Surgical markup in lung cancer resection, 2015-2020

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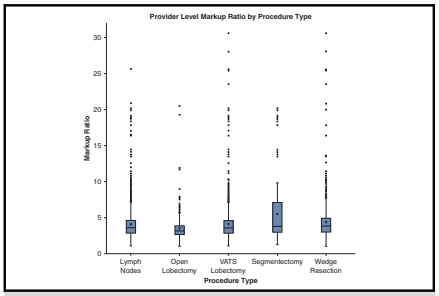
ABSTRACT

Objective: The objective of this study was to assess procedure markup (charge-to-cost ratio) across lung resection procedures and examine variability by geographic region.

Methods: Provider-level data for common lung resection operations was obtained from the 2015 to 2020 Medicare Provider Utilization and Payment Data datasets using Healthcare Common Procedure Coding System codes. Procedures studied included wedge resection; video-assisted thoracoscopic surgery; and open lobectomy, segmentectomy, and mediastinal and regional lymphadenectomy. Procedure markup ratio and coefficient of variation (CoV) was assessed and compared across procedure, region, and provider. The CoV, a measure of dispersion defined as the ratio of the SD to the mean, was likewise compared across procedure and region.

Results: Median markup ratio across all procedures was 3.56 (interquartile range, 2.87-4.59) with right skew (mean, 4.13). Median markup ratio was 3.59 for lymphadenectomy (CoV, 0.51), 3.13 for open lobectomy (CoV, 0.45), 3.55 for video-assisted thoracoscopic surgery lobectomy (CoV, 0.59), 3.77 for segmentectomy (CoV, 0.74), and 3.80 for wedge resection (CoV, 0.67). Increased beneficiaries, services, and Healthcare Common Procedure Coding System score (total) were associated with a decreased markup ratio ($P < .0001$). Markup ratio was highest in the Northeast at 4.14 (interquartile range, 3.09-5.56) and lowest in the South (Markup ratio 3.26; interquartile range, 2.68-4.02).

Conclusions: We observe geographic variation in surgical billing for thoracic surgery. (JTCVS Open 2023;14:538-45)



Markup ratio by procedure type, 2015-2020.

CENTRAL MESSAGE

Our data demonstrate variation in surgical markup across geographic regions, potentially reflecting greater financial distress among uninsured and out-of-network patients in these areas.

PERSPECTIVE

Our results highlight significant variation in surgical pricing across region for lung resection. It is important for surgeons to understand how their services fit into and may be influenced by migration toward value-based payment models.

A procedure-specific markup ratio, defined as the ratio of total charges to Medicare-allowable costs, has been used to study variation in billing practices for physician services.[1] This excess charge forms the basis for negotiations with commercial health insurers and is negotiated down in the case of in-network insurers.[2] Meanwhile, uninsured patients face this inflated charge and out-of-network patients, absent the benefit of a negotiated rate, may be responsible for a significant portion. Markup has come under scrutiny from a cost-containment perspective and as a potential barrier to care. Earlier studies have highlighted variation across procedure and region but no study to date has assessed markup within thoracic surgery and more specifically for lung resection procedures.

Lung cancer represents 20% of the Medicare budget for cancer care.[3] Given the potential for curative intervention

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The Institutional Review Board the Icahn School of Medicine at Mount Sinai deemed this study as exempt research as this dataset is de-identified. Patient written consent for the publication of the study was not required. Provider-level data were pulled from the Center for Medicaid and Medicare Services Provider Utilization and Payment Data: Physician and Other Supplier datasets from 2015 to 2020.

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Abbreviations and Acronyms

CMS = Centers for Medicare and Medicaid Services
CoV = coefficient of variation
HCC = hierarchical condition categories
HCPC = Healthcare Common Procedure Coding System
VATS = video-assisted thoracoscopic surgery

when diagnosed at an early stage and the relative cost-effectiveness of surgery, the low rate of uptake of lung cancer screening, first recommended by the US Preventive Services Task Force in 2013 is troubling.[4] Recently, stage migration has begun to be reported among Medicare-eligible patients.[5] With recent expansion, approximately half of patients now eligible for screening 50 to 64 years are on Medicaid or uninsured.[6] Understanding variation in the markup for lung cancer resection markup is important in the implementation of the care pathway. Understanding variation in surgical pricing will further incentivize payers to improve access and optimize treatment for early-stage lung cancer.[7]

In this investigation, we examined variation in surgical pricing in thoracic surgery in a large nationally representative sample with the aim to identify opportunities to improve care delivery.[8] We further investigated geographic differences in the cost of lung resection as well as cost differences within procedure type (eg, wedge resection vs lobectomy).[9-11]

METHODS

Data Source

Provider-level data were pulled from the Centers for Medicaid and Medicare Services (CMS) Provider Utilization and Payment Data: Physician and Other Supplier datasets from 2015 to 2020.[12] This dataset is organized by the Physician's National Provider Identifier number and includes information on Medicare fee-for-service beneficiaries from resolved Part B claims and thus does not represent the physicians' entire practice population. Providers with fewer than 11 beneficiaries are excluded. The Institutional Review Board at the Icahn School of Medicine at Mount Sinai, deemed this study as exempt research because this dataset is de-identified. Patient written consent for the publication of the study was not required.

Patients undergoing the 7 most common lung thoracic surgical procedures were queried using Healthcare Common Procedure Coding System (HCPCS) codes; procedures were excluded if fewer than 3 providers or 100 total services were located. The final procedural list included video-assisted thoracoscopic (VATS) lobectomy, open lobectomy, segmentectomy, wedge resection, and mediastinal or regional lymphadenectomy. Procedures excluded on the basis of insufficient volume included bilobectomy (open and video-assisted) and pneumonectomy (sleeve, open, and extra-pleural). Nonphysician care providers (eg, physician assistants and nurse practitioners), and procedures performed in the outpatient setting were also excluded from the dataset.

Markup Ratio

The Medicare-allowable costs are what CMS determines to be the cost associated with a given procedure. Initial charge is a reflection of charge-master, a list of items billable to a patient or health insurer. This ledger is typically an inflated price of actual costs but serves as a starting point for negotiations between hospitals and payers.[2]

A procedure-specific markup ratio is defined as the ratio of total charges to Medicare-allowable costs. It has previously been applied to study variability of a number of procedures and surgical fees across provider and region in the United States.[1] Markup ratio is a meaningful way to address cost in surgery as charge is often used to negotiate reimbursement from private insurers, as mentioned. Patients who are out of network or uninsured may face the list price. It has likewise been used to compare hospitals with one another because markup ratio represents the largest proportion of reimbursement during a surgical episode.[13,14]

Variables

The number of beneficiaries and services provided for the 7 surgical procedures were queried along with the total charge amount and total allowable costs. The specialty of the physician, number of unique HCPCS codes billed, state, and region of practice were also recorded. The average age of the Medicare beneficiaries, average Hierarchical Condition Classifier (HCC) risk score (a validated measure of comorbidity burden),[15] and percentage of beneficiaries who qualified for Medicaid were also quantified for each physician. The percentage of the physicians' beneficiaries with a number of common comorbidities (eg, atrial fibrillation, dementia, asthma, cancer, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, diabetes, depression, hyperlipidemia, hypertension, ischemic heart disease, osteoporosis, rheumatic arthritis, stroke, and schizophrenia) were noted. A markup ratio was created for each physician and procedure as described previously, by dividing the average submitted charges per procedure by the Medicare maximum allowable costs associated with each procedure.[1,13]

Statistical Analysis

Descriptive statistics were performed on the total beneficiary count, total services provided, total charges submitted, the total Medicare allowable costs for each procedure. The mean ± SD, coefficient of variation (CoV), median, and interquartile range (IQR) were calculated for the overall study population, by procedure, by region, and by specialty. Correlation coefficients were calculated between the markup ratio for each physician and the average age of their patients, number of unique HCPCS codes billed for, number of beneficiaries who qualified for Medicaid, average HCC risk score of the beneficiaries, and a variety of comorbidities. Markup ratios were calculated for each state and displayed graphically to best understand regional trends in these ratios. All statistical analyses were performed on Statistical Analysis Software version 9.4 (SAS Software).

RESULTS

Baseline Procedure, Provider, and Regional Variation

Median markup ratio across all procedures (Figure 1) was 3.56 (IQR, 2.87-4.59) with right skew (mean, 4.13). The markup ratio was stable across the study period (Table 1). Median markup ratio was 3.59 for lymphadenectomy (CoV, 0.51), 3.13 for open lobectomy (CoV, 0.45), 3.55 for VATS lobectomy (CoV, 0.59), 3.77 for segmentectomy (CoV, 0.74), and 3.80 for wedge resection (CoV, 0.67) (Table 2 and Table 3). Significant right skew was noted across all procedures (Figure 2) and was greatest in both

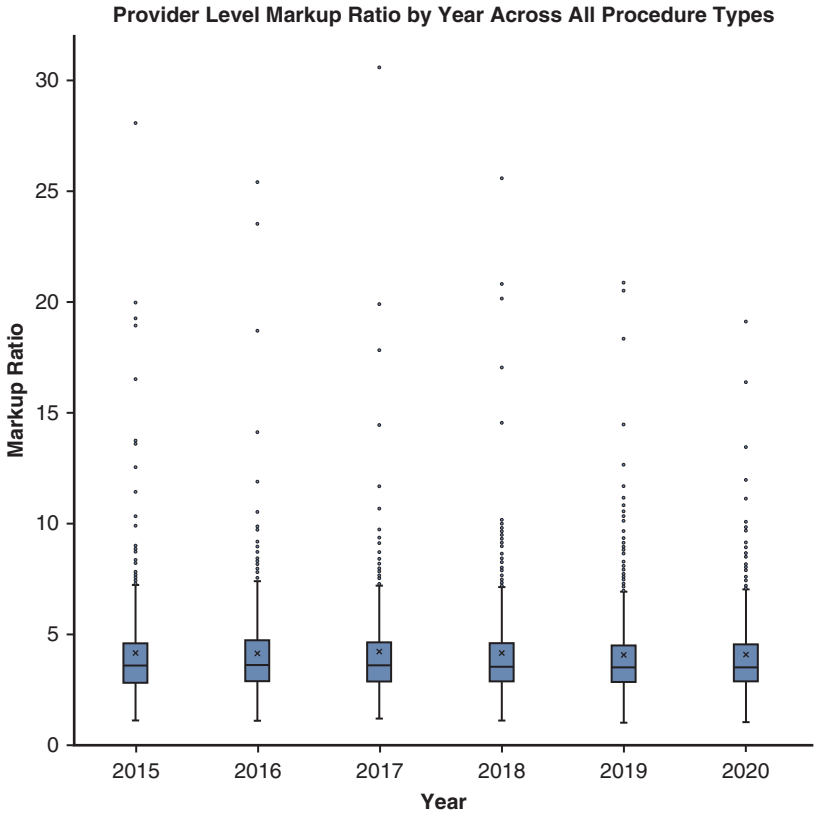

FIGURE 1. Markup ratio by year across all procedure types (2015-2020). The lower and upper borders of the box represent the lower and upper quartiles (25th percentile and 75th percentile). The middle horizontal line represents the median. The lower and upper whiskers represent the minimum and maximum values of non-outliers. The × marks the mean.

open and VATS segmentectomy (Figure 2). Markup ratio was examined by specialty; the median markup ratio for thoracic surgery was 3.69 (IQR, 2.92-4.81) and 3.32 for general surgery (IQR, 2.86-3.95) (Table 4).

Markup ratio was highest in the Northeast at 4.14 (IQR, 3.10-5.56) followed by the Midwest (Markup ratio [MR] 3.82; IQR, 2.95-4.99), West (MR, 3.44; IQR, 2.85-4.59), and South (MR, 3.26; IQR, 2.68-4.02) (Table 4). Among individual states the highest MR was in New Hampshire at 8.96 (IQR, 7.50-9.31); the lowest MR was in Minnesota at 1.99 (IQR, 1.29-4.02) and South Dakota at 1.12 (IQR, 1.10-1.12). State-by-state markup ratios are displayed graphically in Figure 3.

Correlation Coefficients

Correlation coefficients were calculated between the markup ratio for each physician and the average age of their patients, number of unique HCPCS codes billed for, number of beneficiaries who qualified for Medicaid, average HCC risk score of the beneficiaries, and a variety of comorbidities. Significant negative correlations were noted for beneficiaries, services, and HCPCS (total). Age and HCC risk index were not associated with markup ratio (Table 5).

DISCUSSION

Our results highlight variation in billing practices for lung resection that have implications for thoracic oncologic care

TABLE 1. Procedure markup ratio over study period (2015-2020)

Category	Provider	Mean ± SD	Median (interquartile range)	Coefficient of variation
2015	869	4.14 ± 2.48	3.58 (2.82-4.58)	0.60
2016	938	4.12 ± 2.33	3.61 (2.88-4.73)	0.57
2017	954	4.21 ± 2.96	3.59 (2.88-4.63)	0.71
2018	1076	4.15 ± 2.42	3.56 (2.88-4.60)	0.58
2019	1107	4.06 ± 2.16	3.51 (2.84-4.49)	0.53
2020	940	4.09 ± 2.12	3.54 (2.87-4.54)	0.52

TABLE 2. Markup by procedure type (2015-2020)

Procedure (CPT code)	Provider*	Services (total)	Beneficiaries (total)	Mean ± SD	Median (IQR)
Lobectomy					
Open (32,480)	499	168,104	74,056	3.47 ± 1.55	3.13 (2.65-3.84)
VATS (32,663)	1713	317,239	149,141	4.11 ± 2.43	3.55 (2.84-4.56)
Wedge (32,505, 32,666)	1126	74,524	42,556	4.37 ± 2.93	3.80 (2.99-4.89)
Segment (32,484, 32,669)	153	6176	4128	5.48 ± 4.07	3.77 (2.98-6.98)
Lymphadenectomy (32,674)	2393	144,151	89,451	4.07 ± 2.09	3.59 (2.86-4.59)

CPT, Current Procedural Terminology; *IQR*, interquartile range; *VATS*, video-assisted thoracoscopic surgery. *Provider refers to an individual provider-year billing cycle.

delivery. Lung cancer is the leading cause of cancer mortality and detection, and subsequent resection of early-stage disease offers the most efficient therapy and the best rate of remission. Studies have estimated an up to 2-fold increase in lung cancer surgery due to the introduction of low-dose computed tomography screening.[16] Understanding variation in the markup for lung cancer resection markup is important in the implementation of the care pathway.

In our study, the median markup was 3.56 (IQR, 2.87-4.59). Median markup ranged between 3.51 and 3.61 across year, 3.13 to 3.80 by procedure, 3.15 to 3.69 by provider, and 3.26 to 4.14 by region. Among states, the median markup ranged from 1.99 (IQR, 1.29-4.02) in Minnesota to 8.99 (IQR, 7.96-9.76) in Wisconsin. Gani and colleagues examined markup across 8 procedures (aortic aneurysm repair, aortic valvuloplasty, carotid endarterectomy, coronary artery bypass grafting, esophagectomy, pancreatectomy, liver resection, and colectomy) reporting a median MR of 3.5 (IQR, 3.1-4.0) with a range of 3.0 to 6.0 across procedure.[1] Although the median range reported herein is narrow, the differences observed across procedure, region, and provider are statistically significant as assessed by the Kruskal-Wallis test ($P < .0001$). These differences are appreciated when comparing mean markup. For example, the mean markup for segmentectomy was 5.48 ± 4.07 compared to 3.47 ± 1.55 for open lobectomy reflecting the greater rightward skew within this procedure.

Higher markup has been attributed to the provider's market share, which is consistent with our observation of variability across and within region/state. Markup varied significantly across state and was greatest in Wisconsin, a finding previously observed. The association between regional provider density, local practice patterns, and other factors are worth exploring to better disentangle procedural and regional variation in markup.

We identified a negative correlation with procedure volume and HCPCS total, potentially reflecting a cost savings benefit associated with regionalization and high-volume centers.[17] We did not identify an association with HCC risk score, despite previous association with increased postoperative costs in thoracic surgery.[18]

Among the procedures studied, the CoVs are greatest in segmentectomy (0.74). In interpreting this variability, it is helpful to visualize the distribution and consider the skew of the data. For example, for segmentectomy, the median markup rate was 3.77, whereas the mean markup rate was 5.48, indicating substantial rightward or positive skew. Graphically this is evident as a long right-sided tail (Figure 2). Segmentectomies are complex and more likely to be performed at an academic medical instead of community hospitals. This may create an environment of decreased market competition encouraging higher markup for these complex surgeries. Similarly, we observed that markup tended to be higher among more technically challenging operations. The highest mean procedure markup was for segmentectomy—a more complex and technically challenging procedure than nonanatomic resection or lobectomy. Segmentectomy was most commonly performed in the Northeast, which may in part explain the higher median markup ratio observed in this region.

We also investigated the markup ratio differences by surgical specialty. We found thoracic surgeons had the highest

TABLE 3. Coefficient of variation (CoV), total submitted charges, total Medicare-allowable costs, and total payments over the study period (2015-2020)

Procedure (CPT code)	CoV	Total submitted charges, dollars	Total Medicare-allowable costs, dollars	Total payments, dollars
Lobectomy				
Open (32,480)	0.45	401,104,899	121,686,666	96,493,175
VATS (32,663)	0.59	1,258,611,756	306,692,323	242,793,518
Wedge (32,505, 32,666)	0.67	880,686,033	208,726,379	165,086,221
Segment (32,484, 32,669)	0.74	169,014,402	33,352,995	26,403,779
Lymphadenectomy (32,674)	0.51	1,610,988,060	399,876,345	316,534,311

CPT, Current Procedural Terminology; *VATS*, video-assisted thoracoscopic surgery.

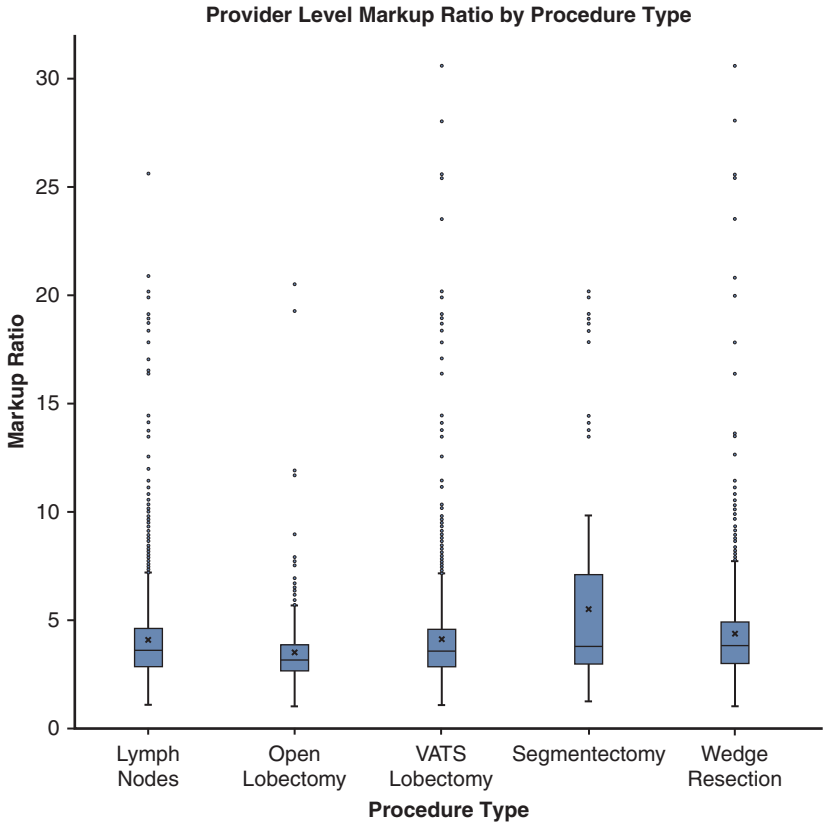

FIGURE 2. Markup ratio by procedure type (2015-2020). The lower and upper borders of the box represent the lower and upper quartiles (25th percentile and 75th percentile). The middle horizontal line represents the median. The lower and upper whiskers represent the minimum and maximum values of non-outliers. The × marks the mean. *VATS*, Video-assisted thoracoscopic surgery.

median and mean markups, which may be attributable to data showing outcomes for lobectomy are better among cardiothoracic and noncardiac thoracic surgeons.[19,20] Previous studies from authors such as Abdelsattar and colleagues[21] and Gani and colleagues[1] have shown that payments for physician services vary significantly for other procedures and conditions. Similarly, markup ratios and inpatient costs for treating surgical conditions have been shown to vary significantly among hospitals, with the highest markup ratios averaging charge to cost ratios above 10.[3,9] These variations in markup ratios are not limited to surgical or hospital-level care, as there have been variations in oncologic payments as well.[15] Overall, the markup ratio for thoracic surgery is comparable to other surgical fields.[18,19]

These previous reports, consistent with the present findings, also reflect the broader variation in cost of care developed across the American health system (Figure 4).[20,22] Skinner and colleagues[23] have shown that the wide variation in per-beneficiary costs across geographic areas is only partially explained by patient comorbidities, environmental, and other risk factors. After controlling for

TABLE 4. Surgical markup by region and provider type (Medicare Provider Utilization and Payment Data 2015-2020)

Category	Provider*	Mean ± SD	Median (IQR)	CoV
Provider type				
Cardiac surgery	748	3.50 ± 2.45	3.15 (2.57-3.85)	0.7
Thoracic surgery	4661	4.25 ± 2.44	3.69 (2.92-4.81)	0.57
General surgery	338	3.78 ± 1.93	3.32 (2.86-3.95)	0.51
Region				
Midwest	1075	4.29 ± 2.65	3.82 (2.95-4.99)	0.62
Northeast	1834	4.79 ± 2.74	4.14 (3.10-5.56)	0.57
South	2088	3.46 ± 1.30	3.26 (2.68-4.02)	0.38
West	845	4.18 ± 3.03	3.44 (2.85-4.59)	0.72

IQR, Interquartile range; *CoV*, coefficient of variation. *Provider refers to an individual provider-year billing cycle.

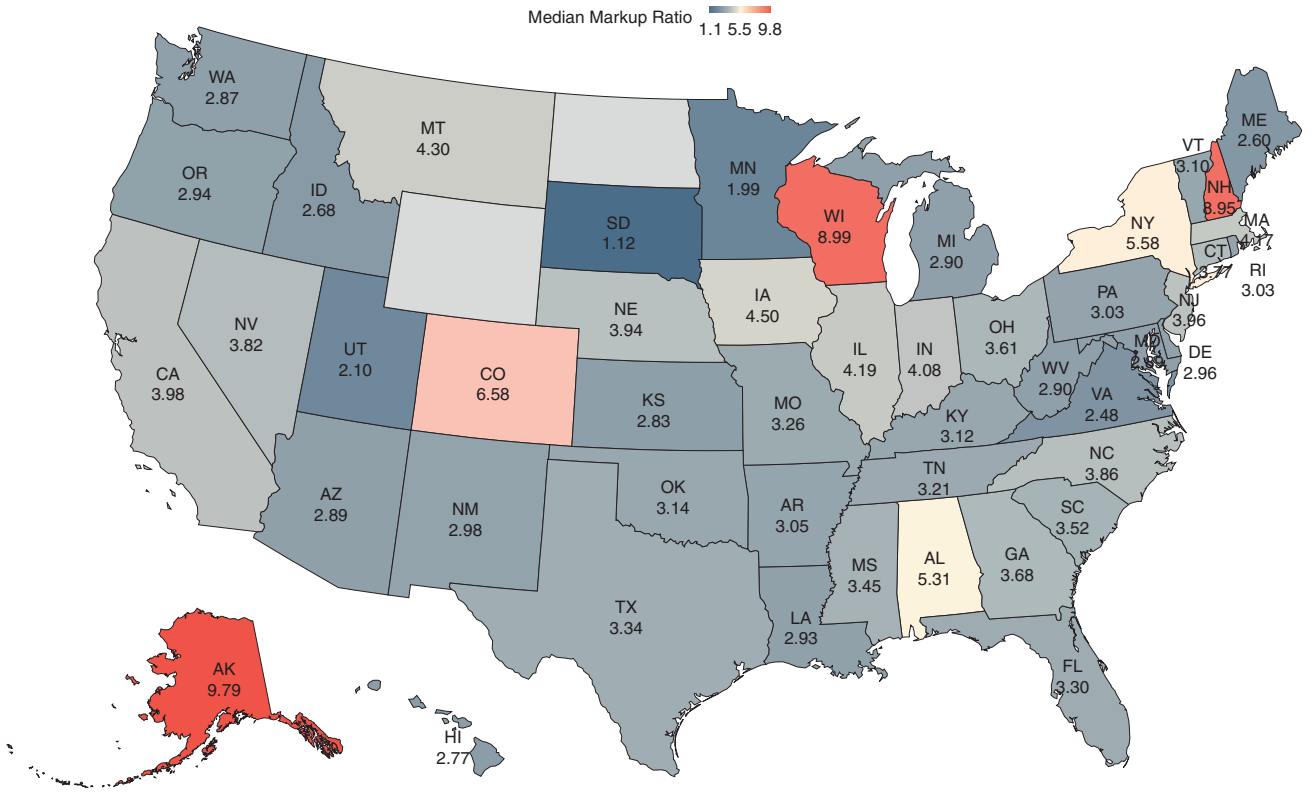

FIGURE 3. State-level variation procedure markup for common lung resection procedures.

demographic and health risk factors, they concluded that more than 70% of spending may be derived from inefficiencies in the provision of care. The disparities seen in the procedure-specific markup indicate an inconsistency between the amount that is charged for a procedure and the cost of care provided. Given the size of the markup—ranging to a factor of 7 between states—it is unlikely to be solely due to hospital and provider operating margins, although this represents an important area that will require further study.

The main causes of these extremely high markups are a lack of price transparency and negotiating power by uninsured patients, out-of-network patients, casualty and workers' compensation insurers, and even in-network insurers. Federal and state policy makers need to recognize the extent of hospital markups and consider policy solutions to contain them. Options include limitations on the overall charge-to-cost ratio, limitations on the charge-to-cost ratio for specific services, some unified form of all-payer rate setting, and mandated price disclosure.

Increased markup within surgery has already resulted in multiple changes ranging from capitated methods of payments[21,22] to center of excellence models.[24] CMS has also announced an innovative reimbursement scheme for radiation oncology services that began January 1, 2021. Estimated to save $230 million over 5 years, the program covers 17 types of cancers, including lung, corrects multiple inefficiencies in billing practices, and reorients incentives toward quality of care. Concurrently, there has been an increased call for price transparency from multiple stakeholders, including nonprofits, patient groups, and governmental agencies.[23,25] In conjunction with the changes in reimbursement from CMS, our findings of wide variability in markup support the move toward value-based care and markup ratios should be published to establish the value that providers are able to deliver on an individual procedure level across the country.

There are several limitations that merit consideration in light of the findings presented here. First, the data presented here were generated from a retrospective review of physician utilization records in the Medicare fee-for-service population, which introduces potential bias and reduces the generalizability of the present study. Furthermore, although the surgeons' procedural volumes may have an effect on the markup ratio as a proxy measure of operative skill, the present study was unable to account for this factor, due to the dataset being limited to this unique population. Patient-level characteristics were not included in this dataset, which represents an important source of confounding for the present results, although utilizing average characteristics across the physicians' whole patient population was able to offset some of this confounding effect. Moreover, we

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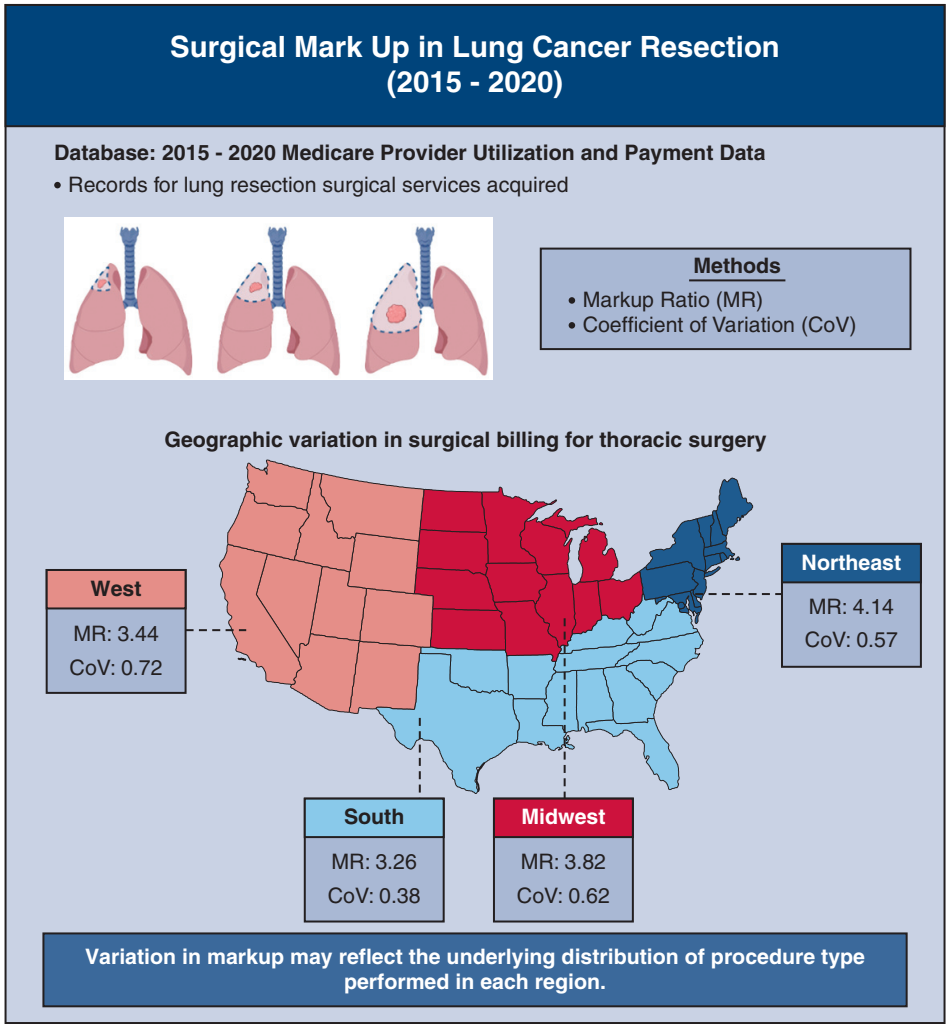

FIGURE 4. Surgical markup in lung cancer resection (2015-2020).

TABLE 5. Correlation between surgical markup and select variables

Variable	*PCC* (*P* value)
Beneficiaries (Total)	−0.05375 (<.0001)
Services (Total)	−0.05946 (<.0001)
HCPCS (Total)	−0.11502 (<.0001)
Beneficiary Age	0.02219 (.0946)
Cancer	0.21288 (<.0001)
HCC Risk Score	0.02519 (.0534)

PCC, Pearson correlation coefficient; *HCPCS*, Healthcare Common Procedure Coding System; *HCC*, Hierarchical Condition Categories.

were unable to assess procedures performed concurrently nor robotic interventions. Finally, the authors had no ability to look at patient outcomes following these procedures, thereby prohibiting the present report from making a statement about the value of these procedures.

CONCLUSIONS

Our results highlight significant variation in billing practices for lung resection across procedure, provider, and region. With a projected increase in these types of

procedures due to increased low-dose computed tomography screening, it will be vital to control costs for long-term sustainability.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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