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Thyroidectomy in an Outpatient versus Inpatient Setting

A Systematic Review and Meta-analysis

Short Title: Outpatient vs Inpatient Thyroidectomy

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32

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34 **Syed Hasham Ali:** Conceived and designed the study; conducted the literature search; performed data
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37 **Zoha Fatima Syed:** Wrote the discussion; assisted with quality assessment; critically revised the
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56 **ABSTRACT**

57

58 **Objectives:** This systematic review and updated meta-analysis evaluates the clinical and economic
59 outcomes of outpatient versus inpatient thyroidectomy

60 **Data Sources:** PubMed/Medline, Cochrane Library, Embase, Scopus, and Web of Science were
61 searched from the inception of databases until 18 May 2025.

62 **Review Methods:** We performed a systematic review of PubMed/MEDLINE, Cochrane Library,
63 Embase, Scopus, and Web of Science from inception through May 18, 2025, without language or time
64 restrictions, with reference-list hand searching. Comparative studies of outpatient (no
65 admission/typically < 24 hours) versus inpatient thyroidectomy were included; outcomes were
66 extracted as defined by individual studies. Meta-analyses were conducted using OpenMeta-Analyst
67 and Review Manager. For dichotomous baseline and clinical outcomes, risk ratios (RRs) with 95%
68 CIs were calculated from raw arm-level event data and pooled; propensity-matched or otherwise
69 adjusted estimates were used where feasible. A random-effects model (Mantel–Haenszel weighting)
70 was used to account for heterogeneity.

71 **Results:** Twenty-six studies (n=291,075) were included. Outpatients were more likely to undergo
72 hemithyroidectomy (RR 1.29) and less likely to require neck dissection (RR 0.45). Outpatient surgery
73 was associated with lower rates of recurrent laryngeal nerve injury/hoarseness (RR 0.59), neck
74 hematoma (RR 0.58), hypocalcemia (RR 0.52), and overall complications after total thyroidectomy
75 (RR 0.52), though confounding by indication cannot be excluded. Readmissions were similar (RR
76 0.78, 95% CI 0.46–1.30; p=0.34), as were reoperations (RR 0.79, 95% CI 0.43–1.46; p=0.46). Direct
77 hospital charges were descriptively US\$850–2800 lower per case.

78 **Conclusion:** Outpatient thyroidectomy appears to be a safe, cost-effective alternative to inpatient
79 admission in selected patients, with comparable readmission and reoperation risk and lower
80 complication rates observed in published cohorts; these associations may partly reflect confounding
81 by indication, including unmeasured comorbidity burden. Careful patient selection remains essential,
82 and higher-quality prospective studies are needed.

83 **Key Words:** Endocrine Surgery, Inpatient, Outpatient, Thyroidectomy

84 **1. INTRODUCTION**

Thyroidectomy, the surgical removal of part or all of the thyroid gland, is a mainstay treatment for various conditions, including benign nodules, goitre, and thyroid cancer. Traditionally performed as an inpatient procedure due to concerns over complications such as airway compromise, hypocalcaemia, and bleeding, thyroidectomy has seen a growing shift toward outpatient management in recent years.¹ This trend has been driven by advancements in surgical techniques, anaesthesia, and postoperative nursing care, earning recognition from both the British Association of Day Surgery (BADs) and the American Thyroid Association (ATA).^{2,3} Given the increasing emphasis on optimizing healthcare resource allocation, reducing costs, and improving patient satisfaction, outpatient thyroidectomy has emerged as an appealing option for surgeons.⁴

Outpatient thyroidectomy, defined as patient discharge within 24 hours of surgery, has gained support due to its association with reduced costs and higher patient satisfaction compared to inpatient procedures.⁵ While critics initially raised concerns about increased postoperative complications, such as hematoma and higher readmission rates, large national registry studies have since demonstrated that outpatient thyroidectomy is linked to lower 30-day surgical complications and is not an independent predictor of readmission.^{6,7}

Previous meta-analyses have established the non-inferiority of outpatient thyroidectomy.⁸ However, these reviews were limited by a small number of included studies and insufficient analysis of cost comparisons between the two approaches. This updated meta-analysis aims to incorporate recent, higher-quality evidence to provide clinicians and policymakers with a comprehensive evaluation of the benefits and drawbacks of outpatient versus inpatient thyroidectomy.

2. METHODOLOGY

This systematic review and meta-analysis was carried out in compliance with Cochrane, Meta-analyses Of Observational Studies in Epidemiology (MOOSE), and Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) guidelines.⁹⁻¹¹ As this was a synthesis of publicly available results, no Institutional Review Board (IRB) clearance was needed.

2.1 Eligibility Criteria

Abstracts, conference proceedings, non-peer reviewed work, case reports, review articles, meta-analyses, non-human studies, and other forms of narrative were not considered. The population of interest was patients undergoing various degrees of a thyroidectomy. Indications for a thyroidectomy were not an inclusion or exclusion threshold. Studies were also excluded if data on excisions of different glands was pooled together (e.g. thyroid *and/or* parathyroid gland excision) without adequate stratification. Studies were incorporated if they met the following PICOS: **P**) patients undergoing total thyroidectomy, hemi-thyroidectomy, or neck dissection, **I**) outpatient thyroidectomy versus, **C**) inpatient thyroidectomy and **O**) reported on prevalence or complication rates for each group, and **S**) were observational (retrospective, prospective, or cross-sectional) or controlled trials.

2.2 Search Strategy

PubMed/Medline, Cochrane Library, Embase, Scopus, and Web of Science were searched from the inception of databases until 18 May 2025. using appropriate keywords and MeSH terms. Full search strings for each database have been enclosed in a supplementary table. (Supplementary Table 1) Filters were not applied during the literature search nor were any language or time limitations. To expand our literature search, the 'References' section of selected studies were hand-parsed to check for any missed articles and authors were contacted for inaccessible articles. All the selected articles were then run in EndNote (Version X7.5; Clarivate Analytics, Philadelphia, PA, United States), and any duplicates were identified and removed. The selected articles were screened on three levels: title, abstract and full text by two independent reviewers (A.A and S.H.A).

2.3 Predictors, Outcomes of Interest, Data Extraction, and Quality Assessment

'Outpatient' as a term was defined at varying time points throughout studies, with a patient not requiring hospital admission. 'Inpatient' entailed admittance usually spanning longer than 24 hours postoperatively. Outcome definitions were used as defined by included studies.

A meta-analysis of select baselines was conducted to determine predictors to an outpatient or inpatient presentation with any baseline characteristic being reported by 3 or more studies included. Baseline characteristics in studies which pooled data on thyroidectomies and parathyroidectomies without adequate stratification were excluded from analysis to maintain the integrity of the dataset.

140 Outcomes included a) procedure-level; ai) total/ completion thyroidectomy, aii) hemithyroidectomy,
141 and aiii) neck dissection, and b) post-procedure level; bi) readmissions, bii) reoperations, c)
142 complication-level; ci) death, cii) Hoarseness/ Vocal Cord Paralysis/ Recurrent Laryngeal Nerve
143 (RLN) Injury, ciii) Surgical Site Infection (SSI), civ) neck haematoma, cv) hypocalcaemic event, and
144 d) overall complications by procedure; di) completion/ total thyroidectomy, dii) hemithyroidectomy.

145 A decision was taken to treat ‘total or completion thyroidectomy’ and ‘Hoarseness/ Vocal Cord
146 Paralysis/ Recurrent Laryngeal Nerve (RLN) Injury’ as one outcome in the interest of maximum data
147 inclusion due to many studies treating these as separate outcomes while others grouped them under
148 umbrella terms. Similarly, ‘neck dissections’ were reported as an umbrella term or as subdivided into
149 lateral and central across studies. Upon discussion, an umbrella term was used here too.

150 A secondary descriptive systematic comparison of the financial aspect of both arms was also planned
151 with the following variables extracted where available: 1) outpatient cost, 2) inpatient cost, 3) cost
152 difference, along with any additional information which might meaningfully inform the review.

153 A predesigned Google Sheets spreadsheet was used to extract study and baseline characteristics,
154 procedural, and postprocedural details. Quality assessment of included studies was conducted using
155 the Newcastle–Ottawa Scale (NOS) for observational studies, Cochrane Risk of Bias Tool version 2.0
156 for randomised trials, and the Joanna Briggs Institute (JBI) checklist for cross-sectional studies
157 independently by two reviewers (S.H.A and Z.F.S), with inconsistencies resolved via discussion.^{12–14}

158

159 2.4 Statistical Analysis

160 We used OpenMeta-Analyst and Review Manager Version 5.4.1 (The Cochrane Collaboration, The
161 Nordic Cochrane Centre, Copenhagen, Denmark) for all meta- analysis related statistical analyses.
162 Risk Ratios (RR) and corresponding 95% Confidence Intervals (CI) of all dichotomous baselines and
163 clinical outcomes were calculated from raw data, pooled and analysed.

164 For continuous baselines, means and standard deviations (SD) were extracted and pooled mean
165 differences and 95% CIs were calculated. In instances where medians and interquartile ranges (IQR)
166 were given, Wan et al.’s method was used to impute medians and IQRs to means and SDs in the

interest of maximum data inclusion.¹⁵ Any continuous data that could not be converted to means and SDs was excluded from the baseline-level meta-analysis. Similarly, any baseline information given solely in Odds Ratios (ORs) was excluded as RRs were the primary measurement metric. Propensity-matched or otherwise adjusted data was used wherever feasible.

A random-effects model was utilized to account for the anticipated heterogeneity, procedural discrepancies, and certain outcome definitions. Weightage of all outcomes was assigned using the Mantel-Haenszel method. An outcome was deemed significant if the p-value < 0.05. Forest plots were generated on Review Manager to visually represent results.

2.4.1 Heterogeneity, Redressal Avenues and Meta-regression

The Higgins (I²) statistic was used to evaluate heterogeneity and a value of 25%–40% was considered mild, 40%–75% as moderate, and >75% as severe heterogeneity. Heterogeneity was only investigated if a) the outcome was significant *and* b) the value was > 40%. The tool of first resort was a leave-one-out sensitivity analysis, followed by a subgroup analysis, and lastly a random-effects univariate meta-regression if the previous two approaches failed to resolve heterogeneity. Arm-level statistics were compressed to study-level statistics for the purposes of meta-regression, with proportions or averages between arms being calculated for each covariate in the meta-regression model. For dichotomous covariates, the formula used to compress arm-level data to study-level data was:-

$$\text{Covariate}_{diff} = [(\text{Covariate}_{outpatient} / N_{outpatient}) - (\text{Covariate}_{inpatient} / N_{inpatient})] \times 1000$$

For continuous covariates, the formula used to compress arm-level data to study-level data was:-

$$\text{Covariate}_{diff} = (\text{Covariate}_{outpatient} + \text{Covariate}_{inpatient}) / 2$$

where:-

Covariate_{diff}- Difference in the proportions of populations of a given covariate

195 *Covariate_{outpatient}* - Population reporting a given covariate in the outpatient arm

196 *Covariate_{inpatient}* - Population reporting a given covariate in the inpatient arm

197 *N_{outpatient}* - Total number of patients in the outpatient arm

198 *N_{inpatient}* - Total number of patients in the inpatient arm

199 *1000*- magnification or re-proportioning factor to improve plotting

200

201 Results were presented in terms of a Regression Coefficient (RC), a 95% CI, and p-value with a p-
202 value < 0.05 considered significant. Bubble plots were generated on OpenMeta[Analyst] to visually
203 represent significant relationships. Publication bias was assessed through a funnel plot for any
204 outcome reported by 10 or more studies in a significant and heterogenous outcome; risk of bias due to
205 missing results (e.g. unpublished small-scale or non-significant studies) for each such synthesis is
206 discussed narratively alongside the corresponding funnel plot findings in the Results and Discussion.

207

208 *2.4.2 Financial Comparative Systematic Review*

209 Descriptive statistics (means, medians, counts and percentages etc.) were extracted where available.
210 To facilitate a fair comparison, all values were 1) converted to the United States Dollar (USD), and 2)
211 adjusted to reflect the value of the USD as of April 2025. The inflation calculator used for
212 conversions and adjustments is informed by the United States Department of Labour's Bureau of
213 Labour Statistics.¹⁶ A more structured analysis was not feasible due to heterogeneous presentation of
214 data across studies.

215

216 *2.5 Data Availability*

217 Data regarding this meta-analysis which is not already divulged herein are available from the
218 corresponding author on reasonable request. This systematic review and meta-analysis was not
219 prospectively registered, and no protocol was published prior to conduct; the methodology described
220 herein reflects the final analytic approach.

221

222 **3. RESULTS**

223 *3.1 Literature Search Synthesis*

Our literature search yielded 23,307 articles, of which 26 studies comprising 291,075 patients remained after exclusion.^{1,6,17-40} The PRISMA flowchart summarizes the results of our literature search (Supplementary Figure 1). Taylor et al., although ostensibly a [outpatient versus inpatient] comparison, was not included as the cohorts therein were stratified based on whether the patients had stayed in the hospital *preoperatively*, as opposed to postoperatively.⁴¹ The authors had to decide between including either Hu et al. or Traill et al. Ultimately the former was included as the latter had the following dataset limitations; 1) the data was drawn from the same database, the American College of Surgeons National Surgical Quality Improvement Program, with a time period overlap, 2) although Traill et al. spanned a longer study period, it only included patients undergoing total thyroidectomy, 3) it only reported complications related to total thyroidectomy and did not include the requisite complications stated above.^{7,18} If Traill et al was to be included, a compromise on the clinical diversity of the dataset would be an imperative, with the complete study period overlap making its inclusion ultimately unfeasible.

3.2 Study Characteristics and Quality Assessment

Most studies were retrospective in nature, with two randomised controlled trials and two cross sectionals included. Most studies scored a 7 on the NOS, with five scoring a 9 due to their reporting of propensity-matched or otherwise adjusted data^{17-19,37,38}. The two trials included were scant on several details including blinding and randomisation techniques, leading to a judgement of high risk of bias. The two large-scale cross-sectionals scored a 'Yes' on all domains of the JBI checklist (Supplementary Table 2) Full summary of study characteristics is tabulated. (Supplementary Table 3)

3.3 Baseline Characteristics

The studies had a predominantly female preponderance, with the most frequent indication for a procedure being a malignancy. A baseline-level meta-analysis to explore predictors revealed that patients identifying as 'white' were significantly more represented in the outpatient setting (RR 1.07 95% CI [1.01-1.13], p=0.03) and were significantly younger (RR -1.39 95% CI [-2.07- -0.71], p<0.0001). However, patients presenting with malignancies underwent inpatient procedures more

often (RR 0.86 95% CI [0.77-0.96], $p=0.008$). Baseline characteristics for each study have been tabulated (Supplementary Table 4).

3.4 Results of the Meta-analysis

3.4.1 Procedures

3.4.1.1 Completion/ Total Thyroidectomy

The rates of completion or a total thyroidectomy in 21 studies^{1,6,17-27,29,31-34,37,38,40} were insignificant between the Outpatient (44518/91694) and Inpatient (114281/198744) arm (RR 0.79 95% CI [0.09-6.78], $p=0.83$, $I^2=100\%$), with the results not changing to statistical significance after a sensitivity analysis. Given the complete heterogeneity ($I^2=100\%$) underlying this pooled estimate, it is reported for completeness but should not be interpreted as a clinically meaningful summary effect; the range of individual study RRs is more informative than the pooled point estimate in this instance. (Figure 1a)

3.4.1.2 Hemithyroidectomy

The rates of hemithyroidectomy in 18 studies^{1,18,19,22,23,25,27,28,30,31,33-40} were significant between the Outpatient (32101/67359) and Inpatient (55134/125743) arm (RR 1.29 95% CI [1.14-1.45], $p<0.0001$, $I^2=99\%$), with the procedure being conducted more in an outpatient setting. A sensitivity and subgroup analysis did not address the heterogeneity. (Figure 1b)

Exploratory meta-regression of 3 studies revealed a relationship between nodular goitre as an indication and the rate of hemithyroidectomies, with the rate of outpatient procedures significantly less in that case.^{18,25,28} (RC -0.004, 95% CI [-0.077, -0.001], $p=0.005$). (Supplementary Figure 2) (Supplementary Table 5) No significant trends were observed with other covariates. A funnel plot generated showed a strong bias towards larger studies, with the lower two quadrants sparsely and asymmetrically populated, a possible cause for heterogeneity. (Supplementary Figure 3)

3.4.1.3 Neck Dissection

280 The rates of neck dissection in eight studies ^{1,17,19,20,23,33,34,40} were significant between the Outpatient
281 (2115/46763) and Inpatient (5336/91203) arm (RR 0.45 95% CI [0.30-0.66], $p < 0.0001$, $I^2=96\%$),
282 with neck dissection being a predominantly inpatient procedure. A subgroup analysis based on type of
283 neck dissection failed to resolve the heterogeneity. (Figure 1c)

284 Exploratory meta-regression of 3 studies revealed a relationship between black/African American
285 patients being the presenting demographic and neck dissections with more outpatient procedures
286 where black patients were more represented. ^{17,33,34} (RC 0.023, 95% CI [0.015, 0.031], $p < 0.001$)
287 (Supplementary Figure 4)(Supplementary Table 6)

288 289 3.4.2 Post-procedure

290 3.4.2.1 Readmissions

291 The rates of readmissions in nine studies ^{18-20,26,27,29,30,33,39} were insignificant between the Outpatient
292 (228/12990) and Inpatient (1769/79836) arm (RR 0.78 95% CI [0.46-1.30], $p = 0.34$, $I^2=64\%$), with
293 the results not changing to statistical significance after a sensitivity analysis. (Figure 2a)

295 3.4.2.2 Reoperations

296 The rates of reoperations in three studies ^{18,24,35} were insignificant between the Outpatient (18/2394)
297 and Inpatient (25/2530) arm (RR 0.79 95% CI [0.43-1.46], $p = 0.46$, $I^2=0\%$), with the results not
298 changing to statistical significance after a sensitivity analysis. (Figure 2b)

301 3.4.3 Complications

302 3.4.3.1 Death

303 The rates of death in three studies ^{18,19,23} were insignificant between the Outpatient (4/12678) and
304 Inpatient (66/79015) arm (RR 0.41 95% CI [0.16-1.02], $p = 0.05$, $I^2=0\%$), with the results not
305 changing to statistical significance after a sensitivity analysis. (Figure 3a)

307 3.4.3.2 Hoarseness/ Vocal Cord Paralysis/ RLN Injury

308 The rates of Hoarseness/ Vocal Cord Paralysis/ RLN Injury in 13 studies^{18,20–25,27,28,32,33,35,36} were
309 significant between the Outpatient (153/5492) and Inpatient (171/3905) arm (RR 0.59 95% CI [0.44-
310 0.80], $p = 0.0006$, $I^2 = 16\%$), with more complications of this nature in the inpatient setting. (Figure 3b)

311

312 3.4.3.3 SSI

313 The rates of SSIs in five studies^{18,24,26,35,39} were insignificant between the Outpatient (17/2619) and
314 Inpatient (16/2806) arm (RR 0.80 95% CI [0.40-1.59], $p = 0.52$, $I^2 = 0\%$), with the results not changing
315 to statistical significance after a sensitivity analysis. (Figure 3c)

316

317 3.4.3.4 Neck Haematoma

318 The rates of neck haematomas in 11 studies^{18–20,23,26,28,31–33,35,36} were insignificant between the
319 Outpatient (117/32486) and Inpatient (1097/111514) arm (RR 0.58 95% CI [0.34-1.00], $p = 0.05$,
320 $I^2 = 56\%$). A sensitivity analysis found Marino et al.³¹ to be the cause of heterogeneity, exclusion of
321 which led to an acceptable value of 0% and a p value of < 0.0001 , with less of these complications in
322 the outpatient setting. (Figure 3d)

323

324 3.4.3.5 Hypocalcaemic Event

325 The rates of hypocalcaemic events in 12 studies^{18,20–27,31–33} were significant between the Outpatient
326 (253/23825) and Inpatient (493/35538) arm (RR 0.52 95% CI [0.38-0.71], $p < 0.0001$, $I^2 = 56\%$), with
327 more complications of this nature in the inpatient setting. A sensitivity analysis found Marino et al.³¹
328 to be the cause of heterogeneity, exclusion of which led to an acceptable value of 0% and no change
329 in significance. (Figure 3e)

330

331 3.4.4 Complications by Procedure

332 3.4.4.1 Completion/ Total Thyroidectomy

333 The rate of overall complications in completion/total thyroidectomy was significantly lower in the
334 outpatient setting (109/16093) versus the inpatient setting (1026/95124) in seven studies.^{19–21,26,29,31,32}
335 (RR 0.52 95% CI [0.31-0.87], $p = 0.01$, $I^2 = 84\%$). Sensitivity analysis found that the exclusion of Black
336 et al. led to an acceptable heterogeneity of 0%, with a change in p -value to < 0.00001 . (Figure 4a)

3.4.4.2 Hemithyroidectomy

The rate of overall complications in hemithyroidectomy was insignificant in the outpatient (100/17941) versus the inpatient setting (566/86830) in six studies.^{19,28,31,35,36,39} (RR 0.74 95% CI [0.32-.1.71], p=0.48, I²=87%), with results not changing after a sensitivity analysis. (Figure 4b)

3.5 A Financial Comparative Systematic Review

This financial comparison is descriptive rather than a pooled economic analysis, given the heterogeneous presentation of cost data across studies (Section 2.4.2). With that caveat, a reduction in hospital costs was reported across all seven studies reporting on the financial aspect.^{17,22,24,25,30,31,34} A cost difference of \$842- \$2802 was seen, favouring the outpatient cohort. In one study which explored the impact of external factors on cost, comorbidities like congestive heart failure and postoperative complications like neck haematomas increased costs significantly.²⁴ As a descriptive, non-pooled comparison, these figures should not be interpreted as formal economic evidence of cost-effectiveness. Relevant financial characteristics have been tabulated. (Table 1)

4. DISCUSSION

This meta-analysis of 26 studies and more than 291,075 patients confirms that outpatient thyroidectomy is not only non-inferior to overnight admission but, for several outcomes, distinctly advantageous. Outpatients were substantially more likely to undergo hemithyroidectomy (RR 1.29) yet far less likely to require a concomitant neck dissection (RR 0.45). They also experienced markedly lower rates of recurrent laryngeal-nerve injury/hoarseness (RR 0.59), neck haematoma (RR 0.58), biochemical hypocalcaemia (RR 0.52) and the pooled “overall-complication” endpoint after total thyroidectomy (RR 0.52), while readmission, re-operation, infection and mortality remained

364 statistically indistinguishable between settings. Direct hospital charges were consistently lower, by
365 roughly US \$850–2800 per case.

366 Predictor modelling clarifies who is most likely to benefit. Pooled baseline data revealed that younger
367 age and White ethnicity, each independently increased the odds of ambulatory care, whereas
368 malignancy shifted treatment toward inpatient admission. These patterns align with patient-selection
369 criteria recommended in surgical reference texts, which emphasise limited resection, normal
370 contralateral vocal-fold mobility and the presence of reliable caregivers as key prerequisites for safe
371 discharge.⁴² They also mirror the real-world case-mix described in early single-centre cohorts: Seybt
372 and Terris reported that their outpatient series, carefully screened to exclude re-operations and frailty,
373 achieved identical or lower complication rates than inpatients despite more than 200 same-day
374 discharges.²⁷

375 Procedure-level differences are intuitive. Hemithyroidectomy is shorter, rarely requires drains and
376 carries minimal calcium disturbance, making it ideal for day surgery, whereas neck dissection
377 involves longer operative times, creates extensive dead space and mandates drains, prompting
378 surgeons to favour overnight observation for early bleeding or chyle-leak surveillance.⁴³ That the
379 outpatient cohort still recorded fewer haematomas and nerve injuries even after sensitivity testing
380 implies that streamlined, protocol-driven peri-operative care contributes to the safety margin. Modern
381 series employing routine post-anaesthetic parathyroid-hormone measurement with calcium/vitamin D
382 supplementation, meticulous haemostasis and avoidance of drains report near-zero permanent RLN
383 palsy and hypocalcaemia, reinforcing the value of such bundles.³

384 Heterogeneity at the procedure-level meta-analysis of hemithyroidectomies in outpatient versus
385 inpatient settings is probably the result of the marked imbalance in study sizes in the said outcome.
386 The meta-regression results are most likely spurious. However, it is worth further exploring the
387 relationship between Black patients undergoing more neck dissections in an outpatient setting. It is
388 possible that this trend hints at the confluence of a delayed oncological presentation and a well-
389 established below-average general socioeconomic status within that section of the population.^{44,45}
390 Studies delving into racial disparities in surgically treated head-and-neck cancer have found that

391 Black patients had higher mortality due to delayed presentation.^{46,47} It is, thus, not far-fetched to
392 hypothesise that black patients could be 1) economically disadvantaged enough to favour outpatient
393 care, and 2) present late enough to warrant a neck dissection. It is likely, too, that the heterogeneity is
394 the result of the heavy sample size discrepancy here too or could just be the result of true clinical
395 diversity.

396 Financial findings were likewise robust. Every study reporting costs demonstrated a net saving for
397 same-day discharge, congruent with the multicentre analysis by Hu et al. in which ambulatory
398 thyroidectomy incurred no excess readmissions or complications yet reduced total hospital charges by
399 more than \$2000 per patient.¹⁸ Extrapolated to the estimated 150,000 thyroidectomies performed
400 annually in the United States,⁴⁹ even the conservative lower-bound estimate of \$850 per case would
401 yield national savings exceeding \$120 million; this extrapolation is illustrative rather than a formal
402 projection, given variation in national procedure-volume estimates. Such figures underscore why the
403 ATA's 2013 consensus statement encouraged broader adoption of outpatient thyroidectomy in
404 appropriately selected patients and called on payers to align reimbursement with evidence-based
405 practice.³

406 Safety data from the present analysis align with more recent evidence syntheses. A 2024 systematic
407 review that aggregated single-arm cohorts likewise concluded that outpatient thyroidectomy is safe
408 when modern protocols are applied, citing low rates of haematoma and nerve injury comparable to
409 inpatient benchmarks.⁴⁸ Together, these contemporary data, historic single-centre experiences, and
410 expert-consensus guidelines form a compelling picture: for well-selected adults, ambulatory
411 thyroidectomy reduces laryngeal, haematologic and metabolic morbidity, trims hospital expenditure
412 and does so without shifting risk downstream.

413 This meta-analysis has several limitations which may limit its generalisability, and the strength of
414 evidence presented. Firstly, the dataset at present focuses almost exclusively on high income nations,
415 with no representation from low-to-middle-income countries. Secondly, meta-regression was used as
416 a last resort due to the acknowledged frailty of any model constructed since covariates were not
417 uniformly reported across studies. This severely limited the number of included studies in any uni-

covariate model. Thus, any and all results of a meta-regression must be seen as purely exploratory and hypothesis-generating, and not at any significant level of concrete evidence.

Additionally, due to the lack of matched data in most studies, confounding bias is assumed. In particular, comorbidity burden and baseline surgical risk were not captured as covariates in the baseline-level meta-analysis (Section 3.3), yet these are arguably the most clinically relevant drivers of outpatient versus inpatient triage: healthier, lower-risk patients are more likely to be selected for outpatient thyroidectomy, which may explain a substantial portion of the lower complication rates observed in that arm independent of any causal effect of the care setting itself.

The lack of RCT-driven data, and an over-representation of retrospectives introduces inherent flaws in the quality of the data synthesised. Furthermore, while every effort has been made to avoid population overlapping and data duplication, due to the vastness of the databases included, the possibility remains. Publication bias towards larger studies is evident from the funnel plot, with small scale studies with perhaps non-significant results standing unpublished or unrepresented on major repositories. The authors acknowledge that a trade-off has been made in several instances where, due to a dataset containing non-relevant procedures without stratification, certain portions of predictor, procedure, and complication-level data have not been used in the interest of statistical and methodological consistency.

6. CONCLUSION

Outpatient thyroidectomy appears to be safe and cost-effective in selected patients, with lower complication rates observed in this analysis; because outpatient versus inpatient assignment is itself likely driven by comorbidity burden and clinical judgement, these associations should not be interpreted as evidence that the care setting itself causes fewer complications. However, this meta-analysis must be understood in the context of its limitations and any clinical decision regarding referral to any one avenue of treatment needs careful pre-procedural patient selection with patient comorbidities, health literacy level, home support and distance from hospital given due regard. Any

future studies must emphasise propensity matching of data and more concrete study designs like RCTs to increase confidence in conclusions.

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TABLE LEGEND

Table 1- Financial Comparisons

Study ID	Average Outpatient Cost (\$)	Average Inpatient Cost (\$)	Mean Difference (\$)	p-value	Additional Comments
<i>AlEssa 2021</i>	4,582	5,424	842		15.5% reduction in health care costs when the procedure is performed as an outpatient procedure.
<i>Finn 2024*</i>	7,669 (6,038-10,210)	8,700 (7006-11024)	996 (-1,646–3,570)	< 0.001	
<i>Rosen 2021</i>	8,900	11,276	2,802	< 0.001	-Comorbidities associated with statistically significant increased costs:- Congestive heart failure (\$9,912 vs \$14,053;p=.028) Arrhythmias (\$9,725 vs \$16,002 p= .048). -Total cost increased with:-

					Progressive increases in ASA scores ($p < 0.001$) Drain Placement (\$8,682 vs \$11,411; $p < 0.001$). -Postoperative complications increasing costs:- hypoparathyroidism / hypocalcemia (\$9,923 vs \$11,781; $p=.021$), neck hematomas (\$10,002 vs \$15,825 $p=.012$)
<i>Terris 2007</i>	12,089	15,917	3,825	< 0.0001	
<i>Lacroix 2014</i>	266/day	531/day	265/day		
<i>Marino 2014</i>	-Total/ Completion: 7138 - Hemithyroidectomy: 6624	-Total/ Completion 8646 - Hemithyroidectomy 7778	1626	< 0.0001	
<i>Al-Qurayshi 2016</i>	≤ 37318 - 75.5% of patients >37318-24.5% of patients	≤ 37318 - 73.4% of patients >37318- 26.6% of patients			

577

578 *Data in medians (Quartile 1- Quartile 3)

579

580 **FIGURE LEGEND**

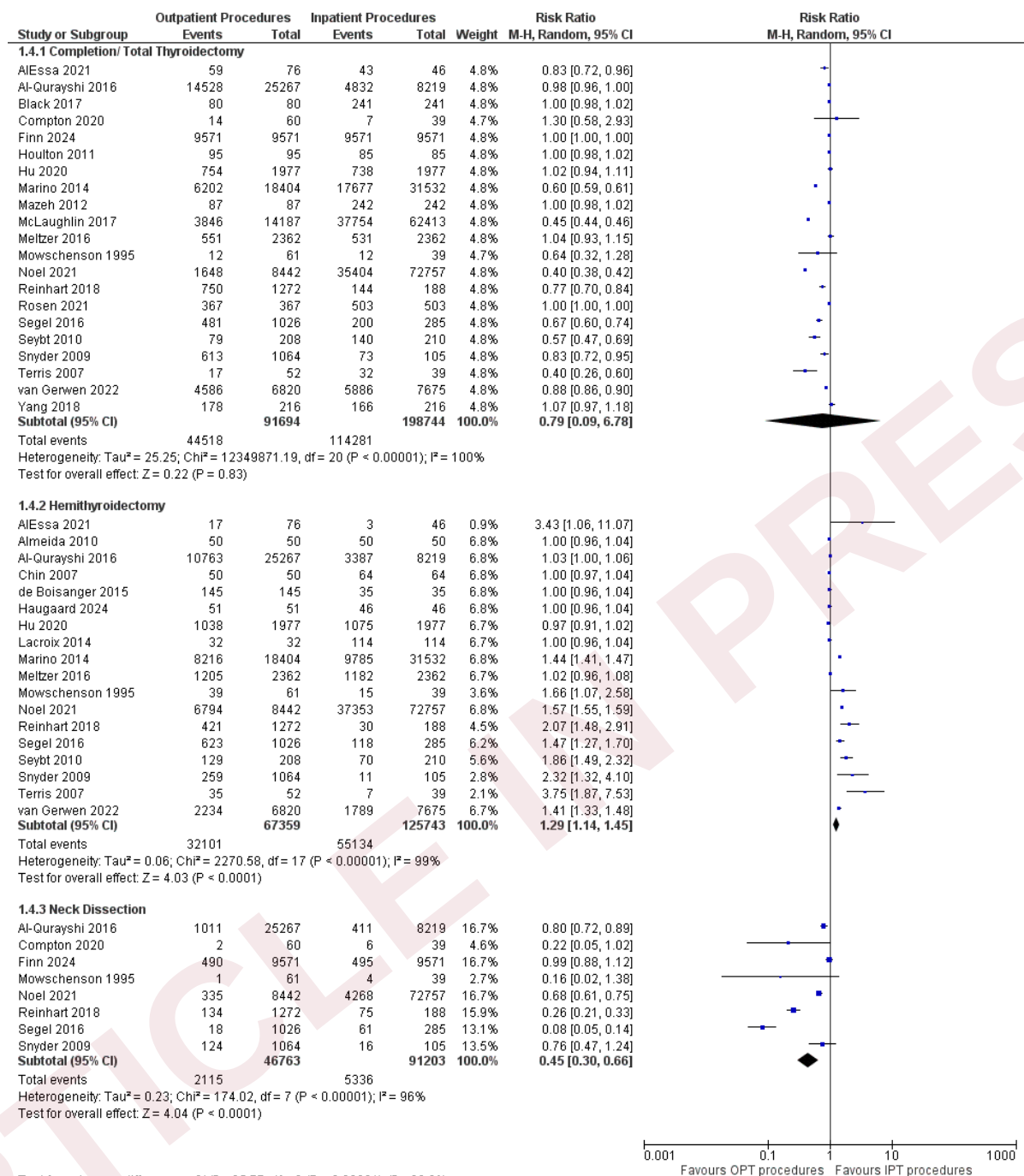
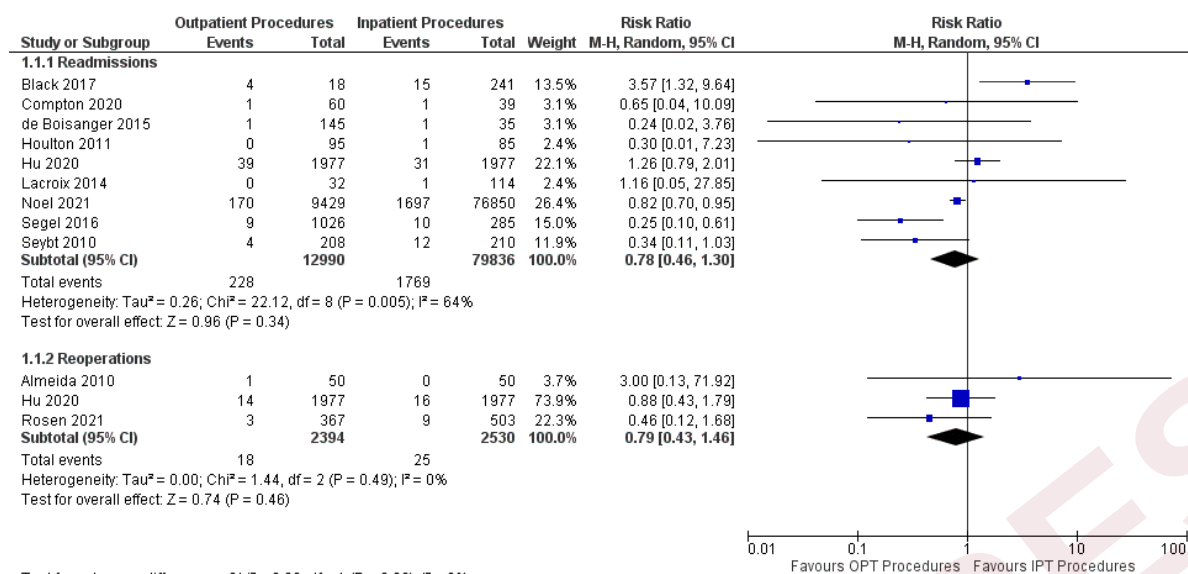


Figure 1. Procedure types.

Forest plots of risk ratios for completion/total thyroidectomy, hemithyroidectomy, and neck dissection comparing outpatient vs inpatient thyroidectomy.



Test for subgroup differences: $\text{Chi}^2 = 0.00$, $\text{df} = 1$ ($P = 0.96$), $I^2 = 0\%$

Figure 2. Readmissions and reoperations.

Forest plots of risk ratios for 30-day readmission and reoperation after outpatient vs inpatient thyroidectomy.

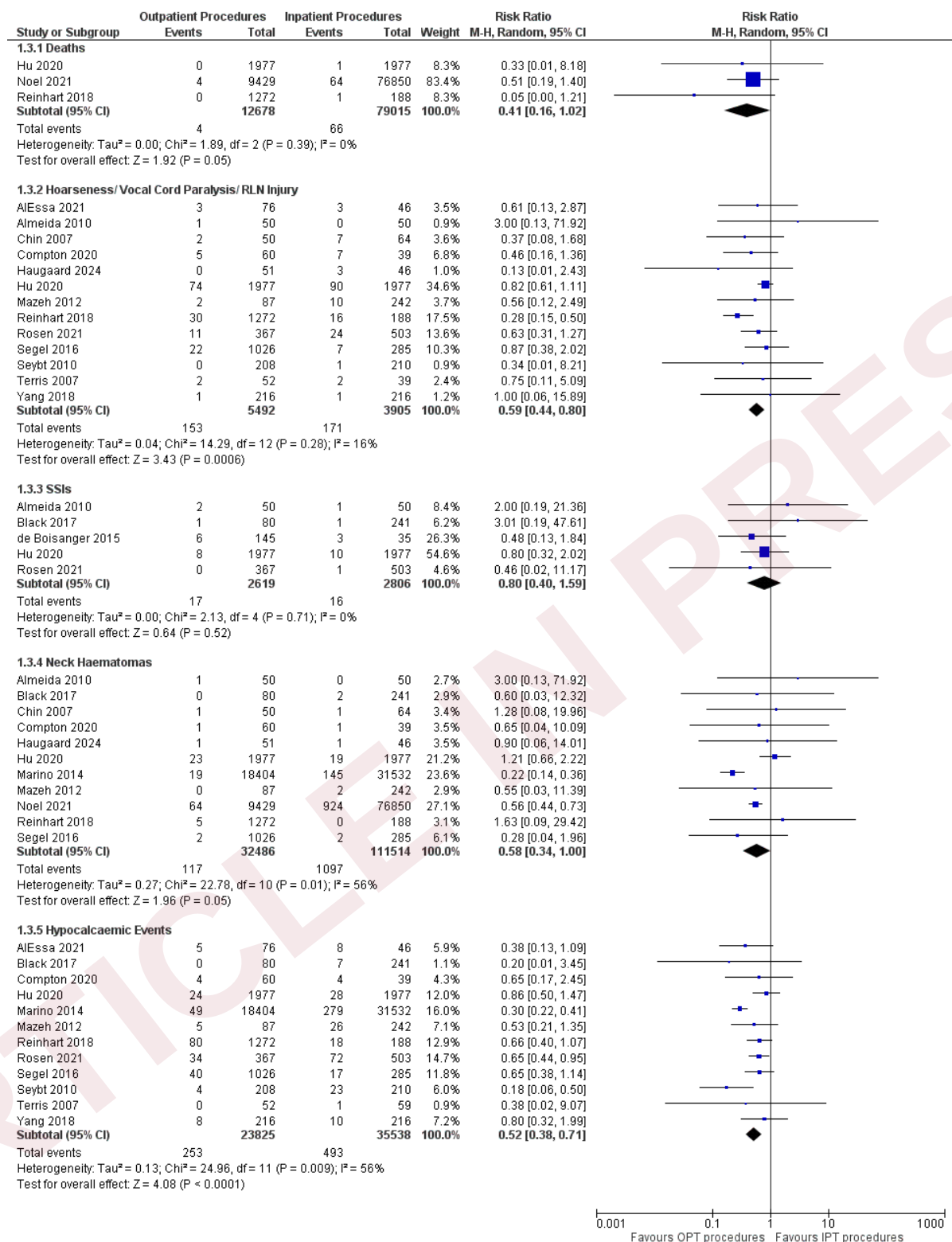
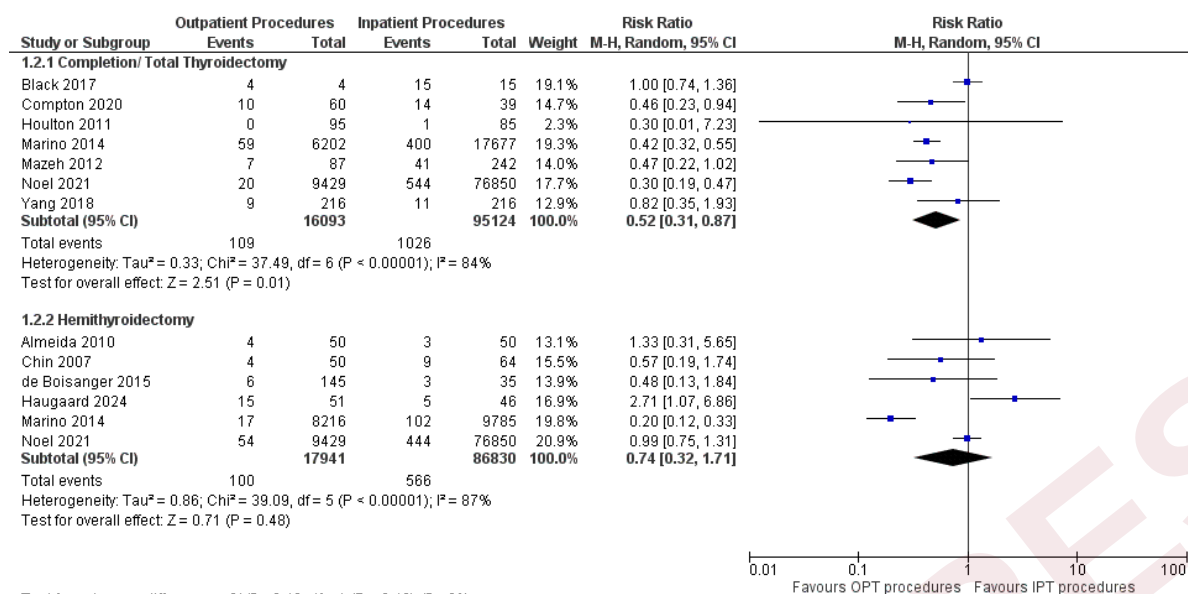


Figure 3. Individual complications.

Forest plots of risk ratios for death, recurrent laryngeal nerve injury/hoarseness, surgical site infection, neck haematoma, and hypocalcaemic events after outpatient vs inpatient thyroidectomy.



Test for subgroup differences: $\text{Chi}^2 = 0.48$, $\text{df} = 1$ ($P = 0.49$), $I^2 = 0\%$

Figure 4. Overall complications by procedure.

Forest plots of risk ratios for overall postoperative complications after completion/total thyroidectomy and hemithyroidectomy in outpatient vs inpatient settings.

SUPPLEMENTAL MATERIAL LEGEND

Supplementary Table 1. Database search strategies.

Full search strings for PubMed/MEDLINE, Embase, Scopus, Cochrane Library, and Web of Science.

Supplementary Figure 1. PRISMA flow diagram.

PRISMA 2020 flowchart of study identification, screening, eligibility, and inclusion.

Supplementary Table 2. Quality assessment.

Newcastle–Ottawa, Cochrane RoB 2.0, and JBI checklist ratings for included studies.

Supplementary Table 3. Study characteristics.

Design, setting, sample size, data source, and outpatient/inpatient definitions for each included study.

Supplementary Table 4. Baseline characteristics.

Demographic and clinical baseline characteristics of outpatient and inpatient cohorts by study.

Supplementary Table 5. Meta-regression: hemithyroidectomy and nodular goitre.

Regression results assessing association between nodular goitre prevalence and hemithyroidectomy risk ratio.

612 **Supplementary Figure 2. Bubble plot: hemithyroidectomy and nodular goitre.**

613 Meta-regression bubble plot of nodular goitre prevalence vs log risk ratio for hemithyroidectomy.

614 **Supplementary Figure 3. Funnel plot: procedure-level outcomes.**

615 Funnel plot evaluating publication bias for procedure-level comparisons between outpatient and

616 inpatient thyroidectomy.

617 **Supplementary Table 6. Meta-regression: neck dissection and Black race.**

618 Regression results assessing association between proportion of Black/African American patients and

619 neck-dissection risk ratio.

620 **Supplementary Figure 4. Bubble plot: neck dissection and Black race.**

621 Meta-regression bubble plot of Black/African American proportion vs log risk ratio for neck

622 dissection.