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The 2015 American Thyroid Association guidelines are associated with an increasing rate of hemithyroidectomy for thyroid cancer

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ABSTRACT

Background: In an attempt to prevent overly aggressive treatment of low-risk thyroid cancers, the American Thyroid Association changed guideline recommendations in late 2015 to state that either hemithyroidectomy or total thyroidectomy are acceptable operations for these patients. We hypothesized that surgeons would increasingly perform hemithyroidectomy after the release of these guidelines.
Methods: The database of the National Surgery Quality Improvement Program was queried to identify all patients with thyroid cancer who were undergoing thyroidectomy between 2009 and 2017. Patients treated before the release of the 2015 American Thyroid Association guidelines were compared with those treated afterward. Temporal trends in operative rates were assessed quarterly using interrupted time series analyses.
Results: A total of 35,291 patients were included in the study. Of those, 26,882 (76.2%) were female and 25,193 (71.3%) were white. After the release of the American Thyroid Association guidelines, there was an increase in hemithyroidectomy rate for patients with cancer from 17.3% to 22.0% ($P < .001$). Interrupted time series analysis controlling for patient factors demonstrated that quarterly growth in the hemithyroidectomy rate accelerated almost 10-fold ($P < .001$) after publication of the revised guidelines. Of note, there was no corresponding increase in the completion thyroidectomy rate (8.3% versus 7.9%, respectively, $P = .213$). Patients treated with hemithyroidectomy were more likely to be managed as outpatients (70.8% versus 57.1%, $P < .001$), had fewer surgical site infections (0.3% versus 0.5%, $P = .050$), and had fewer unplanned reintubations (0.2% versus 0.4%, $P = .005$).
Conclusion: In hospitals participating in the National Surgery Quality Improvement Program, the hemithyroidectomy rate increased significantly after the release of the 2015 American Thyroid Association guidelines. Surgeons at hospitals that participate in the National Surgery Quality Improvement Program may be changing practice patterns in response to these guidelines.

Introduction

Thyroid cancer is the most common endocrine malignancy worldwide, and its incidence in the United States has nearly tripled from 1974 to 2013.[1] Fortunately, the majority of thyroid cancers are well differentiated, papillary thyroid carcinomas (PTC) and are predominantly indolent cancers cured typically by operative excision. Papillary thyroid carcinomas constitute the overwhelming majority of differentiated thyroid cancers (DTCs). Patients with these tumors have excellent 5- and 10-year survival.[1,2] As a result, the American Thyroid Association (ATA) recently issued new treatment guidelines advocating for less diagnostic testing in patients with thyroid nodules and less extensive operations for patients with low-risk DTCs.[3,4] The most recent ATA guidelines considered to be the gold standard of thyroid cancer management in the United States were published online in October 2015.[4] The new guidelines made several changes to the 2009 edition. Many of these changes focused on de-escalating operative therapy for patients with low-risk DTCs, recognizing that more extensive thyroid resections did not improve overall or disease-specific survival in these patients.[4,5]

One of the most important changes in the 2015 edition of the guidelines was equating hemithyroidectomy (HT) with total

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thyroidectomy (TT) for patients with intrathyroidal DTCs 1 to 4 cm in size. This recommendation was based primarily on several large, retrospective studies that demonstrated noninferior overall survival for DTC patients with low-risk neoplasms who underwent HT compared with those patients who had TT. Perhaps the most notable among these studies was performed by Adam et al.[6] who analyzed data from 61,775 patients in the National Cancer Database between 1998 and 2006 and showed no survival advantage for low-risk patients undergoing HT versus TT. This recommendation, however, has been met with controversy, in part because of concern that there may be an increased risk of recurrence for patients with DTC undergoing HT or a need for future completion thyroidectomy.[3,7,8] As a result, it remains unclear to what degree nationwide practices have changed in response to the updated guidelines. In fact, some have expressed concern that the guidelines may not be followed widely.[9]

We hypothesized that, after the release of the 2015 ATA guidelines, surgeons would perform HT increasingly for low-risk thyroid cancers despite the controversy. To examine these trends on a national scale, we queried the database of the National Surgery Quality Improvement Program (NSQIP). NSQIP is a large, nationally validated, risk-adjusted database of primarily American hospitals that collects patient, hospital, and surgeon data from each participating institution on an 8-day rotating schedule. It represents a broad sampling of hospitals that volunteer to participate and includes data extracted directly from patient charts at individual institutions rather than relying on insurance claims data, which may be incomplete or inaccurate.[10] Although it is not designed to be broadly representative of surgical trends in the United States, the NSQIP represents currently more than 1 million annual cases performed at almost 700 hospitals.[11] As a result, the database has been used to study nationwide trends in operative therapy, ranging from axillary lymph node dissection rates among breast cancer patients to types of reconstruction after cystectomy for bladder cancer.[12–14] Thus, querying the NSQIP database presents a unique opportunity to examine broad patterns in thyroid operations before and after the release of the 2015 ATA guidelines. Here, we compare rates of HT in thyroid cancer patients who underwent operative therapy before the ATA guidelines were published online with rates for those treated after publication of the guidelines.

Materials and Methods

Study population

This study was exempt from institutional review board assessment because of the use of nationally available, deidentified data. The NSQIP database was queried to identify all patients undergoing thyroidectomy between 2009 and 2017 by Current Procedural Terminology (CPT) code with a postoperative diagnosis of thyroid cancer by the International Classification of Disease codes (Appendices 1 and 2). Only patients treated by general surgeons or otolaryngologists were included to ensure that all patients were treated by surgeons with formal training in thyroidectomy. Patients undergoing lateral neck dissection were also excluded because these patients would not be treated appropriately with HT under the ATA guidelines. The year of operation and admission quarter were combined to identify the quarter-year in which patients were treated. Patients were divided into two groups: those treated before the publication of the revised ATA guidelines (BG) from 2009 through third quarter 2015 and those treated afterward (AG) from fourth quarter 2015 through 2017. CPT codes were used to differentiate patients undergoing HT from those undergoing subtotal or TT or completion thyroidectomy. Rates of HT and TT were reviewed across the entire cohort by quarter-year. To control for increasing annual enrollment in NSQIP, "rates" of these operations were calculated as percentages of all thyroidectomies (HT + TT) by quarter-year.

Statistical analysis

Descriptive statistics are reported as means with standard deviations for continuous, normally distributed variables or median and interquartile range for skewed continuous or ordinal variables, and categorical variables are reported as number and percent. As NSQIP evolved, some variables were not recorded for the entire cohort. These cases are noted, and the data presented represent only the information available. Categorical variables were compared using the Pearson χ^2 test, continuous normally distributed variables using *t* tests, and skewed or ordinal variables were compared using the Wilcoxon rank-sum (Mann-Whitney) tests. Univariable regressions were performed to identify factors associated with treatment with HT or outpatient management. Those factors found to be associated with these outcomes in univariable analyses were then tested in multivariable regressions to identify confounders for interrupted time series analysis. Interrupted time series analysis with Newey-West standard errors adjusted for patient factors predictive of HT from the multivariate analyses (white race, Hispanic ethnicity, American Society of Anesthesiologists [ASA] class 1) was performed to identify changes in temporal trends after release of the guidelines. Interrupted time series analysis is a regression-based statistical model that measures rates of change in temporal trends. This analysis is designed to estimate the effects of longitudinal interventions where randomization is not possible.[15] All statistical analyses were performed using Stata software v 13.1 (Stata Corp, College Station, TX).

We acknowledge that the NSQIP database remains the full and exclusive copyrighted property of the American College of Surgeons. The American College of Surgeons is not responsible for any claims arising from works based on the original data, text, tables, or figures.

Results

Of the 35,291 patients who met the inclusion criteria for this study, 23,721 were placed in the BG group and 11,570 were placed in the AG group. Patients in the BG group compared with the AG group were more likely to be white (85.4% vs 83.0%, $P < .001$), have a lower ASA class (ASA class 1 or 2: 72.3% vs 66.8%, $P < .001$), and be operated on by a general surgeon (70.9% vs 59.3%, $P < .001$ [Table I]). There was a steady increase in the number of thyroid cancer patients undergoing thyroidectomy included in the NSQIP database from 2009 to 2017 (Fig 1 and Supplemental Table I). The HT rate remained relatively unchanged from 2009 to 2015 in quarter 3, but after the release of the 2015 ATA guidelines, the HT rate increased sharply. A total of 17.3 % of patients in the BG group underwent HT compared with 22.0 % in the AG group ($P < .001$ [Fig 2]).

Univariable logistic regression demonstrated that surgeon specialty, patient race, ethnicity, ASA class, and operation after publication of the guidelines were all predictive of operative treatment by HT (Supplemental Table II). Multivariable regression incorporating these variables demonstrated that a lower ASA class and having an otolaryngologist as the primary surgeon were independent predictors of HT; whereas white race (versus all others) and Hispanic ethnicity were predictive of TT (Table II). Patients in the AG group were 31% more likely to be treated with HT, controlling for these factors (OR 1.31 [CI 1.24–1.38], $P < .001$).

Interrupted time series analysis adjusted for patient characteristics demonstrated that the release of the ATA guidelines in the fourth quarter of the year 2015 marked an obvious transition point

Table I
Preoperative characteristics of NSQIP thyroid cancer patients, 2009 to 2017

Preoperative characteristics	Before guidelines ($N = 23,721$)	After guidelines ($N = 11,570$)	P value
Age, mean ± SD	50.4 ± 14.9	50.3 ± 15.2	.636
Female sex*	18,100 (76.4%)	8,782 (75.9%)	.319
Race*			< .001
White	17,616 (85.4%)	7,577 (83.0%)	
Black	1,524 (7.4%)	7233 (7.9%)	
Asian	1,299 (6.3%)	736 (8.1%)	
Hispanic ethnicity*	1,792 (7.6%)	1,152 (10.0%)	< .001
ASA class			< .001
ASA 1—no Systemic illnesses	1,963 (8.3%)	827 (7.2%)	
ASA 2—mild illness	15,249 (64.0%)	6,900 (59.6%)	
ASA 3—severe illness	6,248 (26.3%)	3,645 (31.5%)	
ASA 4—life-threatening illness	230 (1.0%)	161 (1.4%)	
Surgeon specialty*			< .001
General surgeon	16,817 (70.9%)	6,863 (59.3%)	
Otolaryngologist	6,904 (29.1%)	4,707 (40.7%)	

* Number (%).

in HT rate over time. Before the release of the guidelines, the HT rate increased by just 0.08% of patients per quarter-year. After publication of the guidelines, the HT rate increased by more than almost 10-fold to an increase of 0.81% of patients per quarter-year ($P < .001$ [Fig 2]). In a subgroup analysis, this effect was greater among general surgeons (adjusted pre-guideline increase in HT rate −0.05% per quarter-year vs 0.56% per quarter-year post guidelines, $P = .004$) than otolaryngologists (adjusted preguideline increase in HT rate 0.18% per quarter-year vs 0.51% per quarter-year post guidelines, $P = .044$ [Supplemental Figs 1 and 2]). Of note, there was no concurrent increase in completion thyroidectomy rate after the same time point, adjusting for the same factors ($P = .649$ [Fig 3]). This observation was also true when analyzed by surgeon specialty (general surgeon $P = .476$, otolaryngologist $P = .182$) (Supplemental Figs 3 and 4). In fact, the percentage of patients undergoing completion thyroidectomy in the AG group was 7.9% and in the BG group it was 8.3% ($P = .213$).

During the entire study period, HT patients had lesser durations of stay and were more likely to be managed as outpatients. These same patients also had a lesser operative times (91.0 vs 133.2 minutes, $P < .001$), fewer surgical site infections (0.3% vs 0.5%, $P = .050$), and fewer unplanned reintubations (0.2% vs 0.4%, $P = .005$). HT had no advantage over TT in terms of discharge to home (versus rehabilitation or other care facility), postoperative need for tracheostomy, or postoperative hematoma, although these data were not available for the entire cohort (Table III). Treatment with HT was a strong predictor of outpatient management in the cohort (OR 1.94 [CI 1.82–2.05], $P < .001$), but the type of operative therapy after the ATA guidelines, younger age at treatment, treatment by a general surgeon, ASA class, and white race (versus all others) were

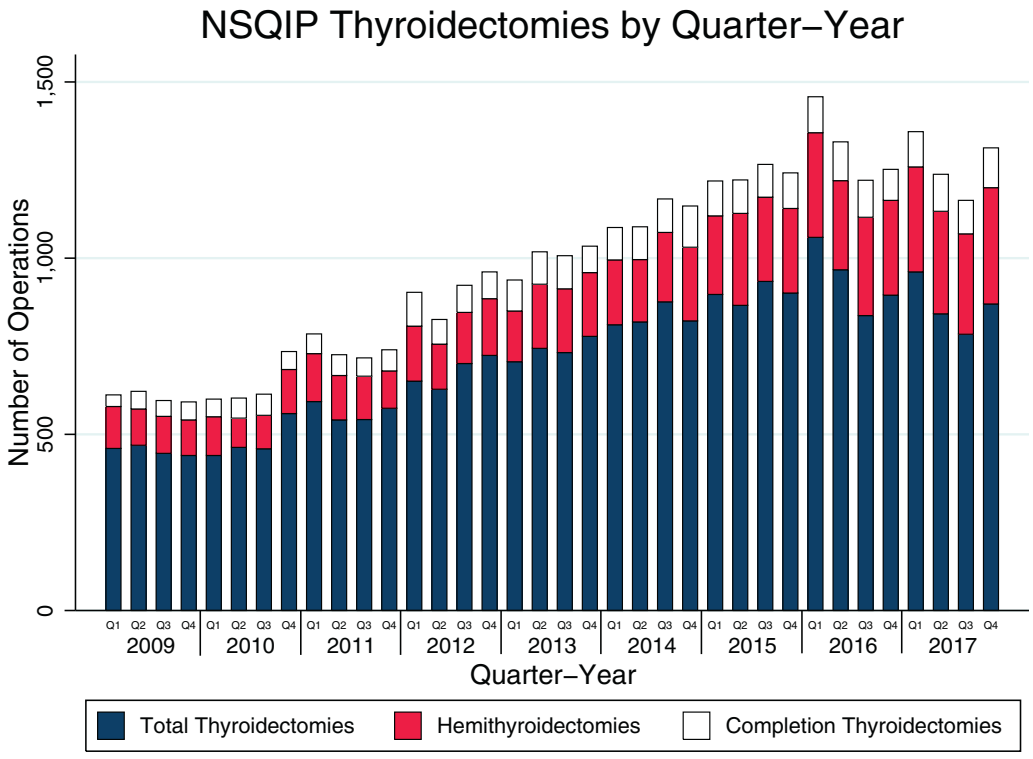

Fig 1. Anatomic thyroid resections included in the database of the National Surgery Quality Improvement Program (NSQIP) during the study period each quarter-year.

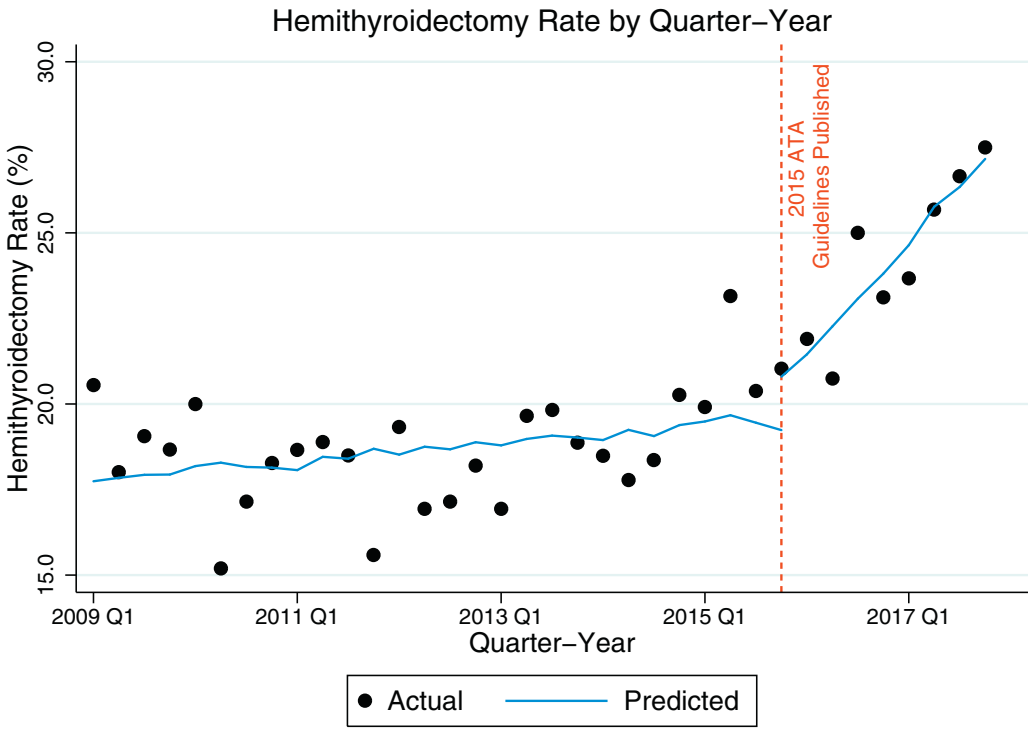

Fig 2. Rate of hemithyroidectomy through time in the database of National Surgery Quality Improvement Program (NSQIP). The predicted rate by interrupted time series analysis adjusted for percentage of patients who were white, Hispanic, and ASA class 1 each quarter-year. Difference in trend lines preguidelines versus postguidelines $P < .001$. *ATA*, American Thyroid Association; *ASA*, American Society of Anesthesiologists.

also independent predictors of outpatient management (Table IV, univariable regression results in Supplemental Table III).

Discussion

This study is the first to examine the effect of the revised ATA guidelines on operative trends for thyroid cancer on a national level in the United States. Despite controversy after the release of the ATA guidelines, we showed that there was a significant increase in the number of thyroid cancer patients treated with HT at NSQIP hospitals. This increase occurred in the context of changing demographics of thyroid cancer patients included in the NSQIP database; however, interrupted time series analysis indicated that the time of publication of the 2015 ATA guidelines marked the transition point of the increase in the rate of HT over time, controlling for these changing patient factors. This increase was true for patients of both general surgeons and otolaryngologists. Otolaryngologists had a greater baseline rate of HT, potentially representing a discrepancy in referral or practice patterns, although we acknowledge that we cannot determine the cause in this data set. Furthermore, endocrine surgeons are coded as general surgeons in the NSQIP database, so we are unable to separate out general surgeons with advanced thyroid-specific, surgical training. This greater rate of baseline HT among otolaryngologists may be the reason that general surgeons had a more dramatic increase in HT rate postguidelines (Supplemental Figs 1 and 2).

Of note, interrupted time series analysis requires the researcher to select the time point when the "intervention" period begins. Online publication of the 2015 ATA guidelines provided widespread access for clinicians, and thus this date was chosen as the beginning of the "intervention" for this analysis. We believe, however, that clinicians likely learned of the changes to the guidelines at different points in time, and therefore the trend in increasing HT rates may have begun before or after online publication.

HT has several advantages over TT. In this cohort, one advantage of HT was that patients were more likely to be managed as outpatients and had a correspondingly lesser duration of stay. Furthermore, as one would expect, patients undergoing HT had lesser operative times and fewer surgical site infections. Known advantages of HT over TT include a decreased risk of postoperative

Table II
Multivariable regression identifies independent predictors of treatment with HT

Case details	Odds of hemithyroidectomy	Confidence interval	*P* value
Operation after guidelines	1.31	1.24–1.38	< .001
Otolaryngologist (versus general surgeon)	1.32	1.25–1.40	< .001
ASA class			
ASA 1—no systemic illnesses	Reference	—	—
ASA 2—mild illness	0.75	0.68–0.83	< .001
ASA 3—moderate illness	0.66	0.60–0.74	< .001
ASA 4—life-threatening illness	0.66	0.51–0.87	.003
White race (versus all others)	0.85	0.80–0.90	< .001
Hispanic ethnicity	0.72	0.65–0.80	< .001

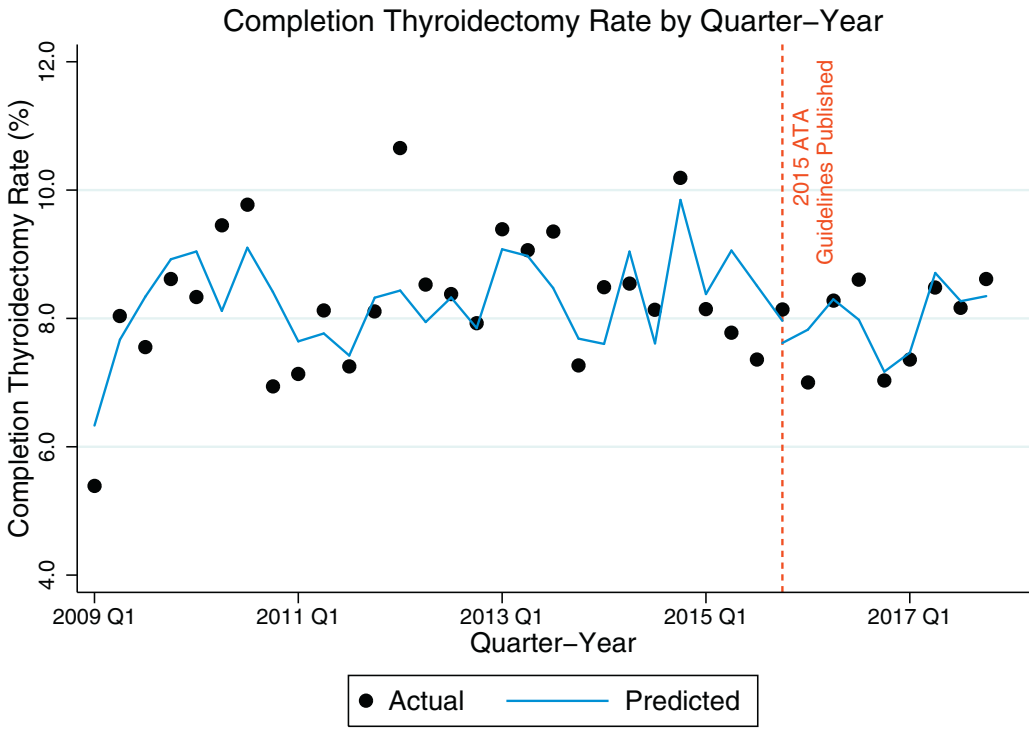

Fig 3. The rate of completion thyroidectomy through time in the database of the National Surgery Quality Improvement Program (NSQIP). The predicted rate by interrupted time series analysis adjusted for percentage of patients who were white, Hispanic, and ASA class 1 each quarter-year. Difference in trend lines pre-guidelines versus post-guidelines $P = .649$. *ATA*, American Thyroid Association; *ASA*, American Society of Anesthesiologists.

hypoparathyroidism and bilateral recurrent laryngeal nerve injury and fewer patients who will need thyroid hormone replacement therapy.[4,16–18] Although we are unable to assess these outcomes using NSQIP, we expect these complications were decreased in this cohort of patients as well. In addition, HT may be a more cost-effective alternative to TT.[19] Thus, the increasing rate of HT for cancer should lead to lesser hospital stays, fewer complications, and fewer patients on hormone replacement therapy.

It seems counterintuitive then that ASA class 2, 3, and 4 patients were less likely to undergo HT than ASA class 1 patients (Table II); however, there may be some reluctance on the part of the operating surgeons to perform HT for patients who are "sicker" or have more comorbidities in order to eliminate the risk of needing a second operation (and therefore additional anesthetic and operative risk) for a completion thyroidectomy. Another possibility is that surgeons erred toward preserving the thyroid tissue of younger, healthier patients who may benefit the most from avoiding lifetime thyroid hormone replacement. Finally, sicker, older patients may have been more likely to have preoperative hypothyroidism or bilateral nodules, in which case the benefits of HT are less, and the surgeon and patient may opt for a TT. Likely, the results documented here are a combination of multiple factors.

The trend toward less extensive operative resections of the thyroid parenchyma for thyroid cancer after the updated ATA guidelines may indicate that changes to national guidelines are an effective mechanism to decrease overtreatment. Recently, increasing attention has been directed to the costs of overtreatment, both in terms of patient morbidity and financial burden.[20] In fact, a survey of physicians in the United States found that they estimated that approximately 20% of the care their patients received was not medically necessary.[21] These trends are not limited to the United States and seem to be particularly evident in

Table III
Postoperative outcomes by type of operation

Outcome	Hemithyroidectomy ($N = 6,642$)	Total thyroidectomy ($N = 25,791$)	P value
Duration of stay, median (IQR), days	1 (0-1)	1 (1-1)	< .001
Managed as outpatient*	4,702 (70.8%)	14,727 (57.1%)	< .001
Discharged to home*,†	5,748 (99.1%)	21,883 (99.2%)	.910
Operative time, mean ± SD, min	91.0 ± 44.4	133.2 ± 67.1	< .001
Any surgical site infection*	19 (0.3%)	119 (0.5%)	.050
Superficial	15 (0.2%)	96 (0.4%)	.069
Deep	4 (0.1%)	23 (0.1%)	.466
Reintubation*	11 (0.2%)	102 (0.4%)	.005
Required tracheostomy *,‡	2 (0.0%)	15 (0.1%)	.373
Postoperative hematoma*,§	11 (0.2%)	75 (0.3%)	.077

* Number (%).
† Data only available for patients treated 2011–2016.
‡ Data only available for patients treated 2012–2016.
§ Requiring return to operating room.

Table IV
Multivariable regression identifies independent predictors of outpatient management

Case details	Odds of outpatient management	Confidence interval	*P* value
Hemithyroidectomy	1.94	1.82–2.05	< .001
Operation after guidelines	2.04	1.94–2.15	< .001
Age (per year)	0.99	0.99–0.99	< .001
Otolaryngologist (versus general surgeon)	0.78	0.75–0.82	< .001
ASA class			
ASA 1—no systemic illnesses	Reference	—	—
ASA 2—mild illness	1.21	1.11–1.32	< .001
ASA 3—severe illness	1.12	1.02–1.24	.014
ASA 4—life-threatening illness	0.58	0.46–0.73	< .001
White race (versus all others)	2.41	2.30–2.55	< .001

cancer care.[22,23] Indeed, the increasing incidence of low-risk thyroid cancers worldwide has prompted pushback against screening and aggressive treatment. In South Korea for example, a publicity campaign seems to have successfully dissuaded patients from being screened for asymptomatic tumors.[24] The trend toward less extensive resections for thyroid cancers identified here may reflect a similarly successful attempt by the ATA to curb overtreatment in the United States despite concerns that the guidelines may have been ineffective.[9]

Hirshoren et al.[25] reported an increase in HT rate at their institution after their adoption of the ATA guidelines; however, this was a single institution study and thus does not address concerns that the ATA guidelines have not been adopted more broadly. Our study suggests that the HT rate across a broad sampling of hospitals has increased, suggesting that these guidelines may be affecting surgical decision-making on a large scale. Furthermore, we suspect that the 25.9% of patients treated with HT in 2017 in this study does not represent the entire population of thyroid cancer patients who would qualify for HT under the ATA guidelines, and thus expect the HT rate to continue to increase in the future as the guidelines are emphasized and adopted more widely.

The interpretation of the data presented here has limitations. Our retrospective design means that results are correlative, and causality cannot be determined. Similarly, conclusions are limited by the fixed granularity and accuracy of CPT and ICD codes and the potential for errors in coding. NSQIP is composed of hospitals that choose voluntarily to contribute their data, and thus NSQIP is not a randomized representative sampling of all US hospitals. Therefore, these data may not be generalizable to non-NSQIP hospitals. Furthermore, hospital-level data are unavailable, and we cannot determine whether trends are different for academic versus community centers or large or smaller hospitals, for example. Despite these limitations, the NSQIP database has been used as a surrogate marker for procedure prevalence before and can provide some indication of broad trends in surgical care.[12–14] The NSQIP database also provides the advantage of being the first nationally validated surgical database to provide the data from 2016 and 2017, allowing us to assess HT rates after publication of the revised ATA guidelines. We believe that the increase in HT rate after the ATA guidelines does reflect a broad shift in management and that its temporal coincidence with the release of the guidelines in fourth quarter 2015 implicates the revised guidelines as a potential impetus for the change. Of note, NSQIP does not provide oncologic (including thyroid cancer subtype, tumor size, or lymph node status) or long-term survival data, so there is no way to determine whether HT was an oncologically appropriate operation for these patients. Similarly, NSQIP includes postoperative diagnosis codes only, so it is not possible to account for patients undergoing diagnostic HT for indeterminate nodules rather than therapeutic HT for preoperatively diagnosed cancers. It is unlikely, however, that either the oncologic characteristics (in terms of cancer type, or prevalence of high-risk features and aggressive cancers) or the incidence of indeterminate nodules changed meaningfully contemporaneously with the release of the ATA guidelines.

In conclusion, after the release of the 2015 edition of the ATA guidelines, there was a significant increase in the proportion of patients undergoing HT for thyroid cancer at NSQIP hospitals. Patients treated with HT had lesser durations of stay and were more likely to be managed as outpatients. Furthermore, they had fewer surgical site infections—possibly attributable to their lesser operative times—and fewer unplanned reintubations. Thus, there are likely substantial financial benefits and decreased morbidity associated with the increased rate of hemithyroidectomy for cancer. This trend occurred in the context of a growing emphasis for less-aggressive treatment of thyroid cancers and may indicate that changes to national guidelines provide a mechanism for further decreasing overtreatment of thyroid cancers in the United States.

Disclosure

The authors report no proprietary or commercial interest in any product mentioned or 309 concept discussed in this article.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.surg.2019.03.002.

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