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American Thyroid Association Statement on Outpatient Thyroidectomy

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for the American Thyroid Association Surgical Affairs Committee Writing Task Force

Background: The primary goals of this interdisciplinary consensus statement are to define the eligibility criteria for outpatient thyroidectomy and to explore preoperative, intraoperative, and postoperative factors that should be considered in order to optimize the safe and efficient performance of ambulatory surgery.
Summary: A series of criteria was developed that may represent relative contraindications to outpatient thyroidectomy, and these fell into the following broad categories: clinical, social, and procedural issues. Intraoperative factors that bear consideration are enumerated, and include choice of anesthesia, use of nerve monitoring, hemostasis, management of the parathyroid glands, wound closure, and extubation. Importantly, postoperative factors are described at length, including suggested discharge criteria and recognition of complications, especially bleeding, airway distress, and hypocalcemia.
Conclusions: Outpatient thyroidectomy may be undertaken safely in a carefully selected patient population provided that certain precautionary measures are taken to maximize communication and minimize the likelihood of complications.

INTRODUCTION

In recent years, there has been an increasing emphasis on outpatient management of surgical procedures. Patient comfort, health, and safety remain the principal objectives. Outpatient surgery is defined for the purposes of this article as same-day discharge from a free-standing or hospital-based surgical unit, not requiring an overnight hospital or postoperative recovery unit stay. Over time, a transition has occurred in which an increasing number of operative procedures previously performed in an inpatient setting are now commonly accomplished as outpatient procedures (1–5). In keeping with this trend, thyroidectomy is now frequently undertaken as an outpatient procedure, with several peer-reviewed reports of safe implementation totaling over 4500 procedures since 2006 as detailed in Table 1 (6–19). This change in management has occurred in the absence of consensus-driven parameters for defining the eligible population of patients or uniformly endorsed precautions for pursuing an outpatient approach. The American Thyroid Association therefore commissioned the current interdisciplinary Task Force (composed of general surgeons, otolaryngologists, and an endocrinologist—some of whom perform outpatient thyroidectomy and some of whom do not) to develop a consensus statement that helps to define the eligibility criteria for outpatient thyroidectomy, and to explore preoperative, intraoperative, and postoperative factors that should be considered in order to optimize the safe and efficient performance of ambulatory surgery. The primary objective of this article is not to mandate outpatient thyroidectomy, but to seek agreement regarding parameters involving the patient, operation, day-surgery setting, and social circumstances that make outpatient thyroidectomy feasible.

To maximize the opportunity to achieve consensus and to respect all viewpoints, a two-phase comment period was

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Table 1. Outpatient Thyroidectomy Outcomes

Study	Year	Outpatient thy (n)	% of all thy	% total thy[a]	Observation (hours)[b]	% hematoma	Fatal hematoma	% hypocalcemia	% readmit
Snyder *et al*. (6)	2006	51	88	24	3.3	2.0	0	5.2	3.9
Spanknebel *et al*. (7)	2006	778	65	59	≥6	–	0	–	–
Terris *et al*. (8)	2007	52	57	33	–	1.9	0	0.0	1.9
Inabnet *et al*. (9)	2008	180	80	43	≥5	0.4	0	1.3	–
Champault *et al*. (10)	2009	77	50	0	≥6	0	0	0	0
Trottier *et al*. (11)	2009	234	99	26	≥4	0.4	0	2.6	1.7
Seybt and Terris (12)	2010	208	50	38	–	0.5	0	1.9	1.9
Snyder *et al*. (13)	2010	1064	86	58	2.7	0.2	0	5.2	1.6
Hessman *et al*. (14)	2011	138	77	46	–	1.4	0	3.6	2.9
Houlton *et al*. (15)	2011	95	53	100	–	0	0	0	0
Sklar *et al*. (16)	2011	94	38	0	≥4	0	0	0	0
Tuggle *et al*. (17)	2011	1168	17	33	–	–	0	–	1.4
Mazeh *et al*. (18)	2012	298	49	29	3–4	0	0	1.7	0
Sahmkow *et al*. (19)	2012	176	88	47	≥3	0	0	10.0	1.7

[a]Total thyroidectomy includes completion thyroidectomy procedures.
[b]Observation period following surgery in hours.
Hematoma, postoperative cervical hematoma; hypocalcemia, postoperative symptomatic hypocalcemia; readmit, postoperative hospital admission for thyroidectomy-related complications following outpatient thyroidectomy; thy, thyroidectomy.

conducted after the initial draft of this article was prepared. First, the American Thyroid Association membership was given an opportunity to make comments. Following this feedback, an additional month of public open comment period was held, including specific invitation to the members of the American Association of Endocrine Surgeons, the American Head and Neck Society, and the American Academy of Otolaryngology–Head and Neck Surgery. More than 100 comments were generated from over 30 respondents. These included suggestions, criticisms, and technical considerations. Each of them was individually considered, and the vast majority of them were implemented in some capacity.

DISCUSSION

Potential Advantages of Outpatient Thyroidectomy

The potential advantages associated with outpatient thyroidectomy fall into the following broad categories: patient safety, patient comfort, and conservation of resources.

The patient's health and safety remain paramount during recovery from any operation. The reality of the hospital environment necessarily exposes the patient to the risk of nosocomial infections with drug-resistant organisms, such as methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant enterococcus, or multidrug-resistant tuberculosis (20). Furthermore, an imperfect system of patient care in the hospital environment also exposes the patient to a host of potential iatrogenic complications that may be avoided with outpatient management. An Institute of Medicine report in 1999 (To Err Is Human) (21) estimated that approximately 98,000 deaths occur each year in American hospitals as a result of these iatrogenic complications. Many patients prefer outpatient surgery from a comfort and convenience perspective. Convalescence in a quiet, comfortable, and familiar setting with supportive family and friends may be preferable to a less quiet, interruptive, and unfamiliar hospital environment. Patients are generally receptive to the notion of outpatient thyroidectomy, particularly if proper patient education and counseling are pursued to mitigate fears and uncertainties in preparation for the outpatient process. A protocol of postoperative assessment in the surgery unit ensures that the patient, family, and friends are adequately prepared for the outpatient experience before discharge.

The U.S. healthcare industry remains under increased scrutiny to maintain quality patient care at reduced cost. Each day a patient spends in the hospital incurs fixed and variable expenses that will differ over sections of the country and from urban to rural settings. Maximizing the efficiency of outpatient surgery serves to minimize utilization of critical hospital resources that may instead be reallocated to other important needs. Furthermore, a gradual transition of some thyroidectomies from an inpatient procedure to an outpatient setting may impart considerable healthcare savings nationwide. Published studies have demonstrated a reduction in charges associated with outpatient thyroidectomy compared with inpatient surgery, which approaches $2500 per encounter (8,13). These savings not only accrue to medical facilities, insurance companies, and the government, but directly benefit the patient as well, since few health insurance plans cover 100% of incurred expenses, with most requiring the patient to pay a percentage of the expenses. Some health insurance plans charge the patient a fixed copay for each day spent in the hospital. Such incentives have naturally created an attitude change in some patients in favor of outpatient surgery.

The advantages of outpatient thyroidectomy may be realized once the patient's safety and comfort in the outpatient setting are optimized. Although not all thyroidectomy procedures can be managed on an outpatient basis, it is worth identifying those patients and procedures for which it is reasonable, and recommending precautions for pursuing it safely.

Preoperative Considerations

Thorough preoperative planning and careful patient selection are critical aspects of any thyroidectomy being contemplated, but are particularly important for the pursuit of a successful outpatient thyroid surgery program. Taking the time and effort to set up a comprehensive and reliable clinical pathway will assure that patient safety is maintained as the

Table 2. Eligibility Criteria for Outpatient Thyroidectomy

No major comorbidities or ASA 4
Provision and understanding of preoperative education
Team approach to education and clinical care
Primary care giver willing and available
Social setting conducive to safe postoperative management
Proximity to skilled facility

ASA, American Society of Anesthesiologists.

first and foremost priority. Clinical pathways assure that all team members "are on the same page," which will help prevent a breakdown in the flow of information and assure a culture of clear communication. Although not always possible because of variability in any given institution's culture, identifying a dedicated outpatient thyroid surgery team will facilitate clear communication between all involved parties. Critical team members include the operating surgeon, the treating anesthesiologist, and the postanesthesia care unit nursing staff. Office personnel such as medical assistants and nurse practitioners also play an important role in patient education and preparation for same-day discharge. Clear communication with the operating room scheduling staff will help minimize erroneous classification of the patient's discharge status, optimize hospital bed utilization, avoid postanesthesia care unit congestion, and enhance patient satisfaction.

Ambulatory thyroid surgery requires a partnership between the patient and the thyroid surgeon beyond the conventional patient–surgeon relationship. Accordingly, patient education is an essential component of a safe outpatient thyroid surgery program and ideally should begin at or even before the patient's consultation with the surgeon. Educational materials can be made available to patients in a variety of forms, such as a letter of introduction, a mailed brochure, or a website that discusses the different aspects of thyroid surgery, including same-day discharge. Written documents or Internet resources should include a clear and easy-to-locate contact number in case of an emergency or development of a postoperative complication. Encouraging patients to review these materials before the initial patient–surgeon consultation may make the consultation more informative for the patients, as their questions may be better directed and reinforce the educational material content. In addition to the standard informed consent for the particular surgery itself, patients must be educated about the signs and symptoms of complications to an extent greater than if they were to be admitted and monitored by healthcare professionals. Furthermore, surgeons who pursue outpatient thyroidectomy are advised to document their discussion with the patient of the potential risks associated with this approach.

Careful patient selection and clinical judgment for same-day discharge is essential (Table 2). A variety of comorbidities may be considered relative contraindications to outpatient thyroidectomy (Table 3), including noncompensated cardiac or respiratory disease, dialysis-dependent renal failure, anticoagulant or antiplatelet therapy, seizure disorder, anxiety disorder, obstructive sleep apnea, hearing loss, visual impairment, mental impairment, pregnancy, unilateral vocal fold paralysis, thyrotoxicosis, chronic pain syndromes, and morbid obesity (especially body mass index >40, or at least 100 pounds [45.4 kg] over ideal body weight) (22–27). Advanced age alone is not a contraindication to outpatient thyroidectomy. Prior intolerance or prolonged recovery from general anesthesia may preclude same-day surgery, if general anesthesia is planned. A thorough preoperative history and physical examination should identify critical comorbidities, and simultaneously reveal the level of motivation and comfort that a patient has with the prospect of outpatient surgery. Social factors such as communication and language barriers, long distance of travel between home and the surgical facility, challenges in transportation, time of day of expected completion of the surgery, lack of family/friend support, and emotional insecurity may favor inpatient care after thyroidectomy. The patient will need ready interaction with family or friends in the early postoperative recovery as well as timely access to transportation to an acute care facility if needed. For this reason, a well-informed family member or committed friend is required for patient safety, not only to assure adequate postoperative care but also for immediate transportation to the surgical facility if a significant complication occurs. Many patients travel long distances for specialized care, and therefore may not be capable of quickly returning to the surgical facility in case of a complication such as bleeding. In major metropolitan areas, traffic patterns, and congestion points such as bridges and tunnels may prove to be significant deterrents to outpatient thyroidectomy. Coordinating postoperative care with the primary care provider, referring physician, or local medical care facility may be necessary to optimize an emergency care plan. It may be most prudent in some circumstances for patients undergoing outpatient thyroidectomy to stay in a nearby hotel for the first night if they live far away.

Table 3. Relative Contraindications to Outpatient Thyroidectomy

Clinical	*Social*	*Procedure*
Uncompensated cardiac or respiratory disease	Excessive distance from skilled facility	Massive goiter
Dialysis for renal failure	Living alone with no person to accompany	Extensive substernal goiter
Anticoagulant or antiplatelet therapy	Lack of transportation	Locally advanced cancer
Seizure disorder	Patient preference	Challenging hemostasis
Anxiety disorder	Communication barriers	Difficult thyroidectomy with Hashimoto's thyroiditis or Graves' disease
Obstructive sleep apnea		
Hearing loss		
Visual impairment		
Mental impairment		
Pregnancy		

The type and extent of surgery may dictate the appropriateness of outpatient thyroidectomy. Unilateral thyroid lobectomy carries a lower probability of laryngeal dysfunction, considering the risk of unilateral versus bilateral vocal fold paralysis. Unilateral lobectomy is devoid of the risk of significant postoperative hypocalcemia compared with completion thyroidectomy or total thyroidectomy. Additionally, unilateral lobectomy has a smaller operative field than a total thyroidectomy, and therefore the potential risk per operation of a compromising postoperative hemorrhage may be reduced (13). However, same-day discharge of patients undergoing total thyroidectomy has been shown to be safe (9).

Surgery for thyroid cancer may require an intraoperative decision to perform a central neck dissection that could further increase the risk of postoperative hypoparathyroidism and/or laryngeal nerve dysfunction as well as lymphatic leak, and may favor inpatient observation or at least the flexibility to convert from an outpatient to an inpatient stay as deemed necessary for patient safety. The risk of postoperative bleeding increases with increasing thyroid gland weight and size of a dominant nodule (28), which could influence the decision for overnight hospital admission.

Intraoperative Considerations

The pursuit of outpatient thyroidectomy, like inpatient thyroidectomy, relies heavily on the judicious performance of the procedure, for which a number of factors are worth noting. It is not the intention with this list to suggest that inpatient surgery should be done any less meticulously than outpatient surgery, but rather to highlight elements of a modern thyroidectomy that are particularly important to consider in a patient who will be discharged shortly after surgery.

Technical

Anesthesia type/technique. Both general and locoregional anesthesia are used for thyroidectomy. An important aspect of anesthesia is minimizing postoperative nausea, which can predispose to vomiting and retching, potentially inducing bleeding in the surgical wound. It is particularly important that the patient's nausea is under control before discharge from outpatient thyroidectomy. Recent randomized studies have shown that the use of dexamethasone or pre-emptive antiemetic agents such as droperidol reduces postoperative nausea and vomiting (29,30). Another important aspect of general anesthesia is smooth emergence to minimize excessive coughing, which may increase the risk of postoperative hemorrhage. Various techniques have been proposed as ways of reducing coughing during emergence, including deep extubation, administration of dexmedotomidine, or intravenous or topical lidocaine.

A number of studies in recent years have validated the efficacy of local/regional anesthesia using superficial or combined deep (level C2–C4)/superficial cervical block with monitored anesthesia care for performing thyroidectomy in properly selected patients. Retrospective review of case series (31–33) as well as a randomized trial (6) have shown that compared with general anesthesia, regional anesthesia with monitored anesthesia care reduces postoperative use of antiemetics, time in the operating room, and length of stay. Superficial and/or a deep cervical block have also been shown to be a helpful adjunct to general anesthesia in reducing postoperative use of narcotics for pain (34–36). This may have some advantage in those who are sensitive to narcotics and likely to develop nausea, where the use of narcotics can be minimized in the outpatient setting. However, a crucial prerequisite for this is the availability of an anesthesiologist or surgeon who is skilled in the administration of superficial and/or deep cervical blocks and proper levels of sedation. A major disadvantage of this approach is the inability to employ continuous nerve monitoring using a laryngeal electromyography endotracheal tube, although transcricothyroid muscle needle electrodes can permit laryngeal electromyography monitoring under local anesthesia of both the recurrent laryngeal nerve and the external branch of the superior laryngeal nerve (37).

Nerve monitoring. The use of laryngeal nerve monitoring with a dual-channel electromyographic endotracheal tube is increasingly utilized during thyroid surgery, especially in the hands of higher-volume surgeons (38), although many experienced thyroid surgeons have not incorporated this technology into their practice. Despite lack of definitive evidence that laryngeal nerve monitoring prevents nerve injuries, it may be useful when contemplating outpatient thyroidectomy since the vagus nerve or the most proximal exposed portion of the recurrent laryngeal nerve can be stimulated to confirm its functional integrity at the end of a thyroidectomy (39). Knowledge of the electrophysiologic integrity of the recurrent laryngeal nerve may influence the decision on whether or not to discharge a patient who underwent total thyroidectomy the same day. If one nerve cannot be stimulated at the end of the case and same-day discharge is planned, the patient's respiratory status and swallowing function should be assessed before discharge. If both nerves fail to stimulate by the end of the case, extreme caution must be exercised before extubating the patient. If nerve monitoring is not available or not routinely used, clinical assessment of the patient's respiratory/vocal status as well as flexible laryngoscopy in the postanesthesia care unit may provide real-time assessment of the vocal cord status before discharge.

Dressings and drain use. It has been shown that pressure dressings do not prevent postoperative hematoma, and may obscure visualization of a hematoma (40). Several randomized prospective studies have shown that the use of a drain after uncomplicated total thyroidectomy, lobectomy, and subtotal thyroidectomy likewise does not reduce the rate of postoperative bleeding (41–44). For this reason, most patients undergoing ambulatory thyroidectomy do not have drains placed. Nursing and discharging staff should be educated on the importance of being certain that the incision is flat before discharge.

Hemostasis

Ligatures versus clips versus energy. Hemostasis in thyroid surgery has traditionally been achieved by a clamp and tie technique, electrocautery, or hemostatic clips. The more recent application of newer energy devices such as ultrasonic dissection and electrothermal bipolar vessel sealing

systems has proven to be feasible and safe, and provides significant reduction of operative time and intraoperative bleeding compared with conventional methods (9,45). They may be advantageous when contemplating outpatient thyroidectomy, although a meticulous surgical technique seeking a completely dry operative field by the end of surgery, irrespective of the method used for hemostasis, is the most important principle in achieving a safe and hemostatic thyroidectomy that facilitates ambulatory management. Gently rubbing or swabbing the surgical field while irrigating with saline before wound closure may help detect possible sources of postoperative bleeding. The "beach chair" position for thyroidectomy has been used by some surgeons to minimize venous bleeding intraoperatively, accompanied by a preclosure valsalva maneuver (up to 30–40 cm H_2O), facilitated by the anesthesiologist that may help detect small venous bleeding sources. Alternatively, the patient may be kept flat during the operation to alert the surgeon to evident venous bleeding in need of hemostasis. Keeping the patient in a head-up 45-degree fowler position in the recovery room may also help minimize postoperative venous bleeding.

Hemostatic agents. A number of biosurgical agents designed to promote hemostasis have been increasingly employed in thyroid surgery, including oxidized regenerated cellulose, gelatin compressed sponge, topical thrombin, and fibrin sealants. These may have a role in minimizing troublesome oozing in patients who are discharged without drains.

Deep extubation. Tracheal extubation while deeply anesthetized, also known as deep extubation, is a useful technique following thyroidectomy, particularly when outpatient management is anticipated. Extubation under deep anesthesia minimizes cardiovascular stimulation and reduces the incidence of coughing and straining on the tube (46). Patients for whom deep extubation may not be appropriate include those with airway pathology, morbid obesity, obstructive sleep apnea, gastro-oesophageal reflux, and those for whom intubation was challenging (47,48).

Strap muscle closure. An advocated alternative method of postoperative hematoma risk-reduction involves the closure of the strap muscles. Although historically these have been reapproximated from top to bottom with 3-O absorbable sutures, recognition that airway obstruction associated with postoperative bleeding is related to venous and lymphatic outflow obstruction (49) has led many surgeons to instead pursue single-point repair of the strap muscle diastasis to mitigate against this risk (50). The purpose of closing the strap muscles is to prevent adhesion of the subcutaneous tissues to the trachea and to avoid the cobra deformity (a central neck depression created by the unsutured medial edges of the strap or platysma muscles); each of these is accomplished by placing a figure-of-eight absorbable suture at the midpoint of the strap muscles to potentially ameliorate the risk of catastrophic airway obstruction. Another technique to accomplish the same goal is to employ interrupted sutures that leave the bottom part of the midline open for potential egress of a central neck hematoma. Still other surgeons do not close the strap muscles at all in patients with thick necks.

Parathyroid management

Particular care must be taken with the parathyroid glands if outpatient thyroidectomy is anticipated. The glands may be subcapsular or intrathyroidal in location and be inadvertently removed during thyroidectomy. Therefore, inspection of the resected thyroid specimen for parathyroid glands before passing off the field may be helpful, and any parathyroid gland found should be reimplanted. Autotransplantation of a parathyroid gland does not preclude outpatient management.

Postoperative Management

Patients should be vigilant for early warning signs of hematoma (such as neck swelling) and pressure, hypocalcemia, airway obstruction, and aspiration (Table 4). Furthermore, they should be aware of how to obtain advice or help if these complications do arise in the home environment. Even nonspecific side effects such as prolonged nausea or failure to take in adequate hydration, nutrition, oral medications, and supplements should be addressed with a preformulated plan for management, should these issues arise.

Bleeding

The possibility of postoperative hematoma is a significant concern following thyroidectomy. The frequency of postoperative hematoma is approximately 1% (51). Most of these events occur within 6 hours of surgery. The results reported from multiple studies are detailed in Table 5 with a combined incidence for postoperative cervical hematoma of 1.2% (819 hematomas with 68,839 procedures) (28,52–63). In a large, retrospective, single-institution study by Leyre *et al.*, 37% of hematomas presented 6–24 hours postoperatively and 10% presented after 24 hours (59), similar to the findings reported by Burkey *et al.* that 37% of hematomas presented 6–24 hours postoperatively and 19% presented after 24 hours (55). An Austrian group reported their findings over a 30-year study period with 81% of the postoperative hematomas occurring within 6 hours of the thyroidectomy, 17% between 6 and 24 hours and 2% after 24 hours with overall 3 fatal outcomes (1 per 10,000 surgeries). The risk of postoperative hematoma was significantly increased by older age, male sex, extent of resection, bilateral procedures (twice as frequent as unilateral procedures), recurrent disease, and surgeon experience (0.4–2.8%) (63). The authors of these studies therefore raised concerns regarding the safety of outpatient thyroidectomy. These findings in part led authors asked by the British Association of Endocrine and Thyroid Surgeons to review the topic to conclude that outpatient thyroidectomy should not be pursued in

Table 4. Signs and Symptoms of Postoperative Complications

Bleeding	*Airway*	*Hypocalcemia*	*Other*
Neck swelling	Dyspnea	Paresthesias	Fever
Bleeding	Dysphonia	Extremity cramping	Nausea/ vomiting
Drainage	Stridor		
Dysphagia	Hoarseness		
Pressure	Aspiration/ choking		

Table 5. Thyroidectomy Postoperative Hematomas

Study	Year	Thy (n)	% bilateral thy	% hematoma	Fatal hematoma	% < 6 hours	% 6–24 hours	% > 24 hours
Shaha and Jaffe (52)	1994	600	42	1.3	0	100	0	0
Bergamaschi *et al*. (53)	1998	1192	67	0.8[a]	1	~60	~10	~30
Reeve and Thompson (54)	2000	10,201	–	1.2	0	–	–	–
Burkey *et al*. (55)	2001	7921	–	0.3	0	43[b]	37[b]	19[b]
Zambudio *et al*. (56)	2004	301	100	1.0	0	–	–	–
Materazzi *et al*. (57)	2007	1571	71	0.6[a]	0	~70	30 (<10 hours)	0
Bergenfelz *et al*. (58)	2008	3660	45	2.1	0	–	–	–
Leyre *et al*. (59)	2008	6830	74	1.0	0	53	37	10
Rosenbaum *et al*. (60)	2008	838	55	0.7	0	67 (<4 hours)	16. 5	16.5
Bononi *et al*. (61)	2010	562	–	0.5	0	0	67	33
Chang *et al*. (62)	2011	1935	100	1.0	0	–	–	–
Lang *et al*. (28)	2012	3086	68	0.7[a]	0	73	27	0
Promberger *et al*. (63)	2012	30,142	–	1.7	3	81	17	2

[a]Excludes hematomas not operated on, but observed: Bergamaschi *et al.* (53), 9 hematomas; Materazzi *et al.* (57), 5 hematomas; Lang *et al.* (28), 19 hematomas.
[b]Percentages are for the total study of 7921 thyroidectomies (21 hematomas) + 5896 parathyroidectomies (21 hematomas).
Hematoma, cervical hematoma.

the United Kingdom (64). The high rate of delayed hematoma described in these two articles, however, has not been reported in any recent American studies. Furthermore, outpatient thyroidectomy has been performed safely in thousands of selected patients in the United States, with a lower reported overall incidence of hematoma, and without any reports of fatal hematomas (Table 1) (6–9,12–15,17,18), leading to a different conclusion by the authors of the present guidelines.

Coughing, nausea, retching, and vomiting transiently raise venous pressures and may predispose to postoperative bleeding, though no formal studies have found these factors to present a significant risk (61). Collaboration with anesthesia and nursing staff is recommended to minimize patient coughing during extubation/emergence from anesthesia and to provide prophylaxis against, as well as treat postoperative nausea and vomiting pharmacologically. Administration of antiemetics (such as intravenous ondansetron or dexamethasone) at the time of anesthetic induction may be considered for prophylaxis, and other antiemetics, including phenergan, prescribed postoperatively. Significant arterial hypertension (SBP >180) should also be avoided as it may predispose to postoperative arterial bleeding.

A certain degree of postoperative swelling can be expected after thyroidectomy; cold compresses may be applied for patient comfort. Signs and symptoms suggestive of hematoma include pronounced or focal (anterior) swelling, a sensation of tightness, and purple discoloration of the skin. Minimizing the wound dressing facilitates visual inspection of the incision for early postoperative changes. Late signs include respiratory distress and stridor. In the outpatient setting, early detection of neck hematoma before discharge is essential and likely rests on thorough nurse education or physician observation. If a patient does develop a compressive hematoma in the outpatient setting, standard operative evacuation and hemostasis should be performed, after which transfer to inpatient status may be most appropriate for expectant management of airway edema. Patients who develop significant neck swelling and/or symptoms suggestive of hematoma after same-day discharge should be instructed to call the physician on call and proceed to the nearest emergency department for care (an accredited emergency room would be expected to be capable of managing a post-thyroidectomy hematoma). It is for that reason that every patient should be given a real-time communication method for guidance (cell phone number, on-call number, etc.), and an emergency care plan to deal with postoperative bleeding, recognizing the potential lethal consequences of this complication when severe.

Calcium management

Significant temporary hypocalcemia may occur in up to 25% of patients following total thyroidectomy, usually manifesting 48–72 hours after surgery. For this reason, routine oral calcium administration (e.g., calcium carbonate 1000 mg per oval q6–8-hour starting in the recovery room with or without the addition of calcitriol 0.5–1 mcg daily) carries several advantages and relatively little downside. This is particularly true in the outpatient setting, where there is limited time available to correct hypocalcemia in a reactive fashion once it is discovered. Several groups have utilized postoperative parathyroid hormone (PTH) levels as an early indicator of hypocalcemia after total thyroidectomy to facilitate prompt (same-day or 23-hour) discharge (15,65,66). Although the optimal timing of PTH measurement following total thyroidectomy has been debated, a measurement taken in the recovery room 1–2 hours after surgery has been proven informative by several independent groups. Oral calcitriol (0.25 mcg per oval twice or thrice daily) can be added to augment oral calcium absorption in patients with low postoperative PTH levels (<15 pg/mL). Routine calcium monitoring may be helpful in the setting of outpatient thyroidectomy even if postoperative PTH levels are measured as a fail-safe mechanism should the PTH level be spuriously normal.

With appropriate nursing and patient education, symptomatic hypocalcemia can generally be managed using oral calcium and calcitriol supplementation. Given the delayed action of these oral agents (1–2 hours), dosing may begin immediately upon the discovery of mild symptoms (circumoral and acral paresthesias) to avoid progression to more pronounced symptoms such as muscle twitching and

cramping. For example, calcium carbonate 2000 mg and calcitrol 0.25 mcg may be administered together upon symptom onset and repeated after 2 hours if relief is not experienced. Intravenous calcium gluconate should be stocked in the outpatient clinic for immediate administration to promptly relieve severe symptomatic hypocalcemia, not initially treated in a hospital Emergency Room.

Vocal fold function

A careful evaluation of the proposed outpatient thyroid surgery patient for dysphonia, dyspnea, or dysphagia with aspiration in the preoperative and immediate postoperative period should be part of the surgeon's checklist. Early identification of unilateral vocal fold paralysis permits a thorough evaluation to optimize the functional outcome for the patient (67,68). Recognition may be either by inability to stimulate the nerve at the completion of the thyroidectomy or by postoperative laryngoscopy before discharge. If the nerve is anatomically intact, eventual recovery of vocal function may be anticipated, and the patient and family/friend can be counseled on drinking maneuvers to avoid aspiration, such as taking liquids in small amounts through a straw while the chin is tilted down and to the side of the injury. Some patients might require inpatient care until they can tolerate oral intake. Patients experiencing any dyspnea at rest after thyroidectomy should not be discharged until undergoing fiberoptic laryngoscopy to evaluate for bilateral vocal fold paralysis, and documenting full recovery from the dyspnea.

Outpatient discharge criteria

Patients are kept in the hospital for at least 2 hours following thyroidectomy (in published studies, patients were observed for a variable amount of time ranging from 2.7 hours to a minimum of 6 hours after surgery) (6,7,9–11,13,16,18,19). Discharge criteria following outpatient thyroidectomy are enumerated in Table 6. Should any of these criteria not be met, consideration should be given for further evaluation and transfer to 23-hour stay or inpatient status.

Follow-up

Follow-up after outpatient thyroidectomy generally takes place in person within 1–4 weeks after surgery. For patients who have traveled significant distances for surgery, phone or telemedicine assessment may be appropriate, provided that adequate local medical support is available.

Table 6. Requirements for Discharge Following Ambulatory Thyroidectomy

Ability to take liquids and postoperative medications
Adequate pain control on oral medications
Ability to void satisfactorily
Ability to ambulate as preoperatively and perform essential activities of daily living
Satisfactory postoperative assessment with attention to the surgical wound, neck swelling/hematoma, dysphonia, dyspnea, and dysphagia
Adequate social support and understanding of instructions
Adequate oxygenation, vital signs, and blood pressure control

Potential Disadvantages of Outpatient Thyroidectomy

There are several possible disadvantages to an outpatient approach to thyroid disease that may limit the utilization of same-day discharge. The major postoperative considerations in same-day thyroidectomy are the risks of bleeding, hypocalcemia, nausea, and vomiting, leading to dehydration and an inability to take essential oral medications and pain control. It is therefore imperative that the patients and their care providers be able to understand, identify, and manage these problems should they arise outside of the hospital setting. One of the key criteria for successful and safe same-day discharge following thyroidectomy is the need for careful patient selection. Poor patient selection can lead to unacceptable risks, which are potentially preventable with a 23-hour admission.

One of the critical factors in the decision to offer outpatient thyroidectomy is to assess the patients' social condition and intellectual ability to understand and follow postoperative instructions. Understanding of this critical information can be impaired following a short postoperative recovery period especially after general anesthesia, and even well-educated patients may not always follow given instructions.

Significant hypocalcemia may be an important disadvantage for centers where prophylactic calcium therapy is not used following total thyroidectomy. In addition, some surgeons recommend acquisition of calcium levels on the first postoperative day, which might be perceived as inconvenient for patients who live at a distance from the surgical facility.

The most significant disadvantage of outpatient thyroidectomy is the potential for postoperative bleeding that results in a central neck hematoma, which can compromise the airway and become lethal when severe or prolonged. Older studies reported that about half of postoperative bleeding occurs later than 6 hours after thyroidectomy, suggesting that this rare but potentially deadly complication can happen while patients are either in transit or at their own homes (55,59). More recent studies have shown in an aggregated experience of more than 1250 outpatients that only 1 hematoma developed within 24 hours, and two others occurred beyond this 24-hour timeframe (representing a hematoma rate of less than 0.3%) (12,13). The surgeon is responsible for providing a plan to the patients and their accompanying family/friends for emergency management of this complication.

The time and effort required to produce written instructions, to educate patients preoperatively, and to provide postoperative support may require additional manpower in order to achieve safe outcomes and may be unavailable in some centers. Another potential disadvantage is that some insurance carriers may not cover same-day discharge thyroidectomy, instead requiring either hospital admission or at least an overnight observation stay.

The safety of a patient in the postoperative period is an important responsibility for the surgeon. In many respects, there is a greater burden placed upon the surgeon (and the patient and the patient's family and care givers) when the decision is made to discharge the patient on an ambulatory basis. Proper assessment of the patient should be performed in order to enhance patient safety and improve the likelihood of a favorable outcome.

There is literature that indicates that higher-volume surgeons achieve superior results when considering complications, length of stay, and costs (69). A recent article assessing

thyroidectomy outcomes in New York State further suggested that outpatient thyroidectomy is significantly more common in high-volume centers (17). Surgeon judgment is required to determine if outpatient surgery is prudent in a given practice, which may be informed by careful self-assessment of typical outcome measures, including the rate of postoperative bleeding. Surgeons who perform a low volume of thyroidectomies may need to consider observing patients overnight.

SUMMARY

Outpatient thyroid surgery continues to evolve, and has grown more popular as mechanisms have been put into place to help ensure its safety. Although it will not always be possible, there are clearly circumstances in which outpatient thyroidectomy is not only possible but also considered an appropriate and desirable alternative. The current article provides guidelines and suggestions regarding the proper steps to be taken when considering the performance of ambulatory thyroid surgery.

AUTHOR DISCLOSURE STATEMENT

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REFERENCES

1. Lam D, Miranda R, Hom SJ 1997 Laparoscopic cholecystectomy as an outpatient procedure. J Am Coll Surg **185:**152–155.
2. Thiel J, Gamelin A 2003 Outpatient total laparoscopic hysterectomy. J Am Assoc Gynecol Laparosc **10:**481–483.
3. De Waele B, Lauwers M, Van Nieuwenhove Y, Delvaux G 2004 Outpatient laparoscopic gastric banding: initial experience. Obes Surg **14:**1108–1110.
4. Bentkover SH, Kozlicak BA, Girouard S 1996 Outpatient parotidectomy at the Fallon Clinic. The first 2 years. Arch Otolaryngol Head Neck Surg **122:**1049–1053.
5. Shott SR, Myer CM 3rd, Cotton RT 1987 Efficacy of tonsillectomy and adenoidectomy as an outpatient procedure: a preliminary report. Int J Pediatr Otorhinolaryngol **13:**157–163.
6. Snyder SK, Roberson CR, Cummings CC, Rajab MH 2006 Local anesthesia with monitored anesthesia care vs general anesthesia in thyroidectomy: a randomized study. Arch Surg **141:**167–173.
7. Spanknebel K, Chabot JA, DiGiorgi M, Cheung K, Curty J, Allendorf J, LoGerfo P 2006 Thyroidectomy using monitored local or conventional general anesthesia: an analysis of outpatient surgery, outcome and cost in 1,194 consecutive cases. World J Surg **30:**813–824.
8. Terris DJ, Moister B, Seybt MW, Gourin CG, Chin E 2007 Outpatient thyroid surgery is safe and desirable. Otolaryngol Head Neck Surg **136:**556–559.
9. Inabnet WB, Shifrin A, Ahmed L, Sinha P 2008 Safety of same day discharge in patients undergoing sutureless thyroidectomy: a comparison of local and general anesthesia. Thyroid **18:**57–61.
10. Champault A, Vons C, Zilberman S, Labaille T, Brosseau S, Franco D 2009 How to perform a thyroidectomy in an outpatient setting. Langenbecks Arch Surg **394:**897–902.
11. Trottier DC, Barron P, Moonje V, Tadros S 2009 Outpatient thyroid surgery: should patients be discharged on the day of their procedures? Can J Surg **52:**182–186.
12. Seybt MW, Terris DJ 2010 Outpatient thyroidectomy: experience in over 200 patients. Laryngoscope **120:**959–963.
13. Snyder SK, Hamid KS, Roberson CR, Rai SS, Bossen AC, Luh JH, Scherer EP, Song J 2010 Outpatient thyroidectomy is safe and reasonable: experience with more than 1,000 planned outpatient procedures. J Am Coll Surg **210:**575–582, 582–584.
14. Hessman C, Fields J, Schuman E 2011 Outpatient thyroidectomy: is it safe and reasonable option? Am J Surg **201:**565–568.
15. Houlton JJ, Pechter W, Steward DL 2011 PACU PTH facilitates safe outpatient total thyroidectomy. Otolaryngol Head Neck Surg **144:**43–47.
16. Sklar M, Ali MJ, Solomon P 2011 Outpatient thyroid surgery in a Toronto community hospital. J Otolaryngol Head Neck Surg **40:**458–461.
17. Tuggle CT, Roman S, Udelsman R, Sosa JA 2011 Same-day thyroidectomy: a review of practice patterns and outcomes for 1,168 procedures in New York State. Ann Surg Oncol **18:**1035–1040.
18. Mazeh H, Khan Q, Schneider DF, Schaefer S, Sippel RS, Chen H 2012 Same-day thyroidectomy program: eligibility and safety evaluation. Surgery **152:**1133–1141.
19. Sahmkow SI, Audet N, Nadeau S, Camiré M, Beaudoin D 2012 Outpatient thyroidectomy: safety and patient's satisfaction. J Otolaryngol Head Neck Surg **41 Suppl 1:**S1–S12.
20. National Nosocomial Infections Surveillance System 2004 National nosocomial infections surveillance (NNIS) system report. Am J Infect Control **32:**470–485.
21. Kohn LT, Corrigan JM, Donaldson MS (eds); Committee on Quality of Health Care in America 1999 To Err Is Human: Building a Safer Health System. Institute of Medicine, National Academy Press, Washington, DC.
22. Bettelli G 2009 High risk patients in day surgery. Minerva Anestesiol **75:**259–268.
23. Shafazand S 2009 Perioperative management of obstructive sleep apnea: ready for prime time? Cleve Clin J Med **76 Suppl 4:**S98–S103.
24. Chung F, Elsaid H 2009 Screening for obstructive sleep apnea before surgery: why is it important? Curr Opin Anaesthesiol **22:**405–411.
25. Ramachandran SK, Kheterpal S, Consens F, Shanks A, Doherty TM, Morris M, Tremper KK 2010 Derivation and validation of a simple perioperative sleep apnea prediction score. Anesth Analg **110:**1007–1015.
26. Chand B, Gugliotti D, Schauer P, Steckner K 2006 Perioperative management of the bariatric surgery patient: focus on cardiac and anesthesia considerations. Cleve Clin J Med **73 Suppl 1:**S51–S56.
27. Owens TM 2006 Bariatric surgery risks, benefits, and care of the morbidly obese. Nurs Clin North Am **41:**249–263, vi.
28. Lang B, Yih P, Lo CY 2012 A review of risk factors and timing for postoperative hematoma after thyroidectomy: is outpatient thyroidectomy really safe? World J Surg **36:**2497–2502.
29. Wang JJ, Ho ST, Lee SC, Liu YC, Ho CM 2000 The use of dexamethasone for preventing postoperative nausea and vomiting in females undergoing thyroidectomy: a dose-ranging study. Anesth Analg **91:**1404–1407.
30. Fujii Y, Saitoh Y, Tanaka H, Toyooka H 1998 Prophylactic antiemetic therapy with granisetron in women undergoing thyroidectomy. Br J Anaesth **81:**526–528.
31. Suri KB, Hunter CW, Davidov T, Anderson MB, Dombrovskiy V, Trooskin SZ 2010 Postoperative recovery advantages in patients undergoing thyroid and parathyroid surgery under regional anesthesia. Semin Cardiothorac Vasc Anesth **14:**49–50.

32. Spanknebel K, Chabot JA, DiGiorgi M, Cheung K, Lee S, Allendorf J, Logerfo P 2005 Thyroidectomy using local anesthesia: a report of 1,025 cases over 16 years. J Am Coll Surg **201:**375–385.
33. Specht MC, Romero M, Barden CB, Esposito C, Fahey TJ 3rd 2001 Characteristics of patients having thyroid surgery under regional anesthesia. J Am Coll Surg **193:**367–372.
34. Dieudonne N, Gomola A, Bonnichon P, Ozier YM 2001 Prevention of postoperative pain after thyroid surgery: a double-blind randomized study of bilateral superficial cervical plexus blocks. Anesth Analg **92:**1538–1542.
35. Aunac S, Carlier M, Singelyn F, De Kock M 2002 The analgesic efficacy of bilateral combined superficial and deep cervical plexus block administered before thyroid surgery under general anesthesia. Anesth Analg **95:**746–750.
36. Shih ML, Duh QY, Hsieh CB, Liu YC, Lu CH, Wong CS, Yu JC, Yeh CC 2010 Bilateral superficial cervical plexus block combined with general anesthesia administered in thyroid operations. World J Surg **34:**2338–2343.
37. Lifante JC, McGill J, Murry T, Aviv JE, Inabnet WB 3rd 2009 A prospective, randomized trial of nerve monitoring of the external branch of the superior laryngeal nerve during thyroidectomy under local/regional anesthesia and IV sedation. Surgery **146:**1167–1173.
38. Sturgeon C, Sturgeon T, Angelos P 2009 Neuromonitoring in thyroid surgery: attitudes, usage patterns, and predictors of use among endocrine surgeons. World J Surg **33:**417–425.
39. Shindo M, Chheda NN 2007 Incidence of vocal cord paralysis with and without recurrent laryngeal nerve monitoring during thyroidectomy. Arch Otolaryngol Head Neck Surg **133:**481–485.
40. Piromchai P, Vatanasapt P, Reechaipichitkul W, Phuttharak W, Thanaviratananich S 2008 Is the routine pressure dressing after thyroidectomy necessary? A prospective randomized controlled study. BMC Ear Nose Throat Disord **8:**1.
41. Ayyash K, Khammash M, Tibblin S 1991 Drain vs. no drain in primary thyroid and parathyroid surgery. Eur J Surg **157:**113–114.
42. Hurtado-Lopez LM, Lopez-Romero S, Rizzo-Fuentes C, Zaldivar-Ramirez FR, Cervantes-Sanchez C 2001 Selective use of drains in thyroid surgery. Head Neck **23:**189–193.
43. Lee SW, Choi EC, Lee YM, Lee JY, Kim SC, Koh YW 2006 Is lack of placement of drains after thyroidectomy with central neck dissection safe? A prospective, randomized study. Laryngoscope **116:**1632–1635.
44. Schoretsanitis G, Melissas J, Sanidas E, Christodoulakis M, Vlachonikolis JG, Tsiftsis DD 1998 Does draining the neck affect morbidity following thyroid surgery? Am Surg **64:**778–780.
45. Siperstein AE, Berber E, Morkoyun E 2002 The use of the harmonic scalpel vs conventional knot tying for vessel ligation in thyroid surgery. Arch Surg **137:**137–142.
46. Morgan GE Jr., Mikhail MS, Murray MJ 2006 Airway management (Chapter 5). In: Morgan GE Jr., Mikhail MS, Murray MJ (eds) Clinical Anesthesiology, 4th ed. McGraw-Hill, New York, pp 91–116.
47. Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW 2005 Management of the difficult airway: a closed claims analysis. Anesthesiology **103:**33–39.
48. Cooper RM 2004–2005 Tracheal extubation of the difficult airway. Internet J Airway Manage **3**. www.adair.at/ijam/volume03/specialarticle01/default.htm
49. Harding J, Sebag F, Sierra M, Palazzo FF, Henry JF 2006 Thyroid surgery: postoperative hematoma—prevention and treatment. Langenbecks Arch Surg **391:**169–173.
50. Terris DJ 2009 Novel surgical maneuvers in modern thyroid surgery. Op Techn Otolaryngol Head Neck Surg **20:**23–28.
51. Zarnegar R, Brunaud L, Clark OH 2003 Prevention, evaluation, and management of complications following thyroidectomy for thyroid carcinoma. Endocrinol Metab Clin North Am **32:**483–502.
52. Shaha AR, Jaffe BM 1994 Practical management of post-thyroidectomy hematoma. J Surg Oncol **57:**235–238.
53. Bergamaschi R, Becouarn G, Ronceray J, Arnaud JP 1998 Morbidity of thyroid surgery. Am J Surg **176:**71–75.
54. Reeve T, Thompson NW 2000 Complications of thyroid surgery: how to avoid them, how to manage them, and observations on their possible effect on the whole patient. World J Surgery **24:**971–975.
55. Burkey SH, van Heerden JA, Thompson GB, Grant CS, Schleck CD, Farley DR 2001 Reexploration for symptomatic hematomas after cervical exploration. Surgery **130:**914–920.
56. Zambudio AR, Rodriguez J, Riquelme J, Soria T, Canteras M, Parrilla P 2004 Prospective study of postoperative complications after total thyroidectomy for multinodular goiters by surgeons with experience in endocrine surgery. Ann Surg **240:**18–25.
57. Materazzi G, Dionigi G, Berti P, Rago R, Frustaci G, Docimo G, Puccini M, Miccoli P 2007 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 **39:**182–188.
58. Bergenfelz A, Jansson S, Kristoffersson A, Martensson H, Reihner E, Wallin G, Lausen I 2008 Complications to thyroid surgery: results as reported in a database from a multicenter audit comprising 3,660 patients. Langenbecks Arch Surg **393:**667–673.
59. Leyre P, Desurmont T, Lacoste L, Odasso C, Bouche G, Beaulieu A, Valagier A, Charalambous C, Gibelin H, Debaene B, Kraimps JL 2008 Does the risk of compressive hematoma after thyroidectomy authorize 1-day surgery? Langenbecks Arch Surg **393:**733–737.
60. Rosenbaum MA, Haridas M, McHenry CR 2008 Life-threatening neck hematoma complicating thyroid and parathyroid surgery. Am J Surg **195:**339–343.
61. Bononi M, Amore Bonapasta S, Vari A, Scarpini M, De Cesare A, Miccini M, Meucci M, Tocchi A 2010 Incidence and circumstances of cervical hematoma complicating thyroidectomy and its relationship to postoperative vomiting. Head Neck **32:**1173–1177.
62. Chang LY, O'Neill C, Suliburk J, Sidhu S, Delbridge L, Sywak M 2011 Sutureless total thyroidectomy: a safe and cost-effective alternative. Anz J Surg **81:**510–514.
63. Promberger R, Ott J, Kober F, Koppitsch C, Seemann R, Freissmuth M, Hermann M 2012 Risk factors for postoperative bleeding after thyroid surgery. Br J Surg **99:**373–379.
64. Doran HE, England J, Palazzo F 2012 British Association of Endocrine and Thyroid Surgeons. Questionable safety of thyroid surgery with same day discharge. Ann R Coll Surg Engl **94:**543–547.
65. Wiseman JE, Mossanen M, Ituarte PH, Bath JM, Yeh MW 2010 An algorithm informed by the parathyroid hormone level reduces hypocalcemic complications of thyroidectomy. World J Surg **34:**532–537.
66. Grodski S, Lundgren CI, Sidhu S, Sywak M, Delbridge L 2009 Postoperative PTH measurement facilitates day 1 discharge after total thyroidectomy. Clin Endocrinol (Oxf) **70:**322–325.
67. Yung KC, Likhterov I, Courey MS 2011 Effect of temporary vocal fold injection medialization on the rate of permanent

medialization laryngoplasty in unilateral vocal fold paralysis patients. Laryngoscope **121:**2191–2194.
68. Friedman AD, Burns JA, Heaton JT, Zeitels SM 2010 Early versus late injection medialization for 2461 unilateral vocal cord paralysis. Laryngoscope **120:**2042–2046.
69. Sosa JA, Bowman HM, Tielsch JM, Powe NR, Gordon TA, Udelsman R 1998 The importance of surgeon experience for clinical and economic outcomes from thyroidectomy. Ann Surg **228:**320–330.

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