

# Impact of resident training on operative time and safety in hemithyroidectomy

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**ABSTRACT:** *Background.* The purpose of this study was to present our assessment of the impact of resident participation on operative duration and outcomes after hemithyroidectomy, which may identify opportunities for optimization of educational programs, reduction in cost of healthcare delivery, and maximizing patient safety, while continuing to train a competent physician workforce for the future.

*Methods.* The American College of Surgeons' National Surgical Quality Improvement Program (ACS NSQIP) dataset from 2006 to 2012 identified 13,151 adult patients who underwent hemithyroidectomy. Differences in operative duration, postoperative complications, reoperation, and readmission rates were assessed based on stratification by resident participation in surgery.

*Results.* Compared with operations performed by attending surgeons alone, resident participation with attending supervision prolonged the operative duration by 10.5% (82.5 minutes vs 91.2 minutes;  $p < .0001$ ). The incidence of readmission and wound complications was higher for patients who underwent surgery with resident participation.

*Conclusion.* Resident participation in hemithyroidectomy may be associated with increased operative duration, higher incidence of wound complications, and readmission. © 2017 Wiley Periodicals, Inc. *Head Neck* 39: 1212–1217, 2017

**KEY WORDS:** thyroid surgery, hemithyroidectomy, resident participation, operative duration, complications, length of stay, outcomes

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The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) and the hospitals participating in the ACS NSQIP 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.

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## INTRODUCTION

The ongoing changes in healthcare economics have placed greater emphasis on evaluation of established workflow, clinical care paradigms, and teaching practices in an effort to improve efficiency, promote quality, and reduce wastage of resources.

Over the last half-century, residency-training programs at academic healthcare facilities in the United States have been largely funded and supported through public programs, including Medicare.<sup>1</sup> However, with increased efforts toward fiscal responsibility and changing patterns of cost sharing, the structure and value of supporting such training have been under scrutiny.<sup>2,3</sup>

Teaching institutions and the general public have heightened awareness and expectations for quality and cost-effective delivery of care, and the impact of resident participation in clinical care is under examination.<sup>4–6</sup> Although significant focus on patient outcomes is justified, there is an urgent need to identify and improve upon indirect costs incurred by patients, institutions, and the society that may be linked to physician training.<sup>7</sup>

The traditional model of surgical residency requires hands-on instruction, mentorship, and training that largely takes place in the operating room environment. The influence of resident participation on time resource utilization in the operating room has not been studied for thyroid surgery.

The primary purpose of this study was to investigate the differences in operative duration associated with resident participation under direct attending supervision when compared to attending surgeons operating without resident assistance during hemithyroidectomy.

## MATERIALS AND METHODS

The American College of Surgeons' National Surgical Quality Improvement Program (ACS NSQIP) is a risk-mix and case-mix adjusted national quality assessment program.

Surgical clinical reviewers collect preoperative, intraoperative, postoperative, and postdischarge variables (up to 30 days after discharge) for randomly selected patients from over 700 academic and community-based healthcare facilities. Blinded risk adjusted information is made available for assessment of quality metrics, which prevents identification of individual institutions by name or type, but ensures that the complexity of sampled cases from various institutions remains comparable.<sup>8</sup>

To fulfill the study objectives, we utilized the ACS NSQIP dataset for the years 2006 to 2012. After exclusion of cases in which concurrent procedures were involved, we identified case observations with the Current Procedural Terminology codes 60220 (thyroid lobectomy, unilateral, with or without isthmusectomy) and 60225 (thyroid lobectomy, with contralateral subtotal lobectomy, including isthmusectomy) listed as the principal operative procedure.

Because neurovascular dissection contributes to a majority of time related to thyroid surgery, and because both of these codes involve neurovascular dissection on one side only, it was felt that time commitments related to procedures with these codes are likely to be different from those procedures that require bilateral neurovascular dissection (60240, total thyroidectomy), reoperative cases (60260, completion thyroidectomy), or substernal dissection (60271, total thyroidectomy, including substernal thyroid). Additionally, inclusion of total thyroidectomy (60240) with unilateral procedures may inaccurately estimate time differences because of variable involvement of residents in dissection on one side versus the other.

Using these 2 codes, we identified 16,342 cases. Cases in which data regarding surgeon participation were incomplete or when the attending surgeon was not scrubbed (but available in the immediate vicinity) were excluded. This resulted in 13,151 cases available for evaluation, and these were stratified into 2 groups; including cases in which an attending surgeon scrubbed with a resident surgeon and those in which the attending surgeon operated alone without resident assistance (the attending alone group).

Preoperative variables and comorbid conditions were assessed to establish comparability between the 2 groups. The intraoperative time endpoints were identified and operative durations were compared to assess impact of directly supervised resident participation versus cases that were performed by an attending surgeon alone. Secondary outcome variables included postoperative complications, length of hospitalization, reoperation rates, and readmission rates.

In order to limit the effect of potential outliers in a very large sample, the top and bottom 1% of values of the outcome variables were removed from the analyses. Student's *t* tests, Pearson chi-square tests (with exact tests used in which expected cell sizes were <5), and Fisher's exact tests were performed in order to examine the basic differences based on resident presence. Missing and null values were excluded for all analyses.

## RESULTS

There were no statistical differences based on sex or race between the 2 patient groups. The attending alone group demonstrated higher body mass indices (BMI; mean BMI  $\pm$  SD, 29.49  $\pm$  7.31 kg/m<sup>2</sup>) compared to the attending and resident group (28.91  $\pm$  6.98), and a higher mean age at the time of surgery (mean age in years  $\pm$  SD, 52.22  $\pm$  14.76 vs 50.37  $\pm$  14.66; Table 1).

The sets of patients were similar in prevalence of most preoperative comorbid conditions. However, the attending alone group had a statistically significant higher prevalence of patients with chronic obstructive pulmonary disease (2.1% vs 1.3%), hypertension (35.8% vs 31.7%), and history of cerebrovascular disease without neurologic deficit (1.1% vs 0.8%), compared to the attending with resident group.

When comparing time durations against attending alone group, cases involving resident participation required longer duration to achieve the various intraoperative endpoints, including time from induction of anesthesia to surgery start, surgical incision to closure (operative duration), incision closure to anesthesia stop, and total time in the operating room.

Mean duration of intervals representing anesthesia start to surgical incision (attending alone vs attending with resident groups, 28.4; SD = 10.2; vs 33.2; SD = 11.7; minutes) and incision closure to anesthesia stop (14.7; SD = 6.8; vs 17.5; SD = 7.7; minutes) were significantly shorter for the attending alone group (all *p* values < .0001; Table 2).

The total operative duration (incision to closure; "cut time") was significantly shorter for the attending alone group at 82.5 minutes (SD = 32.5 minutes) versus 91.2 minutes (SD = 34.0 minutes) for the group with resident involvement (*p* < .0001; Table 2). Similarly, patients in the attending alone group required an overall shorter utilization of operating room facility (mean duration in operating room for attending alone = 119.7 minutes (SD = 36.8 minutes) and 132.4 minutes (SD = 39.2 minutes) for the patients in the attending with resident group.

Attending surgeons when operating alone performed more outpatient-based surgeries (64.2%) compared to the attending with resident group (55.9%; *p* < .0001).

There were no significant differences in incidence of postoperative complications, including surgical site infection, pneumonia, acute renal failure, urinary tract infections, cerebrovascular accidents, cardiac arrest, myocardial infarction, bleeding, venous thromboembolism, or sepsis. The risk of requiring a return trip to the operating room was similar in the 2 groups (attending alone group = 3.7% and attending with resident group = 3.6%; *p* = .897; Table 3).

The group with resident participation (attending with resident group) experienced higher incidence of

TABLE 1. General characteristics of patients undergoing hemithyroidectomy by resident participation (total no. patients, 13,151).

General variables	Attending surgeon alone group (No. of patients, 4457)	Attending surgeon with resident group (No. of patients, 8694)	<i>p</i> value
Age, y, mean ± SD	52.22 ± 14.76	50.37 ± 14.66	< .0001
BMI, mean ± SD ( <i>n</i> = 13,063)	29.5 ± 7.3	28.9 ± 7.0	< .0001
Sex, female ( <i>n</i> = 13,117)	3614 (81.3)	6935 (80.0)	.063
Race ( <i>n</i> = 11,516)			.386
White	3314 (83.9)	6268 (82.9)	
Black	431 (10.9)	884 (11.7)	
Other	207 (5.2)	412 (5.5)	
Diabetes			.074
None	4027 (90.4)	7923 (91.1)	
Oral hypoglycemic	168 (3.8)	319 (3.7)	
Noninsulin	145 (3.3)	215 (2.5)	
Insulin	117 (2.6)	237 (2.7)	
Current smoker	665 (14.9)	1190 (13.7)	.055
Alcohol use >2 drinks/d in 2 wk before admission ( <i>n</i> = 12,948)	45 (1.0)	117 (1.4)	
Functionally dependent before surgery ( <i>n</i> = 13,150)	31 (0.7)	35 (0.4)	.024
Severe COPD	94 (2.1)	116 (1.3)	.001
Hypertension	1595 (35.8)	2757 (31.7)	> .0001
Prior PCI ( <i>n</i> = 12,948)	90 (2.1)	157 (1.8)	.364
Peripheral vascular disease resulting in revascularization or amputation ( <i>n</i> = 12,948)	10 (0.2)	17 (0.2)	.716
On dialysis	13 (0.3)	21 (0.2)	.592
Cerebrovascular accident without neuro deficit ( <i>n</i> = 12,947)	48 (1.1)	64 (0.8)	.040
Preoperative wound/infection	13 (0.3)	19 (0.2)	.420
Steroid use	50 (1.1)	119 (1.4)	.234
Recent chemotherapy (<30 d)	8 (0.2)	22 (0.3)	.412
Recent radiotherapy (<90 d) ( <i>n</i> = 12,947)	3 (0.1)	12 (0.1)	.260
Prior operation within 30 d ( <i>n</i> = 12,274)	30 (0.7)	55 (0.7)	1.000
Wound classification			.0002
I: Clean	366 (98.0)	8574 (98.6)	
II: Clean/contaminated	87 (2.0)	100 (1.2)	
III: Contaminated	4 (0.1)	20 (0.2)	
IV: Dirty	0 (0)	0 (0)	
ASA classification			< .0001
I	554 (12.4)	1130 (13.0)	
II	2909 (65.3)	5931 (68.3)	
III	957 (21.5)	1559 (17.9)	
IV	32 (0.7)	65 (0.8)	
V	2 (0)	1 (0)	
Unknown	1 (0)	4 (0.1)	
Preoperative albumin, mean ± SD ( <i>n</i> = 4412)	4.11 ± 0.44	4.12 ± 0.43	.337
Recent weight loss	24 (0.5)	37 (0.4)	.367
Outpatient procedures	2863 (64.2)	4859 (55.9)	< .0001

Abbreviations: BMI, body mass index; COPD, chronic obstructive pulmonary disease; PCI, percutaneous coronary intervention; ASA, American Society of Anesthesiologists.

All data reported as number of observations, unless otherwise indicated.

Percent value as part of category is indicated in parenthesis.

(Selected preoperative variables included; for details on additional variables, see Supplementary Table S1, online only).

wound disruption (9 events) compared to the attending alone group (no wound disruption reported; *p* = .033).

Information related to readmission within 30 days of the operation was available for procedures performed in 2011 and 2012 (*n* = 1517). Readmission risk was lower

TABLE 2. Intraoperative time variables for hemithyroidectomy.

Variables	Attending surgeon alone group	Attending surgeon with resident group	<i>p</i> value
Anesthesia start to incision time, min ± SD ( <i>n</i> = 12,760)	28.4 ± 10.2	33.2 ± 11.7	< .0001
Operative time ("cut time"), min ± SD ( <i>n</i> = 12,907)	82.5 ± 32.5	91.2 ± 34.0	< .0001
Incision closure to anesthesia stop time, min ± SD ( <i>n</i> = 12,672)	14.7 ± 6.8	17.5 ± 7.7	< .0001
Total time in operating room, min ± SD ( <i>n</i> = 12,855)	119.7 ± 36.8	132.4 ± 39.2	< .0001

All data reported as mean duration in minutes.

for patients who underwent surgery by the attending alone group (2.2% vs 4.2%; *p* = .037; Table 3).

## DISCUSSION

The quality of operative care and surgical outcomes rendered by resident trainees has been scrutinized in a variety of clinical settings, including general surgery, gynecology, urology, neurosurgery, and otorhinolaryngology.<sup>4,9–14</sup> Resident participation has been associated with increasing operative time in a variety of surgical populations. The measurement of effect of resident training on postoperative morbidity has been more difficult to assess because of issues related to sample size, heterogeneity, and inherent complexity related to the procedures that have been studied. Investigator estimations of morbidity attributable to resident participation range from increased risk to no difference in risk, and, in some cases, a decreased risk for complications.<sup>4,9–15</sup>

Resident participation in thyroid surgery has been evaluated as part of larger heterogeneous pooled analyses and studies that included small patient sample sizes with varying proportions of total, subtotal, and hemithyroidectomy procedures.<sup>13,14,16</sup>

We analyzed data from 13,151 patients who underwent hemithyroidectomy procedures between 2006 and 2012 and found that directly supervised resident participation was associated with a significant prolongation of all evaluable intraoperative time durations compared with procedures performed by the attending surgeon alone. Cut time (time from incision to closure) demonstrated an

increase by 10.5% when residents were scrubbed in the case with an attending surgeon. Similarly, total time in the operating room was increased by nearly 11% over the attending alone group.

Our analysis of a large dataset agrees with similar observations in pediatric otolaryngology, urology, orthopedics, general surgery, and others, in which prolongation of operative time was directly associated with a teaching environment.<sup>9,10,17,18</sup> A smaller analysis of hemithyroidectomy procedures by Reinisch et al<sup>14</sup> evaluated data from 88 patients and found that although resident-assisted procedures took 10 minutes longer to complete than those performed by attending surgeons alone, this difference did not achieve statistical significance in the small patient cohort. Pollei et al<sup>13</sup> identified increased cost and operative time related to the institution of otolaryngology resident training. However, the study population was heterogeneous and included a relatively modest 117 thyroidectomies over a study period of nearly 18 years. Our study helps to overcome these limitations and evaluates a large dataset with homogeneity in the nature of procedures involved, and permits detection of statistically and clinically significant differences in operative time associated with resident participation in hemithyroidectomy.

Although Puram et al<sup>18</sup> preface their observations related to prolonged operative time with resident participation with the possibility of differential case complexity, these limitations are mitigated in the current study. Because the data include a large sample that is risk adjusted and collected by independent reviewers, it is unlikely that the

TABLE 3. Selected 30-day complications, readmissions, reoperation, and length of stay by resident participation.

Variables	Attending surgeon alone (No. of patients = 4457)	Attending surgeon with resident (No. of patients = 8694)	<i>p</i> value
Superficial surgical site infection	6 (0.1)	20 (0.2)	.303
Deep incisional surgical site infection	0 (0)	4 (0.1)	.307
Wound disruption	0 (0)	9 (0.1)	.033
Pneumonia	6 (0.1)	4 (0.1)	.098
Unplanned intubation	12 (0.3)	11 (0.1)	.064
Return to OR	164 (3.7)	316 (3.6)	.897
Readmission ( <i>n</i> = 1517)	12 (2.2)	41 (4.2)	.037
Mean length of stay, days ± SD ( <i>n</i> = 13,150)	1.0 ± 1.6	0.9 ± 4.3	.557

Abbreviation: OR, operating room.

All data reported as number of observations, unless otherwise indicated. Percent value as part of category is indicated in parenthesis.

effects observed are due to differences in the complexity of patient cohorts. Additionally, data are free of selection bias that may otherwise be observed in other surgeon-recorded registries.

Although this study assesses the impact of resident participation on operative time, the training background of attending surgeons, and operative volumes may potentially influence operative time as well.<sup>19,20</sup> Because of limitations inherent to the dataset in identifying the surgical volume of individual surgeons, and specialty or subspecialty training background of attending surgeons, we did not find it feasible to reliably assess the interaction of surgical volume and training background of attending surgeons with resident participation.

Prolongation of operating room times can be associated with increased cost of health care.<sup>13,21–24</sup> These costs may be related to direct costs, such as anesthesia charges, operating room charges, or costs linked to increased risk of complications associated with a prolonged operative procedure.<sup>21,22</sup> Other indirect costs may be challenging to measure, but may have significant impact on healthcare systems, including opportunity costs to providers and potential limitation to operating room access.

Conversely, resident training may have its inherent benefits in terms of fulfilling staffing needs and creation of a competent surgical work force for the future. The balance of risk and opportunities related to resident training in the operating room may be difficult to measure, but is critical for obvious reasons.

Besides “cut time” and total time in the operating room, we found that it took longer to achieve all other operative “way points” when residents participated in the surgical care of patients undergoing hemithyroidectomy. Prolongation of time intervals related to “anesthesia start to surgical incision” and “incision closure to anesthesia stop” may be impacted by factors other than resident participation in surgery. These factors may include composition of anesthesia and ancillary teams, involvement of trainees in anesthetic care, and other workflow-related issues in the operating room.<sup>25,26</sup> However, the proficiency and time management of resident participants may also contribute to these findings to a variable degree.<sup>27</sup> Given the limitations of the data set, this cannot be clearly delineated.

In our analysis, the patient cohort operated upon by attending surgeons alone had a higher baseline comorbidity, and a higher likelihood of undergoing outpatient surgery. Despite these differences, the attending alone group demonstrated a statistically significant reduction in the number of wound disruptions and readmissions within 30 days, in comparison to the group with resident involvement. Although these findings are similar to those by Kiran et al,<sup>12</sup> who indicated a higher risk for wound complications linked to increasing operative duration, it must be emphasized that, in a large patient cohort, the overall incidence of wound disruption was infrequent, and although statistically significant, this difference may be clinically insignificant. In congruence with our findings, increased risk for postdischarge readmission was associated to resident participation by other investigators.<sup>9,11</sup> Despite a higher occurrence of outpatient procedures in the attending alone group, we observe that the overall length of

hospital stay for patients in this group was not different from that in the attending with resident group. It is possible that this difference in breakdown between outpatient and inpatient procedures in the 2 groups may be too small to detect an impact on length of hospitalization. Although we acknowledge that provider, institutional, and regional variations in classification of patients as “inpatient” or “outpatient” for similar procedures may exist because of influences of payer mix and practice patterns, the large and diverse nature of participating institutions contributing to this data are expected to mitigate the effect of such variations. We recognize that the retrospective and deidentified nature of the database creates some limitations in deriving additional conclusions related to hospital length of stay. However, it is reassuring that resident participation did not adversely impact the overall mean length of hospitalization, which remained comparable between the 2 groups at or below 1 day.

There were no statistical differences when comparing other intraoperative or postoperative outcomes, including hemorrhage, reoperative risk, and other medical and surgical complications. This is in line with a recent study that identified no differences in short-term morbidity and mortality in patients who underwent major head and neck surgery with or without resident participation.<sup>4</sup> Although the current NSQIP dataset limits the ability for evaluation of recurrent laryngeal nerve dysfunction or hypoparathyroidism, other smaller studies did not find any significant differences in risk of these complications between patients operated upon by attending surgeons alone, or with resident participation.<sup>14,28</sup>

Data from this study and others indicate that the current operating room based mentored training can be accomplished with relative safety, but may incur significant direct and indirect costs related to prolonged utilization of the operating room resources. In a health care economy that is increasingly and rightly cost sensitive, this information may inform and impact patient choices, clinician and organizational practices, and contract negotiations by institutions and insurance providers.

Resident participation in the operating room is particularly important to ensure the training of skilled surgical workforce of tomorrow, because studies indicate a looming national physician shortage over the coming decades. The Association of American Medical Colleges forecasts a physician shortage between 46,100 and 90,400 physicians by the year 2025.<sup>29</sup> These anticipated shortages make conditions rife for significant unmet needs with ongoing factors, like an aging “baby boomer” generation, attrition of aging physicians, and likely increasing patient access to health care under reforms like the Affordable Care Act.<sup>30</sup>

In this setting, a reflexive condemnation of longer operating room times and potentially related costs in surgical training programs, although easy, may be ill advised and simplistic. On the other hand, inertia is not an option for a health care economy whose fiscal burdens threaten to jeopardize national priorities.

Our study draws attention to the unique opportunities available to improve training and reduce operating room time and resource utilization. The ideas of value-based care and resident education do not have to be competing goals, and strategies to improve operating room efficiency,

workflow management, and communication may help achieve both.

Indeed, integration of simulation training and goal-oriented approaches in resident work style has been shown to improve metrics in a variety of hospital-based activities.<sup>31,32</sup> Skill acquisition and development through courses outside the operating room may serve as good preparation and may improve skill and efficiency in the operating room.<sup>33</sup> Communication of expectations, goals, and preoperative preparatory guidance for residents and timely and in-depth feedback related to operative performance may identify areas for reflection, adjustment, and improvements.<sup>34,35</sup> Changing the workflow such that efficiencies and parallel processes are the norm is an opportunity that should be emphasized.

These findings may serve to reassure the public and policy makers about comparative safety of resident training during such procedures. Additionally, it may inform educators about opportunities to reduce the impact of resident training on operating room time utilization by identifying and incorporating strategies, such as simulation, workflow review, and clear communication of plans inside and outside the operating room.

## CONCLUSION

Directly supervised participation by residents in training may be associated with prolonged operative duration and a potential increase in the 30-day readmission rates for patients undergoing a hemithyroidectomy. The perceived costs related to the training environment should be balanced with the need to train competent surgical providers. Opportunities for process improvement and innovative redesign of training practices may help to mitigate effects of resident participation on operating room resource utilization.

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