The American Journal of Surgery 220 (2020) 813–820

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Featured Article

Post-thyroidectomy emergency room visits and readmissions: Assessment from the Collaborative Endocrine Surgery Quality Improvement Program (CESQIP)

Aida Taye [a, *], William B. Inabnet III [b], Stephanie Pan [c], Sally E. Carty [d], Travis Cotton [e], Peter Czako [f], Gerard Doherty [g], Paul Gauger [h], John Hanks [i], David McAneny [j], Mira Milas [k], Nancy Perrier [l], Jennifer Rosen [m], David F. Schneider [n], Jyotirmay Sharma [o], Allan Siperstein [p], Julie Ann Sosa [q]

[a] Department of Surgery, Icahn School of Medicine at Mount Sinai, New York, NY, USA
[b] Department of Surgery, University of Kentucky, Lexington, KY, USA
[c] Department of Population Health Science and Policy, Icahn School of Medicine at Mount Sinai, New York, NY, USA
[d] Department of Surgery, University of Pittsburgh School of Medicine at University of Pittsburgh Medical Center, Pittsburgh, PA, USA
[e] Department of Surgery, Brown University Warren Alpert School of Medicine at University Surgical Associates, Providence, RI, USA
[f] Department of Surgery, Oakland University William Beaumont School of Medicine at Royal Oak Surgical Associates, Royal Oak, MI, USA
[g] Department of Surgery, Harvard Medical School at Brigham and Women's Hospital, Boston, MA, USA
[h] Department of Surgery, Michigan Medicine, Ann Arbor, MI, USA
[i] Department of Surgery, University of Virginia School of Medicine at University of Virginia Health Systems, Charlottesville, VA, USA
[j] Department of Surgery, Boston University School of Medicine at Boston Medical Center, Boston, MA, USA
[k] Department of Surgery, University of Arizona College of Medicine at Banner-University Medical Center, Phoenix, AZ, USA
[l] Department of Surgical Oncology, University of Texas MD Anderson Cancer Center, Houston, TX, USA
[m] Department of Surgery, MedStar Washington Hospital Center, Washington, DC, USA
[n] Department of Surgery, University of Wisconsin School of Medicine, Madison, WI, USA
[o] Department of Surgery, Emory University School of Medicine at Emory University Hospital, Atlanta, USA
[p] Department of Surgery, Cleveland Clinic, Cleveland, OH, USA
[q] Department of Surgery, University of California San Francisco-UCSF, San Francisco, CA, USA

ARTICLE INFO

Article history:
Received 23 September 2019
Received in revised form
7 February 2020
Accepted 17 February 2020

A portion of these data were presented at the American College of Surgeons' 2017 Clinical Congress on October 25, 2017

Keywords:
Thyroidectomy
Emergency room visits
Readmissions
Outcomes
Quality

ABSTRACT

Background: This study analyzed independent factors associated with post-thyroidectomy Emergency Room (ER) visits and Hospital Readmissions (HR).
Methods: This is a retrospective review from the CESQIP registry of 8381 thyroidectomy patients by 173 surgeons at 46 institutions. A total of 7142 ER visits and 7265 HR were analyzed. Multivariable logistic regression analysis was performed to determine the risk factors for an ER visit or HR.
Results: Within 30-days of surgery, rates of all ER visits were 3.4% (n = 250) and all HR were 2.3% (n = 170). Hypocalcemia was the reason for 21.9% of ER encounters and 36.4% of HR. BMI >40 kg/m^2 was a risk factor for both ER visit (OR1.86) and HR (OR1.94). Surgical duration >3 h (OR2.63), and transection of recurrent laryngeal nerve (OR4.58) were risk factors for HR.
Conclusions: Strategies to decrease hypocalcemia and improve perioperative care of patients with BMI >40 kg/m^2 may improve post-thyroidectomy outcome.

* Corresponding author. Icahn School of Medicine at Mount Sinai, Department of Surgical Oncology, Mount Sinai West & St. Luke's Hospital, 425 West 59th Street, 7th Floor, New York, NY, 10019, USA.
E-mail addresses: aida.taye@mountsinai.edu (A. Taye), william.inabnet@uky.edu (W.B. Inabnet), stephanie.pan@mountsinai.org (S. Pan), cartyse@upmc.edu (S.E. Carty), tcotton@usasurg.org (T. Cotton), pczako@beaumont.edu (P. Czako), gmdoherty@partners.org (G. Doherty), pgauger@med.umich.edu (P. Gauger), JBH@hscmail.mcc.virginia.edu (J. Hanks), david.mcaneny@bmc.org (D. McAneny), Mira.Milas@bannerhealth.com (M. Milas), nperrier@mdanderson.org (N. Perrier), jennifer.e.rosen@medstar.net (J. Rosen), schneiderd@surgery.wisc.edu (D.F. Schneider), jsharm3@emory.edu (J. Sharma), sipersa@ccf.org (A. Siperstein), julie.sosa@ucsf.edu (J.A. Sosa).

https://doi.org/10.1016/j.amjsurg.2020.02.036
0002-9610/

Background

Thyroidectomy is one of the most commonly performed operations in general surgery. The number of thyroidectomies performed in the U.S. has increased significantly during the last two decades due to a rise in the detection of thyroid nodules.[1] Thyroid surgery is generally safe, including in the ambulatory setting.[2–5] In the current era of value-based care, it is essential to measure thyroidectomy outcomes, especially those associated with resource-intensive postoperative emergency room (ER) visit and hospital readmissions (HR). Hospitals with high surgical volume and low surgical mortality have reported the lowest postoperative 30-day HR.[6] In addition, ER visit and HR have become cornerstones of quality metrics and are outcomes that, in the future, may be tied to physician compensation.[7]

Complications unique to thyroidectomy include hypocalcemia, neck hematoma, and compromise in vocal fold function.[2] Analyses of thyroidectomy outcomes have been limited by a relative paucity of generalizable data, as the majority of studies have come from single surgeons or single institutions.[2,8] More recently, there have been larger scale studies using data from the American College of Surgeons National Surgical Quality Improvement Program (ACS - NSQIP), Kaiser Permanente California, Surveillance, Epidemiology, and End Results (SEER) - Medicare database, and the Agency for Healthcare Research and Quality (AHRQ) Health Care Utilization Project-National Inpatient Sample,[9–13] although better powered, large database studies mostly address complications and risk factors common to all operations and are not specific to thyroid surgery.[3,9,10,14] ACS-NSQIP has responded to some of this criticism by creating a thyroidectomy-specific-module in 2013.[15] Using this new module, Liu et al., in 2017 noted that hypocalcemia and recurrent laryngeal nerve injury could be used for national hospital quality improvement by showing significant variation in these metrics among participating hospitals.[15]

The Collaborative Endocrine Surgery Quality Improvement Program (CESQIP) was launched in 2013 to address the need for an organ-specific database for endocrine surgery, including thyroidectomy, parathyroidectomy, adrenalectomy, and pancreatectomy or bowel resection for neuroendocrine tumors. Analysis of data from CESQIP's standardized data endpoints is intended to potentially inform quality benchmarks of performance in endocrine surgery.[16] Our aim was specifically to examine the rates of ER visit and HR within 30-days of thyroid surgery and identify factors associated with these adverse outcomes using the thyroidectomy-specific CESQIP registry.

Methods

CESQIP accepts surgeons from hospitals and practices that enroll in its data use agreement. Participating sites use a secure web-based interface to enter perioperative data for one of six endocrine operation modules in a binary (yes/no) fashion or code their responses based on options provided via drop down menu, supplemented by limited free text information. The thyroidectomy module includes a total of 36 data points.

To access CESQIP's de-identified data, we obtained an approval by CESQIP and an expedited institutional review board (IRB) approval from the Icahn School of Medicine at Mount Sinai. We then performed a retrospective review of prospectively collected data from the CESQIP 'Thyroid Module'. We included all adult patients undergoing all types of thyroidectomies by 173 surgeons at 46 institutions in the U.S. and one site in Mexico from September 2013 to September 2016. We excluded all patients who had combined parathyroidectomy cases, observations without entry for 30-day outcomes, missing reasons for ER visit or HR, and complications entered without designation of the encounter as an ER visit or HR. Our goal was to find out the risk factors specifically for ER visit only (without subsequent hospital admissions) and also to identify risk factors leading to hospital readmission. In order to achieve this, we performed our analysis of these two groups separately and removed the patients that had entries for both events. Neck dissection-only procedures were also excluded. Data were collected on 8361 patients and after appropriate exclusions, 7142 patients in the ER visit only cohort and 7265 patients in the HR cohort were analyzed (Fig. 1). However, for calculations of rate of ER visits and rate of HR, any ER encounter and any HR were considered. Data were collected from the five domains of the Thyroid Module in CESQIP, including patient demographics, clinical characteristics, operative details, surgical pathology, and 30-day outcomes. Within the 30-day outcomes domain, CESQIP participants first select an encounter as either an ER visit or HR, followed by selection of a reason for each entry from a list of potential complications or entry of a free text diagnosis. These data were organized into the following categories: hypocalcemia, hematoma, respiratory distress (including shortness of breath, pneumonia, cough), wound swelling/seroma, or wound infection. Other complications, such as tracheal injury, cardiac complications, chyle leak, and vocal cord paralysis were reported collectively. All minor complaints or complaints unrelated to thyroidectomy, such as allergy, constipation, gout, and pregnancy related hyperemesis, were reported in aggregate.

The two primary endpoints for this study were the occurrence rates for an ER visit or HR $\leq$ 30 days from the date of thyroidectomy, and information was collected regarding the specific reasons for each patient re-presentation. The secondary endpoint was to identify risk factors associated with post-thyroidectomy ER visit and HR. Independent variables collected from the patient 'demographics and characteristics' section included age, sex, race, body mass index (BMI) > 40 kg/m^2, prior neck surgery, vocal cord dysfunction on preoperative laryngoscopy, and anti-coagulation use. From the 'disease characteristics' section, the presence/absence of preoperative symptoms of compression, substernal thyroid, and Fine Need Aspiration (FNA) Bethesda category were ascertained. Data collected from the 'operative detail' domain of the Thyroid Module were organized into "total thyroidectomy or near total thyroidectomy" and "less than total thyroidectomy" (lobectomy, nodulectomy, subtotal thyroidectomy, and isthmusectomy). Intraoperative data on surgical duration and known transection of the recurrent laryngeal nerve, both unintentional injury and intentional sacrifice, also were collected. Information regarding whether a thyroid cancer diagnosis was made on final pathology, excluding incidental papillary thyroid microcarcinoma (PTmC), was collected as a yes/no option from the 'pathology' section. From the '30-days outcomes section', patients' length of stay was obtained.

Baseline characteristics of patients were compared with the Student's t-test for continuous variables and the Chi-square test or Fisher's exact test, as appropriate, for categorical variables. Two multivariable logistic regression analyses were performed to determine the risk factors for ER visit or HR $\leq$ 30 days after undergoing thyroidectomy. The variables at the univariate level with a significance of $p \leq 0.15$ made up the model covariates. In modeling those who only had an ER visit, we included patient age, BMI >40 kg/m^2, surgical duration >3 h, operation type, and length of stay as independent risk factors (Table 3). In modeling those who had evidence of a HR visit, we included patient sex, BMI >40 kg/m^2, thyroid cancer

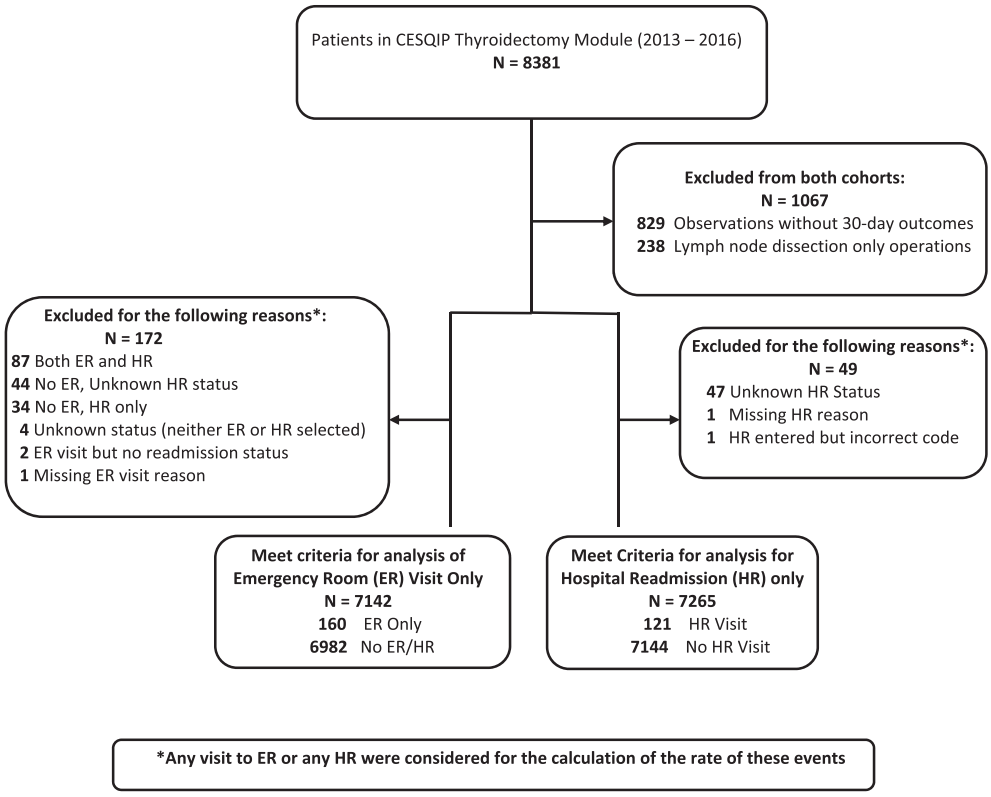


Fig. 1. Consort diagram.

diagnosis, vocal cord dysfunction on preoperative laryngoscopy, FNA classification, surgical duration >3 h, operation type, transection of recurrent laryngeal nerve, and length of stay as independent risk factors (Table 4). The adjusted odds ratios and 95% confidence intervals of the risk factors for ER visit or HR are reported. Statistical analyses for this study were performed using SAS software, version 9.4 (SAS Institute, Inc., Cary, NC). Two-sided p-values <0.05 were considered statistically significant.

Results

The data were analyzed for a total of 8381 consecutive adult patients logged in the CESQIP 'Thyroid Module' (Fig. 1). Of those, we excluded 829 patients without documentation in the 30-day outcomes section and 238 patients who had only lymph node operations. For those in the ER visit cohort, we excluded patients who were simultaneously entered as having an ER visit and also an HR, only HR, unknown readmission status, and visits not associated with a diagnosis (n = 172). In the HR cohort, we excluded 49 patients whose visits were not associated with a diagnosis. A total of 7142 and 7265 patients were the subjects of analysis for the ER visit and HR cohorts, respectively (Fig. 1). Characteristics of excluded patients were not different from the general population (Appendix). Most of the patients in both groups were female (Table 1).

The mean age of patients who experienced an ER visit was 47.2 (SD16.4) years, and for HR was 49.3 (SD17.0) years. About two-thirds of the patients in both groups were described as non-Black. Among those with ER visits or HR visits, the percentages of patients with thyroid cancer were 46.3% and 55.8%, respectively. The percentage of patient who underwent a total thyroidectomy was 76.3% of the ER visit cohort and 83.2% of the HR cohort. Most of the thyroidectomy patients in both the ER group and HR group remained in the hospital for 1 day postoperatively, 66.9% and 52.9%, respectively.

The percentage of patients who had any ER visits after thyroidectomy was 3.4% (n = 250). The top two reasons for ER visits only group (n = 160) were minor complaints or complaints unrelated to thyroidectomy, and hypocalcemia (Table 2). Patients who visited the ER with minor complaints or complaints unrelated to thyroidectomy made up just 1.1% of the entire study cohort, but 50.6% of all ER visits. Patients with hypocalcemia who visited the ER represented 0.5% of the entire study cohort and 21.9% of ER encounters.

The rate of any post-thyroidectomy HR was 2.3% (n = 170). The two main reasons for HR only group (n = 121) were hypocalcemia and minor complaints or complaints unrelated to thyroidectomy. Patients readmitted for hypocalcemia made up 0.6% of the entire study cohort and 36.4% of all HR (Table 2). Minor complaints or complaints unrelated to thyroidectomy accounted for 0.4% of the entire study population, but 23.1% of all HR.

The remaining categories of complications were infrequent. For ER visits, swelling/seroma, wound infection, and respiratory distress (including shortness of breath, pneumonia, cough) made up 0.6% of the complications of the entire cohort. With regard to complications resulting in HR, wound infection and respiratory distress were each 0.2%, and neck hematoma 0.1% of the complications. Rare procedure-related complications such as tracheal injury and chyle leak accounted for 0.04% of complications leading to ER visit and 0.2% of HR (Table 2).

The potential association between patient factors and 30-day ER visit or HR was assessed using multivariable logistic regression (Figs. 2 and 3). In multivariable analysis, post-thyroidectomy ER visits were associated with BMI >40 kg/m^2 (OR 1.86, 95% CI 1.20,

Table 1
Demographics and characteristics of thyroidectomy patients in CESQIP from September 2013 to September 2016.

Variables	ER Cohort			HR Cohort		
	ER Visit Only (n = 160)	No ER/HR Visit (n = 6982)	p-value	HR Visit (n = 121)	No HR Visit (n = 7144)	p-value
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Age, years	47.2 ± 16.4	49.5 ± 15.5	0.06	49.3 ± 17.0	49.4 ± 15.6	0.90
	No. of pts (%)	No. of pts (%)		No. of pts (%)	No. of pts (%)	
Male	27/160 (16.9)	1365/6982 (19.6)	0.40	34/121 (28.1)	1392/7144 (19.5)	0.02
Race			0.46			0.58
Black	20/159 (12.6)	711/6938 (10.2)		14/120 (11.7)	731/7099 (10.3)	
Non-Black	104/159 (65.4)	4946/6938 (70.6)		81/120 (67.5)	5003/7099 (70.5)	
Asian	6/159 (3.8)	228/6938 (3.3)		2/120 (1.7)	234/7099 (3.3)	
Hispanic	22/159 (13.8)	722/6938 (10.4)		17/120 (14.2)	744/7099 (10.5)	
Unknown	7/159 (4.4)	380/6938 (5.5)		6/120 (5)	387/7099 (5.5)	
BMI > 40	25/159 (15.7)	624/6913 (9)	0.004	16/120 (13.3)	649/7074 (9.2)	0.12
Cancer diagnosis	74/160 (46.3)	2839/6943 (40.9)	0.17	67/120 (55.8)	2914/7105 (41)	0.001
Vocal cord dysfunction on preoperative laryngoscopy	5/158 (3.2)	134/6811 (2)	0.25	7/121 (5.8)	140/6971 (2)	0.01
Preoperative compressive symptoms	49/132 (37.1)	1918/6006 (31.9)	0.21	35/94 (37.2)	1967/6140 (32)	0.28
Preoperative anticoagulation medication	14/159 (8.8)	761/6938 (11)	0.39	18/120 (15)	775/7099 (10.9)	0.16
Prior neck surgery	12/159 (7.5)	677/6938 (9.8)	0.35	9/120 (7.5)	689/7099 (9.7)	0.42
Substernal	13/132 (9.8)	575/6005 (9.6)	0.92	13/94 (13.8)	588/6139 (9.6)	0.17
FNA classification			0.55			0.003
Bethesda I or II	36/110 (32.7)	1658/5091 (32.6)		14/84 (16.7)	1694/5203 (32.6)	
Bethesda III or IV	36/110 (32.7)	1889/5091 (37.1)		33/84 (39.3)	1926/5203 (37)	
Bethesda V or VI	38/110 (34.5)	1544/5091 (30.3)		37/84 (44.1)	1583/5203 (30.4)	
Surgical duration > 3 h	18/160 (11.3)	510/6982 (7.3)	0.06	27/121 (22.3)	528/7144 (7.4)	<0.001
Operative type			0.02			<0.001
Total or near total thyroidectomy	122/160 (76.3)	4652/6913 (67.3)		99/119 (83.2)	4776/7075 (67.5)	
Less than total thyroidectomy[a]	38/160 (23.7)	2261/6913 (32.7)		20/119 (16.8)	2299/7075 (32.5)	
Transection of recurrent laryngeal nerve	1/160 (0.6)	40/6979 (0.6)	0.61	4/121 (3.3)	41/7141 (0.6)	0.007
Length of stay			0.06			<0.001
Outpatient	41/160 (25.6)	2513/6982 (36)		31/121 (25.6)	2555/7144 (35.8)	
1 day	107/160 (66.9)	4037/6982 (57.8)		64/121 (52.9)	4145/7144 (58)	
2+ days	12/160 (7.5)	426/6982 (6.1)		26/121 (21.5)	438/7144 (6.1)	
Already inpatient	0/160 (0)	6/6982 (0.1)		0/121 (0)	6/7144 (0.1)	

[a] Operations include: nodulectomy, lobectomy, subtotal thyroidectomy, and isthmusectomy.

2.88), controlling for all other covariates. The observed risk factors for HR were BMI >40 kg/m^2 (OR 1.94, 95% CI 1.05, 3.59), surgical duration >3 h (OR 2.63, 95% CI 1.43, 4.85), and transection of the recurrent laryngeal nerve (OR 4.58, 95% CI 1.05, 19.96). A risk factor common to both ER and HR was a diagnosis of BMI >40 kg/m^2. After adjusting for other covariates, the odds of returning to the ER within 30 days of thyroidectomy for BMI >40 kg/m^2 were 1.86 times higher (95% CI 1.20, 2.88) than for those with BMI<40 kg/m^2. The odds of being readmitted to the hospital for patients with a BMI >40 kg/m^2 were 1.94 times greater (95% CI 1.05, 3.59) than for those with BMI<40 kg/m^2, controlling for other risk factors (Fig. 3).

Discussion

The purpose of this study was to identify risk factors for ER visit or HR $\leq$ 30 days after an index thyroid operation. Since CESQIP focuses on endocrine operations rather than all of general surgery, it captures information with enhanced granularity, including

Table 2
Reasons for emergency room (ER) visits and hospital readmissions (HR) within 30-days of thyroidectomy.

ER Visit Only Reasons	ER Visits n = 160 (%)	All Patients n = 7142 (%)
Minor complaints or complaints unrelated to thyroidectomy	81 (50.6)	81 (1.1)
Hypocalcemia	35 (21.9)	35 (0.5)
Swelling and Seroma	18 (11.3)	18 (0.3)
Respiratory Distress	13 (8.1)	13 (0.2)
Wound Infection	10 (6.3)	10 (0.1)
Rare Procedure Related Complications (Hematoma, Tracheal Injury, Chyle Leak, Recurrent Laryngeal Nerve Paralysis, Myocardial Complications)	3 (1.9)	3 (0.04)
Hospital Readmission Reasons	**HR n = 121 (%)**	**All Patients n = 7265 (%)**
Hypocalcemia	44 (36.4)	44 (0.6)
Minor complaints or complaints unrelated to thyroidectomy	28 (23.1)	28 (0.4)
Rare Procedure Related Complications (Swelling and Seroma, Tracheal Injury, Chyle Leak, Recurrent Laryngeal Nerve Paralysis, Myocardial Complications)	14 (11.6)	14 (0.2)
Wound Infection	14 (11.6)	14 (0.2)
Respiratory Distress	11 (9.1)	11 (0.2)
Hematoma	10 (8.3)	10 (0.1)

Table 3
ER visit variables with a significance of $p \leq 0.15$ at the univariate level.

Covariates	Emergency Room Visit	
	Adjusted OR (95% CI)	P-value
Age	0.99 (0.98, 1.00)	0.06
BMI > 40	1.86 (1.20, 2.88)	0.005
Surgical duration >3 Hours	1.29 (0.75, 2.22)	0.36
Operation type		0.12
Total or near total thyroidectomy	Reference	
Less than total thyroidectomy[a]	0.74 (0.50, 1.09)	
Length of stay [b]		0.21
Outpatient	Reference	
1 day	1.41 (0.96, 2.07)	
2+ days	1.37 (0.68, 2.75)	

[a] Operations include: nodulectomy, lobectomy, subtotal thyroidectomy, and isthmusectomy.
[b] Due to low cell count, those already inpatient are excluded from the analysis.

conditions and complications specific to thyroid operations. In this retrospective study of aggregate CESQIP data, we observed that 3.4% of patients visited the ER, and 2.3% had HR during the ≤30 days period after thyroidectomy. The most common reasons for these postoperative encounters were minor complaints or complaints unrelated to thyroidectomy (50.6% of ER visits and 23.1% of HR). We also observed that hypocalcemia accounted for 21.9% of ER and 36.4% of HR visits. In multivariable analysis, we further observed that BMI >40 kg/m^2 was a common risk factor for both ER visit and HR.

Prior to our study, few reports had addressed ER visit or HR in the immediate post-thyroidectomy setting. Among them were two ACS-NSQIP studies and a Kaiser Permanente health system study from California; all described higher rates of HR (2.5–4.1%) than the 2.3% we observed in CESQIP.[4,9,11] Using NSQIP data, Khavanin et al. analyzed outcomes following total thyroidectomy, lobectomy, and total thyroidectomy with neck dissection from 2011–12 and reported 30-day HR rates of 2.5% (n = 203 events) for 8,185 outpatient operations and 3.3% (n = 273 events) for 8185 matched inpatient operations.[11] Another ACS-NSQIP study by Mullen et al. reported a post-thyroidectomy 30-day HR rate of 4.1% (n = 153 events) for 3,711 thyroid operations.[9] In a Kaiser Permanente study, Meltzer et al. evaluated 15 years of data for 5412 hemi-thyroidectomies, 8019 total thyroidectomies, and 2916 parathyroidectomies and reported a HR rate of 3.4% (n = 127 events) for outpatients and 3.6% (n = 395) for inpatients.[4] Meltzer also examined post-thyroidectomy ER visits and reported a rate of 7.1% for inpatient and 6.32% for outpatient operations.[4] Post-thyroidectomy ER visits/HR are costly phenomena.[17] Perioperative patient education and detailed discharge instructions, in addition to early postoperative follow-up phone calls and office visits, may decrease the need for post-operative ER visits/HR.

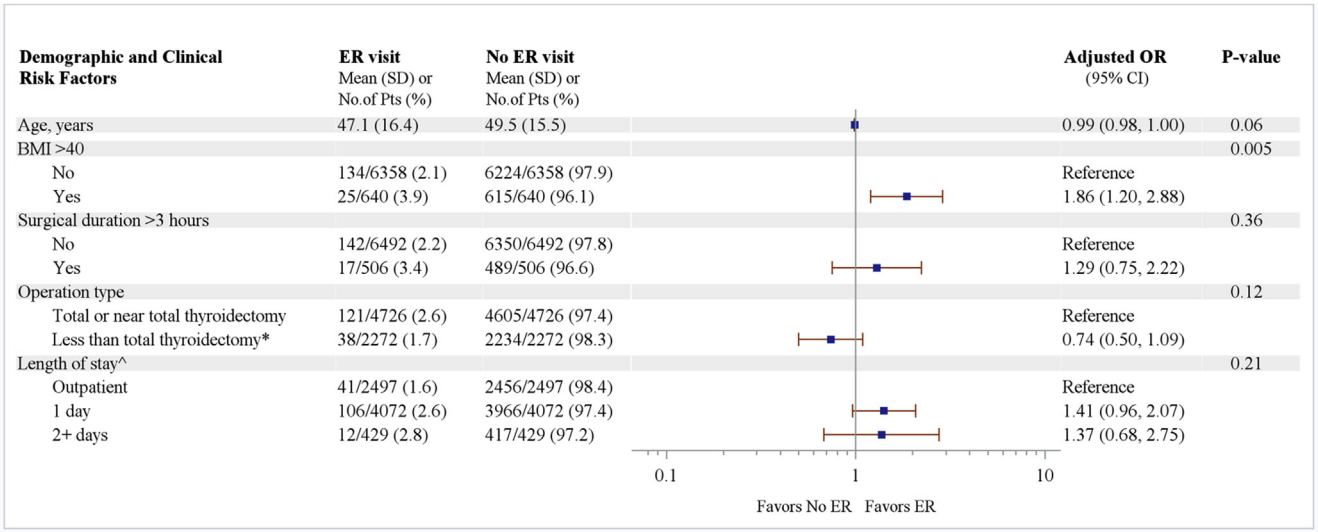
Table 4
HR variables with a significance of $p \leq 0.15$ at the univariate level.

Covariates	Hospital Readmission	
	Adjusted OR (95% CI)	P-value
Sex		0.19
Female	Reference	
Male	1.39 (0.85, 2.29)	
BMI > 40	1.94 (1.05, 3.59)	0.03
Cancer Diagnosis	1.75 (0.99, 3.10)	0.06
Vocal cord dysfunction on preoperative laryngoscopy	0.61 (0.15, 2.53)	0.50
FNA classification		0.08
Bethesda I or II	Reference	
Bethesda III or IV	1.92 (1.00, 3.69)	
Bethesda V or VI	1.22 (0.58, 2.59)	
Surgical Duration >3 Hours	2.63 (1.43, 4.85)	0.002
Operation Type		0.17
Total or near total thyroidectomy	Reference	
Less than total thyroidectomy[a]	0.65 (0.36, 1.20)	
Transection of recurrent laryngeal nerve	4.58 (1.05, 19.96)	0.04
Length of Stay [b]		0.33
Outpatient	Reference	
1 day	1.04 (0.60, 1.80)	
2+ days	1.74 (0.77, 3.94)	

[a] Operations include: nodulectomy, lobectomy, subtotal thyroidectomy, and isthmusectomy.
[b] Due to low cell count, those already inpatient are excluded from the analysis.

One of the strengths of the CESQIP database is that it includes a detailed record of the reasons for ER visits or HR, including thyroidectomy-specific events such as postoperative neck hematoma, hypocalcemia, and vocal cord dysfunction. In this large cohort, we noted a 0.1% postoperative hematoma rate, consistent with that reported in the literature (0.3%–1.2%).[18–20] Hypocalcemia following thyroidectomy occurs in 4.7%–10% of patients within 4–6 weeks of total thyroidectomy.[15,21,22] The CESQIP cohort experienced a <1% incidence of hypocalcemia ≤30 days after thyroidectomy. In an ACS-NSQIP study by Liu et al. using thyroidectomy-specific 30-day postoperative complication data (severe hypocalcemia, recurrent laryngeal nerve injury, and hematoma) among 14,540 patients, surgeons at the best-performing hospitals often prescribed oral calcium, vitamin D, or both and less often measured postoperative PTH levels before discharge.[15] Routine supplementation of calcium and/or vitamin D remains controversial in the prevention of hypocalemia.[22–24] In order to avoid post-thyroidectomy hypocalcemic events, the most prominent reason for ER visits and/or HR, calcium and vitamin D supplementation may be beneficial. As CESQIP expands its data points, we hope the detailed information on post-operative calcium and vitamin D supplementation can be correlated with outcomes for the various types of patients undergoing thyroidectomy. Fitzgerald et al. highlight the importance of teaching patients the symptoms of hypocalemia as well as ascertaining that patients have calcium and vitamin D prescriptions immediately after discharge.[25] After thyroidectomy, rates of recurrent laryngeal nerve (RLN) injury are reported in systematic reviews to be between 2% and 8% for paresis (temporary injury) and between 0.5% and 3% for permanent vocal cord paralysis.[26] In most such studies, including the present one, routine post-operative flexible laryngoscopy is not performed on all patients because RLN injuries can recover, and therefore accurate identification of vocal fold dysfunction is challenging. Moreover, RLN dysfunction can present with various symptoms like dysphonia, difficulty swallowing, aspiration, or airway obstruction.[27] Therefore, the true incidence of recurrent laryngeal nerve injury may be underestimated here and in other large studies.

In regards to risk factors for ER visit or HR, we have found BMI >40 kg/m^2 as a common risk factor for both. High BMI has been shown to be a risk factor for complications following a number of different procedures, but studies associating thyroidectomy complications with higher BMI have also been scant. Buerba et al. looked at 18,828 thyroidectomies in the ACS-NSQIP database from 2005 to 2008 and reported increased risk for having one or more overall complications in obese patients with BMI ≥30 (OR 1.5, 95% CI 1.0–2.1) and morbidly obese patients with BMI ≥35 (OR 1.6, 95% CI 1.1–2.4).[28] Furthermore, more wound complications were seen in both the obese (OR 2.3, 95% CI 1.1–4.9) and morbidly obese patients (OR 5.5, 95% CI 1.7–7.1).[28] As thyroidectomy become increasingly an ambulatory procedure, future CESQIP studies can



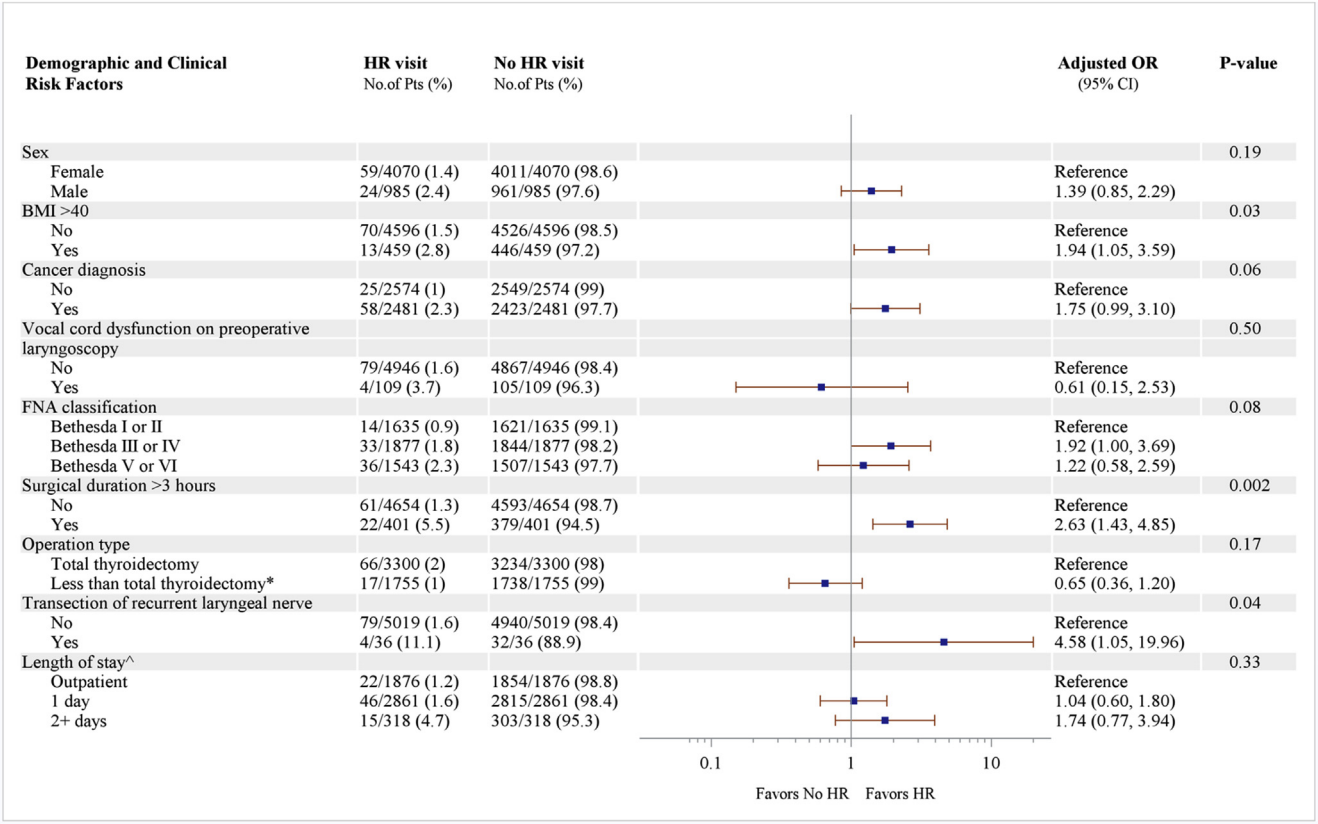
Demographic and Clinical Risk Factors	ER visit Mean (SD) or No.of Pts (%)	No ER visit Mean (SD) or No.of Pts (%)	Adjusted OR (95% CI)	P-value
Age, years	47.1 (16.4)	49.5 (15.5)	0.99 (0.98, 1.00)	0.06
BMI >40				0.005
No	134/6358 (2.1)	6224/6358 (97.9)	Reference	
Yes	25/640 (3.9)	615/640 (96.1)	1.86 (1.20, 2.88)	
Surgical duration >3 hours				0.36
No	142/6492 (2.2)	6350/6492 (97.8)	Reference	
Yes	17/506 (3.4)	489/506 (96.6)	1.29 (0.75, 2.22)	
Operation type				0.12
Total or near total thyroidectomy	121/4726 (2.6)	4605/4726 (97.4)	Reference	
Less than total thyroidectomy*	38/2272 (1.7)	2234/2272 (98.3)	0.74 (0.50, 1.09)	
Length of stay^				0.21
Outpatient	41/2497 (1.6)	2456/2497 (98.4)	Reference	
1 day	106/4072 (2.6)	3966/4072 (97.4)	1.41 (0.96, 2.07)	
2+ days	12/429 (2.8)	417/429 (97.2)	1.37 (0.68, 2.75)	

* Operations include: nodulectomy, lobectomy, subtotal thyroidectomy, and isthmusectomy

^ Due to low cell count, those already inpatient are excluded from the analysis

Fig. 2. Multivariable analysis of ER visit. * Operations include: nodulectomy, lobectomy, subtotal thyroidectomy, and isthmusectomy. ^ Due to low cell count, those already inpatient are excluded from the analysis.

address if this group of patients may be the ones that may benefit from overnight observation, early post-operative visits, or phone calls. In depth analysis of higher BMIs (BMI >45 kg/m^2, BMI >50 kg/m^2, and BMI >60 kg/m^2), specific co-morbidities in high BMI patients, and length of stay, may yield more helpful recommendation to decrease ER visits and hospital readmission for this group.



Demographic and Clinical Risk Factors	HR visit No.of Pts (%)	No HR visit No.of Pts (%)	Adjusted OR (95% CI)	P-value
Sex				0.19
Female	59/4070 (1.4)	4011/4070 (98.6)	Reference	
Male	24/985 (2.4)	961/985 (97.6)	1.39 (0.85, 2.29)	
BMI >40				0.03
No	70/4596 (1.5)	4526/4596 (98.5)	Reference	
Yes	13/459 (2.8)	446/459 (97.2)	1.94 (1.05, 3.59)	
Cancer diagnosis				0.06
No	25/2574 (1)	2549/2574 (99)	Reference	
Yes	58/2481 (2.3)	2423/2481 (97.7)	1.75 (0.99, 3.10)	
Vocal cord dysfunction on preoperative laryngoscopy				0.50
No	79/4946 (1.6)	4867/4946 (98.4)	Reference	
Yes	4/109 (3.7)	105/109 (96.3)	0.61 (0.15, 2.53)	
FNA classification				0.08
Bethesda I or II	14/1635 (0.9)	1621/1635 (99.1)	Reference	
Bethesda III or IV	33/1877 (1.8)	1844/1877 (98.2)	1.92 (1.00, 3.69)	
Bethesda V or VI	36/1543 (2.3)	1507/1543 (97.7)	1.22 (0.58, 2.59)	
Surgical duration >3 hours				0.002
No	61/4654 (1.3)	4593/4654 (98.7)	Reference	
Yes	22/401 (5.5)	379/401 (94.5)	2.63 (1.43, 4.85)	
Operation type				0.17
Total thyroidectomy	66/3300 (2)	3234/3300 (98)	Reference	
Less than total thyroidectomy*	17/1755 (1)	1738/1755 (99)	0.65 (0.36, 1.20)	
Transection of recurrent laryngeal nerve				0.04
No	79/5019 (1.6)	4940/5019 (98.4)	Reference	
Yes	4/36 (11.1)	32/36 (88.9)	4.58 (1.05, 19.96)	
Length of stay^				0.33
Outpatient	22/1876 (1.2)	1854/1876 (98.8)	Reference	
1 day	46/2861 (1.6)	2815/2861 (98.4)	1.04 (0.60, 1.80)	
2+ days	15/318 (4.7)	303/318 (95.3)	1.74 (0.77, 3.94)	

* Operations include: nodulectomy, lobectomy, subtotal thyroidectomy, and isthmusectomy

^ Due to low cell count, those already inpatient are excluded from the analysis

Fig. 3. Multivariable analysis of HR visit. * Operations include: nodulectomy, lobectomy, subtotal thyroidectomy, and isthmusectomy. ^ Due to low cell count, those already inpatient are excluded from the analysis.

Additional risk factors for HR were transection of recurrent laryngeal nerve and surgical duration >3 h. Complications of recurrent laryngeal nerve such as aspiration or respiratory distress could be reasons for HR. For surgical duration >3 h, HR may be related to prolonged anesthesia or difficulty of the operation but this is hard to deduce as speed of thyroidectomy is varied among both skilled and novice surgeons. Thyroid cancer was found in 47.8% of the ER visit cohort and 56.1% of the HR cohort, however, on multivariable analysis, thyroid cancer was not a significant risk factor for both cohorts. Our findings did not validate prior studies that have demonstrated thyroid cancer to be a hazard for adverse outcomes after thyroidectomy.[3,12,29]

There are several limitations to our study that are largely related to the design of CESQIP. First, our study was limited by CESQIP privacy policies that do not allow the use of surgeon volume data. This CESQIP analysis shows lower rates of ER visit and HR compared to other published literature. Our suspicion is that the difference may be due to the abundance of high volume centers and surgeons participating in CESQIP. Only participating surgeons in CESQIP are presented with a dashboard that shows their volume and outcomes, which are displayed in a de-identified comparison to surgeons at other sites. Therefore, we were not able to validate the relationship between increased surgeon volume of thyroidectomies and reduced rate of complications.[13,30–32] Second, the small number of events available for examination limits the number of covariates that could be included in the multivariable analysis. Third, although we demonstrate in the Appendix that excluded patients without reported 30-day outcomes (n = 829) had similar findings to our analyzed data, we did not redo our analysis with a completed 30-days outcome data. Fourth, the data were self-reported, and there has not yet been a database-wide audit to confirm accuracy; while some institutions participating in CESQIP use independent coders to independently enter data, the program needs to determine how often data are recorded by surgeons or trainees rather than by neutral abstracters.

In conclusion, this study highlights the importance of conducting analyses using variables relevant to endocrine surgery. A BMI >40 kg/m^2 is an independent risk factor for post-thyroidectomy ER visit or HR and therefore it is important that surgeons employ post-operative vigilance for this group. Our study shows that HR is higher in patients with thyroidectomy duration >3 h and those with transection of the recurrent laryngeal nerve. Studies looking into intensive interventions prior to discharge for these patients may decrease HR. In future analyses, CESQIP has the ability to capture thyroidectomy patient outcomes data beyond 30 days in the 'longitudinal outcomes' section that can provide long-term outcomes of high-risk patients identified in this study.

Disclaimer

CESQIP and the hospitals participating in CESQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors. The conclusions, findings, and opinions expressed by the authors do not necessarily reflect the official position of the AAES or CESQIP. Use of CESQIP data does not imply endorsement by any of the groups named above.

Declaration of competing interest

Julie Ann Sosa is a member of the Data Monitoring Committee of the Medullary Thyroid Cancer Consortium Registry supported by GlaxoSmithKline, Novo Nordisk, Astra Zeneca and Eli Lilly.

Appendix. Patients removed from analysis: patients with no reported 30-day outcomes (n = 829) and those with lymph node dissection only procedures (n = 238)

Variables	Removed Cohort (n = 1067)
	Mean ± SD
Age, years	49.6 ± 16.2
	No. of patients (%)
Male	242/1067 (22.7)
Race	
Black	103/1066 (9.7)
Non-Black	767/1066 (72)
Asian	37/1066 (3.5)
Hispanic	129/1066 (12.1)
Unknown	30/1066 (2.8)
BMI > 40	105/1066 (9.8)
Cancer Diagnosis	296/447 (66.2)
Vocal Cord Dysfunction on Preoperative Laryngoscopy	16/427 (3.7)
Preoperative Compressive Symptoms	319/783 (40.7)
Preoperative Anticoagulation Medication	129/1066 (12.1)
Prior Neck Surgery	328/1066 (30.8)
Substernal	92/782 (11.8)
FNA Classification	
Bethesda I or II	171/610 (28)
Bethesda III or IV	189/610 (31)
Bethesda V or VI	250/610 (41)
Surgical Duration > 3 Hours	114/1067 (10.7)
Operative Type	
Total or near total thyroidectomy	568/793 (71.6)
Less than total thyroidectomy*	225/793 (28.4)
Transection of recurrent laryngeal nerve	9/1067 (0.8)
Length of stay	
Outpatient	56/238 (23.5)
1 day	148/238 (62.2)
2+ days	33/238 (13.9)
Already inpatient	1/238 (0.4)

References

1. Davies L, Welch HG. Increasing incidence of thyroid cancer in the United States. *JAMA*. 2006;295(18):2164–2167, 1973-2002.
2. Terris DJ, Snyder S, Carneiro-Pla D, et al. American Thyroid Association statement on outpatient thyroidectomy. *Thyroid*. 2013;23(10):1193–1202.
3. Caulley L, Johnson-Obaseki S, Luo L, Javidnia H. Risk factors for postoperative complications in total thyroidectomy: a retrospective, risk-adjusted analysis from the National Surgical Quality Improvement Program. *Medicine (Baltim)*. 2017;96(5), e5752.
4. Meltzer C, Klau M, Gurushanthaiah D, et al. Safety of outpatient thyroid and parathyroid surgery: a propensity score-matched study. *Otolaryngol Head Neck Surg*. 2016;154(5):789–796.
5. Inabnet WB, Shifrin A, Ahmed L, Sinha P. Safety of same day discharge in patients undergoing sutureless thyroidectomy: a comparison of local and general anesthesia. *Thyroid*. 2008;18(1):57–61.
6. Tsai TC, Joynt KE, Orav EJ, Gawande AA, Jha AK. Variation in surgical-readmission rates and quality of hospital care. *N Engl J Med*. 2013;369(12):1134–1142.
7. Fontanarosa PB, McNutt RA. Revisiting hospital readmissions. *Jama*. 2013;309(4):398–400.
8. Landry CS, Grubbs EG, Hernandez M, et al. Predictable criteria for selective, rather than routine, calcium supplementation following thyroidectomy. *Arch Surg*. 1960;147(4):338–344, 2012.
9. Mullen MG, LaPar DJ, Daniel SK, Turrentine FE, Hanks JB, Smith PW. Risk factors for 30-day hospital readmission after thyroidectomy and parathyroidectomy in the United States: an analysis of National Surgical Quality Improvement Program outcomes. *Surgery*. 2014;156(6):1423–1430. discussion 1430-1421.
10. Tuggle CT, Park LS, Roman S, Udelsman R, Sosa JA. Rehospitalization among elderly patients with thyroid cancer after thyroidectomy are prevalent and costly. *Ann Surg Oncol*. 2010;17(11):2816–2823.

11. Khavanin N, Mlodinow A, Kim JY, Ver Halen JP, Antony AK, Samant S. Assessing safety and outcomes in outpatient versus inpatient thyroidectomy using the NSQIP: a propensity score matched analysis of 16,370 patients. *Ann Surg Oncol*. 2015;22(2):429–436.
12. Goldfarb M, Perry Z, R AH, Parangi S. Medical and surgical risks in thyroid surgery: lessons from the NSQIP. *Ann Surg Oncol*. 2011;18(13):3551–3558.
13. Adam MA, Thomas S, Youngwirth L, et al. Is there a minimum number of thyroidectomies a surgeon should perform to optimize patient outcomes? *Ann Surg*. 2017;265(2):402–407.
14. Sippel RS, Chen H. Limitations of the ACS NSQIP in thyroid surgery. *Ann Surg Oncol*. 2011;18(13):3529–3530.
15. Liu JB, Sosa JA, Grogan RH, et al. Variation of thyroidectomy-specific outcomes among hospitals and their association with risk adjustment and hospital performance. *JAMA Surg*. 2017, e174593.
16. Wang TS, Yen TW. Readmission after thyroidectomy and parathyroidectomy: what can we learn from NSQIP? *Surgery*. 2014;156(6):1419–1422.
17. Stavrakis AI, Ituarte PH, Ko CY, Yeh MW. Surgeon volume as a predictor of outcomes in inpatient and outpatient endocrine surgery. *Surgery*. 2007;142(6):887–899. discussion 887-899.
18. Burkey SH, van Heerden JA, Thompson GB, Grant CS, Schleck CD, Farley DR. Reexploration for symptomatic hematomas after cervical exploration. *Surgery*. 2001;130(6):914–920.
19. Reeve T, Thompson NW. Complications of thyroid surgery: how to avoid them, how to manage them, and observations on their possible effect on the whole patient. *World J Surg*. 2000;24(8):971–975.
20. Promberger R, Ott J, Kober F, et al. Risk factors for postoperative bleeding after thyroid surgery. *Br J Surg*. 2012;99(3):373–379.
21. Khan MI, Waguespack SG, Hu MI. Medical management of postsurgical hypoparathyroidism. *Endocr Pract*. 2011;17(Suppl 1):18–25.
22. Bergenfelz A, Jansson S, Kristoffersson A, et al. Complications to thyroid surgery: results as reported in a database from a multicenter audit comprising 3,660 patients. *Langenbeck's Arch Surg*. 2008;393(5):667–673.
23. Wang TS, Roman SA, Sosa JA. Postoperative calcium supplementation in patients undergoing thyroidectomy. *Curr Opin Oncol*. 2012;24(1):22–28.
24. Noureldine SI, Genther DJ, Lopez M, Agrawal N, Tufano RP. Early predictors of hypocalcemia after total thyroidectomy: an analysis of 304 patients using a short-stay monitoring protocol. *JAMA Otolaryngol Head Neck Surg*. 2014;140(11):1006–1013.
25. FitzGerald RA, Sehgal AR, Nichols JA, McHenry CR. Factors predictive of emergency department visits and hospitalization following thyroidectomy and parathyroidectomy. *Ann Surg Oncol*. 2015;22(Suppl 3):S707–S713.
26. Malik R, Linos D. Intraoperative neuromonitoring in thyroid surgery: a systematic review. *World J Surg*. 2016;40(8):2051–2058.
27. Kadakia S, Mourad M, Hu S, Brown R, Lee T, Ducic Y. Utility of intraoperative nerve monitoring in thyroid surgery: 20-year experience with 1418 cases. *Oral Maxillofac Surg*. 2017 Sep;21(3):335–339.
28. Buerba R, Roman SA, Sosa JA. Thyroidectomy and parathyroidectomy in patients with high body mass index are safe overall: analysis of 26,864 patients. *Surgery*. 2011;150(5):950–958.
29. Meltzer C, Klau M, Gurushanthaiah D, et al. Risk of complications after thyroidectomy and parathyroidectomy: a case series with planned chart review. *Otolaryngol Head Neck Surg*. 2016;155(3):391–401.
30. Sosa JA, Bowman HM, Tielsch JM, Powe NR, Gordon TA, Udelsman R. The importance of surgeon experience for clinical and economic outcomes from thyroidectomy. *Ann Surg*. 1998;228(3):320–330.
31. Kandil E, Noureldine SI, Abbas A, Tufano RP. The impact of surgical volume on patient outcomes following thyroid surgery. *Surgery*. 2013;154(6):1346–1352. discussion 1352-1343.
32. Adkisson CD, Howell GM, McCoy KL, et al. Surgeon volume and adequacy of thyroidectomy for differentiated thyroid cancer. *Surgery*. 2014;156(6):1453–1459. discussion 1460.