Sex-Specific Differences in Outcomes Following Thyroidectomy: A Population-Based Cohort Study

Lara Gut\textsuperscript{a}  Selina Bernet\textsuperscript{a}  Monika Huembelin\textsuperscript{a}  Magdalena Mueller\textsuperscript{a}  Ciril Baechli\textsuperscript{a}  Daniel Koch\textsuperscript{a}  Christian Nebiker\textsuperscript{b}  Philipp Schuetz\textsuperscript{a}  Beat Mueller\textsuperscript{a}  Emanuel Christ\textsuperscript{c}  Fahim Ebrahimi\textsuperscript{c,d}  Alexander Kutz\textsuperscript{a,c}

\textsuperscript{a}Division of Endocrinology, Diabetes, and Metabolism, University Department of Medicine, Kantonsspital Aarau, Aarau, Switzerland; \textsuperscript{b}Department of Surgery, Cantonal Hospital of Aarau, Aarau, Switzerland; \textsuperscript{c}Division of Endocrinology, Diabetes, and Metabolism, University Hospital Basel, Basel, Switzerland; \textsuperscript{d}University Center for Gastrointestinal and Liver Diseases, St. Clara Hospital and University Hospital, Basel, Switzerland

Keywords
Sex · Thyroidectomy · Readmission · Intensive care unit · Outcome · Postsurgical complications · Hypocalcemia · Vocal cord paresis · Hematoma

Abstract

Introduction: Numbers of thyroidectomies and awareness of postoperative quality measures have both increased. Potential sex-specific variations in clinical outcomes of patients undergoing thyroidectomy are controversial. Objective: The aim of this study was to investigate sex-specific differences in outcomes following thyroidectomy. Methods: This is a population-based cohort study of all adult patients undergoing either hemi- or total thyroidectomy in Switzerland from 2011 to 2015. The primary outcome was all-cause 30-day readmission rate. The main secondary outcomes were intensive care unit (ICU) admission, surgical re-intervention, in-hospital mortality, length of hospital stay (LOS), postsurgical calcium disorder, vocal cord paresis, and hematoma. Results: Of 16,776 patients undergoing thyroidectomy, the majority of patients undergoing thyroidectomy were female (79%), with a median age of 52 (IQR 42–64) years. Within 30 days after the surgery, male patients had significantly higher rates of hospital readmission (adjusted risk ratio [RR] 1.38; 95% confidence interval [95% CI] 1.11–1.72, \( p = 0.008 \)) and higher risks for postoperative ICU admission (RR 1.25; 95% CI, 1.09–1.44, \( p = 0.003 \)) than female patients. There were no significant differences among sexes in the LOS, rates of surgical re-interventions, or in-hospital mortality. While postsurgical calcium disorders due to hypoparathyroidism were less prevalent among male patients (RR 0.63; 95% CI, 0.54–0.72, \( p < 0.001 \)), a 2-fold higher incidence rate of postoperative hematoma was observed (RR 1.93, 95% CI, 1.51–2.46, \( p < 0.001 \)). Conclusions: Male patients undergoing thyroidectomy have higher 30-day hospital readmission and ICU admission rates. Following surgery, male patients revealed higher rates of neck hematoma, while hypocalcemia was more frequent among female patients.

Lara Gut and Selina Bernet contributed equally as first authors. Fahim Ebrahimi and Alexander Kutz contributed equally as senior authors.
Sex Differences in Outcomes after Thyroidectomy

Introduction

Thyroid surgery has evolved to one of the most common procedures in endocrine surgery, and over the past decades, numbers of thyroidectomies have substantially risen, in particular in female patients [1, 2]. With increasing numbers of surgical procedures, and thus a higher patient exposure, the awareness on postoperative quality measures is paramount. Since the early improvements of the surgical procedure by Kocher in the late 19th century, postoperative mortality has declined drastically, currently being below 0.15% [3–5]. Other quality outcomes of interest are postoperative hospital readmission rates ranging between 2.9 and 4.7% as well as unplanned surgical re-interventions, which were necessary in 0.07–1.95% of all cases following thyroidectomy [4, 6, 7]. The most frequently reported adverse events after thyroidectomy are disorders of calcium homeostasis due to transient or permanent hypoparathyroidism, vocal cord paresis, and neck hematoma [7–10].

Various factors determine clinical outcomes after thyroidectomy, including experience of the performing surgeon, size and procedural volume of the hospital, and quality of perioperative management [4, 11–19]. Due to the extent of surgery, total thyroidectomy has been known to have a higher rate of complications than hemithyroidectomy [14, 20]. Relevant patient factors determining outcomes are age and ASA score (physical status classification system) [21], malignant thyroid disorder as underlying disease, and comorbidities such as diabetes mellitus, obesity, malnutrition, and chronic obstructive pulmonary disease [7, 13–15].

Besides, there is growing evidence of sex disparities in clinical outcomes after thyroidectomy with conflicting results. Some studies revealed poorer outcomes in male patients [7, 22, 23], while others contradict these results [14, 24]. However, underlying reasons for potential sex-specific differences remain poorly understood so far. Hence, the aim of this study was to investigate sex-specific variations in relevant patient-oriented clinical outcomes following thyroidectomy using a large population-based cohort.

Material and Methods

Study Design, Data Sources, and Participants

In this nationwide cohort study, data were provided by the Swiss Federal Office for Statistics (Bundesamt für Statistik, Neuchâtel, Switzerland). In this database, the patient information is fully pseudo-anonymized. We included all hospitalizations for adult inpatients undergoing hemi- or total thyroidectomy from January 1, 2011, to November 30, 2015. No written informed consent was given to the patients who were unidentifiable due to pseudo-anonymization. The database includes all Swiss inpatient discharge records from acute care, general, and specialty hospitals, excluding hospital units of post-acute care institutions, regardless of payer, and thus, creates a near 100% sample of inpatient discharges in Switzerland between 2011 and 2015. Each patient in this database was uniquely identified so that rehospitalizations could be tracked. A single patient may have more than one index admission in the study period. The database included information such as patient’s residency, hospital teaching level, year and month of hospitalization, length of hospital stay (LOS) as well as age at admission, and admission diagnosis. Medical diagnoses were coded using the International Classification of Disease version 10, German Modification (ICD-10 GM) codes (http://www.who.int/classifications/icd/en/).

To qualify for inclusion in this study cohort, hospitalized patients must have had a principal discharge record featuring a hemi- or total thyroidectomy according to the “Swiss classification of operation” code: 06.2, 06.2X, 06.2X.00, 06.2X.11, 06.2X.12, 06.2X.99, 06.39, 06.39.00, 06.39.11, 06.39.12, 06.39.13, 06.39.14, 06.39.15, and 06.39.99 for hemithyroidectomies and 06.4X, 06.4X.00, 06.4X.10, 06.4X.11, 06.4X.99 and 06.50, 06.50.00, 06.50.10, 06.50.99, 06.51, 06.51.00, 06.51.10, 06.51.00, 06.52, 06.52.00, 06.52.10, and 06.52.99 for total thyroidectomies. According to the SwissDRG definition, all admissions after 18 days from discharge or admissions into another hospital were defined as new case in the nationwide hospital claims data [25]. For the end point of all-cause readmission rate, every rehospitalization within 30 days after discharge was counted as hospital readmission. Solely unplanned readmissions to hospital were included, whereas planned rehospitalizations due to adjuvant radioactive iodine therapy or completion surgery were not considered for the end point assessment. In patients who were transferred between acute care hospitals, the hospital stays were combined into a single episode of care and the patient outcome was attributed to the first hospitalization. Readmissions were always attributed to the discharging hospital. Patients without hemi- or total thyroidectomy as main procedure and nonadult (age <18 years) admissions were excluded from the analysis. All hospitalizations to a clinical department other than the surgical department (e.g., gynecological, pediatric, geriatric, and psychiatric) were also excluded from the analysis. All eligible patients required an underlying thyroid pathology.

Institutional review board approval, including waiver of the requirement of participant informed consent, as the data were de-identified, was provided by the Institutional Review Board of Northwestern Switzerland (AG/SO 2009/074 and EKNZ BASEC PB_2017-00449). This study followed the Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines [26].

Outcomes

The primary outcome was all-cause 30-day readmission rate. Readmissions could be tracked for each patient on a longitudinal scale including admissions to surgical and nonsurgical departments. Secondary outcomes were all-cause 1-year readmission rate, ICU admission rate, surgical re-intervention rate, in-hospital mortality rate, and LOS. Further secondary outcomes included incidence of calcium disorders, vocal cord paresis, and neck hema-
For coding of postoperative hematoma in Switzerland, it is mandatory to confirm causality with a previous surgical intervention. All outcomes were stratified by type of thyroidectomy (hemi- or total thyroidectomy). To determine the cause of re-admission, primary and secondary diagnoses as well as coded treatments of each readmission were independently reviewed by 4 authors and grouped into clinically relevant categories.

Statistical Analysis
In all analyses, we examined patient sex as an exposure potentially associated with postoperative outcomes. Descriptive statistics were used to compare male and female patients stratified by type of thyroidectomy. Summary statistics were calculated for patient demographics and major comorbid conditions for each study cohort. Estimates of the effect size and corresponding 95% confidence intervals (CI) were determined using linear, logistic, or Cox proportional hazards regression, as appropriate. Multivariable regression analyses were adjusted for age, underlying thyroid disorder, neck dissection, thyroid hormone function, Charlson comorbidity index (CCI), comorbidities (diabetes mellitus, obesity, neoplasms other than thyroid carcinoma, cardiovascular diseases, hypertension, chronic obstructive pulmonary disease, and renal insufficiency), quality outcomes (calcium disorder, vocal cord paralysis, and hematoma), hospital size and teaching level, and date and type of admission. Kaplan-Meier curves were used to illustrate differences in time to discharge and time to readmission. Sensitivity analyses were performed stratified by the type of thyroidectomy. Statistical significance was indicated by an alpha level of 5%. All p values are 2-sided and have not been adjusted for multiple testing. Statistical analyses were performed using Stata 15.1 (StataCorp. LP, College Station, TX, USA).

Results

Index Hospitalization
From January 2011 to November 2015, we identified a total of 16,776 hospitalizations meeting the inclusion criteria (Fig. 1). Baseline characteristics of included patients are shown in Table 1. The majority of patients undergoing thyroidectomy (79.0%) were female, and the 2 types of thyroidectomy (total vs. hemithyroidectomy) were performed equally often. Male patients were slightly older (54 vs. 52 years) and had significantly higher rates of thyroid carcinoma as cause of surgery than female patients (31.2 vs. 21.7%) and were more likely to undergo neck dissection (5.7 vs. 2.7%). However, thyroid nodules and goiter were the most common thyroid pathologies leading to surgery and were more prevalent in women than in men (72.3 vs. 64.1%). Concerning thyroid function, >80% of patients undergoing thyroid surgery were euthyroid. Male patients suffered from more comorbidities such as diabetes mellitus or cardiovascular disease than females, resulting in a higher mean CCI (2.1 vs. 1.5 pts.).

Incidence of 30-Day Readmissions
The overall incidence of all-cause 30-day hospital re-admission was 2.2%. Male patients had a higher risk of
readmission within 30 days to the index hospital than female patients (3.3 vs. 1.9%; adjusted risk ratio [RR] 1.38, 95% CI, 1.11–1.72; \( p = 0.008 \)) (Fig. 2, 3). These results were consistent among patients undergoing total and hemithyroidectomy (see online suppl. Table 1, Fig. 1; see www.karger.com/doi/10.1159/000510618 for all online suppl. material).

### Causes of 30-Day Readmissions

Of 370 readmissions, 194 (52.4%) were due to nonthyroid causes and 176 (47.6%) were due to thyroid-specific causes. Among thyroidectomy-related causes of hospital readmissions within 30 days, local neck hematomas (26.4 vs. 12.2%) and infections (24.5 vs. 8.1%) were significantly more frequent in men. Female patients though were at a significantly higher risk of postoperative hypocalcemia than male patients (35.8 vs. 13.2%; \( p = 0.002 \)) (online suppl. Table 2a; Fig. 4a).

### Secondary Outcomes

Overall in-hospital mortality was low in our population (\( n = 7 \)), without any apparent differences between sexes. However, male patients were at a higher risk of ICU admission after thyroid surgery (7.7 vs. 4.8%; RR 1.25 [95% CI, 1.09–1.44]; \( p = 0.003 \)) (Fig. 2). The sex-specific difference in ICU admission was predominantly observed for patients undergoing total thyroidectomy (online suppl. Table 1, Fig. 1).

Rates of in-hospital surgical re-interventions were rare in general but slightly more frequent among male pa-
Patients (2.1 vs. 1.2%). However, multivariable regression analysis did not show any difference between sexes ($p = 0.57$) (Fig. 2). When stratified by the type of surgery, there was a trend toward higher rates of surgical re-interventions in men following hemithyroidectomy but not total thyroidectomy (online suppl. Fig. 1).

The mean LOS was comparable among male and female patients (3.5 vs. 3.2 days), with no difference in Cox proportional hazards regression (regression coefficient $-0.01$ [95% CI $-0.11$ to $-0.08$]; $p = 0.80$). Likewise, there was no difference between male and female patients when stratified by the type of thyroid surgery.

**Adverse Events**

Incidence rates of postoperative adverse events are summarized in Table 2 and Figure 2. Transient or permanent disorders of calcium homeostasis were the most frequent postoperative complications reported in 6.0% of male patients and 8.6% of female patients. Multivariable linear regression showed a significant lower risk among male patients (adjusted RR 0.63; 95% CI, 0.54–0.72; $p < 0.001$). Results were consistent among hemi- and total thyroidectomy (online suppl. Fig. 1).

The overall incidence of vocal cord paresis was rather low with 2.3% after hemithyroidectomy and 2.6% after...
Fig. 4. Causes of 30-day readmission after thyroidectomy. The graphs show thyroid (a) and non-thyroid (b) causes of 30-day readmissions.
total thyroidectomy. There was no difference between sexes \((p = 0.38)\). However, frequencies of postoperative neck hematoma were 1.4% after hemithyroidectomy and 2.1% after total thyroidectomy. Neck hematomas occurred approximately twice as often in male patients (2.9 vs. 1.4%) when compared to that in female patients \((RR 1.93; 95\% CI, 1.51–2.46; p < 0.001)\).

### Discussion/Conclusion

The findings of this large study using a comprehensive set of administrative data of adult patients undergoing either hemi- or total thyroidectomy are 3-fold. First, thyroid surgery is safe, with low rates of mortality or other adverse events. Second, there are sex-specific differences after surgery with a higher risk for 30-day readmission rates in male patients regardless of the type of surgery. Third, rates of adverse events after total thyroidectomy differ between sexes, with a higher rate of neck hematoma and infections in men as opposed to a higher rate of calcium disorders in female patients.

In line with previous studies, overall in-hospital mortality (<0.5%), 30-day hospital readmission rate (2.2%), surgical re-intervention rate (1.4%), and ICU admission rate (5.4%) after thyroidectomy were rather low \([3, 4, 7, 10]\). The average LOS following thyroid surgery was relatively long with a median duration of 3 days, which is primarily due to an in-hospital management of patients undergoing thyroid surgery in Switzerland. This is comparable with previous studies, even though there is an enforced trend toward same-day and outpatient surgeries \([14]\).

Using nationwide administrative data with almost no loss to follow-up allows for a highly accurate and comprehensive analysis of postoperative outcomes. In our analysis, planned rehospitalizations for radioactive iodine therapy or for completion surgery were not counted as
readmissions. A recent systematic review by Margolick et al. [7] described an increased risk for 30-day readmissions in male patients, consistent with our findings. Similarly, other studies have reported higher 30-day readmission rates in men as well, although without statistical significance due to a lack in statistical power, and one study reported higher same-day rehospitalizations in men after outpatient thyroidectomies [6, 15, 27]. So far, higher re-admission rates up to 11% have been reported in elderly patients (>65 years) and those with thyroid carcinoma as the underlying cause of thyroid surgery [13, 15].

To our knowledge, this is the first study describing imbalanced patient outcomes in men regarding ICU admission and surgical re-intervention. Since we are not able to evaluate the urgency and the specific causes of reoperations during the index hospitalization, the increased rate of re-interventions among male patients in particular after hemithyroidectomies may be related to the unexpected detection of malignancy in the resected part. This decision to perform a re-intervention during the index hospitalization was made on a case-by-case basis and was up to the discretion of the surgeon. Another factor to be taken into account is that male patients have been shown to have an elevated risk of postoperative neck hematoma after total thyroidectomy [22, 23], and neck hematoma has been described as the most common reason for re-intervention after thyroidectomy [28]. Whether anatomical differences might explain this observation requires further investigation [29]. Further known risk factors for postoperative neck hematoma are older age and renal insufficiency, which were significantly more prevalent among our male patient cohort [22]. Unfortunately, data on intake of anticoagulants were not available in our dataset.

ICU admission following thyroid surgery is a common practice for postoperative monitoring, especially among smaller hospitals. A significant number of patients were in fact operated in low-volume hospitals (data not shown). A significant higher proportion of thyroid carcinoma as the underlying cause of surgery in male patients with possibly more aggressive surgical approach might explain sex differences in ICU admission rates.

Regarding further adverse events, there were also significant gender differences in calcium disorders, which are known to be the most common postoperative complication [14, 24]. This is in accordance with previous data showing that female gender was independently associated with a higher rate of hypocalcemia in multivariable analysis [30, 31]. Furthermore, patients with Graves’ disease are known to be at a higher risk of developing transient and permanent hypocalcemia. Since Graves’ disease is more prevalent among women, this may have as well contributed to the sex differences observed in our study. It could be due to the higher complexity of operations owing to increased vascularity of the thyroid gland; however, one would assume that this would have led to higher rates of hematoma as well [32]. Further mechanisms explaining sex differences in hypocalcemia include higher rates of vitamin D deficiency among female patients [33].

Various reasons for these sex differences may be considered such as the fact that men more frequently suffer from thyroid carcinoma and lymph node metastasis and, thus, require more complex or extensive surgery [7, 34]. Some studies also suggest a tougher neck tissue and stronger neck muscles in males, provoking the slipping of ligatures or the reopening of previous ligated vessels, causing more hematoma [35, 36]. Moreover, males are more likely to have hypertension and unfavorable habits such as smoking and drinking [37]. Due to missing data, we were unable to analyze whether hypertension, smoking, or alcohol abuse could be risk factors for postoperative complications. Another explanation for higher postoperative complications in men may be the fact that male patients had more comorbidities with a significant higher CCI score and higher median age at the time of operation. Neck hematoma and local infectious complications post-surgery may as well be due to more aggressive operations in men who had higher rates of malignant causes of thyroidectomy. Nonetheless, all these variables were included into our models, minimizing residual confounding.

There are several strengths of this analysis. Our analysis was based on nationwide hospital claims data with high external validity and strong statistical power. Moreover, the study reflects highly accurate estimates at a national level, incorporating a rigorous multivariable adjustment of relevant independent covariates, such as etiology of disease and extent of surgery. Furthermore, consistency of the results in subgroup analyses, comparing outcomes after hemi- and total thyroidectomy, underlines the robustness of the herein presented data. Our study has relevant clinical implications, as thyroid surgery is one of the most commonly performed surgical procedures worldwide, and already a small absolute difference (1.4% between-group difference in all-cause 30-day readmission) will have substantial implications on a public health-care level. Calculating a “number needed to harm” for male gender of 71 thyroidectomies needed for one additional unplanned 30-day readmission supports the notion of clinical relevance.
These data will have to be interpreted in the context of the study design. First, using administrative data is prone to confounding, as hospitalizations were selected according to the “Swiss classification of operation” code, with the risk of misclassification and underreporting of complications. Second, based on the data availability, we were not able to provide information on any postsurgical complications treated in the outpatient setting, underestimating the “real” postsurgical burden of complications. Third, the nonexperimental design of our study limits the ability to draw a firm causal link between gender and postoperative outcomes and complication rates, thus the data are hypothesis generating. Fourth, since we do not have information about medications, clinical appearance, and laboratory parameters, we are unable to account for unmeasured (and unmeasurable) residual confounding (e.g., blood pressure playing an important role in the development of neck hematoma). Finally, we do not have any information on the temporal dynamics of postsurgical complications.

In conclusion, male patients undergoing thyroidectomy showed more unfavorable clinical outcomes than female patients, especially in terms of readmission rates. While these findings are not explained by the common complications of thyroidectomy, reasons for these sex differences need further investigation. However, understanding sex-specific differences is clinically and practically important in order to improve individualized postoperative management and preventive measures.

Acknowledgement

This study was only possible thanks to the Swiss Federal Office for Statistics in Switzerland providing the administrative claims data.

References

1. Cherenfant J, Gage M, Mangold K, Du H, Moo-Young T, Winchester DJ, et al. Trends in thyroid surgery in Illinois. Surgery. 2013 Nov;154(5):1016–23.
2. Jegerlehner S, Bulliard JL, Aujesky D, Rodondi N, Germani S, Konzelmann I, et al. Overdiagnosis and overtreatment of thyroid cancer: a population-based temporal trend study. PLoS One. 2017;12(6):e0179387.
3. Rosato L, Avenia N, Bernante P, De Palma M, Gulino G, Nasi PG, et al. Complications of thyroid surgery: analysis of a multicentric study on 14,934 patients operated on in Italy over 5 years. World J Surg. 2004 Mar;28(3):271–6.
4. 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 Feb;22(2):429–36.
5. Sarkar S, Banerjee S, Sarkar R, Sikder B. A review on the history of ‘thyroid surgery’. Indian J Surg. 2016 Feb;78(1):32–6.
6. Fitzgerald RA, Sehgal AR, Nichols JA, McHenry CR. Factors predictive of emergency department visits and hospitalization following thyroidectomy and parathyroidectomy. Ann Surg Oncol. 2015 Dec;22(Suppl 3):S707–13.
7. Margolick J, Chen W, Wiseman SM. Systematic review and meta-analysis of unplanned reoperations, emergency department visits and hospital readmission after thyroidectomy. Thyroid. 2018 May;28(5):624–38.
8. Materazzi G, Dionigi G, Berti P, Rago R, Frustaci G, Docimo G, et al. One-day thyroid surgery: retrospective analysis of safety and patient satisfaction on a consecutive series of 1,571 cases over a three-year period. Eur Surg Res. 2007;39(3):182–8.
9. Iannuzzi JC, Fleming FJ, Kelly KN, Ruan DT, Monson JR, Moalem J. Risk scoring can predict readmission after endocrine surgery. Surgery. 2014 Dec;156(6):1432–40.

Statement of Ethics

This study complies with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. Institutional review board approval, including waiver of the requirement of participant informed consent, as the data were de-identified, was provided by the Institutional Review Board of Northwestern Switzerland (AG/SO 2009/074 and EK NZ BASEC PB_2017-00449). This study followed the Strengthening the Reporting of Observational Studies in Epidemiology reporting guidelines [26].

Conflict of Interest Statement

The authors have nothing to disclose.

Funding Sources

This study was supported in part by the Swiss National Science Foundation (SNSF, National Research Program [NRP 74], 407440_167376), the research council (Grant No. 3071410.000.086) and the “Wissenschaft & Weiterbildung” (W&W) Fonds (140.000.495) of the Kantonsspital Aarau AG, and the “Hugo und Elsa Isner Foundation” of the Argovian Department of Health and Social Affairs. The funding sources had no role in the study design, data collection, data analysis, data interpretation, or writing of the report.

Author Contributions

L.G., S.B., M.H., M.M., F.E., and A.K. designed the study and wrote the manuscript. A.K. had access to all the data. L.G., S.B., M.H., M.M., F.E., and A.K. analyzed the data. F.E. and A.K. were responsible for the decision to submit the manuscript. All authors provided comments on drafts and approved the final report.
Sex Differences in Outcomes after Thyroidectomy

DOI: 10.1159/000510618

10 Al-Qurayshi Z, Randolph GW, Srivastav S, Kandil E. Outcomes in endocrine cancer surgery are affected by racial, economic, and healthcare system demographics. Laryngoscope. 2016 Mar;126(3):775–81.

11 Birkmeyer JD, Stukel TA, Siewers AE, Goodney PP, Wennberg DE, Lucas FL. Surgeon volume and operative mortality in the United States. N Engl J Med. 2003 Nov 27;349(22):2117–27.

12 Pieracci FM, Fahey TJ 3rd. Effect of hospital volume of thyroidectomies on outcomes following substernal thyroidectomy. World J Surg. 2008 May;32(5):740–6.

13 Tuggle CT, Park LS, Roman S, Udelman R, Sosa JA. Rehospitalization among elderly patients with thyroid cancer after thyroidectomy are prevalent and costly. Ann Surg Oncol. 2010 Nov;17(11):2816–23.

14 Vashishta R, Mahalingam-Dhingra A, Lander L, Shin EJ, Shah RK. Thyroidectomy outcomes: a national perspective. Otolaryngol Head Neck Surg. 2012 Dec;147(6):1027–34.

15 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 Dec;156(6):1423–1.

16 Al-Qurayshi Z, Robins R, Hauch A, Randolph GW, Kandil E. Association of surgeon volume with outcomes and cost savings following thyroidectomy: a national forecast. JAMA Otolaryngol Head Neck Surg. 2016 Jan;142(1):32–9.

17 Meltzer C, Klaau M, Gurusanthaya D, Tsai J, Meng D, Radler L, et al. Surgeon volume in thyroid surgery: surgical efficiency, outcomes, and utilization. Laryngoscope. 2016 Nov;126(11):2630–9.

18 Adam MA, Thomas S, Youngwirth L, Hyslop T, Reed SD, Scheri RP, et al. Is there a minimum number of thyroidectomies a surgeon should perform to optimize patient outcomes? Ann Surg. 2017 Feb;265(2):402–7.

19 Lee DJ, Chin CJ, Hong CJ, Perera S, Witterick IJ. Outpatient versus inpatient thyroidectomy: a systematic review and meta-analysis. Head Neck. 2018 Jan;40(1):192–202.

20 Zerey M, Prabhu AS, Newcomb WL, Lincourt AE, Kercher KW, Heniford BT. Short-term outcomes after unilateral versus complete thyroidectomy for malignancy: a national perspective. Am Surg. 2009 Jan;75(1):20–4.

21 Dripps RD, Lamont A, Eckenhoff JE. The role of anesthesia in surgical mortality. JAMA. 1961 Oct 21;178:261–6.

22 Weiss A, Lee KC, Brumund KT, Chang DC, Bouvet M. Risk factors for hematoma after thyroidectomy: results from the nationwide inpatient sample. Surgery. 2014 Aug;156(2):399–404.

23 Suzuki S, Yasunaga H, Matsuji H, Fushimi K, Saito Y, Yamasoba T. Factors associated with neck hematoma after thyroidectomy: a retrospective analysis using a Japanese inpatient database. Medicine. 2016 Feb 9;5(7):e2812.

24 Docimo G, Ruggiero R, Casalino G, Del Genio G, Docimo L, Tolone S. Risk factors for postoperative hypocalcemia. Updates Surg. 2017 Jun;69(2):255–60.

25 Swiss DRG. Regeln und Definitionen zur Fallabrechnung unter SwissDRG. https://www.swissdrg.org/application/files/4714/8111/3146/160620_SwissDRG_Falldefinitionen_v5.pdf. Accessed 2019 Oct 24.

26 von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Epidemiol. 2014 Dec;43(12):1495–9.

27 Hessman C, Fields J, Schuman E. Outpatient thyroidectomy: is it a safe and reasonable option? Am J Surg. 2011 May;201(5):565–8.

28 Terris DJ, Snyder S, Carneiro-Pla D, Inabnet WB 3rd, Kandil E, Orloff L, et al. American Thyroid Association statement on outpatient thyroidectomy. Thyroid. 2013 Oct;23(10):1193–202.

29 Turcios S, Lence-Anta JJ, Santana JL, Pereda CM, Velasco M, Chappe M, et al. Thyroid volume and its relation to anthropometric measures in a healthy cuban population. Eur Thyroid J. 2015 Mar;4(1):55–61.

30 Edafe O, Antakia R, Laskar N, Uttlty L, Balasubramanian SP. Authors’ reply: systematic review and meta-analysis of predictors of post-thyroidectomy hypocalcaemia (Br J Surg 2014;101:307–20). Br J Surg. 2014 Mar;101(7):883–4.

31 Hughes T, Slavopavics V, Jansonus V, Zeromskas P, Beisa V, Strupas K, et al. Predictors of postoperative hypocalcemia occurring after a total thyroidectomy: results of a prospective multicenter study. BMC Surg. 2018 Aug 9;18(1):55.

32 Hassan I, Danila R, Aljabri H, Hoffmann S, Wunderlich A, Karakas E, et al. Is rapid preparation for thyroidectomy in severe Graves’ disease beneficial? The relationship between clinical and immunohistochemical aspects. Endocrine. 2008 Apr;33(2):189–95.

33 Yamashita H, Noguchi S, Murakami T, Uchi-no S, Watanabe S, Ohshima A, et al. Calcium and its regulating hormones in patients with graves disease: sex differences and relation to postoperative tetany. Eur J Surg. 2000 Dec;166(12):924–8.

34 Lin DZ, Qu N, Shi RL, Lu ZW, Ji QH, Wu WL. Risk prediction and clinical model building for lymph node metastasis in papillary thyroid microcarcinoma. Onco Targets Ther. 2016;9:5307–16.

35 Kwak HY, Dionigi G, Liu X, Sun H, Woo SU, Son GS, et al. Predictive factors for longer operative times for thyroidectomy. Asian J Surg. 2017 Apr;40(2):139–44.

36 Liu J, Sun W, Dong W, Wang Z, Zhang P, Zhang T, et al. Risk factors for post-thyroidectomy haemorrhage: a meta-analysis. Eur J Endocrinol. 2017 May;176(5):591–602.

37 Calo PG, Pisans G, Piga G, Medas F, Tatti A, Donati M, et al. Postoperative hematomas after thyroid surgery. Incidence and risk factors in our experience. Ann Ital Chir. 2010 Sep–Oct;81(5):343–7.