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ORIGINAL RESEARCH

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Inpatient total thyroidectomy costs and outcomes vary regionally: A nationwide study

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Abstract

Objectives: While it is known that surgical costs continue to rise in the United States, there is little information about the specific underlying factors for this variation in many common procedures. This study investigates the influence of geographic location and hospital demographics on hospital cost and postoperative outcomes in adult patients undergoing total thyroidectomy (TT).

Methods: The National Inpatient Sample was queried for patients who underwent primary TT between 2016 and 2017. Multivariable analyses were conducted to determine estimates and odds ratios (OR) between various hospital factors and total cost, prolonged length of stay (LOS), and non-home discharge. Reference categories were small bed-size and Northeast region.

Results: A weighted total of 16,880 patients with mean age of 50.6 years were included. Most patients were female (73.8%), White (57.0%), and treated at Southern (32.4%), large bed-size (65.1%), and urban teaching (82.7%) hospitals. Medium and large bed-size hospitals were associated with a 6.5% ($p < .001$) and 7.5% ($p < .001$) reduction in TT cost, respectively. TT cost was greatest in the West, associated with a 32.4% increase ($p < .001$). Patients in the Midwest (OR 1.366, $p = .011$) had prolonged LOS, whereas patients treated in the Midwest (OR 0.436, $p < .001$), South (OR 0.438, $p < .001$), and West (OR 0.502, $p < .001$) had lower odds of non-home discharge.

Conclusion: There is geographic variation in both costs and outcomes of TT. Although Northeastern hospitals had the lowest costs for TT, they were associated with the greatest odds for non-home discharge.

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Level of evidence: IV

KEYWORDS
cost, geographic variation, National Inpatient Sample, postoperative outcomes, total thyroidectomy

1 | INTRODUCTION

Health care in the United States (US) faces many critical issues related to outcome, quality, and patient safety.[1] One of the most pressing issues is consistently increasing costs which are unsustainable at their present rate.[1,2] Medical bills account for over 50% of personal bankruptcy in the United States, even among the insured.[3] Over the past 20 years, the share of the economy allocated for health care spending as measured by gross domestic product has risen from 12.8% to 17.4%, which is by the far the most of any country worldwide.[1] Although the ratio of health care spending to gross domestic product in the United States is among the highest of all industrialized countries, increased health care spending does not necessarily reflect improved outcomes or quality of care.[4]

Thyroidectomy has either benign or malignant surgical indications and is generally well tolerated.[1] One study using data from the National Survey of Ambulatory Surgery (NSAS) reported the number of thyroidectomies increasing by 39% over the last decade with charges for inpatient thyroidectomy doubling and aggregate charges tripling despite a portion of the procedure transitioning from inpatient to outpatient settings in the same period of time.[5] Factors suggested to contribute to rising costs for thyroidectomy are male sex, extended operative time, extended hospital stays, occurrence of complications, and increased hospital volume.[1,2] Moreover, charges for thyroidectomy have been demonstrated to vary geographically even after wage adjustment with 27% of the variation not explained by patient-, hospital-, or state-level related factors.[6,7] Outcomes of thyroidectomy such as hypocalcemia and recurrent laryngeal nerve injury and rates of performing thyroidectomy have also been demonstrated to vary geographically.[8,9] Evidence documenting geographic variations in other outcomes including length of stay (LOS) and non-home discharge is scarce.

Thyroid diseases affect an estimated 20 million patients in the United States and total thyroidectomy (TT) is a mainstay of the standard-of-care for many thyroid diseases including goiter and malignancy.[10,11] Given increasing rates of thyroid disease, the identification of factors that contribute to geographic variation of TT costs and outcomes has clinical relevance. Of note, the transition from International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) to International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) coding has impacted billing, costs, and prevalence data.[12] To our knowledge, our study is the first to use the National Inpatient Sample (NIS) and ICD-10 coding to examine factors underlying variation in cost and outcomes for TT.

2 | METHODS

Retrospective database analysis was conducted using the NIS database, which contains information regarding inpatient utilization, quality, outcomes, cost, hospital ownership, and access. Inclusion criteria consisted of all cases during 2016–2017 with a primary ICD-10 procedure code of 0GTK0ZZ, open approach to excision of the thyroid gland, or 0GTK4ZZ, percutaneous endoscopic approach to excision of the thyroid gland. By selecting only cases with these codes as primary procedures, our study increased the likelihood that TT was the primary reason for their visit. For statistical analysis, the cases were then weighed with a preset NIS discharge weight. Hospital region was defined based on the NIS regional designations, including the Northeast, Midwest, South, and West. This study is exempt from Rutgers New Jersey Medical School Institutional Review board as the NIS database contains de-identified patient information.

To demonstrate the relationship of hospital region to cost and outcomes, generalized linear models were used while controlling for potential confounding variables, such as demographics, hospital characteristics, comorbidities, and number of procedures. Outcome measures included prolonged LOS (>90th percentile) and non-home discharge. Mortality was excluded as a measured outcome because there were minimal deaths within 30 days following TT. Total costs, defined by the NIS as expenses incurred by production of hospital services such as wages, supplies, and utility costs, were calculated by multiplying cost-to-charge ratio and total charges.[13] The costs for 2016 were then adjusted according to 2017 inflation levels, as provided by the US Consumer Price Index.[14] Gamma distribution with logistic link regression was used to understand the relationship between hospital type and total cost, while accounting for the confounding variables previously stated. Similarly, binary logistic regressions were used for prolonged LOS and non-home discharge.

Demographics examined for this study included age, sex, and race (White, Black, Hispanic, Asian or Pacific Islander, Native American, or Other). Hospital characteristics accounted for included region of hospital, wage index, location/teaching status of hospital, and bed-size of hospital. Patient characteristics examined included county of residence, median income quartile of patient zip code, mortality risk, severity of illness, transfer status, elective versus non-elective (emergency, urgent, trauma center, or other) admission, primary expected payer, and number of chronic conditions.

Cohort demographics distribution, categorized by hospital region, was assessed utilizing univariate and multivariable analysis. Univariate analysis was accomplished with Pearson chi-square tests for categorical variables and ANOVA for continuous variables. Evaluation of

TABLE 1 Weighted patient demographics for total thyroidectomy cases during 2016–2017.

Characteristics	Northeast	Midwest	South	West	*p*-value
No. of patients	4090 (24.2)	2900 (17.2)	5470 (32.4)	4420 (26.2)	
Age, years (mean [SD])	49.5 [16.7]	50.3 [17.4]	51.1 [17.2]	51.0 [17.2]	<.001
Sex					.008
Female	3050 (74.6)	2075 (71.6)	4090 (74.8)	3245 (73.4)	
Male	1040 (25.4)	825 (28.4)	1380 (25.2)	1175 (26.6)	
Race					<.001
Black	565 (13.8)	460 (15.9)	1370 (25.0)	260 (5.9)	
Asian or Pacific Islander	290 (7.1)	65 (2.2)	115 (2.1)	520 (11.8)	
Hispanic	485 (11.9)	145 (5.0)	855 (15.6)	1150 (26.0)	
White	2320 (56.7)	2155 (74.3)	2855 (52.2)	2300 (52.0)	
Other	430 (10.5)	75 (2.6)	275 (5.0)	190 (4.3)	
Patient county of residence					<.001
Central county of metro area >1 million	1640 (40.1)	810 (27.9)	1460 (26.7)	2390 (54.1)	
Fringe country of metro area >1 million	1345 (32.9)	715 (24.7)	1265 (23.1)	660 (14.9)	
County in metro area 250–999 k	515 (12.6)	445 (15.3)	1360 (24.9)	840 (19.0)	
County in metro area 50–250 k	215 (5.3)	345 (11.9)	450 (8.2)	265 (6.0)	
Micropolitan county <50 k	215 (5.3)	365 (12.6)	425 (7.8)	190 (4.3)	
Not metropolitan or micropolitan	160 (3.9)	220 (7.6)	510 (9.3)	75 (1.7)	
Median income in patient zip code					<.001
First quartile	875 (21.4)	820 (28.3)	2170 (39.7)	750 (17.0)	
Second quartile	900 (22.0)	790 (27.2)	1495 (27.3)	1035 (23.4)	
Third quartile	965 (23.6)	795 (27.4)	1130 (20.7)	1215 (27.5)	
Fourth quartile	1350 (33.0)	495 (17.1)	675 (12.3)	1420 (32.1)	
Insurance					<.001
Medicare	915 (22.4)	855 (29.5)	1640 (30.0)	1050 (23.8)	
Medicaid	920 (22.5)	530 (18.3)	680 (12.4)	995 (22.5)	
Private including HMO	2125 (52.0)	1380 (47.6)	2645 (48.4)	2160 (48.9)	
Self-pay	55 (1.3)	30 (1.0)	240 (4.4)	80 (1.8)	
Other	75 (1.8)	105 (3.6)	265 (4.8)	135 (3.1)	
Mortality risk					<.001
Minor	2665 (65.2)	1725 (59.5)	3520 (64.4)	2715 (61.4)	
Moderate	1240 (30.3)	1025 (35.3)	1530 (28.0)	1435 (32.5)	
Major/extreme	185 (4.5)	150 (5.2)	420 (7.7)	270 (6.1)	
Severity of illness					<.001
Minor	1750 (42.8)	960 (33.1)	2070 (37.8)	1725 (39.0)	
Moderate	1955 (47.8)	1545 (53.3)	2650 (48.4)	2145 (48.5)	
Major/extreme	385 (9.4)	395 (13.6)	750 (13.7)	550 (12.4)	
Patient transferred in					<.001
Yes	125 (3.1)	50 (1.7)	110 (2.0)	160 (3.6)	
No	3965 (96.9)	2850 (98.3)	5360 (98.0)	4260 (96.4)	
Length of stay, days (mean [SD])	2.50 [3.60]	2.90 [3.76]	3.15 [4.68]	2.65 [4.66]	<.001
Number of chronic conditions (mean [SD])	4.87 [3.16]	5.50 [3.48]	5.00 [3.27]	4.74 [3.31]	<.001
Admission type					<.001
Non-elective	1045 (25.6)	245 (8.4)	920 (16.8)	520 (11.8)	
Elective	3045 (74.4)	2655 (91.6)	4550 (83.2)	3900 (88.2)	

(Continues)

TABLE 1 (Continued)

Characteristics	Northeast	Midwest	South	West	*p*-value
Hospital characteristics					
Bed-size					<.001
Small	425 (10.4)	435 (15.0)	850 (15.5)	460 (10.4)	
Medium	605 (14.8)	655 (22.6)	1575 (28.8)	885 (20.0)	
Large	3060 (74.8)	1810 (62.4)	3045 (55.7)	3075 (69.6)	
Wage index (mean [SD])	1.17 [0.18]	0.96 [0.08]	0.89 [0.07]	1.27 [0.20]	<.001
Hospital type					<.001
Urban nonteaching/rural	280 (6.8)	500 (17.2)	1105 (20.2)	1040 (23.5)	
Urban teaching	3810 (93.2)	2400 (82.8)	4365 (79.8)	3380 (76.5)	

Note: For length of stay, number of chronic conditions, wage index, and age, the mean with the standard deviation in parenthesis are presented. ANOVA was used to calculate the *p*-value. For the remainder of variables, we show the number of cases, with percent of total cases in parenthesis. *p*-values were derived using Pearson chi-square.
Abbreviations: HMO, Health Maintenance Organization; SD, standard deviation.

TABLE 2 Mean cost of total thyroidectomy during 2016–2017 by hospital region.

Year	Number of cases	US cost, $ (SE)	Northeast cost, $ (SE)	Midwest cost, $ (SE)	South cost, $ (SE)	West cost, $ (SE)
2016	9085	14,690 (190)	13,238 (304)	14,308 (320)	13,031 (197)	18,687 (611)
2017	7795	16,720 (226)	13,641 (313)	15,954 (322)	15,880 (446)	20,667 (524)

Abbreviations: SE, standard error; US, United States.

estimates, odds ratio (OR), and confidence intervals (CI) of costs and outcomes associated with hospital characteristics was completed via multivariable regression models. Reference categories set were small bed-size for hospital bed-size, Northeast region for hospital region, and urban nonteaching/rural status for hospital type. All statistical analyses were completed using SPSS version 24.0 (IBM Corp, Armonk, NY). A *p*-value less than .05 was considered statistically significant.

3 | RESULTS

A weighted total of 16,880 patients with mean age of 50.6 years were included for analysis. Most patients were female (73.8%), White (57.0%), and treated at hospitals listed as Southern (32.4%), large bed-size (65.1%), and urban teaching status (82.7%) (Table 1). The 10th, 25th, 50th, 75th, and 90th percentiles for LOS were 1, 1, 2 (median), 3, and 6 days, respectively. Significant differences were observed between regions for both hospital characteristics and patient demographics ($p < .05$).

In 2016, there were 9085 TT cases, and in 2017, there were 7795 cases (Table 2). TT procedures on average in the United States increased from $14,690 ± $190 in 2016 to $16,720 ± $226 in 2017. TT procedures were most expensive in the West in both 2016 ($18,687 ± $611) and 2017 ($20,667 ± $524). TT procedures were least expensive in the South in 2016 ($13,031 ± $197), but in 2017 the operation was cheapest in the Northeast ($13,641 ± $313).

Patient and hospital characteristics were then evaluated for significant predictors of TT cost (Table 3). Increased age in increments of 10 years (Exp[β] 0.966, 95% CI 0.961–0.970, $p < .001$) and female sex (Exp[β] 0.884, 95% CI 0.871–0.897, $p < .001$) were some of the most significant patient demographic predictors of decreased TT procedure costs, while Black patients relative to White patients were associated with a predicted significantly increased cost of TT (Exp[β] 1.101, 95% CI 1.079–1.124, $p < .001$). Compared to patients living in the central county of a metro area with a population >1 million, the cost was predicted to be significantly higher for patients of all other residential categories besides those residing in a county in a metro area with a population of 250,000 to 999,000 ($p = .102$).

Median income and insurance type were also observed as significant predictors of cost of TT. Compared to patients in the first quartile of median income, patients in the second quartile were predicted to have a significantly reduced cost of procedure (Exp[β] 0.970, 95% CI 0.953–0.988, $p = .001$) whereas patients in the fourth quartile were predicted to have significantly increased cost of TT (RR 1.027, 95% CI 1.005–1.049, $p = .014$). Relative to privately insured patients, patients covered under Medicare had no significantly predicted change in cost of TT ($p = .110$). Medicaid patients, on the other hand, were associated with a predicted decrease in cost of TT (Exp[β] 0.948, 95% CI 0.931–0.966, $p < .001$), while both self-pay patients (Exp[β] 1.173, 95% CI 1.124–1.224, $p < .001$) and patients covered under other insurance types (Exp[β] 1.068, 95% CI 1.031–1.107, $p < .001$) were associated with increased procedural costs.

Patients with moderate (Exp[β] 1.062, 95% CI 1.138–1.187, $p < .001$) and major/extreme (Exp[β] 1.195, 95% CI 1.150–1.242, $p < .001$) mortality risk relative to patients with minor mortality risk undergoing TT were predicted to have higher procedural costs.

TABLE 3 Impact of patient demographics and hospital characteristics on total thyroidectomy cost.

Variables	Estimate (Exp[β])	95% confidence interval	*p*-value
Age (10-year increments)	0.966	0.961–0.970	**<.001**
Sex (female vs. male)	0.884	0.871–0.897	**<.001**
Race (vs. White)			
Black	1.101	1.079–1.124	**<.001**
Asian or Pacific Islander	0.957	0.930–0.986	**.003**
Hispanic	1.018	0.998–1.039	.077
Other	0.946	0.920–0.974	**<.001**
Patient county of residence (vs. central county of metro area >1 million)			
Fringe county of metro area >1 million	1.044	1.025–1.062	**<.001**
County in metro area 250–999 k	1.016	0.997–1.035	.102
County in metro area 50–250 k	1.096	1.067–1.126	**<.001**
Micropolitan county (<50 k)	1.099	1.069–1.130	**<.001**
Not metropolitan or micropolitan	1.142	1.107–1.178	**<.001**
Median income in patient zip code (vs. first quartile)			
Second quartile	0.970	0.953–0.988	**.001**
Third quartile	1.012	0.993–1.031	.222
Fourth quartile	1.027	1.005–1.049	**.014**
Insurance (vs. private)			
Medicare	1.016	0.996–1.035	.110
Medicaid	0.948	0.931–0.966	**<.001**
Self-pay	1.173	1.124–1.224	**<.001**
Other	1.068	1.031–1.107	**<.001**
Mortality risk (vs. minor)			
Moderate	1.162	1.138–1.187	**<.001**
Major/extreme	1.195	1.150–1.242	**<.001**
Severity of illness (vs. minor)			
Moderate	1.060	1.043–1.077	**<.001**
Major/extreme	1.119	1.084–1.155	**<.001**
Patient transferred in (vs. no)	1.056	1.014–1.101	**.009**
Length of stay (1-day increments)	1.066	1.063–1.069	**<.001**
Number of chronic conditions (1-condition increments)	1.013	1.010–1.016	**<.001**
Elective admission (vs. non-elective)	1.050	1.030–1.070	**<.001**
In-patient mortality (vs. alive)	0.689	0.528–0.900	**.006**
Non-home discharge (vs. home)	1.100	1.067–1.133	**<.001**
Hospital characteristics			
Bed-size (vs. small)			
Medium	0.935	0.914–0.956	**<.001**
Large	0.925	0.907–0.944	**<.001**
Wage index (0.1-point increments)	1.073	1.068–1.078	**<.001**
Hospital type (vs. urban nonteaching/rural)			
Urban teaching	0.981	0.964–0.999	**.035**
Hospital region (vs. Northeast)			
Midwest	1.248	1.221–1.276	**<.001**
South	1.250	1.223–1.277	**<.001**
West	1.324	1.298–1.351	**<.001**

Note: *p*-values were determined using a gamma distribution with a log-link function. Significant values are bolded.

TABLE 4 Impact of hospital characteristics on non-home discharge and length of stay.

	Prolonged length of stay (≥6 days)			Non-home discharge (vs. home)		
Hospital characteristic	OR	95% CI	*p*-value	OR	95% CI	*p*-value
Region (vs. Northeast)						
Midwest	1.366	1.073–1.739	**.011**	0.436	0.333–0.572	**<.001**
South	1.230	0.975–1.553	.081	0.438	0.338–0.568	**<.001**
West	1.055	0.843–1.320	.641	0.502	0.387–0.650	**<.001**
Bed-size (vs. small)						
Medium	0.930	0.727–1.189	.561	0.704	0.528–0.940	**.017**
Large	1.194	0.962–1.481	.108	0.784	0.611–1.004	.054
Hospital type (vs. urban nonteaching/rural)						
Urban teaching	0.886	0.732–1.070	.208	1.169	0.919–1.486	.203

Note: *p*-values were determined using multivariable binary logistic regressions.
Abbreviations: CI, confidence interval; OR, odds ratio.

Similarly, patients with moderate (Exp[β] 1.060, 95% CI 1.043–1.077, $p < .001$) and major/extreme (Exp[β] 1.119, 95% CI 1.084–1.155, $p < .001$) illness severity compared to patients with minor illness severity were associated with greater cost of TT. Transferred patients (Exp[β] 1.056, 95% CI 1.014–1.101, $p = .009$), LOS (Exp[β] 1.066, 95% CI 1.063–1.069, $p < .001$), number of chronic conditions (Exp[β] 1.013, 95% CI 1.010–1.016, $p < .001$), elective hospital admission (Exp[β] 1.050, 95% CI 1.030–1.070, $p < .001$), and non-home discharge (Exp[β] 1.100, 95% CI 1.067–1.133, $p < .001$) were all predictors of higher cost of TT. In-patient mortality was a significant predictor of reduced TT costs (Exp[β] 0.689, 95% CI 0.528–0.900, $p = .006$).

Total cost of TT was less in medium (Exp[β] 0.935, 95% CI 0.914–0.956, $p < .001$) and large (Exp[β] 0.925, 95% CI 0.907–0.944, $p < .001$) bed-size hospitals, while TT cost was the highest in the West (Exp[β] 1.324, 95% CI 1.298–1.351, $p < .001$). Similarly, the cost of TT was greater in both the Midwest (Exp[β] 1.248, 95% CI 1.221–1.276, $p < .001$) and the South (Exp[β] 1.250, 95% CI 1.223–1.277, $p < .001$) when compared with the Northeast. 0.1-point increases in the Wage Index were associated with increased cost of TT (Exp[β] 1.073, 95% CI 1.068–1.078, $p < .001$). TT performed at urban teaching hospitals was associated with statistically significantly decreased costs (Exp[β] 0.981, 95% CI 0.946–0.999, $p = .035$).

Multivariable analyses were also performed to discern if hospital characteristics were significant predictors of prolonged LOS (≥6 days) and non-home discharge (Table 4). Relative to TT procedures completed in the Northeast, TT patients operated on in the Midwest (OR 1.366, 95% CI 1.073–1.739, $p = .011$) were associated with prolonged LOS. TT performed in the Midwest (OR 0.436, 95% CI 0.333–0.572, $p < .001$), South (OR 0.438, 95% CI 0.338–0.568, $p < .001$), and West (OR 0.502, 95% CI 0.387–0.650, $p < .001$) were all associated with significantly reduced probability of non-home discharge. Medium bed-size predicted a lower likelihood of non-home discharge (OR 0.704, 95% CI 0.528–0.940, $p = .017$). Hospital teaching status was not a significant predictor for either LOS or non-home discharge ($p > .05$).

4 | DISCUSSION

Thyroidectomy is one of the most common procedures in otolaryngology. TT is indicated for a variety of pathologies, including nodular disease, hyperthyroidism, and thyroid cancer.[6] Although total thyroidectomies are performed across the United States, past literature has established that the cost of these procedures vary across each state in the country.[6] Furthermore, procedures across a variety of surgical subspecialties have shown to differ in hospital costs in different regions in the United States.[15,16] However, with the transition from ICD-9 to ICD-10 coding in 2015, morbidity and mortality statistics as well as hospital costs and reimbursements have been affected by the change.[12,17] Little research has been done analyzing regional and hospital differences in costs and outcomes using the new ICD-10 coding, especially in otolaryngology. Through the use of ICD-10 coding, our study sought to not only explore recent regional differences in TT cost, but also determine hospital characteristics that are associated with cost, non-home discharge rates, and LOS.

Concordant with other studies on thyroidectomy, most patients in this study were female, White, elective cases, and in teaching hospitals, with the South region having the most thyroidectomies.[6,18,19] Furthermore, the Northeast and West had significantly greater proportions of total thyroidectomies performed in large bed-size hospitals and higher wage indexes, while the Northeast had a significantly higher percentage of procedures performed in urban teaching hospitals compared to other regions. These findings are likely due to the increased population density in both regions, because 40.1% of Northeastern thyroidectomies and 54.1% of Western thyroidectomies were performed on patients from counties with population size >1 million, compared to only 27.9% and 26.7% of Midwestern and Southern thyroidectomies, respectively. Although the majority of patients in our cohort underwent elective TT, our cohort had an unusually high rate of non-elective admissions (8.4%–25.6%). TT is usually an elective procedure, and our rate of non-elective admissions may be related to the NIS collecting data from hospitalizations and accordingly representing a higher-risk category of patients.

Our results showed that the South was the cheapest region in 2016 and Northeast was the cheapest region in 2017, while the West had the most expensive procedures in both years. After controlling for patient demographic and hospital factors, multivariable analyses showed similar results. Compared with procedures in the Northeast, total thyroidectomies in the Midwest, South, and West were associated with a 24.8%, 25.0%, and 32.4% increase in cost, respectively. These findings are supported by previous literature in other surgical procedures and inpatient care costs. Augustine et al. found that trauma care cost was most expensive in the West and cheapest in the Northeast, consistent across multiple specific traumatic injuries.[20] Makarov et al. discovered that Colorado (a Western state) had the most expensive prostatectomies and New Jersey (a Northeastern state) had the cheapest ones.[21] Zygourakis et al. presented similar results for lumbar laminectomy and lumbar fusion being most expensive in the West.[16] Although several studies have demonstrated similar results, the underlying reason for the cost variation is still debated. It has been previously hypothesized that while wage index as a comparative measure of salaries has shown its usefulness, it still does not adequately account for the high cost of labor especially in Western states.[16,22,23] Furthermore, health care policies such as minimum nurse to patient ratios in acute care hospitals in California (a Western state) and health care reform in Massachusetts in 2006 likely play a significant role in costs faced by hospitals in each region.[16,23–25] Finally, literature has shown that Western hospitals in the US tend to have greater overall profitability, which may be in part due to differences in market penetration, efficiency, supply, and state-mandated price regulation, among other factors.[20,25–27] Other hospital characteristics were also found to have a significant association with TT cost, notably bed-size and wage index. Our results showed that smaller hospitals, as measured by bed-size, had higher costs, which has previously been noted in older studies.[16,28,29] This is likely due to smaller hospitals needing to spend more on administrative expenses and surgical supplies for total thyroidectomies as a consequence of having less buying power than larger hospitals and thus emphasizing the importance of economy to scale in lowering prices for hospitals.[16] Additionally, increased wage index was correlated with increased TT costs, supported by previous literature.[16,23,29] Given that wage indexes measure the relative hospital wage level in a specific area compared to national average hospital wages, an increased wage index indicates increased costs for labor, thus predictably increasing TT costs.

Our study additionally demonstrated regional variation in non-home discharge rates and prolonged LOS for patients following TT. Overall, our study found a median LOS of 2 days. Advances in TT have allowed for shorter LOS of inpatient cases and a greater proportion of outpatient TT.[30,31] The NIS only captures patients who are admitted and our LOS may be skewed upward due to representation of sicker patients with more medical comorbidities and surgical complications. Northeast hospitals were associated with significantly increased odds of non-home discharge compared with hospitals in all other regions, as also noted in previous literature.[28,32–34] Moreover, patients in Midwestern hospitals were 36.6% more likely to have prolonged LOS compared with those in the Northeast. Although the reasoning behind these regional factors causing variation in LOS and non-home discharge rates is currently unclear, there is growing support for the idea that regional differences in these outcomes are primarily due to differences in health care systems, including spending, physician practices, hospital resources, and physician supply.[35] Our results included hospital size as another statistically significant hospital characteristic that was associated with non-home discharge; hospitals classified as small bed-size had increased non-home discharge odds compared with medium. One feasible explanation for these results is that smaller hospitals do not have some of the advanced resources that bigger hospitals have and therefore may transfer patients to other larger facilities, thereby increasing non-home discharge rates. Finally, hospital teaching status was not associated with LOS or non-home discharge.

Our study is unique in that it explores regional and hospital variation in TT costs and outcomes using recent ICD-10 coding. Unlike previous literature, such as the studies by Reinke et al. and Liu et al. which analyzed data from the ICD-9 coding era and focused on either geography or hospital factors impacting either cost or outcomes, our study uses ICD-10 codes to determine both geographical and hospital factors that impact both costs and outcomes.[6,23] A better understanding of how multiple factors interact and increase costs and poor outcomes can help identify ways to improve efficiency and cost-effectiveness of otolaryngology care, particularly for total thyroidectomies.

While the study has notable strengths, it also has several limitations. One limitation is that NIS does not provide a breakdown of the hospital costs, so it is impossible to determine what specifically is contributing to the variation across regions and hospitals. Another limitation is reliance on deriving costs from charges and accurate hospital coding, which may contain inaccuracies. This also leads to exclusion of any prehospital and postsurgical care costs, which may be significant components of costs that are not included in NIS-based costs. Therefore, costs measured in NIS may overestimate or underestimate true costs faced by hospitals. The NIS only captures data from hospitalizations which may skew several parameters in our study including admission type (i.e., elective vs. non-elective) and LOS. Finally, this study included data from the first two years of ICD-10 which may not represent current trends in cost after hospitals have adjusted to the ICD-10 changes.

5 | CONCLUSION

Our results demonstrate that regional variation in the United States exists for TT costs, with procedures done in the Northeast being the cheapest and West being the most expensive. Regional variation is also seen in postoperative outcomes, in which the Northeast was associated with the highest rate of non-home discharge and the Midwest had statistically significantly increased odds for prolonged LOS. Furthermore, smaller hospitals were associated with increased costs and odds for non-home discharge. Our results are highly relevant to resource utilization considerations for otolaryngology procedures, providing evidence that geographic and hospital variation are significant factors in play. Additional studies are needed to determine how this variation applies to other otolaryngology procedures and how these findings may translate into improved health care policies and patient outcomes.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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