

Risk Factors for Recurrent Laryngeal Nerve for Post Thyroidectomy

An All Of Us Database Analysis

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ABSTRACT

Introduction: Recurrent laryngeal nerve (RLN) injury is a serious complication after thyroid surgery. Postoperative dysphonia, however, is not synonymous with RLN injury, and electronic health record (EHR) coding may reflect both clinical disease and patterns of documentation and healthcare contact. **Objective:** Evaluate the incidence and correlates of coded postoperative voice diagnoses after thyroid surgery in the National Institutes of Health All of Us Research Program. **Methods:** Retrospective cohort study of 1,091 participants indexed at their most recent qualifying thyroid-operation episode. Patients with coded voice diagnoses during the preceding 365 days were excluded, and evidence of observation through postoperative day 180 was required. Exact OMOP concepts defined a primary broad coded voice outcome and a secondary exploratory paralysis-coded outcome. Modified Poisson models estimated adjusted risk ratios (RRs). Postoperative non-voice utilization was treated as an ascertainment correlate rather than a preoperative risk factor. **Results:** The 180-day incidences were 5.7% (62/1,091; 95% CI, 4.4%–7.2%) for the broad coded outcome and 2.4% (26/1,091; 95% CI, 1.6%–3.5%) for the paralysis-coded outcome. Older age was modestly associated with the broad coded outcome (RR 1.33; 95% CI, 1.02–1.73). Postoperative non-voice utilization was associated with broad coding (RR 2.00; 95% CI, 1.33–3.03) and paralysis coding (RR 2.32; 95% CI, 1.29–4.19). Calendar year was associated with increased broad coding (RR 1.55; 95% CI, 1.16–2.07) but not clearly with paralysis coding (RR 1.06; 95% CI, 0.70–1.58). **Conclusion:** Coded postoperative voice diagnoses varied with age, calendar time, and healthcare contact. These associations characterize EHR ascertainment and cannot be interpreted as predictors of verified RLN injury. Studies intended to estimate nerve injury require laryngeal examination findings, operative detail, and clinical adjudication.

INTRODUCTION

Recurrent laryngeal nerve (RLN) injury is a recognized complication of thyroid and parathyroid surgery and can result in vocal fold paralysis, dysphagia, and airway compromise. Transient RLN palsy occurs in approximately 3% of patients and permanent injury in about 0.4–0.5%, although reported rates vary by institution and follow-up method (Cozzi et al., 2023; Vasileiadis et al., 2016). Postoperative dysphonia, however, is not synonymous with RLN injury and may also reflect intubation effects, edema, pain, or other laryngeal conditions. Established clinical and operative risk factors include advanced age, anatomic variants, Graves' disease, extent of resection, and re-operative surgery, with total thyroidectomy and scarred operative fields carrying greater risk (Mahoney et al., 2021; Tabriz et al., 2024).

Here we estimate the 180-day incidence and correlates of coded postoperative voice diagnoses after thyroid surgery, and assess the extent to which these outcomes reflect diagnostic coding and follow-up patterns rather than verified RLN injury. Secondary objective: to compare a broad symptom-based case definition with a paralysis-specific definition in the same cohort.

METHODS

A retrospective cohort study was conducted using patients who underwent thyroid surgery identified from standardized clinical concepts in the NIH All of Us database. This research was approved by the VCOM Institutional Review Board (IRB: 2428155-1) and was conducted in accordance with the *All of Us* code of conduct. Procedure records were normalized and deduplicated, and thyroid operation episodes were grouped using a 14-day window to collapse closely spaced records likely representing the same operative episode. The index surgery was defined as the most recent qualifying thyroid-operation episode. Patients with any voice-related diagnosis during the preceding 365 days were excluded, and the analytic cohort was restricted to individuals with complete observation through postoperative day 180 and index surgeries occurring in 2000 or later. The final cohort included N = 1,091. Covariates were selected a priori and included standardized age, sex at birth, index operation class, prior thyroid reoperation, thyroid cancer indication, comorbidity burden, postoperative non-voice utilization, and calendar year.

The primary outcome was a broad coded postoperative voice diagnosis; the secondary exploratory outcome included paralysis-specific codes. Modified Poisson regression with a log link and HC0 variance estimated adjusted risk ratios and 95% CIs. Postoperative non-voice utilization was interpreted as an ascertainment correlate rather than a baseline risk factor because it was measured during the same 180-day outcome window. Rare categories were collapsed to improve estimability.

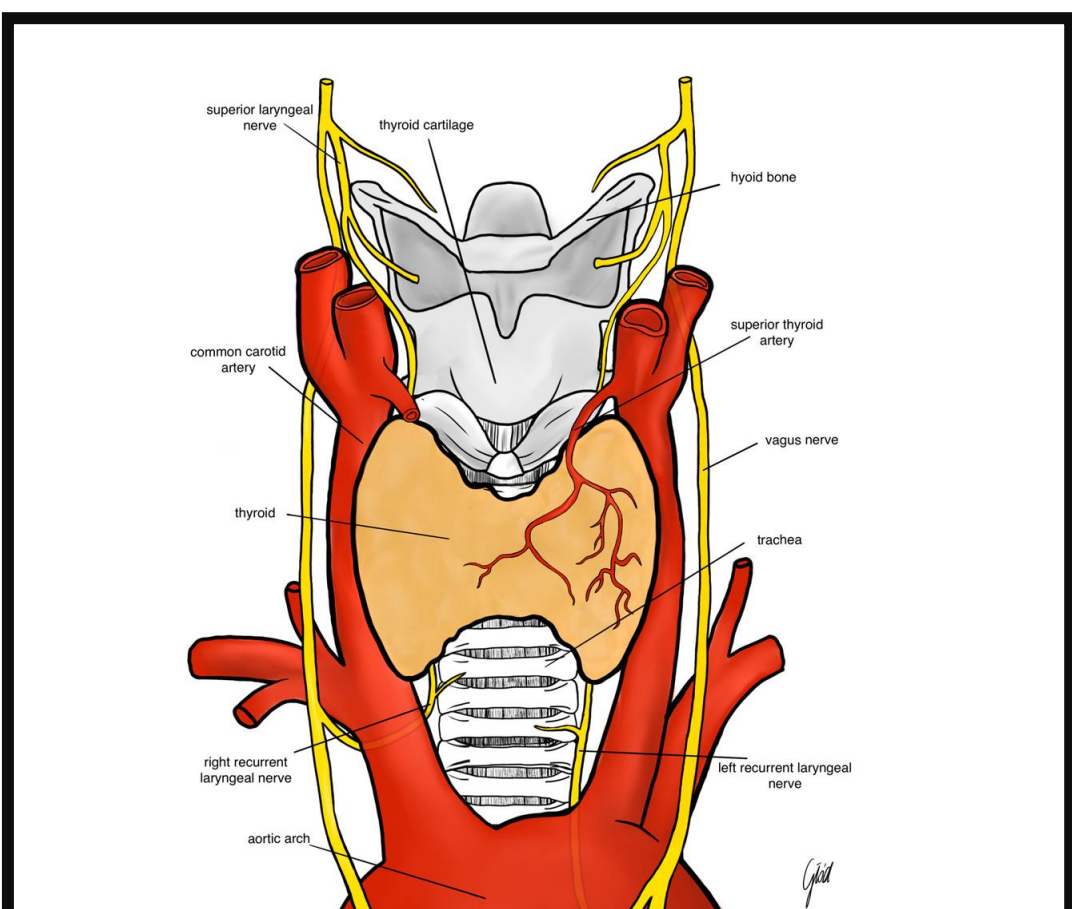


Figure 1. Recurrent laryngeal nerve anatomy relative to the thyroid and larynx

RESULTS

The final cohort included 1,091 participants with complete 180-day follow-up and no documented preoperative voice diagnosis. Median age was 54 years (IQR, 43–61), 77.8% were female, 55.5% were White, and 19.6% were Black or African American. Total thyroidectomy was the most common index operation, accounting for 850 procedures (77.9%). Prior thyroid reoperation history was present in 79 patients (7.2%). (Table 1). During days 0–180, 62 participants had a broad coded voice outcome, corresponding to an incidence of 5.7% (95% CI, 4.4%–7.2%). Twenty-six participants had a paralysis-coded outcome, corresponding to an incidence of 2.4% (95% CI, 1.6%–3.5%). During days 0–90, 45 participants had a broad coded outcome (4.1%), while fewer than 20 had a paralysis-coded outcome (<1.9%) (Table 2).

Table 1: Baseline demographics of patients with 0-180 follow-up (N=1,091)

Characteristic		Number (%)
Age at index, median (IQR)	1,091	54 (43, 61)
Sex at birth	1,091	
Female		849 (77.8%)
Male		229 (21.0%)
Race	1,091	
White		606 (55.5%)
Black or African American		214 (19.6%)
Other single population		36 (3.3%)
More than one population		45 (4.1%)
None indicated / Skip		190 (17.4%)
Ethnicity	1,091	
Not Hispanic or Latino		875 (80.2%)
Hispanic or Latino		193 (17.6%)
Index operation	1,091	
Total		850 (77.9%)
Completion		74 (6.8%)
Subtotal		28 (2.6%)
Other		139 (12.7%)
Reoperation history	1,091	79 (7.2%)

Among postoperative voice-related diagnosis entries recorded within 180 days, dysphonia was the most frequent diagnosis, accounting for greater than 59.3% of entries. Vocal cord paralysis accounted for 36.5%, while bilateral partial vocal cord paralysis accounted for fewer than 5.9%. (Table 3). This distribution demonstrates that the broad coded phenotype contains a substantial proportion of postoperative voice symptoms that do not necessarily represent documented vocal fold paralysis. In adjusted models, older age was associated with greater risk of a broad coded diagnosis (RR per SD, 1.33; 95% CI, 1.02–1.73; P=.038) (Table 4).

Table 2: Overall incidence using 180-day denominator (N = 1,091)

Group	Events	N	Prop
Overall (full 180 FU; any)	62	1,091	5.70%
Overall (full 180 FU; high-spec)	26	1,091	2.40%
0–90 among 180 FU (any)	45	1,091	4.10%
0–90 among 180 FU (high-spec)	<20	1,091	<1.83%

Table 3: Concept mix of post-index voice conditions within 0-180 days

Group	Events	N	Prop	95% CI
Dysphonia	>200	>59.34%	8.20%	(5.4%, 11.8%)
Vocal cord paralysis	123	36.50%	5.60%	(3.7%, 8.2%)
Bilateral partial vocal cord paralysis	<20	<5.93%	6.10%	(1.8%, 7.1%)

Table 4: Incidence of any post-thyroidectomy voice complication within 0–180 days by age group among patients with full 180-day follow-up (N = 1,091)

Age Group	N	Events	Incidence	95% CI
60+	318	>25	>7.86%	(5.4%, 11.8%)
45–59	446	25	5.60%	(3.7%, 8.2%)
<=44	327	<20	<6.11%	(1.5%, 7.4%)

Postoperative non-voice utilization was associated with broad coding (RR 2.00; 95% CI, 1.33–3.03; P<.001), while calendar year was also positively associated with broad coding (RR 1.55; 95% CI, 1.16–2.07; P=.003). For the exploratory paralysis-coded outcome, the age estimate was imprecise (RR 1.51; 95% CI, 0.95–2.39; P=.082). Postoperative non-voice utilization remained associated with coding (RR 2.32; 95% CI, 1.29–4.19; P=.005), whereas calendar year was not clearly associated with the outcome (RR 1.06; 95% CI, 0.70–1.58; P=.792). Sex, operation class, prior operation history, thyroid cancer indication, and comorbidity burden were not clearly associated with either coded outcome. Postoperative healthcare contact was the most consistent correlate of recorded outcomes. Because healthcare utilization and diagnosis were measured during the same postoperative period, this association may reflect additional opportunities for symptom recognition and coding, reverse causation from postoperative symptoms increasing healthcare use, or greater postoperative complexity. It should not be interpreted as a surgical risk factor. Prior thyroid reoperation was not clearly associated with the broad coded outcome (RR 0.59; 95% CI, 0.14–2.54; P=.483).

Exploratory analyses of Graves' disease and thyroid cancer proxies similarly produced imprecise estimates with wide confidence intervals. Other proposed high-risk features, including substernal goiter, invasive disease, and nonrecurrent laryngeal nerve anatomy, were too sparsely represented in structured data for meaningful inference.

DISCUSSION/CONCLUSION

In this retrospective All of Us cohort, 5.7% of participants had a broad coded voice diagnosis and 2.4% had a paralysis-coded diagnosis within 180 days after thyroid surgery. Older age was associated with the broad coded outcome, while the corresponding estimate for the paralysis-coded outcome was less precise. Greater postoperative non-voice healthcare utilization was associated with both outcomes, but this relationship should be interpreted as an ascertainment correlate rather than a surgical risk factor. Patients with more healthcare contact have more opportunities for symptoms to be recognized and coded, while postoperative symptoms may themselves increase utilization; therefore, causal ordering cannot be determined.

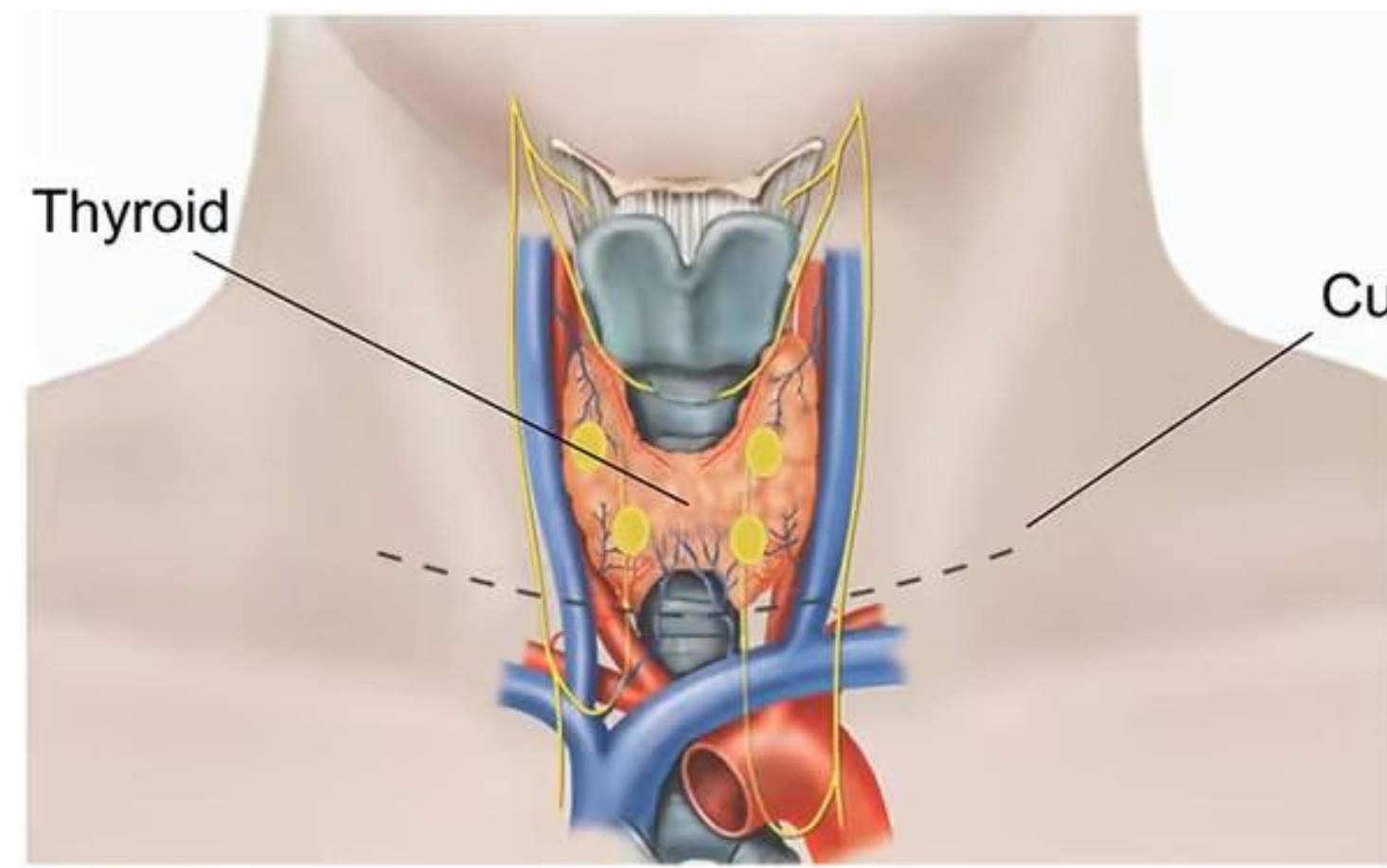


Figure 2. Incision for Thyroidectomy

The broad coded outcome increased over calendar time, while the paralysis-coded outcome did not show a corresponding trend. This pattern is consistent with secular changes in documentation, coding practices, and follow-up, although these mechanisms cannot be directly tested in the present dataset. Prespecified high-risk features including reoperation, Graves' disease, and thyroid cancer did not demonstrate clear associations with coded postoperative voice outcomes, but sparse exposed-event combinations and limited operative detail restrict interpretation. Preoperative laboratory abnormalities also showed no clear associations, with analyses limited by incomplete laboratory coverage. Overall, these findings characterize the behavior of coded postoperative EHR phenotypes rather than verified RLN injury. This distinction is essential because dysphonia may occur without nerve injury and paralysis codes remain unvalidated without examination findings. Future studies should incorporate standardized preoperative and postoperative laryngeal examinations, detailed operative and provider-level variables, and clinical adjudication, while EHR-only studies should report broad symptom and paralysis-specific codes separately.

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Conflict of interest:

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

- [1] Mahoney RC, Vossler JD, Murayama KM, Woodruff SL. Predictors and consequences of recurrent laryngeal nerve injury during open thyroidectomy: An American College of Surgeons National Surgical Quality Improvement Project database analysis. *The American Journal of Surgery*. 2021;221(1):122–126. doi:https://doi.org/10.1016/j.amjsurg.2020.07.0233. [2] Navid Tabriz, Muehlbeyer S, Weyhe D, Usar V. Risk Factors for Recurrent Laryngeal Nerve Palsy in Thyroid Surgery: A Single Center Experience of 1147 Procedures with Intermittent Intraoperative Neuromonitoring. *Journal of Personalized Medicine*. 2024;14(7):714–714. doi:https://doi.org/10.3390/jpm140707145. [3] Anna Teresa Cozzi, Ottavi A, Paolo Lizza, et al. Intraoperative Neuromonitoring Does Not Reduce the Risk of Temporary and Definitive Recurrent Laryngeal Nerve Damage during Thyroid Surgery: A Systematic Review and Meta-Analysis of Endoscopic Findings from 73,325 Nerves at Risk. *Journal of personalized medicine*. 2023;13(10):1429–1429. doi:https://doi.org/10.3390/jpm131014296. [4] Ioannis Vasileiadis, Karatzas T, Georgios Charitoudis, Ethimos Karakostas, Tseleni-Balafouta S, Kourakis G. Association of Intraoperative Neuromonitoring With Reduced Recurrent Laryngeal Nerve Injury in Patients Undergoing Total Thyroidectomy. *JAMA otolaryngology-- head & neck surgery*. 2016;142(10):994–994. doi:https://doi.org/10.1001/jamaoto.2016.19547. [5] Wojtczak B, Sutkowska-Stepien K, Glod M, Kaliszewski K, Sutkowski K, Barczynski M. Current Knowledge on the Use of Neuromonitoring in Thyroid Surgery. *Biomedicines*. 2024;12(3):675. doi:https://doi.org/10.3390/biomedicines1203067516. ZenOnco. Thyroidectomy. ZenOnco.io. Published 2024. Accessed February 12, 2026. https://zenonco.io/cancer/thyroidectomy/