longest hospital stays with the lowest home discharge rates. Inquiring into the patient, hospital, and surgeon factors influencing this variability may help define best practices for improved standardization of higher-value, cost-conscious care associated with shoulder arthroplasty.

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None.

AUTHOR CONTRIBUTIONS

- SYS – lead writer
- MEM – lead writer
- AJ – investigation, data curation and formal analysis, editing
- JL – investigation, data curation and formal analysis, editing
- PJD – supervision, validation, project administration, editing

DISCLOSURES

- SYS certifies that he had nothing of value related to this study.
- MEM is a consultant for and receives royalties from Arthrex, Inc.
- Andrew Jawa is a paid speaker and consultant for DJO Global, a paid consultant for Ignite orthopedics, receives royalties from Depuy Synthesis, and has equity in Boston Outpatient Surgical Suites.
- Jonathan Levy is a paid consultant for DJO Orthopaedics and Globus Medical. He receives royalties from DJO Orthopaedics and Innomed.
- Patrick Denard is a consultant for and receives royalties from Arthrex, Inc.

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CONFERENCE PRESENTATION

This work has been previously presented as a podium presentation at the American Academy of Orthopedic Surgeons Annual Meeting 2022 in Chicago, Illinois.

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