Title

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Journal

Indian Journal of Otolaryngology and Head and Neck Surgery, 74(Suppl 3)

ISSN

2231-3796

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Publication Date

2022-12-01

DOI

10.1007/s12070-021-02650-5

Peer reviewed

Indian J Otolaryngol Head Neck Surg
(December 2022) 74(Suppl 3):S5384–S5390; https://doi.org/10.1007/s12070-021-02650-5

ORIGINAL ARTICLE

Discrepancies in Thyroidectomy Outcomes Between General Surgeons and Otolaryngologists

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Received: 12 April 2021 / Accepted: 17 May 2021 / Published online: 28 May 2021

Abstract Thyroidectomy is a common operation, performed by general surgeons and otolaryngologists. Few studies compare complication rates between these two specialties. We hypothesized that there would be no difference in the incidence of postoperative complications including recurrent laryngeal nerve (RLN) injury, hypocalcemia, or hematoma based on the surgical specialty performing the thyroidectomy. The 2016–2017 National Surgical Quality Improvement Program Targeted Thyroidectomy database was queried for patients who underwent thyroidectomy for both benign and malignant thyroid diseases. Thyroidectomies performed by general surgeons were compared to those performed by otolaryngologists. Multivariate logistic regression was used to identify risk factors associated with RLN injury, hematoma, and hypocalcemia. From 11,595 patients, 6313 (54.4%) were performed by general surgeons and 5282 (45.6%) by otolaryngologists. Goiter (43.7%) and nodule/neoplasm (40.8%) were the most common indications for the general surgery and otolaryngology cohorts respectively. General surgeons used an energy vessel sealant device more frequently (77.7% vs. 51.5%, $p < 0.001$), whereas RLN monitoring (67.4% vs. 58.3%, $p < 0.001$) and drain placement (44.3% vs. 14.8%, $p < 0.001$) were utilized more often by otolaryngology. After controlling for covariates, thyroidectomy by general surgeons had an increased associated risk of RLN injury (OR = 1.26, CI = 1.07–1.48, $p = 0.006$) and post-operative hypocalcemia (OR = 1.17, CI = 1.00–1.37, p = 0.046). Thyroidectomy volume is relatively equally distributed among general surgeons and otolaryngologists. Operation by a general surgeon is associated with an increased risk for RLN injury and postoperative hypocalcemia. This discrepancy may be explained by case volume, training, and/or completion of an endocrine surgery fellowship; however, this discrepancy still merits ongoing attention.

Keywords Thyroidectomy · Recurrent laryngeal nerve injury · Surgical oncology · Otolaryngology · Endocrine surgery

Introduction

Thyroidectomy is a commonly performed surgical procedure for benign and malignant thyroid diseases [1]. As the incidence of thyroid cancer increases, it is projected that that the surgical burden of thyroid disease will continue to rise [2]. The rate of new thyroid cancer diagnoses has increased annually by over 5% per year and the American Cancer Society projects over 52,000 new cases of thyroid cancer in 2020 [3, 4].

Thyroidectomy is a well-tolerated procedure, with a reported mortality rate less than 0.2% and a relatively low morbidity [5–8]. However, significant complications specific to thyroidectomy may occur; such as recurrent laryngeal nerve (RLN) injury (0.5–10%), postoperative hypocalcemia (6.2–38%), and neck hematoma (0.7–1.5%) [5, 9–11]. An injury to the RLN can cause transient or permanent dysphonia. Postoperative hypocalcemia due to

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direct trauma or devascularization of the adjacent parathyroid glands may manifest with neuromuscular and neurological symptoms. Lastly, an expanding neck hematoma may lead to progressive airway compromise and require emergent decompression.

The vast majority of thyroid procedures are performed by general surgeons (including surgical oncology and/or endocrine fellowship-trained general surgeons) or otolaryngologists [12, 13]. Regardless of specialty, high surgical volume is a known predictor of improved outcomes after thyroidectomy [14, 15]. Several studies have assessed significant differences in residency training, resident involvement, and perioperative practices between general surgery and otolaryngology in the context of thyroid surgery [16–20]. Despite these differences, little is known about the relationship between surgical specialty and thyroidectomy complications. Studies comparing outcomes between general surgery and otolaryngology are rare [19, 21, 22]. Thus, we sought to compare clinical outcomes of patients undergoing thyroidectomy performed by otolaryngology versus general surgery. We hypothesize that there would be no significant difference in the incidence of postoperative complications such as RLN injury, post-operative hypocalcemia, or neck hematoma based on the surgical specialty performing the surgery.

Methods

The American College of Surgeon National Surgical Quality Improvement Program (ACS-NSQIP) Procedure Targeted Thyroidectomy database was queried to identify adult patients who underwent thyroidectomy for both benign and malignant diseases in 2016 and 2017. Any patient without a documented surgical service performing the thyroidectomy was excluded. Two groups were compared: general surgery versus otolaryngology. The primary outcomes were RLN injury, postoperative hypocalcemia, and neck hematoma. RLN injury was defined, per the NSQIP dictionary, as persistent hoarseness or vocal cord dysfunction beyond post-operative day one, with and without confirmation by laryngoscopy. The relationship between post-operative complications and baseline patient demographics, pre-hospital comorbidities, operative information, and provider specialty were analyzed.

Patient demographic information was collected including pre-hospital comorbidities such as hypertension (HTN), congestive heart failure (CHF), dialysis, chronic obstructive pulmonary disease (COPD), smoking status, diabetes, steroid use, and prior neck surgery. Indications for thyroidectomy included benign and malignant pathology. Operative information such as central neck dissection, intra-operative nerve monitoring, use of a vessel sealant device such as LigaSure or Harmonic scalpel, and use of closed suction drain placement in the neck were collected. The outcomes evaluated included hospital length of stay (LOS), operative time, and mortality. Additional postoperative complications analyzed included vocal paralysis (with confirmation by laryngoscopy), pneumonia, ventilation greater than 48-h, unplanned intubation, stridor or dyspnea, and respiratory failure.

A Student's t-test or Mann–Whitney-U test were used to compare continuous variables and chi-square was used to compare categorical variables for bivariate analysis. Categorical data was reported as percentages, and continuous data was reported as medians with interquartile range. The magnitude of the association between predictor variables and primary outcomes were first measured using a univariable logistic regression model and chosen based on a review of the literature [5–11]. Covariates were entered into a hierarchical multivariate logistic regression model and the risk for each post-thyroidectomy complication was reported with an odds ratio (OR) and 95% confidence intervals (CI). All p-values were two-sided, with a statistical significance level of < 0.05. All analyses were performed with IBM SPSS Statistics for Windows (Version 24, IBM Corp., Armonk, NY).

Results

Patient Demographics

From 11,595 patients, 6313 (54.4%) underwent surgery by a general surgeon and 5282 (45.6%) by an otolaryngologist. The general surgery cohort was older compared to the otolaryngology cohort (median age, 53 vs. 52-years-old, $p = 0.016$), and included a larger percentage of female patients (79.7% vs. 76.5%, $p < 0.001$). General surgery patients were less often American Society of Anesthesiologists (ASA) physical status class 1 compared to otolaryngologists (5.4% vs 8.7%, $p < 0.001$). Compared to otolaryngology patients, the general surgery patients had increased rates of hypertension (40.1% vs. 36.9%, $p < 0.001$), CHF (0.6% vs. 0.3%, $p = 0.011$), and dialysis (0.5% vs. 0.2%, $p = 0.002$) (Table 1).

Indications for Surgery and Operative Characteristics

The most common indication for surgery by a general surgeon was goiter (43.7%) and the most common indication for surgery by an otolaryngologist was single nodule or neoplasm (40.8%) (Table 2). A central neck dissection was performed for the majority of cases in each cohort, but more often performed by general surgeons (76.2% vs. 73%,

Table 1 Thyroidectomy patient characteristics

Variable	General surgery (N = 6313, 54.4%)	Otolaryngology (N = 5282, 45.6%)	*p* value
Age, years, median (IQR)	53.0 (40, 64)	52.0 (41, 62)	0.016
Sex, female, n (%)	5033 (79.7%)	4040 (76.5%)	< 0.001
Race, n (%)			< 0.001
White	3996 (63.3%)	2649 (50.2%)	
Black	1083 (17.2%)	634 (12%)	
Asian	346 (5.5%)	159 (3%)	
Native American/Alaskan	21 (0.3%)	42 (0.8%)	
Pacific/Hawaii native	8 (0.1%)	27 (0.5%)	
Not reported	859 (13.6%)	1771 (33.5%)	
Ethnicity, n (%)			
Hispanic	373 (6.7%)	210 (5.9%)	0.126
ASA classification, n (%)			< 0.001
1	338 (5.4%)	457 (8.7%)	
2	3680 (58.3%)	2988 (56.6%)	
3	2129 (33.7%)	1688 (32.0%)	
4	134 (2.1%)	107 (2.0%)	
None assigned	32 (0.5%)	42 (0.8%)	
Neoplasm*	3758 (59.5%)	3289 (62.3%)	0.003
History of prior neck surgery	554 (8.6%)	590 (11.2%)	< 0.001
Comorbidities			
HTN	2534 (40.1%)	1948 (36.9%)	< 0.001
CHF	38 (0.6%)	15 (0.3%)	0.011
Dialysis	32 (0.5%)	9 (0.2%)	0.002
COPD	186 (2.9%)	145 (2.7%)	0.517
Smoker	937 (14.8%)	825 (15.6%)	0.246
Diabetes	867 (13.7%)	674 (12.8%)	0.124
Steroid Use	186 (2.9%)	130 (2.5%)	0.110

IQR interquartile range, *ASA* American society of anesthesiologists physical status, *HTN* hypertension, *CHF* congestive heart failure, *COPD* chronic obstructive pulmonary disease.

*Neoplasm: final pathology report indicated benign or malignant neoplasm

$p < 0.001$). In terms of operative technique, general surgeons used an energy vessel sealant device more frequently than otolaryngologists (77.7% vs. 51.5%, $p < 0.001$). In contrast, RLN monitoring (67.4% vs. 58.3%, $p < 0.001$) and placement of closed suction drain in the neck (44.3% vs. 14.8%, $p < 0.001$) were used more often by otolaryngology. General surgeons had statistically longer operation times compared to otolaryngologists (121.7 and 115.3 min, $p < 0.001$) (Table 3). Postoperatively, general surgeons more often checked patient calcium levels (65.8% vs. 60.8%, $p < 0.001$), whereas otolaryngologists more often checked patient parathyroid hormone (PTH) levels (42.9% vs. 37.9%, $p < 0.001$) (Table 2).

Primary Outcomes

RLN injury occurred more frequently in general surgery cases compared to otolaryngology cases (6.7% vs. 5.2%, $p < 0.001$). Unilateral or bilateral vocal cord paralysis (confirmed by laryngoscopy) occurred in only 2 patients in each cohort ($p > 0.05$). In addition, the incidence of hypocalcemia within 30 days was higher for general surgery cases compared to otolaryngology cases (7.1% vs. 6.1%, $p = 0.034$), as was the incidence of hypocalcemia prior to discharge (4.5% vs. 4.7%, $p < 0.001$). However, the two cohorts had similar rates of post-operative neck hematoma (1.6% vs. 1.8%, $p = 0.332$). There were no differences in incidence of postoperative pneumonia, ventilation, unplanned intubation, stridor or dyspnea, or respiratory failure. The mean LOS was higher for otolaryngology compared to general surgery (1.33 vs.

Table 2 Operative information and primary indications for thyroidectomy

Variable	General surgery	Otolaryngology	*p* value
Indication, n (%)			$p < 0.001$
Goiter	2761 (43.7%)	1786 (33.8%)	
Graves	463 (7.3%)	286 (5.4%)	
Thyroid malignancy	905 (14.3%)	891 (16.9%)	
Lymphoma, sarcoma	12 (0.2%)	11 (0.2%)	
Single nodule or neoplasm	1990 (31.5%)	2153 (40.8%)	
Other specified/ unknown	182 (2.9%)	155 (2.9%)	
Operative information, n (%)			
Nerve monitoring	3638 (58.3%)	3509 (67.4%)	< 0.001
Drain placement	934 (14.8%)	2338 (44.3%)	< 0.001
Energy sealant device use	4780 (77.7%)	2663 (51.5%)	< 0.001
Central neck dissection	4779 (76.2%)	3799 (73.3%)	< 0.001
Checked postop Ca level	4154 (65.8%)	3213 (60.8%)	< 0.001
Checked postop PTH level	2392 (37.9%)	2267 (42.9%)	< 0.001

Ca calcium, *PTH* parathyroid hormone

Table 3 Complications by surgeon specialty

Outcome variables	General surgery	Otolaryngology	*p* value
Mortality	5 (0.1%)	1 (0.0%)	0.155
Total operation time, minutes, mean (SD)	121.71 (0.835)	115.34 (1.022)	< 0.001
LOS, days, mean (SD)	1.23 (0.043)	1.33 (0.039)	< 0.001
Postoperative complications, n (%)			
RLN injury	419 (6.7%)	267 (5.2%)	0.001
Vocal cord paralysis	2 (0.0%)	2 (0.0%)	0.858
Hypocalcemia prior to discharge	285 (4.5%)	249 (4.7%)	< 0.001
Hypocalcemia within 30 days	423 (7.1%)	309 (6.1%)	0.034
Hematoma	100 (1.6%)	95 (1.8%)	0.332
Pneumonia	16 (0.3%)	9 (0.2%)	0.337
Ventilation > 48 h	15 (0.2%)	14 (0.3%)	0.768
Unplanned intubation	29 (0.5%)	20 (0.4%)	0.505
Stridor or dyspnea	3 (0.0%)	3 (0.1%)	0.827
Respiratory failure	1 (0.0%)	0 (0.0%)	0.360

SD standard deviation, *LOS* length of hospital stay

1.23 days, $p < 0.001$). Overall mortality was very low and did not differ among cohorts (0.1% vs. < 0.1%, $p = 0.155$) (Table 3).

Multivariable Regression Analysis for Risk of RLN Injury

On multivariable analysis, independent risk factors predisposing to RLN injury included operation by a general surgeon compared to an otolaryngologist (OR = 1.26, CI = 1.07–1.48, $p = 0.006$), age over 65-years-old (vs. younger) (OR = 1.59, CI = 1.34–1.89, $p < 0.001$), and operation time greater than two hours (OR = 1.94, CI = 1.65–2.28, $p < 0.001$). Nerve monitoring was associated with decreased risk of RLN injury (OR = 0.81, CI = 0.68–0.95, $p = 0.01$) (Table 4). Having a prior history of neck surgery, male sex, undergoing central neck dissection, and having a benign or malignant neoplasm (indicated on final pathology) did not increase the risk of RLN injury.

Multivariable Regression Analysis for Risk of Hypocalcemia

When controlling for significant covariates there was an increased risk of hypocalcemia within 30 days when comparing general surgeons to otolaryngologists (OR = 1.17, CI = 1.00–1.37, $p = 0.046$). Additional significant risk factors for postoperative hypocalcemia included central neck dissection (OR = 2.17, CI = 1.85–2.55, $p < 0.001$), male sex (OR = 1.54, CI = 1.25–1.89, $p < 0.001$), and operation time greater than two hours (OR = 1.72, CI = 1.47–2.00, $p < 0.001$). Age greater than 65-years-old was associated with decreased risk for developing hypocalcemia (OR = 0.60, CI = 0.48–0.75, $p < 0.001$) (Table 5).

Multivariable Regression Analysis for Development of Neck Hematoma

After controlling for covariates there was no difference in risk of neck hematoma when comparing general surgeons

Table 4 Multivariable analysis for risk of recurrent laryngeal nerve injury in thyroidectomy patients

Risk factor	OR	95% CI	*p* value
Operation by general surgeon versus otolaryngologist	1.26	1.07–1.48	0.006
Nerve monitoring	0.81	0.68–0.95	0.010
History of prior neck surgery	1.13	0.88–1.47	0.343
Male sex	1.16	0.95–1.41	0.142
Age > 65	1.59	1.34–1.89	< 0.001
Operation time > 2 h	1.94	1.65–2.28	< 0.001
Neoplasm	1.11	0.94–1.31	0.233
Central neck dissection	1.15	0.96–1.38	0.121

Table 5 Multivariable analysis for risk of developing hypocalcemia within 30 days of thyroidectomy

Risk factor	OR	95% CI	*p* value
Operation by general surgeon versus otolaryngologist	1.17	1.00–1.37	0.046
Nerve monitoring	0.83	0.71–0.97	0.022
History of prior neck surgery	1.22	0.95–1.56	0.125
Male sex	1.54	1.25–1.89	< 0.001
Age > 65	0.60	0.48–0.75	< 0.001
Operation time > 2 h	1.72	1.47–2.00	< 0.001
Neoplasm	1.18	1.00–1.39	0.05
Central neck dissection	2.17	1.85–2.55	< 0.001

Table 6 Multivariable analysis for risk of developing neck hematoma in thyroidectomy patients

Risk factor	OR	95% CI	*p* value
Operation by general surgeon versus otolaryngologist	1.02	0.74–1.39	0.923
Energy sealant device use	0.56	0.42–0.76	< 0.001
Drain placement	0.95	0.67–1.35	0.796
History of prior neck surgery	0.76	0.45–1.28	0.305
Male sex	0.57	0.42–0.77	< 0.001
Age > 65	1.46	1.06–2.00	0.021
Operation time > 2 h	1.19	0.87–1.63	0.267
Neoplasm	0.65	0.48–0.86	0.003
Central neck dissection	1.05	0.75–1.48	0.780

to otolaryngologists (OR = 1.02, CI = 0.73–1.39, $p = 0.923$). Age over 65 years (OR = 1.46, CI = 1.06–2.00, $p = 0.021$) was the only factor associated with increased risk (Table 6).

Discussion

As the burden of operative thyroid disease rises there is increased demand for thyroid surgeons regardless of initial residency training. Over the past two decades, there has been a two-fold increase in the number of office visits to otolaryngology or general surgery for thyroid-related diseases [13]. This nationwide sample using NSQIP data, demonstrates that thyroidectomy is currently performed by a relatively equal mix of general surgeons and otolaryngologists. However, on multivariate analysis, operations performed by general surgeons were associated with a higher risk for RLN injury and postoperative hypocalcemia compared to otolaryngologists. There was no difference in risk of neck hematoma. We found variations in operative technique, with general surgeons more likely to use energy vessel sealant device and otolaryngologists more likely to use nerve monitoring or leave a drain. When evaluating nontechnical morbidity such as pneumonia or unplanned intubation there was no difference between the two groups.

RLN injury is a known complication of thyroid surgery, and can lead to transient or permanent vocal cord paralysis; rarely bilateral vocal cord involvement can lead to airway compromise requiring tracheostomy. The average incidence of RLN palsy in the immediate postoperative period is reported between 0.5 and 10.0%, while permanent RLN injury rates range from 0 to 5% [9, 11, 23–25]. However, there is limited data regarding the rates of RLN injury based on provider specialty. One single-center retrospective German study by Kohnen et al. observed a significantly lower vocal cord palsy rate in thyroid operations performed by otolaryngologists (4.7%) compared to general surgeons (8.2%) (OR = 0.55, $p < 0.001$) [22]. Similarly, our national analysis found 1.26 times increased associated risk for RLN injury by general surgeons. Furthermore, this study controlled for presence of neoplasm, prior neck surgery, and reoperation which are known risk factors for RLN palsy [24, 26]. It may be tempting to attribute this difference to the utilization of intraoperative nerve monitoring (IONM), however, our analysis controlled for the use of IONM. In addition the increased use of energy-based devices by general surgeons could hypothetically cause an increased risk of thermal nerve injury, however, the safety of these devices has been shown in a prior large systemic review [27].

One potential explanation for the disparity in thyroid specific complications is a difference in thyroidectomy case volume between otolaryngologists and general surgeons. Zarebczan et al. [16] previously documented significant differences in endocrine case volumes among graduating U.S. residents; with otolaryngology residents performing twice as many thyroid and parathyroid operations compared to general surgery residents. This decrease in case volume is reflected in residents' own perspective on thyroid surgery competency as shown by Lee et al. who found that otolaryngology residents were more confident performing thyroid surgery independently (95%) compared to general surgery residents (81%) [17]. While disparities in endocrine training within otolaryngology and general surgery is an important factor that residency programs nationwide should be aware of, this is certainly not to say general surgeons do not make good thyroid surgeons. Greater than 70% of general surgery residents seek additional fellowship training [28]. Therefore, these findings may be a product of general surgeons who are non-fellowship trained having higher rates of RLN injury and hypocalcemia, which is a significant limitation of the NSQIP database as it does not provide case volume and/or level of training. In support of this, in a previous study

endocrine specialization was associated with higher case volume per year and lower rates of RLN palsy compared to non-fellowship trained general surgeons [14]. Future research is needed to determine if the discrepancy in RLN injury is a product of training differences or case volume and if so, is there a way to offset this risk with strategic interventions such as augmented residency case numbers or elucidate a case volume threshold to optimally perform thyroid surgery.

Few studies have evaluated the impact of surgical specialty on the risk of post-thyroidectomy complications. In a 2010–2015 NSQIP database analysis consisting of 55,402 patients, Monteiro et al. found no differences in duration of stay, morbidity, or return to operating room when comparing otolaryngology to general surgery [19]. Unfortunately at that time NSQIP did not specify specific post-thyroidectomy complications (i.e. RLN injury, hypocalcemia, or neck hematoma). An additional single center retrospective review by Kim et al. analyzed 96 cases performed by general otolaryngologists and saw no discrepancies between their rate of complications compared to rates reported in the literature by general surgeons [21]. Furthermore, a prospective cohort of 255 patients studied by Gonzalez et al. observed a significantly lower incidence of hypocalcemia in patients operated on by endocrine-specialized surgeons compared to general surgeons [14]. Thereby suggesting that operative volume and/or fellowship training as opposed to one's residency training may be the most important factor to minimize the risk for post-op hypocalcemia or nerve injury. This is correlated by multiple other studies which shows an inverse relation between operative volume and complications [15, 29–31].

Several studies have independently examined risk factors that contribute to or prevent post-thyroidectomy hematoma. Post-surgical thyroid drains have not been found to offer any significant advantage in reducing hematoma or hemorrhage risk and have been associated with increased length of stay and surgical site infections [32]. In this context, the stark difference in thyroidectomy practice between general surgeons and otolaryngologists—drain placement (14.8% vs. 44.3%) is intriguing. This may point to a more fundamental difference in otolaryngology and general surgery training.

This study represents an effort to understand differences in thyroid surgery outcomes between general surgery and otolaryngology on a national level. It has several limitations including those inherent to retrospective large database studies including misclassification, missing data, and selection bias. The NSQIP database attempts to safeguard against this through its random sampling process designed to minimize selection bias with regards to multispecialty cases. A significant limitation, as previously mentioned, is the lack of data regarding the surgeon's experience such as current case volume and prior training (residency and/or fellowship). Additional pertinent missing data variables include whether there was clear intraoperative identification of the RLN and parathyroid glands, intraoperative PTH values, postoperative use of antiplatelet/anticoagulants, intraoperative findings, and persistent hypocalcemia or nerve palsy. Despite these many limitations our study provides a generalizable framework for ongoing discussion regarding multi-specialty care for patients requiring thyroidectomy. The authors do not believe this is an indictment of general surgeons but should serve to further the discussions toward considering thyroidectomy to be specialized surgery that is best performed by those with sufficient training and ongoing case volume.

Thyroidectomy volume is equally distributed between general surgeons and otolaryngologists, however differences in practice and outcomes exist. Thyroidectomy by a general surgeon is associated with an increased risk for RLN injury and postoperative hypocalcemia, while the risk for neck hematoma appears similar between otolaryngology and general surgery specialties. While this discrepancy may be explained by case volume, training, or completion of an endocrine surgery fellowship, this difference still merits ongoing attention.

Acknowledgements This study was supported by the faculty of University of California in Irvine. Authors did not have any potential conflict of interest.

Author contributions SS contributed to data curation, visualization, and writing the original draft. AG contributed to the conceptualization, methodology, and formal analysis. RR, ZJ, MY, and ML contributed to the critical revision of the manuscript. JN contributed to the conceptualization, methodology, formal analysis, supervision, and final approval of the version to be published.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data Availability The data that support the findings of this study are available from the American College of Surgeons. Restrictions apply to the availability of these data, which were used under license for this study. Data are available https://www.facs.org/quality-programs/acs-nsqip/participant-use with the permission of The American College of Surgeons.

Declarations

Conflict of interest The authors report no actual or potential conflicts of interest, financial or otherwise.

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