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Review Article

Clinical outcomes of outpatient thyroidectomy: A systematic review and single-arm meta-analysis

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ABSTRACT

Background: The aim of this meta-analysis is to investigate the safety of outpatient thyroidectomy based on 24-h and same-day discharge criteria.
Methods: CENTRAL, Embase, PubMed, and Scopus were searched. A meta-analysis of selected studies was performed. The review was registered prospectively with PROSPERO (CRD42022361134).
Results: Thirty-one studies met the eligibility criteria, with a total of 74328 patients undergoing thyroidectomy in an outpatient setting based on 24-h discharge criteria. Overall postoperative complications after outpatient thyroidectomies were 5.7% (95%CI: 0.049–0.065; I2 = 97.3%), consisting of hematoma (0.4%; 95%CI: 0.003–0.005; I2 = 83.4%), recurrent laryngeal nerve injury (0.4%; 95%CI: 0.003–0.006; I2 = 93.5%), and hypocalcemia (1.6%; 95%CI: 0.012–0.019; I2 = 93.7%). The rate of readmission was 1.1% (95%CI: 0.007–0.015; I2 = 95.4%). Results were similar for same-day criteria.
Conclusions: Our analysis demonstrated that outpatient thyroidectomy is a safe procedure in the management of thyroid disease for selected patients.

1. Introduction

Thyroidectomy is a common procedure used to treat thyroid nodules, thyroid cancer, and hyperthyroidism.[1–3] In recent years, there has been a growing trend towards performing thyroidectomy in an outpatient setting, with an estimated 61% increase over the last decade, compared to 39% seen with the inpatient approach.[4] According to the American Thyroid Association (ATA), outpatient thyroidectomy involves surgery at an ambulatory surgical center or hospital with home discharge in 24 h or less.[5] Interestingly, outpatient thyroidectomy is not exclusive to adults and has become recognized as a viable option for pediatric populations as well. This has been attributed to the thorough patient and family education, as well as preoperative and postoperative protocols put in place to ensure safe outcomes for pediatric candidates.[6]

Existing literature on the topic demonstrates rates of complications to favor the outpatient approach over the inpatient thyroidectomy.[7] This finding is applicable to pediatric populations who demonstrate higher incidences of complications post-thyroidectomy compared to adults.[8] Furthermore, other studies have shown increased patient satisfaction secondary to shorter hospital stays and faster recovery with adequate pain control.[9–12] In a wider context, the cost-effective implications of outpatient thyroidectomy at the institutional and patient levels have also been well documented.[4,13]

Despite the advantages of outpatient thyroidectomy, not all adult or pediatric patients are considered candidates. While the ATA recommends its practice, other international bodies, such as the British Association of Endocrine and Thyroid Surgeons, have not reached a consensus on selection criteria.[14] Early discharge from outpatient surgeries raises apprehension of postoperative issues that may have been avoided with

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Abbreviations and acronyms

ASA	The American Society of Anesthesiologists
ATA	The American Thyroid Association
RLN	Recurrent laryngeal nerve

close inpatient monitoring.[15,16] This is in part due to the threat of complications such as recurrent laryngeal nerve (RLN) injury or airway compromise, which can be critical if not managed acutely enough.[17] The potential to miss cervical hematomas, and difficulty managing postoperative hypocalcemia, also weigh concerns on decisions for outpatient surgery.[18]

Most studies on outpatient thyroid surgery are from single institutions, which may be prone to selection bias and have limitations of external generalization from the nature of study designs. Moreover, the only prior study in this space focused on inpatient versus outpatient discharge after thyroidectomy; however, the focus of our study is the evaluation of outpatient thyroidectomy with an emphasis on the more common controversy of type. To our knowledge, no meta-analysis of existing studies has conducted a study on outpatient thyroidectomy based on 24-h and same-day discharge criteria, defined as being discharged on the same calendar. Thus, this meta-analysis aims to investigate the safety and efficacy of outpatient thyroidectomy by synthesizing the most available findings from the literature to provide direction on best clinical practice.

2. Methods

2.1. Data sources and search Strategies

A comprehensive search of several databases from each database's inception to December 2nd, 2022, was conducted in compliance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.[19] The databases included Medline (PubMed), Scopus (Elsevier), CENTRAL (Wiley), and Embase (Elsevier). The search strategy was designed and conducted by an experienced librarian with input from the study's principal investigator. Controlled vocabulary supplemented with keywords was searched for adult and pediatric patients who underwent thyroidectomy in an outpatient setting. The actual strategy listing all search terms used and how they are combined is available in **Supplementary Item 1**. The review was registered prospectively with PROSPERO (CRD42022361134).

2.2. Eligibility criteria and quality assessment

Eligible studies were randomized controlled trials or cohort studies that met the following inclusion criteria: 1) Adult and/or pediatric participants who underwent outpatient thyroidectomy based on 24-h criteria; 2) Outcomes of postoperative overall complication rates; and/or 3) Outcomes of postoperative endocrine-related complication rates, including hematoma, RLN injury, and hypocalcemia; and/or 4) Outcomes of postoperative readmission rates. Case reports, case series, abstracts, conference abstracts, and articles that were not reported in English were excluded from the study. This meta-analysis also excluded studies if greater than ten percent of included patients did not meet our 24-h outpatient thyroidectomy discharge criteria (i.e. discharged less than 24 h postoperatively), or outcomes of outpatient discharge were not clearly defined and/or reported. Lastly, the eligibility of studies was assessed based on per-protocol analysis using the outpatient criteria to accurately represent patients who were discharged within 24 h. The quality of each study was independently evaluated by two authors (HN and RW) using the Newcastle-Ottawa Scale.[20] Any discrepancies were discussed by the two independent assessors, with disagreements addressed via an adjudicator (HC). Results of the quality assessment of all included studies are shown in **Supplementary Item 2**.

2.3. Extracted outcomes

For complication rates under 24-h discharge criteria, the following were extracted: overall complications, endocrine-related complications, subclassified endocrine complications of hematoma, RLN injury, and hypocalcemia, as well as wound infection and pediatric-only wound complications. However, our study could not specifically comment on temporary or permanent complications, as many studies did not delineate this, and the length of follow-up requires at least 6 months. For postoperative outcomes under 24-h discharge criteria, the following were extracted: emergency department visit within 30 days, readmission within 30 days, reoperation rates within 30 days, mortality within 30 days, as well as pediatric-only readmission within 30 days. For postoperative and complication rates under same-day discharge criteria, the following were extracted: overall complications, endocrine-related complications, subclassified endocrine complications of hematoma, RLN injury, and hypocalcemia, as well as wound infection and readmission rates within 30 days. In the context of this meta-analysis, endocrine-related complications include hypocalcemia, RLN injury, and hematoma. 24-hour and same-day discharge criteria were defined as patients getting discharged within 24 h and on the same calendar day, respectively, after thyroidectomy. Additionally, separate subgroup analyses in adult and pediatric cohorts were attempted; however, the meta-analysis could not be performed due to patient overlap in the included studies. Lastly, subgroup analysis with only randomized controlled trials (RCT) was attempted, but this could not be performed due to missing primary data.

2.4. Statistical analysis

The pooled means and proportions of our data were analyzed using a random-effects, generic inverse variance method of DerSimonian and Laird, which assigns the weight of each study based on its variance.[21] The heterogeneity of effect size estimates across the studies was quantified using the Q statistic and I^2 ($P < 0.10$ was considered significant). A value of I^2 of 0–25% indicates insignificant statistical heterogeneity, 26–50% low heterogeneity, and 51–100% high heterogeneity.[22] Furthermore, a leave-one-out sensitivity analysis was conducted to assess each study's influence on the pooled estimate by omitting one study at a time and recalculating the combined estimates for the remaining studies. Publication bias was assessed using a funnel plot.[23] If mean and standard deviation (SD) were unavailable, the median was converted to mean using the formulas from the Cochrane Handbook for Systematic Reviews of Interventions.[24] Data analysis was performed using Open Meta analyst software (CEBM, Brown University, Providence, Rhode Island, USA).

3. Results

3.1. Study selection and patient characteristics

The initial literature search of the electronic database yielded 1440 studies. After removing duplicates, the articles were screened for inclusion and exclusion criteria, and 117 studies were retained for full-text review. 31 unique studies involving 74328 patients were included in this meta-analysis. Twenty of the included studies[9,25–43] were retrospective cohort studies, six[44–49] were prospective cohort studies, and four[50–53] were RCTs. Twelve studies[25,28,30,32,34,36,37,40,42,43,47,50] were performed as multi-center studies, and nineteen[9,26,27,29,31,33,35,38,39,41,44–46,48,49,51–54] were single-center studies. The reported mean age ranged from 30.1 to 52.1 years, and 59538 patients (81.6%) were women. A PRISMA flowchart of the study selection process is depicted in **Supplementary Item 3**. The baseline characteristics of the included studies are comprehensively described in Table 1.

Table 1
Baseline characteristics and quality assessment of included studies.

Study	Publication Year	Country	Study Type	Data Collection (Years)	Number of Patients, N	Female, N (%)	Age, Mean ± SD (Years)	Age Range Min-Max (Years)	Inclusion of Pediatric Patients	ASA Classes	Outpatient Criteria
AlEssa et al.	2021	Saudi Arabia	Retrospective	2017–2019	76	60 (78.9%)	44.0 ± 12.8	NR	NR	ASA I: 17 ASA II: 46 ASA III: 13	Same day
Almeida et al.	2010	Portugal	Retrospective	2005–2008	50	40 (80.0%)	47.0 ± 4.8	39–58	No	NR	Same day
Arikan et al.	2014	Turkey	Retrospective	2011–2013	672	529 (78.7%)	48.0 ± 13.0	NR	NR	NR	Less than 24 h
Bhinder et al.	2021	USA	Retrospective	2012–2017	122	105 (86.1%)	NR	<7-18	Yes	ASA I: 31 ASA: 84	Same day
Chereau et al.	2021	France	Prospective	2018–2020	529	NR	NR	NR	NR	NR	Same day
Chin et al.	2007	Singapore	Retrospective	2004–2005	50	44 (88.0%)	41.0 ± NR	NR	NR	ASA I/ II: 50	Same day
de Boisanger et al.	2015	Scotland	Retrospective	2010–2013	106	88 (83.0%)	44.0 ± NR	NR	NR	ASA I: 39 ASA II: 60 ASA III: 7	Same day
de la Fuente Bartolomé et al.	2022	Spain	Retrospective	2019–2020	79	NR	NR	NR	NR	ASA I-III: 79	Less than 12 h
Dionigi et al.	2008	Italy	Prospective	2007–2008	112	67 (59.8%)	39.8 ± 12.5	19–69	No	ASA I/ II: 112	Less than 23 h
Hu et al.	2020	USA	Retrospective	2016–2017	2776	2226 (80.2%)	50.5 ± 14.5	NR	NR	ASA I/ II: 2034 ASA III: 716 ASA IV: 26	Same day
Jeppesen et al.	2020	Denmark	Retrospective	2014–2019	137	110 (80.3%)	50.0 ± 10.4	NR	NR	ASA I/ II: 137	Same day
Khavanin et al.	2015	USA	Retrospective	2011–2012	11691	9505 (81.3%)	51.1 ± 14.6	NR	NR	ASA I/ II: 8546 ASA III-V: 3145	Less than 23 h and same day
Lacroix et al.	2014	France	Prospective	2011–2021	34	26 (76.5%)	47.3 ± 7.2	NR	NR	ASA I/ II: 34	Same day
Lang et al.	2016	China	Prospective	2011–2013	1004	814 (81.1%)	52.1 ± 14.9	NR	NR	ASA I: 447 ASA II: 467 ASA III: 87	Less than 24 h
Lou et al.	2022	China	NR	2019–2019	157	148 (94.3%)	30.1 ± 7.8	13–48	Yes	NR	Less than 23 h
Materazzi et al.	2007	Italy	Retrospective	2001–2004	1571	1244 (79.2%)	43.0 ± 17.8	11–82	Yes	ASA I/ II: 1543	Less than 24 h
Molinari et al.	2015	Brazil	Retrospective	1997–2014	3411	3007 (88.2%)	48.8 ± 15.5	7–90	Yes	NR	Less than 18 h
Noel et al.	2021	Canada	Retrospective	1993–2017	8442	6789 (80.4%)	NR	>18	No	NR	Same day
Perera et al.	2014	England	Retrospective	2008–2010	164	133 (81.1%)	NR	NR	NR	NR	Less than 23 h
Rajeev et al.	2014	England	Retrospective	2000–2011	802	NR	NR	NR	NR	NR	Less than 23 h and same day
Sahai et al.	2005	England	Prospective	2001–2002	104	94 (90.4%)	51.8 ± 16.6	14–83	Yes	NR	Less than 23 h
Samson et al.	1997	Philippines	RCT	1982–1994	809	737 (91.1%)	31.0 ± 11.8	18–65	No	NR	Less than 24 h
Spanknebel et al.	2005	USA	Prospective	1988–2003	1025	812 (79.2%)	50.0 ± 19.0	13–89	Yes	ASA I: 102 ASA II: 716 ASA III: 87	Less than 24 h

(continued on next page)

Table 1 (*continued*)

Study	Publication Year	Country	Study Type	Data Collection (Years)	Number of Patients, N	Female, N (%)	Age, Mean ± SD (Years)	Age Range Min-Max (Years)	Inclusion of Pediatric Patients	ASA Classes	Outpatient Criteria
										ASA IV: 7	
Stack et al.	2013	USA	Retrospective	2005–2010	38362	31287 (81.6%)	49.1 ± 14.7	2–114.9	Yes	NR	Less than 23 h
Teoh et al.	2008	China	Retrospective	2005–2006	50	44 (88.0%)	45.6 ± 7.4	NR	NR	ASA I: 38 ASA II: 12	Same day
Testini et al.	2002	Italy	RCT	2000–2001	40	30 (75.0%)	NR	NR	NR	NR	Less than 24 h
Trottier et al.	2009	Canada	Retrospective	2002–2004	232	195 (84.1%)	47.5 ± 15.5	20–85	No	ASA I: 77 ASA II: 128 ASA III: 12	Same day
Tuggle et al.	2011	USA	Retrospective	2004–2004	1168	979 (83.8%)	NR	18-65+	No	NR	Same day
Yakhlef et al.	2017	France	Retrospective	2009–2013	130	103 79.2 %)	44.0 ± NR	NR	NR	ASA I/ II: 130	Same day
Yang et al.	2018	China	RCT	2014–2016	216	168 (77.8%)	44.7 ± 12.3	NR	NR	NR	Less than 24 h
Zhang et al.	2021	China	RCT	2019–2019	207	154 (74.4%)	39.6 ± 9.3	NR	NR	ASA I: 112 ASA II: 95	Less than 24 h

Acronyms: ASA = The American Society of Anesthesiologists, N = Number of patients/scores, NR = Not reported, SD = Standard deviation.

3.2. Risk of bias

Results of the quality assessment of all included studies are shown in **Supplementary Item 2.** Nine studies[9,36,38,44,46,48–50,54] were determined to be of poor quality with critical selection bias due to unspecified or significant loss to follow-up and insufficient follow-up period. The remainder of the included studies were judged to be of fair quality. The patients appeared to represent the whole experience of the investigator. The exposure and outcome were adequately ascertained, and the lengths of follow-up were adequate.

3.3. Clinical characteristics

Thirty-one studies met eligibility criteria with a total of 74328 patients undergoing outpatient thyroidectomy, discharged less than 24 h postoperatively, per protocol. Of those patients, 99.8% (n = 74209) were discharged within 24-h discharge criteria. American Society of Anesthesiologists (ASA) grading was reported in seventeen studies,[9,25,28–35,41,43,45–47,49,53] and the proportion of ASA classification I/II and III-V was 78.6% (n = 15056) and 21.4% (n = 4106), respectively. Among thirteen studies[9,26,28,35–37,40,42,45,48–50,54] that reported the age range, pediatric patients (age less than 18) were included in seven studies.[28,35,36,40,48,49,54] The pathological evaluation of included studies revealed 70.3% (n = 43277) with benign pathology and 29.7% (n = 18314) with malignant pathology. The type of thyroidectomy consisted of total thyroidectomy (49.5%; n = 36402) and lobectomy (35.6%; n = 26159). The remaining 15% are unknown due to a lack of description in primary data. Among eighteen reported studies,[9,25,26,28–33,37,39,41–44,46,49,54] our meta-analysis included 15084 patients with thyroidectomy who were discharged from the ambulatory care unit without an overnight stay. Selection criteria for individual studies are further elaborated in **Supplementary Item 4**. Additionally, the clinical characteristics of outpatient thyroidectomy are described in Table 2.

3.4. Outpatient thyroidectomy complication rates (24-h discharge criteria)

Based on 24-h discharge criteria, overall complications after outpatient thyroidectomy were reported in 29 studies.[9,25–27,29–41,43–54] A pooled proportion of overall complications was 5.7% (95%CI: 0.049–0.065; $I^2 = 97.3\%$; n = 1491). Endocrine-related complications, consisting of hematoma, RLN injury, and hypocalcemia, were reported in 29 studies,[9,25–27,29–41,43–54] and pooled proportion was 3.2% (95%CI: 0.027–0.037; $I^2 = 96.0\%$; n = 1144). Furthermore, subgroup analyses on complications after outpatient thyroidectomy were performed. Pooled proportion of hematoma was 0.4% (95%CI: 0.003–0.005; $I^2 = 83.4\%$; n = 182) among 26 studies.[9,25–27,29,30,32–41,43–45,47–49,51–54] Twenty-two studies[9,25–27,29,30,32–36,38–41,44,45,47–49,51,54] reported RLN injury, and a pooled proportion was 0.4% (95%CI: 0.003–0.006; $I^2 = 93.5\%$; n = 308). The pooled proportion of hypocalcemia was 1.6% (95%CI: 0.012–0.019; $I^2 = 93.7\%$; n = 654) among 24 studies,[9,25–27,29–32,34–36,38–40,43–45,47–53] and wound infection was 0.2% (95%CI: 0.001–0.003; $I^2 = 73.3\%$; n = 70) among 20 studies.[9,26–35,38–40,45,47–49,53,54] In addition to the overall outcomes, the pediatric population-only outcomes on wound complications were reported by Bhinder et al., and the authors reported that no pediatric patient among 122 had wound complications.[28] Outpatient thyroidectomy complication rates based on 24-h discharge criteria are described in Fig. 1.

Additionally, based on 24-h discharge criteria, the number of visits to the emergency department for any cause within thirty days was reported in nine studies[9,25,26,30,31,37,38,41,47] with the pooled proportion as 5.3% (95%CI: 0.012–0.094; $I^2 = 98.0\%$; n = 1037). The pooled estimate of the readmission rate for any cause within thirty days among 24 studies[9,25,27,28,30–39,41,42,45–49,51–53] was 1.1% (95%CI: 0.007–0.015; $I^2 = 95.4\%$; n = 558). Of sixteen studies,[9,26,28,29,32,34–36,38,39,41,43,44,47,49,52] the pooled proportion of the reoperation rate within thirty days was 0.5% (95%CI: 0.002–0.007; $I^2 = 86.1\%$; n = 193). The mortality rate within thirty days was reported in fifteen studies,[9,27,30,32,34,35,38,39,41,45,47–50,53] the proportion of which

Table 2
Perioperative clinical characteristics.

Study	Publication Year	24-h Discharge N (%)	Same-day Discharge N (%)	Benign Pathology N (%)	Malignancy N (%)	Total Thyroidectomy N (%)	Lobectomy N (%)	Drain N (%)
AlEssa et al.	2021	76 (100%)	76 (100%)	44 (57.9%)	32 (42.1%)	50 (65.8%)	17 (22.4%)	NR
Almeida et al.	2010	50 (100%)	50 (100%)	NR	NR	0	50 (100%)	48 (96.0%)
Arikan et al.	2014	672 (100%)	NR	443 (65.9%)	229 (34.1%)	672 (100%)	0	645 (96.0%)
Bhinder et al.	2021	122 (100%)	122 (100%)	NR	NR	31 (25.4%)	91 (74.6%)	NR
Chereau et al.	2021	523 (98.9%)	523 (98.9%)	NR	NR	16 (3.0%)	483 (91.3%)	NR
Chin et al.	2007	50 (100%)	45 (90.0%)	47 (94.0%)	3 (6.0%)	0	50 (100%)	40 (80.0%)
de Boisanger et al.	2015	106 (100%)	106 (100%)	NR	NR	0	106 (100%)	NR
de la Fuente Bartolomé et al.	2022	79 (100%)	72 (91.1%)	NR	NR	0	79 (100%)	NR
Dionigi et al.	2008	112 (100%)	NR	102 (91.1%)	10 (8.9%)	62 (55.4%)	50 (44.6%)	112 (100%)
Hu et al.	2020	2776 (100%)	2776 (100%)	2530 (91.1%)	246 (8.9%)	716 (25.8%)	1638 (59.0%)	194 (7.0%)
Jeppesen et al.	2020	124 (90.5%)	124 (90.5%)	137 (100%)	0	0	137 (100%)	0
Khavanin et al.	2015	11691 (100%)	NR	NR	NR	11691 (100%)	0	NR
Lacroix et al.	2014	32 (94.1%)	32 (94.1%)	34 (100%)	0	0	34 (100%)	NR
Lang et al.	2016	1004 (100%)	NR	805 (80.2%)	199 (19.8%)	598 (59.6%)	320 (31.9%)	0
Lou et al.	2022	157 (100%)	157 (100%)	NR	NR	74 (47.1%)	83 (52.9%)	157 (100%)
Materazzi et al.	2007	1543 (98.2%)	NR	1358 (86.4%)	213 (13.6%)	1119 (71.2%)	450 (28.6%)	NR
Molinari et al.	2015	3396 (99.6%)	NR	2612 (76.6%)	799 (23.4%)	2251 (66.0%)	1063 (31.2%)	1321 (38.7%)
Noel et al.	2021	8442 (100%)	8442 (100%)	5425 (64.3%)	3017 (35.7%)	1648 (19.5%)	6794 (80.5%)	NR
Perera et al.	2014	160 (97.6%)	NR	107 (65.2%)	57 (34.8%)	40 (24.4%)	101 (61.6%)	NR
Rajeev et al.	2014	802 (100%)	163 (20.3%)	750 (93.5%)	52 (6.5%)	NR	NR	NR
Sahai et al.	2005	104 (100%)	NR	89 (85.6%)	15 (14.4%)	65 (62.5%)	36 (34.6%)	104 (100%)
Samson et al.	1997	809 (100%)	NR	809 (100%)	0	0	167 (20.6%)	NR
Spanknebel et al.	2005	984 (96.0%)	820 (80.0%)	556 (54.2%)	463 (45.2%)	589 (57.5%)	391 (38.1%)	NR
Stack et al.	2013	38362 (100%)	NR	26079 (68.0%)	12283 (32.0%)	16399 (42.7%)	13653 (35.6%)	NR
Teoh et al.	2008	49 (98.0%)	49 (98.0%)	47 (94.0%)	3 (6.0%)	0	50 (100%)	NR[a]
Testini et al.	2002	38 (95.0%)	NR	33 (82.5%)	7 (17.5%)	40 (100%)	0	40 (100%)
Trottier et al.	2009	231 (99.6%)	231 (99.6%)	174 (74.0%)	61 (26.0%)	43 (18.3%)	99 (42.1%)	NR
Tuggle et al.	2011	1168 (100%)	1168 (100%)	826 (70.7%)	342 (29.3%)	NR[b]	NR[b]	NR
Yakhlef et al.	2017	128 (98.5%)	128 (98.5%)	123 (94.6%)	7 (5.4%)	0	130 (100%)	NR
Yang et al.	2018	214 (99.1%)	NR	147 (68.1%)	69 (31.9%)	178 (82.4%)	0	NR[a]
Zhang et al.	2021	205 (99.0%)	NR	0	207 (100%)	120 (58.0%)	87 (42.0%)	207 (100%)

Acronyms: N = Number of patients, NR = Not reported, SD = Standard deviation.
[a] Drainage was not routinely used.
[b] Total thyroidectomy or substernal thyroidectomy (n = 386), Partial thyroid lobectomy (n = 782).

was 4 out of 21328 patients. In addition to the overall outcomes, the pediatric population-only outcomes on 30-day readmissions were reported by Bhinder et al..[28] Among 122 patients, the authors reported 3 pediatric patients (2.5%) with readmissions. Details of outpatient thyroidectomy postoperative outcomes based on 24-h discharge criteria are described in Fig. 2.

3.5. Outpatient thyroidectomy postoperative complication rates (same-day discharge criteria)

Based on same-day discharge criteria, overall complications after outpatient thyroidectomy were evaluated in fifteen studies.[9,25,26,29–33,37,39,41,43,44,46,54] A pooled proportion of overall complications was 5.0% (95%CI: 0.032–0.069; $I^2 = 93.2\%$; n = 320). Endocrine-related complications, consisting of hematoma, RLN injury, and hypocalcemia, were reported in fifteen studies[9,25,26,29–33,37,39,41,43,44,46,54] with a rate of 2.2% (95%CI: 0.012–0.033; $I^2 = 86.9\%$; n = 232). Furthermore, subgroup analyses on complications based on same-day discharge criteria were performed. The complication rate of hematoma was conducted in thirteen studies[9,25,26,29,30,32,33,37,39,41,43,44,54] and was found to be 0.7% (95%CI: 0.005–0.008; $I^2 = 0\%$; n = 95). Among eleven studies,[9,25,26,29,30,32,33,39,41,44,54] the pooled proportion of RLN injury was 1.5% (95%CI: 0.006–0.024; $I^2 = 72.8\%$; n = 98). Hypocalcemia was evaluated in ten studies[9,25,26,29–32,39,43,44] and had a pooled proportion of 0.7% (95%CI: 0.004–0.011; $I^2 = 15.67\%$; n = 39). Wound infection was reported in ten studies[9,26,28–33,39,54] and was 0.6% (95%CI: 0.002–0.010; $I^2 = 12.5\%$; n = 23). Readmission rates were evaluated in twelve studies[9,25,28,30–33,37,39,41,42,46] and were 1.2% (95%CI: 0.008–0.017; $I^2 = 58.3\%$; n = 234). Details of outpatient thyroidectomy postoperative outcomes based on same-day discharge criteria are described in Fig. 3.

4. Discussion

Ongoing debates on outpatient thyroidectomy have revolved around assessing the safety of this approach for selected patients. This meta-analysis is the most comprehensive and current to demonstrate 1) low overall and endocrine-related complication rates, including hematomas, recurrent laryngeal never (RLN) injury, and hypocalcemia, based on 24-h discharge criteria, 2) low incidents of emergency department visits, readmissions, reoperation rates, and mortality within 30-day based on 24-h discharge criteria, and 3) low overall and endocrine-related complication rates, including hematomas, RLN injury, and hypocalcemia, based on same-day discharge criteria. Although discharge criteria

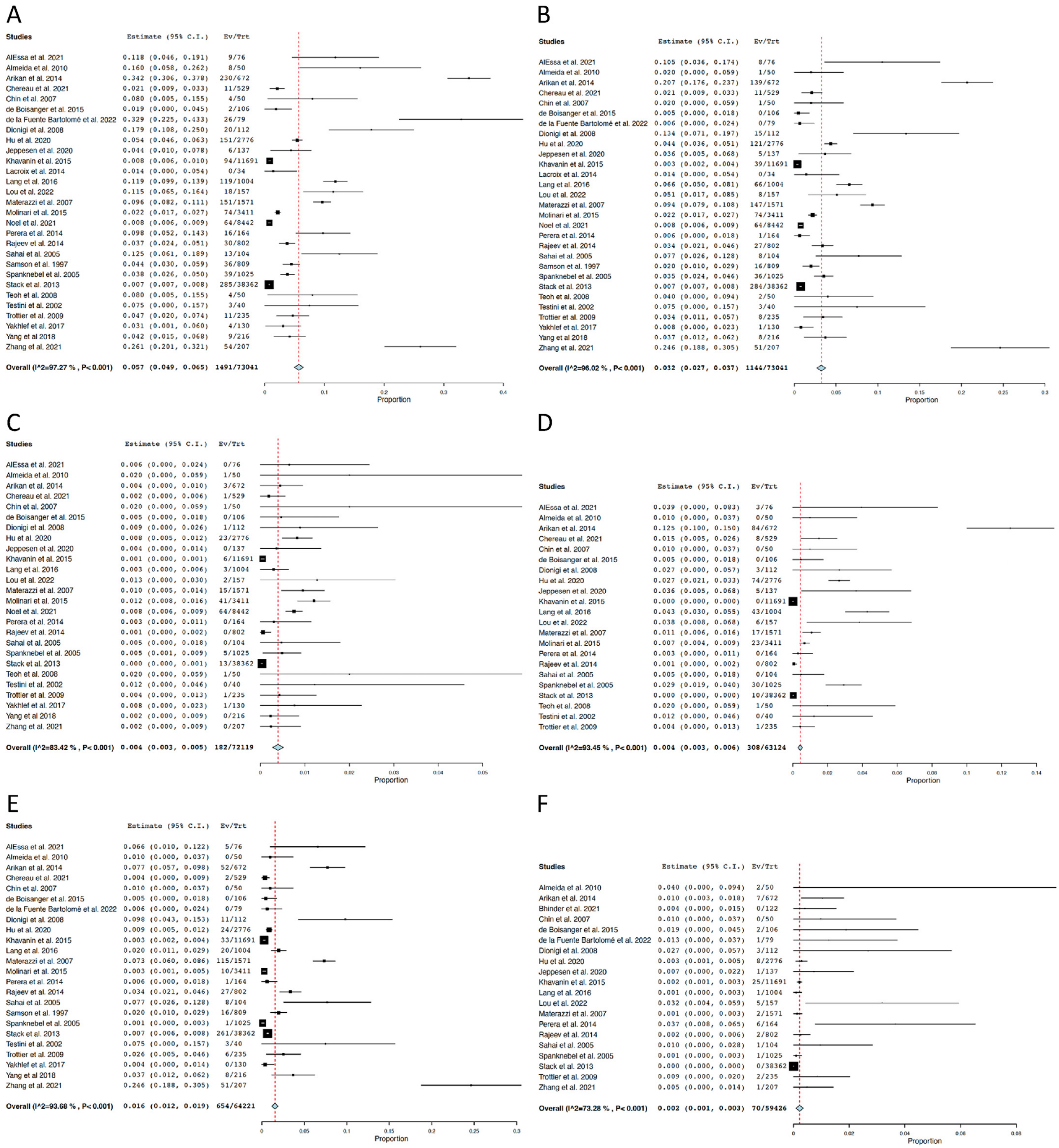

Fig. 1. A pooled estimate of outpatient thyroidectomy complication rates based on 24-h discharge criteria: **an** overall complications; **b** endocrine-related complications; **c** hematoma; **d** recurrent laryngeal nerve injury; **e** hypocalcemia; **f** wound infection.

and selection criteria are likely variable and hard to generalize, the findings of this meta-analysis demonstrate that outpatient thyroidectomy is safe and overall favorable compared to historical literature for RLN injury, hypocalcemia, and death, and should be applied in clinical practice to achieve the best amalgamation between cost-effective healthcare and patient outcomes for selected cases.

One of the most serious adverse outcomes that can arise from thyroid surgery is a postoperative hematoma. From this meta-analysis, hematoma incidences were less than 1% based on 24-h and same-day discharge criteria, consistent with a previous meta-analysis comparing outpatient to inpatient thyroidectomies.[7] Likewise, our rate of hematoma is consistent with the findings from a pediatric-only study which reported 1.9%.[6] While these rates may be considered low, the consequences of hematomas can prove to be critical as this can lead to asphyxia via airway compromise or trachea compression, and in most severe scenarios, death.[55] The life-threatening nature of these complications stresses the

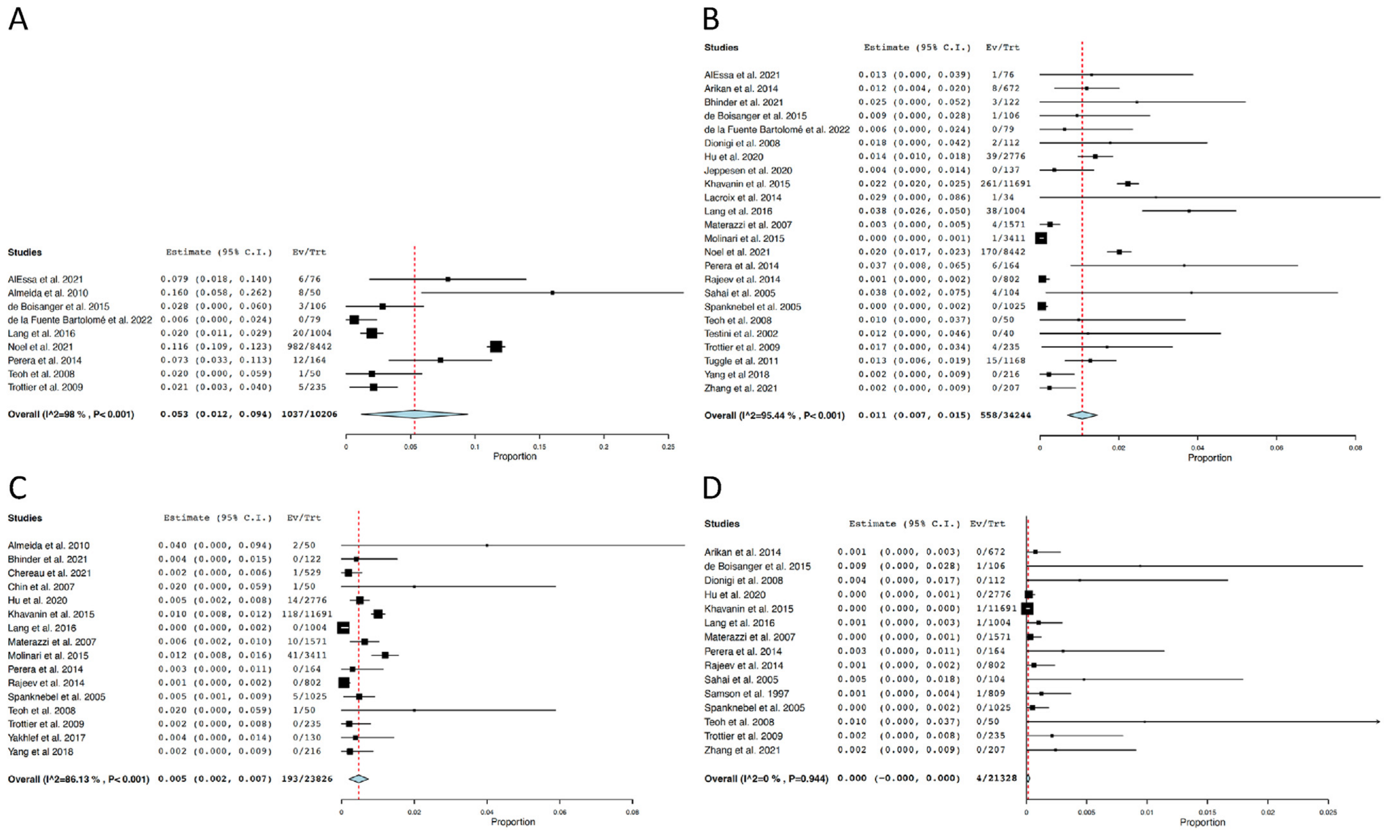

Fig. 2. A pooled estimate of outpatient thyroidectomy postoperative outcomes based on 24-h discharge criteria: **an** emergency department visits; **b** readmission rates; **c** reoperation rates; **d** mortality rates.

importance of identifying the postoperative period whereby these events are most likely to occur. Rajeev et al. report that most bleeding events in the postoperative period occur within 6 h after surgery,[39] with an increased risk for patients undergoing total thyroidectomy compared to lobectomy. This 6-h period in which the likelihood of hemorrhagic events is most common coincides with prior literature.[56–58] Delays in hematoma events later than 6 h can still occur, with Burkey et al., reporting 38% of patients between 7 and 12 h and 8% after 24 h in their study.[59] Despite there being no international consensus regarding the selection criteria for outpatient thyroidectomy, understanding the risk factors and onset of potential complications for cervical hematoma has undoubtedly improved judgment as to the time and conditions appropriate for discharge.

Hypocalcemia is one of the most common postoperative complications encountered in outpatient thyroidectomy. The incidence of hypocalcemia in our meta-analysis was 1.6%. This rate proved to be lower than the incidence of hypocalcemia in a previous meta-analysis that reported 4.19% in the outpatient group.[7] Transient hypocalcemia is the most common variant, which can be defined by hypocalcemia lasting within 6 months postoperatively, in comparison to permanent which lasts greater than 6 months.[38,60] Dedivitis et al. discuss that the rate of transient hypocalcemia ranges from 3 to 53%, whereas the rate of permanent hypocalcemia varies between 0.4 and 13%.[61] Within the pediatric population, approximately 35% of patients had endocrine-specific complications after thyroidectomy, with the most cases being transient hypocalcemia (32.7%).[6] One proposed method to predict the incidence of hypocalcemia has been the utilization of postoperative PTH as an early marker, which can by extension reduce readmission rates.[62,63] There has been an estimated sensitivity of 90% and specificity of 86% in predicting hypocalcemia in adults 4 h postoperatively.[64] The ATA mentions that PTH measurements taken 1–2 h postoperatively have proven to be the optimal time to make accurate assessments. While there is no widely agreed consensus on a standardized protocol, such evidence brings forth promising findings to help develop methods to identify and manage high-risk patients and discharge those at minimal risk with more certainty.

RLN injury rate was calculated to be 0.4%, comparable to the findings in the literature.[7,65] Paresis or paralysis of the laryngeal nerve can have serious consequences, ranging from mild injuries of neuropraxia to the most severe cases of respiratory distress arising from bilateral RLN injury.[66] In their study, Lacroix et al. utilized recurrent laryngeal nerve monitoring to ensure close monitoring of the function of the nerve during operation.[46] Methods of intraoperative nerve monitoring have been investigated extensively by Bai et al., and their meta-analysis demonstrated evidence for reducing the risk of nerve injury, especially in cases of operations of malignancy where bilateral nerve injury may be at risk.[67,68]

Lower readmission rates after thyroid surgery are important parameters since these could serve as an indication of fewer postoperative complications and successful recovery at home. The findings from this meta-analysis suggest that the readmission rate in patients undergoing outpatient thyroidectomy was low, at around one percent, based on 24-h and same-day discharge criteria. This finding is consistent with the US National Surgical Quality Improvement Program in which outpatient thyroid surgeries demonstrated low incidents of 30-day hospital readmission.[69] Nonetheless, the readmission rate after outpatient thyroidectomy could be influenced by other confounding factors. This is reflected in the study by Tuggle et al., in which they observe a much greater proportion of rehospitalization in the elderly population as well as the comorbidity status of patients.[42] Postoperatively, they attributed symptomatic hypocalcemia as the most common reason for readmission for the outpatient thyroidectomy cohort. Additionally, Hu et al. postulate that confounders such as the surgeon's experience and volume of cases, the comfort level of surgeon and patient as well as geographic and social

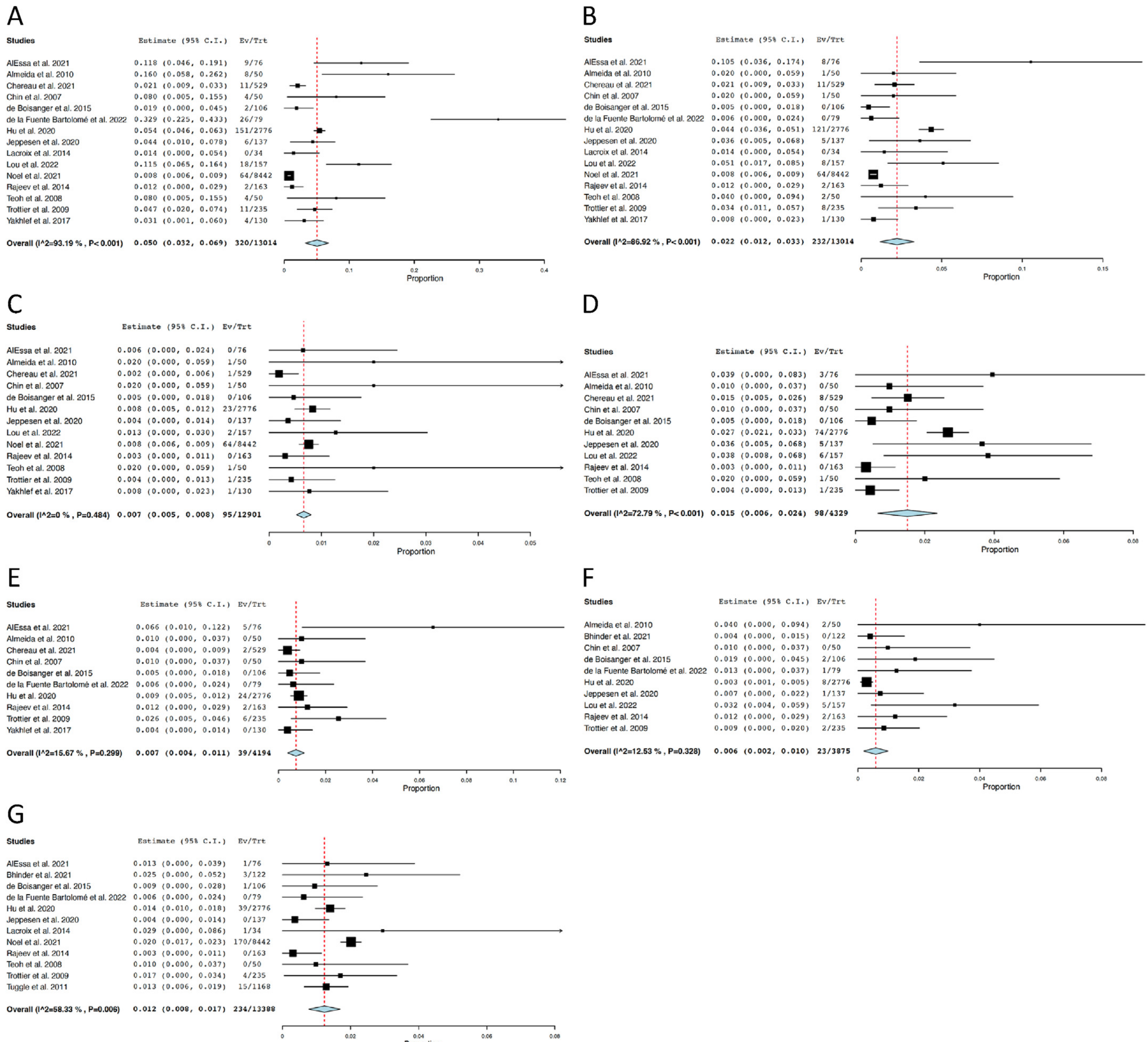

Fig. 3. A pooled estimate of same-day thyroidectomy complication rate and postoperative outcomes: **a** overall complications; **b** endocrine-related complications; **c** hematoma; **d** recurrent laryngeal nerve injury; **e** hypocalcemia; **f** wound infection; **g** readmission rates.

factors have an impact on the incidence of readmission.[32] In the pediatric subset of patients, Bhinder et al.[28] revealed low rates of readmission (2.5%), which is comparable to Dream et al., as well as other studies investigating the pediatric population.[6,70,71] They attribute one of the primary reasons for its success to the supervision of high-volume surgeons with expertise in performing pediatric surgeries. Nonetheless, more studies with larger sample sizes that delineate pediatric from adult populations are required to help further validate these findings.

The selection criteria proposed by the ATA outlines several factors, consisting of clinical, social, and procedural factors, to evaluate the eligibility of outpatient thyroidectomy in both adults and pediatrics.[5] Due to the absence of a generalized consensus of selection criteria for outpatient thyroidectomy, this meta-analysis demonstrated difficulty in controlling heterogeneity in the selection process across selected studies. Despite this, many included studies shared similar features to the selection criteria set out by bodies like the ATA. For example, while Hu et al. focused their selection on papillary thyroid carcinoma, they excluded patients with signs and suspicions of local to distant metastasis due to increased risk of reoperation.[32,72] Additionally, they identified patients with major comorbidities such as liver and kidney dysfunction and any severe chronic diseases that were not fit for outpatient thyroid surgery. Another point of contention is the ASA grading, which in their study was the exclusion of ASA classes of 3 or higher. In contrast, the ATA recommends the exclusion of ASA classes of 4 or higher,[5] which was adopted by other included studies within this meta-analysis.[25,28,30,31,46,47,73] Materazzi et al. set out to define anesthesiologic and surgical criteria but also emphasized the importance of social-logistical criteria which resonate with ATA recommendations.[35,74] Discussing the importance of establishing patient autonomy at discharge, suitable housing conditions for recovery, contacts in case of emergency, and clear instructions to identify postoperative health consequences are vital to the success of outpatient thyroidectomy. In doing so, efforts to strengthen patient education should be continually developed to provide appropriate and timely management of complications from thyroid surgery. Therefore, while there are shared characteristics between studies, establishing a consensus in the selection criteria for patients suitable for outpatient thyroidectomy will undoubtedly reduce heterogeneity and improve the accuracy of findings.

This paper is not devoid of limitations. Firstly, there were 31 studies, of which the majority were retrospective and observational rather than randomized control trials. Due to this design, inherent biases were exposed, such as selection and information bias as well as confounders, which must be considered when measuring the outcomes in this meta-analysis. Secondly, heterogeneity among surgeon experience and case volume with outpatient thyroidectomy could have contributed to the rate of complications that may have been mitigated by standardized expertise.[75,76] Furthermore, the heterogeneity in reported outcomes proved to be high in some instances, which can be attributed to differences in patient selection, unclear delineation of adult from pediatric patients, patient comorbidities, surgeon's volume/experience, hospital/institution protocols, or available resources across the included studies. Thirdly, especially in the larger studies conducted by Khavanin et al. and Stack et al., the degree of data underreported as these were retrospective in nature and accessed databases from multiple contributors.[34,40] Moreover, these studies obtained information from the NSQIP database, whereby the outcome data is generic and does not routinely track thyroid-specific complications, such as neck hematoma and hypocalcemia. Therefore, if there were errors or underestimations from sources, then the accuracy of studies may be potentially compromised, and this must be considered when evaluating the outcomes. Fourthly, hypocalcemia rates are likely minuscule following a lobectomy compared to total thyroidectomy, but we cannot quantify this difference. Next, differences in discharge protocols among studies, including PTH cutoff level, could have resulted in selection bias among the outpatient cohort and underestimated the rate of hypocalcemia. Another limitation was that the majority of the studies lacked the reporting of the baseline characteristics and subgroup analysis of postoperative outcomes of outpatient thyroidectomy based on the same-day discharge criteria. Thus, the results of same-day discharge criteria must be evaluated with caution due to selection bias and heterogeneity among included studies. Finally, while efforts have been made, especially by bodies such as the ATA, the selection criteria for outpatient candidates for thyroidectomy differs across the studies.[5] Therefore, ensuring a more homogenous and robust selection/discharge criteria may enhance and validate the findings from this meta-analysis.

5. Conclusions

This single-arm meta-analysis is the most comprehensive and current study to demonstrate outpatient thyroidectomy as a safe approach in selected patients. Notably, the results demonstrate low rates of overall and endocrine-related complications as well as readmission within both 24-h and same-day discharge criteria. Despite these promising results, further studies must evaluate the selection criteria and effect of long-term outcomes of outpatient thyroidectomy.

Data Availability statement

With the publication, the data set used for this meta-analysis will be shared upon request from the study authors.

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Conflict of interest disclosure

BEJ has received proctoring and educational event fees from Intuitive Surgical outside the submitted work. The remainder of the authors declares no competing interests.

Ethical approval

This systematic review and meta-analysis do not require ethical approval.

CRediT authorship contribution statement

Hayato Nakanishi: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Rongzhi Wang:** Conceptualization, Data curation, Formal analysis, Writing – review & editing. **Shahid Miangul:** Conceptualization, Data curation, Writing – review & editing. **Grace E. Kim:** Data curation, Formal analysis, Writing – review & editing. **Omotayo A. Segun-Omosehin:** Data curation, Formal analysis, Writing – review & editing. **Natalie E. Bourdakos:** Data curation, Formal analysis, Writing – review & editing. **Christian A. Than:** Data curation, Formal analysis, Writing – review & editing. **Benjamin E. Johnson:** Data curation, Formal analysis, Writing – review & editing. **Herbert Chen:** Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. **Andrea Gillis:** Formal analysis, Writing – original draft, Writing – review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2024.02.037.

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