Surgery 165 (2019) 423–430

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/surg

Endocrine

Presented at the Academic Surgical Congress 2018

Understanding nationwide readmissions after thyroid surgery ☆

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ARTICLE INFO

Article history:
Accepted 4 September 2018
Available online 10 December 2018

ABSTRACT

Background: The 30-day readmission rate is increasingly utilized as a metric of quality that impacts reimbursement. To date, there are no nationally representative data on readmission rates after thyroid surgery. We aimed to determine national readmission rates after inpatient thyroidectomy operations and whether select clinical factors were associated with increased odds of postthyroidectomy readmission.

Methods: Using the 2014 Nationwide Readmissions Database, we identified patients undergoing inpatient thyroid surgery as defined by the International Classification of Diseases, Ninth Revision, procedure codes for thyroid lobectomy, partial thyroidectomy, complete thyroidectomy, and substernal thyroidectomy. Descriptive statistics were used to report readmission rates, most common diagnosis and causes of readmission, and timing of presentation after discharge. Multivariable logistic regression models controlling for potential confounders were used to determine whether select factors were associated with 30-day readmission.

Results: A total of 22,654 patients underwent inpatient thyroid surgery during the study period, 990 of whom (4.4%) were readmitted within 30 days. Among these, the most common diagnoses during readmission were disorders of mineral metabolism and hypocalcemia, accounting for 36.0% and 26.6% of readmissions, respectively. This held true regardless of the apparent indication for thyroid surgery (goiter, cancer, or thyroid function disorder) or timing of readmission after discharge. Calcium-related abnormalities were the top diagnoses at readmissions (22.1%). Most readmissions (54.6%) occurred within 7 days of discharge, with 24.6% within the first 2 days Factors associated with an increased odds of readmission included having Medicare (adjusted odds ratio [AOR] 1.47 and 95% confidence interval [CI] 1.03–2.11) or Medicaid insurance (AOR 1.44 [CI 1.04–1.99]), being discharged to inpatient post acute care (AOR 2.31 [CI 1.48–3.62]) or to home health care (AOR 1.78 [CI 1.21–2.63]), having an Elixhauser comorbidity score ≥ 4 (AOR 2.04 [CI 1.27–3.26]), and a duration of stay ≥2 days after the thyroid surgery (AOR 2.7 [CI 1.9–3.82]). The only complication during index admission associated with increased odds of readmission was hypocalcemia (AOR 1.5 [CI 1.1–2.06]. Indications for thyroid surgery were not associated with increased odds of readmission.

Conclusion: Readmissions after thyroid surgery are relatively low and occur early after surgery. The most common diagnoses identified on readmission were calcium and mineral metabolism disorders, which also were the most common cause of readmission. Socioeconomic factors, comorbidities, and complications during the index admissions were found to be associated with nonelective, postthyroidectomy readmissions. Recognition of these risk factors may guide the development of interventions and protocols to decrease readmissions.

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Introduction

According to the Centers for Medicare and Medicaid Services (CMS), health expenditure from 2012 to 2022 is expected to increase at a faster rate than the Gross Domestic Product (GDP).[1] A nationwide effort is underway to decrease health care costs and improve the quality of care and patient experience. One strat-

☆ Presented at the 2018 Annual Academic Surgical Congress.

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https://doi.org/10.1016/j.surg.2018.09.007
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egy that has been incentivized by the Affordable Care Act is the decrease in 30-day readmissions for certain conditions/patient subgroups.[2]

Thyroidectomy procedures have been increasing in the past decade, reaching almost 100,000 cases per year in 2006 from 71,000 in 1996 and accounting for $1.16 billion and $1.37 billion in national aggregate hospital charges in the outpatient and inpatient setting, respectively.[3] Thyroidectomy has proven to be a procedure associated with low morbidity and mortality; therefore, most patients are discharged within 1 day of the procedure.

Previous studies of readmission after thyroidectomy have reported readmission rates ranging between 0.1% to 11%,[4–10] and identified readmission risk factors related to characteristics of both the patient and facility or providers. These factors include decreased patient functional status,[6] hypocalcemia,[4,7] hypoalbuminemia,[8] renal insufficiency,[6,8] malignancy,[8] duration of stay of less than 1 day[6] or an increased duration of stay,[5] and low-volume surgeons.[9] But earlier studies had limited sample size, reported data from a single institution, and were unable to capture readmissions occurring at a hospital other than where the index operation took place (index hospital), or had patient samples that, although greater in size, are limited in ability to capture precise reasons for readmission.[6]

No nationally representative comprehensive data exist on reasons for readmission after thyroidectomy. Therefore, using the largest all-payer readmissions data set in the United States, we determined national rates of unplanned readmissions, described diagnoses present on readmission, reviewed the causes and timing of readmission, and determined whether select clinical and hospital factors are associated with increased odds of readmissions in patients undergoing all types of inpatient thyroidectomy operations. We hypothesized that specific patient and hospital characteristics such as sex, socioeconomic status, and payer, type of procedure, and indication for thyroid surgery were associated with increased readmissions.

Methods

Approval and permissions

The present study was approved by the Institutional Review Boards of the Thomas Jefferson University and University of Pennsylvania (both in Philadelphia).

Study population

Using the 2014 Nationwide Readmissions Database (NRD), we identified patients undergoing thyroid surgery as defined by the International Classification of Diseases, Ninth Revision (ICD-9), procedure codes for complete thyroidectomy (06.4, referred to as total), thyroid lobectomy (06.3), and partial thyroidectomy (06.4; referred to as less than total), and substernal thyroidectomy (06.5).

Data source

The NRD was developed through a Federal-State-Industry partnership sponsored by the Agency for Healthcare Research and Quality. This data set is constructed using data from all hospitalizations occurring in each of the 27 contributing states. Unweighted, it contains data from approximately 17 million discharges each year. The NRD is designed to be used with sampling weights to create national estimates of readmissions in the United States.

The NRD includes data on individuals of all ages, all payers, and the uninsured. More than 100 clinical and nonclinical variables for each hospital stay are available for study, including demographics (ie, age, sex, quartile of median household income, and urban/rural location of the patient's residence), payer (eg, Medicare, Medicaid, private, uninsured), International Classification of Diseases, Clinical Modification 9th Edition diagnosis and procedure codes, timing between admissions for patients, duration of stay of the index operation, identification of transfers, same-day stays, identification of patients who reside within the state, and hospital characteristics (size, teaching status, ownership status, urban-rural designation).[11]

Demographic, clinical, and hospital-related characteristics

We assessed demographic, clinical, and hospital-associated variables, including age (< 45, 45–65, > 65 years), sex, payer (private, Medicare, Medicaid, self-pay, no charge, other), quartile of income based on zip code ($1–$37,999, $38,000–$47,999, $48,000–$63,999, $64,000+), disposition after index hospital stay (home/routine, home with home health care, inpatient postacute care, other), Elixhauser comorbidity score (single numeric value that describes the comorbidity burden of a patient that is useful for multivariate analysis),[12] duration of stay of index thyroid operation, obesity (body mass index [BMI] > 30 kg/m^2), complications during index admission (wound infection, hematoma, hypocalcemia, respiratory, vocal cord paralysis, cardiac, gastrointestinal, urinary, other [Appendix 1]), indication for procedure given by primary ICD-9 diagnosis code during index admission (240 "simple goiter" [referred as goiter], 193 "malignant neoplasm of thyroid gland" [referred as thyroid cancer], 242 "thyrotoxicosis with or without goiter," and 245.2 "chronic lymphocytic thyroiditis" [referred as thyroid function disease], 241 "nontoxic nodular goiter" [referred as nontoxic nodular thyroid disease]), and hospital ownership, size, and teaching status (metropolitan nonteaching, metropolitan teaching, nonmetropolitan).

Outcome measures

The primary outcome was 30-day readmission. The readmission rate was determined by assessing the proportion of patients who were readmitted to any hospital within 30 days after discharge. Secondary outcomes included the various diagnoses identified on readmission, which were assessed using any of admitting ICD-9 diagnoses codes at the time of readmission and were stratified according to type of procedure (total thyroidectomy, less than total thyroidectomy, substernal thyroidectomy), indication for procedure (goiter, thyroid cancer, thyroid function disease, and nontoxic nodular thyroid disease), and timing of readmission relative to procedure date (postoperative day [POD] 1, POD 2, POD 3–7, > POD 7). In addition, to elucidate the causes of readmission, we performed a subanalysis just including the primary ICD-9 diagnosis codes as the cause of readmissions for all type of thyroidectomies.

Statistical analysis

Descriptive statistics were used to report demographic, clinical, and hospital-related characteristics, readmission rates, most common causes for readmission, and timing of presentation after discharge. Multivariable logistic regression models, controlling for potential confounders (identified a priori) were used to determine factors associated with increased 30-day readmission. NRD survey weights were used to generate national estimates.

Results

Patient and clinical characteristics associated with readmission

A total of 22,654 patients underwent thyroid surgery during the study period, 990 of whom (4.37%) were readmitted within 30 days. Patients who were readmitted were more likely to be somewhat younger (median [IQR], readmitted 53.1 years [1.35–4.58])

versus not readmitted 57.5 [27.4–70.7]), to have Medicare (38.7% vs 27.1%) or Medicaid insurance (20.7% vs 16.3%), have 4 or more comorbidities (39.7% vs 18.3%), to be obese (24.2% vs 17.1%), to have greater durations of hospital stay after the index operation (median [IQR], 2.43 days [1.35–4.58] vs 2.05 days [0.72–5.71]), and to have a lesser rate of routine home discharge (78.2% vs 94.4%) ($P < .05$ for all). Analysis of the a priori–identified complications of the thyroid operations revealed that readmitted persons were more likely to have hypocalcemia (19.6% vs 9.9%), vocal cord paralysis (5.4% vs 2.8%), wound infection (1.5% vs 0.2%), or other complications (4% vs 1.6%; all $P < .05$). Indications for thyroid surgery differed in patients who were readmitted, with a somewhat greater proportion of a diagnosis of Graves' (12.2% vs 8.5%) and lesser proportion of goiter (36.2% vs 44%, all $P < 05$). There was no difference in the distribution of sex, income quartile, type of thyroid surgery, hospital size, and hospital ownership (Table 1) by readmission status.

Diagnoses on readmission, causes of readmission, and timing of readmission after thyroidectomy

The most common diagnoses identified at the time of readmission after any type of thyroidectomy were disorders of mineral metabolism (DMM), which includes disorders of calcium, iron, copper, magnesium, and phosphorus metabolism, as well as hungry bone syndrome (36%), hypocalcemia (26.6%), and thyroid cancer (24.6%; which can represent a planned readmission for further treatment of thyroid cancer, or in patients with a known diagnosis of thyroid cancer not coded as a "present on admission" diagnosis). Obesity was also present among the top diagnoses on readmission at 17.1%, compared with its prevalence of 24.2% among thyroid surgery readmissions and 17.1% among those not readmitted. A similar trend was observed when the cohorts of thyroidectomies were categorized according to type of procedure. For total thyroidectomy, the most common diagnoses identified on readmission were DMM (42.1%), hypocalcemia (31.6%), thyroid cancer (26.6%), and obesity (15%). For less than total thyroidectomy, the diagnoses identified on readmission were DMM (27.2%), hypocalcemia (18.7%), obesity (21.6%), and thyroid cancer (20%). For substernal thyroidectomy, the top diagnoses identified were thyroid cancer (22.3%), obesity (20%), and DMM (13.4% [Table 2]).

As presented in Table 3, when the cohort was stratified by the indication for thyroid surgery, DMM, hypocalcemia, obesity, and thyroid cancer remained among the top diagnoses identified on readmission. Specifically, for goiter, the complications of DMM, hypocalcemia, and obesity were at the time identified as 40.0%, 28.3%, and 23.6% of readmissions, respectively. For thyroid cancer, the top diagnoses identified on readmissions were thyroid cancer, DMM, and hypocalcemia, accounting for 49.5%, 34.1%, and 24.5%, respectively. For thyroid function disorders, the top diagnosis included DMM, hypocalcemia, and thyroid cancer with 42.8%, 35.1% and 11.6%, respectively.

Table 4 presents the *causes* of readmission for all thyroidectomies, based on primary diagnosis. Calcium disorders (such as hypocalcemia, hypercalcemia, hypoparathyroidism, hungry bone syndrome) were the most common cause, accounting for 22.1% of readmissions, followed by infections (sepsis, site infection, cellulitis, abscess), respiratory complications (pneumonia, bronchitis, aspiration pneumonitis, acute or chronic respiratory failure), wound complications (seroma, hematoma), cardiovascular complications (atrial fibrillation, cerebral artery occlusion, cerebral ischemia, vascular complications, hypotension, syncope, pulmonary embolism and infarction), and thyroid cancer.

As presented in Table 5 and Fig 1, most readmissions (54.6%) occurred within 7 days of operation, with 24.6% occurring within the first 2 days. Again, a very similar trend was observed in terms of the most common diagnoses on readmissions relative to postoperative day.

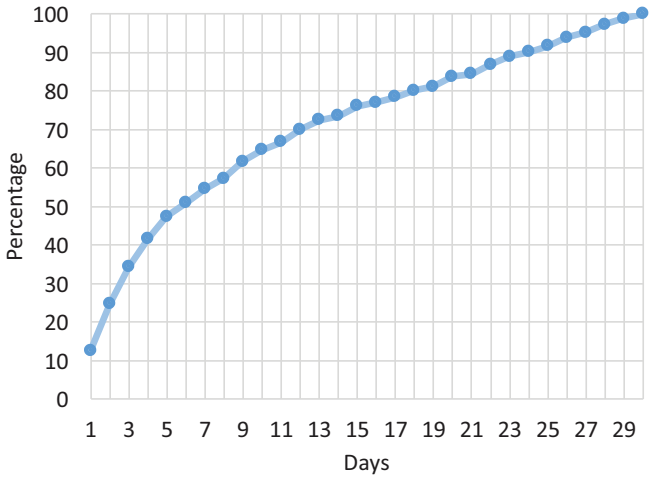

Fig 1. Cumulative percentage of readmission after inpatient thyroidectomy by day after operation.

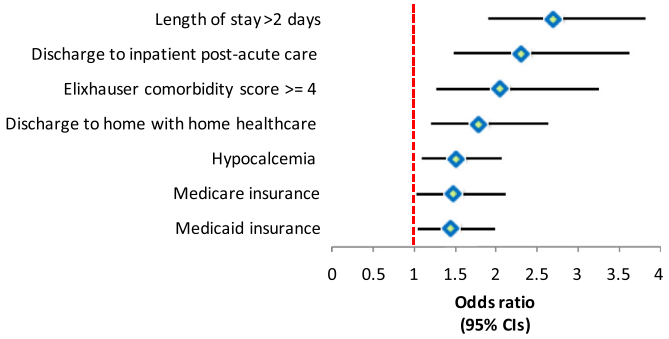

Fig 2. Forest plot showing factors associated with increased odds of readmission after inpatient thyroidectomy.

Readmission by indication for thyroidectomy

Examination of readmission rates by specific type of procedure found that 4.3% of total thyroidectomy, 4.2% of less than total thyroidectomy, and 5.4% of substernal thyroidectomy cases were readmitted within 30 days (Table 2). Readmission rates, according to indication for thyroid surgery, were 3.6% for goiter, 4.6% for thyroid cancer, 5.3% for thyroid function disorder, and 3.5% for nontoxic, nodular thyroid disease (Table 3). There was no association between type of procedure or indication for thyroid surgery and readmission after thyroid surgery (Table 6).

Multivariate analysis revealed that Medicare insurance (AOR:1.47, 1.03–2.11), Medicaid insurance (AOR 1.44, 1.04–1.99), discharge to inpatient postacute care (AOR 2.31, 1.48–3.62) or home with home healthcare (AOR 1.78, 1.21-2.63), Elixhauser comorbidity score $\geq$ 4 (AOR 2.04, 1.27–3.26), length of stay $\geq$2 days (AOR 2.70, 1.90–3.82) were independently associated with increased odds of readmission. Subanalysis on specific index admission complications showed that hypocalcemia was associated with increased odds of readmission (AOR 1.50, 1.10–2.06) Fig 2. There was no association of readmission with procedure type or surgery indication (Table 6).

Table 1
Demographic, clinical case mix, and hospital level (weighted percentages) of patients undergoing inpatient thyroid surgery, by readmission status.

Characteristic	Nonreadmitted ($n = 21,664$)	Readmitted ($n = 990$)	P[a]
Age (years), median (IQR)			.03
< 45	6,700 (30.9)	260 (26.3)	
45–65	9,545 (44.1)	412 (41.6)	
> 65	5,415 (25)	317 (32)	
Sex			.12
Male	4,950 (22.9)	264 (26.6)	
Female	16,711 (77.1)	726 (73.4)	
Primary payer			< .01
Medicare	5,850 (27.1)	382 (38.7)	
Medicaid	3,515 (16.3)	204 (20.7)	
Private insurance	10,776 (49.8)	342 (34.6)	
Self-pay/no-charge/other	1,479 (6.8)	58 (5.9)	
Zip-code quartile			.22
$1–$37,999	5371 (25.2)	294 (30.1)	
$38,000–$47,999	5544 (26)	252 (25.7)	
$48,000– $63,999	4944 (23.2)	200 (20.5)	
$64,000+	5478 (25.7)	232 (23.7)	
Index stay disposition			< .01
Home/routine	20,457 (94.4)	774 (78.2)	
Inpatient postacute care	430 (2)	[b]	
Home with HHC	730 (3.4)	[b]	
Other	44 (0.2)	[c]	
Elixhauser comorbidity score			< .01
0 conditions	3,225 (14.9)	82 (8.3)	
1 condition	5,654 (26.1)	121 (12.2)	
2 conditions	5,350 (24.7)	217 (21.9)	
3 conditions	3,477 (16.1)	178 (18)	
4+ conditions	3,955 (18.3)	393 (39.7)	
Obese	3,703 (17.1)	240 (24.2)	< .01
Duration of index stay			< .01
1 day	13,449 (62.1)	337 (34.1)	
2 days	3,758 (17.3)	153 (15.4)	
> 2 days	44,53 (20.6)	500 (50.5)	
Complications			
Wound infection	40 (0.2)	15 (1.5)	.03
Hematoma	537 (2.5)	47 (4.7)	.05
Hypocalcemia	2,134 (9.9)	194 (19.6)	< .01
Respiratory complications	112 (0.5)	[c]	.93
Vocal paralysis	606 (2.8)	53 (5.4)	.02
Cardiac complications	174 (0.8)	14 (1.4)	.22
Gastrointestinal complications	43 (0.2)	[c]	.52
Urinary complications	19 (0.1)	[c]	.66
Other complications	351 (1.6)	40 (4)	0.01
Diagnosis			
Goiter	9,541 (44)	358 (36.2)	< .01
Substernal goiter	262 (1.2)	17 (1.7)	.48
Graves'	1,845 (8.5)	121 (12.2)	.02
Toxic nodular	746 (3.4)	48 (4.9)	.21
Hashimoto	1,490 (6.9)	56 (5.7)	.29
Cancer	9,607 (44.4)	461 (46.6)	.4
Procedure type			.66
Less than total	5,764 (26.6)	255 (25.7)	
Total	14,500 (66.9)	656 (66.2)	
Substernal	1,396 (6.4)	79 (8)	
Ownership			.63
Government, nonfederal	2,877 (13.3)	139 (14)	
Private, not-for-profit	16,069 (74.2)	711 (71.8)	
Private, invest-own	2,714 (12.5)	141 (14.2)	
Hospital size			.59
Small	2,833 (13.1)	118 (12)	
Medium	5,015 (23.2)	252 (25.4)	
Large	13,812 (63.8)	620 (62.6)	
Teaching status			< .01
Metropolitan nonteaching	3,793 (17.5)	181 (18.3)	
Metropolitan teaching	17,186 (79.3)	796 (80.4)	
Nonmetropolitan	682 (3.1)	13 (1.3)	

[a] P values derived from χ^2 tests.
[b] Suppressed data to ensure that cells with counts less than 10 cannot be imputed through back calculations.
[c] Cells with counts equal or lesser to 10 are not shown as per the NRD Data User Agreement.

Table 2
Top diagnoses identified on readmissions after inpatient thyroid surgery by procedure type.

All procedures ($n = 990$, 4.37% readmission rate)			Total thyroidectomy ($n = 656$, 4.33% readmission rate)			Less than total thyroidectomy ($n = 255$, 4.23% readmission rate)			Substernal thyroidectomy ($n = 79$, 5.38% readmission rate)		
Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission
DMM	356	35.96%	DMM	276	42.11%	DMM	69	27.18%	Thyroid cancer	18	22.32%
Hypocalcemia	263	26.55%	Hypocalcemia	207	31.63%	Hypocalcemia	48	18.68%	Obesity[d]	16	19.98%
Thyroid cancer	243	24.55%	Thyroid cancer	174	26.58%	Obesity[c]	55	21.64%	DMM	11	13.39%
Obesity[a]	170	17.12%	Obesity[b]	98	15.02%	Thyroid cancer	51	20.04%			
Hemorrhage or hematoma	78	7.86%	Hemorrhage or hematoma	62	9.53%	Wound infection	20	7.91%			
Vocal cord paralysis	46	4.69%	Wound infection	22	3.43%	Hemorrhage or hematoma	15	6.02%			
Wound infection	46	4.58%	Vocal cord paralysis	31	4.69%	Vocal cord paralysis	12	4.60%			

Obesity prevalence during index admission:
[a] overall: 17.89% (n = 4,052), readmitted: 24.2% (n = 240)
[b] complete: 16.99% (n = 2,575)
[c] less than total: 18.14% (n = 1,092)
[d] substernal: 26.08% (n = 385) represent the prevalence preoperatively of obesity in these cohorts. *DMM*, disorders of mineral metabolism.

Table 3
Top diagnoses identified on readmissions after inpatient thyroid surgery by indication for surgery.

Goiter ($n = 358$, 3.62% readmission rate)			Thyroid cancer ($n = 461$, 4.58% readmission rate)			Thyroid function disorder ($n = 220$, 5.30% readmission rate)			Non-toxic nodular thyroid disease ($n = 334$, 3.50% readmission rate)		
Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission
DMM	143	39.87%	Thyroid cancer	229	49.65%	DMM	94	42.75%	DMM	129	38.55%
Hypocalcemia	101	28.27%	DMM	157	34.11%	Hypocalcemia	77	35.14%	Hypocalcemia	98	29.36%
Obesity[a]	84	23.55%	Hypocalcemia	113	24.52%	Thyroid cancer	26	11.60%	Obesity[d]	69	20.81%
Hemorrhage or hematoma	24	6.60%	Obesity[b]	62	13.46%	Obesity[c]	25	11.30%	Hemorrhage or hematoma	22	6.62%
Thyroid cancer	22	6.01%	Hemorrhage or hematoma	39	8.49%	Hemorrhage or hematoma	20	9.03%	Thyroid cancer	22	6.51%
Wound infection	21	5.85%	Vocal cord Paralysis	31	6.67%				Wound infection	13	3.78%
			Wound infection	22	4.66%						

Obesity prevalence during index admission:
[a] goiter: 20.81% (n = 2,061)
[b] Cancer: 14.63% (n = 1,474)
[c] thyroid functional disorder: 16.73% (n = 695)
[d] Non toxic: 21.47% (n = 2,048) represent the prevalence preoperatively of obesity in these cohorts. *DMM*, disorders of mineral metabolism.

Table 4
Primary diagnoses on readmissions after inpatient thyroidectomies.

Cause of readmission	Percentage of all readmissions ($n = 990$)
Hypocalcemia	22.10%
Infectious complications	7.80%
Respiratory complications	7.30%
Wound complications	5.90%
Cardiovascular complications	5.80%
Thyroid cancer	3.40%

Discussion

In this study, we present national data on readmissions after thyroid surgery among hospitalized persons. Our primary findings are that 4.3% of patients discharged after undergoing thyroid surgery are readmitted within 30 days. More than half of readmissions occurred within 1 week of discharge, and one-quarter of readmissions occurred within 2 days of the operation. Patients with Medicaid or Medicare insurance, clinically relevant comorbidities, a prolonged duration of postoperative hospital stay, postacute care, and whose index admission were complicated by hypocalcemia were more likely to be readmitted after any type of thyroidectomy. These results are consistent with those from earlier studies assessing risk factors associated with increased readmissions and demonstrate that indeed, readmissions are relevant on the national level.[6,8] Of note, the type of thyroidectomy and the indications for thyroid surgery did not seem to predict readmission.

Readmission rates

Earlier studies on readmissions after thyroid surgery have demonstrated varied results. Our findings are congruent with data from the American College of Surgeons National Surgical Quality

Table 5
Top diagnoses identified on readmissions after inpatient thyroid surgery, by time of readmission relative to procedure date.

POD 1 ($n = 125$, 12.6% of all readmissions)			POD 2 ($n = 119$, 12.01% of all readmissions)			POD 3-7 ($n = 296$, 29.94% of all readmissions)			> POD 7 ($n = 450$, 45.45% of all readmissions)		
Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission	Diagnosis	Count	Percent of readmission
DMM	50	40.70%	DMM	83	70.05%	DMM	124	41.67%	Thyroid cancer	117	26.03%
Hypocalcemia	42	33.67%	Hypocalcemia	69	58.22%	Hypocalcemia	91	30.85%	DMM	98	21.88%
Thyroid cancer	31	25.21%	Obesity[a]	21	17.89%	Thyroid cancer	73	24.79%	Obesity[a]	90	20.01%
Hemorrhage or hematoma	11	8.77%	Thyroid cancer	21	17.69%	Obesity[a]	52	17.42%	Hypocalcemia	60	13.38%
			Hemorrhage or hematoma	17	14.47%	Hemorrhage or hematoma	27	9.33%	Wound infection	26	5.81%
						Wound infection	15	4.91%	Hemorrhage or hematoma	22	4.89%
									Vocal cord paralysis	21	4.78%

[a] 17.89% (n = 4,052) represents the preoperatively prevalence of obesity in the entire population during index admission. *POD*, postoperative day; *DMM*, disorders of mineral metabolism.

Improvement Program (NSQIP). For instance, Mullen et al.[6] found a 4.1% 30-day readmission rate after thyroid surgery, using NSQIP. Although this was one of the largest cohorts published to date (3,711 patients), the sampling strategy of NSQIP is not designed to be nationally representative because it is a convenience sample, unlike the data used for this study. Nevertheless, their findings were similar to ours in terms of rates of readmission, reinforcing the fact that readmission should be an actionable item after thyroid surgery. Recognition of these risk factors may guide the development of interventions to decrease readmissions and inform policy discussions regarding readmissions.

Another study found that the readmission rates were 2.8% for total thyroidectomy and 2.1% for thyroid lobectomy; whereas for substernal thyroidectomy, the rate was somewhat greater (3.8%), a trend also seen in our cohort, related perhaps to the greater complexity and propensity for complications associated with substernal thyroidectomies.[13] Increased risk of complications and mortality has been described previously for substernal thyroidectomy, using a national data set.[13] Readmission rates for elderly patients undergoing thyroidectomy for thyroid cancer have been reported at a greater rate (8%) than the current results,[5] but our nationally representative analysis found that age was not associated with increased odds of readmission.

Lesser readmission rates have been reported previously in smaller and single academic center studies. For instance, Hessman et al.[7] found a 2.6% readmission rate among all types of thyroidectomies. In the United Kingdom, Perera et al.[14] found a 2.4% readmission rate in total or completion thyroidectomy cases with less than a 24-hour hospital stay. Trottier et al.[15] found a 1.7% readmission rate, using data from tertiary care centers. One study in Italy had a surprisingly low readmission rate (0.2%) in a cohort of 1,571 patients undergoing thyroid surgery, possibly attributable to the selection of patients undergoing day surgery (< 24-hour hospital stay) and different patient characteristics.[4] Although these lesser rates of readmission in selected institutional cohorts demonstrate that there may be potential for improvement, our nationally representative results that are in accordance with earlier, large-scale studies demonstrate that readmission after thyroidectomy is considerable. Our findings—that readmissions occurred commonly by postoperative day 2, and the majority of readmissions occurred within the first week after discharge—are consistent with a study that showed that the median time of emergency department presentation after thyroid and parathyroid surgery is postoperative day 5.[16]

Clinical factors associated with readmission

DMM and hypocalcemia diagnoses together were identified in almost two-thirds (62.5%) of readmissions after thyroid surgery and more than one-fifth (22.1%) were attributed directly to calcium-related abnormalities. The third most common diagnosis during readmissions was thyroid cancer, which can represent a planned readmission for further treatment of thyroid cancer, or patients with a known diagnosis of thyroid cancer not coded as a "present on admission" diagnosis. These three diagnoses likely directly reflect readmissions for treatment of thyroid-related disorders. In contrast, obesity was not a direct cause for readmission, but it was among the most common diagnoses identified at the time of readmission. This finding could be attributable to the fact that obesity may be a comorbid condition associated with increased risk of readmission, by impacting surgical outcomes, such as a wound infection[17] or a condition not coded as "present on admission" diagnosis.

Clinical implications of hypocalcemia and readmission

As stated, disorders of mineral metabolism and hypocalcemia were the two most common diagnoses on readmissions after thyroid surgery. In fact, it is likely that most of the cases coded as DMM (ICD-9 diagnosis code 275) in our cohort were actually hypocalcemia because hypocalcemia is one of the mineral metabolism disorders included in the broader diagnosis of DMM (ICD-9 diagnosis code 275.4). Therefore, calcium abnormalities potentially were identified in more than half of readmissions after thyroidectomy. Subanalysis of primary ICD-9 diagnosis codes revealed that calcium-related disorders accounted directly for more than one-fifth of readmissions. This finding is consistent with some earlier reported results.[5,8,18] In our analyses, hypocalcemia during the index admission was an independent predictor of 30-day readmission, which is also concordant with earlier data.[8]

Not surprisingly, we found that both DMM and hypocalcemia were among the most common diagnoses identified on readmission among patients undergoing partial thyroidectomy. The NRD does not contain data on earlier/remote surgical history; therefore, we could not determine whether a partial thyroidectomy was in fact a completion thyroidectomy or if an earlier parathyroid operation had been performed, which would place the patient at an even greater risk of postoperative disruption of calcium hemostasis. These findings are a reminder that surgeons must be astute in considering hypocalcemia risks in all types of thyroidectomy oper-

Table 6
Multivariate analysis of factors associated with 30-day readmission after inpatient thyroid surgery.

Characteristic	Adjusted odds* ratio (AOR) (95% CI)
Procedure type	
Less than total	Reference
Total	1.03 (0.79–1.34)
Substernal	0.87 (0.53–1.45)
Diagnosis	
Goiter	0.76 (0.52–1.1)
Substernal goiter	0.95 (0.46–1.96)
Graves'	1.18 (0.77–1.81)
Hashimoto/toxic nodular	1.25 (0.69–2.27)
Thyroid cancer	0.89 (0.56–1.42)
Age (years)	
< 45	Reference
45–65	0.99 (0.68–1.42)
> 65	0.79 (0.5–1.26)
Sex	
Male	Reference
Female	1.03 (0.81–1.32)
Primary payer	
Medicare†	1.47 (1.03–2.11)
Medicaid†	1.44 (1.04–1.99)
Private insurance	Reference
Self-pay/no-charge/other	1.03 (0.68–1.58)
Zip-code quartile	
$1–$37,999	1.06 (0.69–1.63)
$38,000–$47,999	0.98 (0.66–1.43)
$48,000–$63,999	0.86 (0.58–1.29)
$64,000+	Reference
Index stay disposition	
Home/routine	Refnce
Inpatient postacute care†	2.31 (1.48–3.62)
Home with HHC†	1.78 (1.21–2.63)
Other†	1.22 (0.26–5.72)
Elixhauser comorbidity score	
0 conditions	Reference
1 condition	0.82 (0.54–1.23)
2 conditions	1.31 (0.84–2.05)
3 conditions	1.53 (0.99–2.39)
4+ conditions†	2.04 (1.27-3.26)
Duration of index hospital stay	
1 day	Reference
2 days	1.36 (0.96–1.92)
> 2 days†	2.70 (1.9–3.82)
Teaching status	
Metropolitan nonteaching	1.13 (0.88–1.45)
Metropolitan teaching	Reference
Nonmetropolitan†	0.37 (0.14–0.96)

* Models controlled for age, sex, payer, index admission disposition, Elixhauser comorbidity score, duration of stay, teaching status, type of procedure, and indication for surgery.
† Significant at $P < .05$.

ations. The knowledge gained from these results can help in designing efforts toward decreasing readmissions. These efforts may include more directed attention to calcium levels before discharge and during the first week after discharge, as well as educating patients on symptoms of hypocalcemia before discharge so they can potentially be identified and treated as outpatients without needing inpatient readmission. Efforts to manage illnesses related to comorbid diseases may also result in a decrease in the rate of readmissions. We appreciate that postoperative calcium management is surgeon specific. Therefore, we propose that intentional follow-up regarding calcium status be performed in the first week postoperatively. A phone call or telehealth follow-up in the early postoperative period may detect early symptoms of hypocalcemia. Outpatient laboratory calcium levels may be utilized as needed to detect issues before the need for an emergency room visit. These efforts should be directed especially for those patients who had a prolonged duration of hospitalization after the thyroid operation, and those with multiple comorbidities, public or no insurance, discharge to other than home, or who had hypocalcemia during the index admission.

Limitations

The limitations of the present study are inherent to the use of an administrative data set. Data collected for the purposes of documenting processes of care rather than for research may not contain other relevant and desired additional data, such as detailed clinical assessments, functional status, social and family history, laboratory findings, and patient-reported outcomes. All retrospective data are subject to recall, misclassification, and selection bias. Administrative data are additionally subject to coding bias. The NRD captures inpatient procedures that excludes outpatient thyroidectomies, which account for a large proportion of thyroidectomies in the United States.[3] The individuals in our final sample, therefore, may have different baseline health status, patient, or clinical factors that drive the receipt of inpatient as opposed to outpatient hospital care. Therefore, our study would not reflect the patient, clinical factors and other characteristics, and outcomes that would be observed in an exclusively outpatient thyroid surgery cohort. Nevertheless, we maintain that our data are representative of real-world outcomes among thyroidectomy patients. Despite pressure for same-day discharge and cost reductions, most thyroidectomies are currently still performed as inpatient procedures.[3] Finally, not all readmissions are avoidable or worthy of fault. Some may be attributable to patient socioeconomic circumstances, such as being unable to afford medications that have been prescribed, for which these data did not allow us to account. Nonetheless, this study provides a national perspective to direct further research.

In conclusion, despite the large number of thyroidectomies performed in the United States, nationwide readmission rates are relatively low and occur early after surgery. Calcium-related abnormalities are prevalent and the most common cause of readmission. Recognition of timing and populations at risk for readmission after thyroidectomy may guide clinical decisions and the development of protocols aimed at decreasing unplanned readmissions.

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