Otolaryngologic critical care

Anesthesiology Clinics Volume 19, **Issue 1**, Pages 55-72 (January 2003)

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Intensivists collaborate with otolaryngologists to care for critically ill patients in several ways. Patients undergoing otolaryngologic surgical procedures may require postoperative monitoring. Peri-operative morbidity may require admission to the intensive care unit. Conditions necessitating critical care may require otolaryngologic evaluation and intervention, and critically ill patients may also develop complications that require otolaryngology evaluation and intervention. In this article we provide an overview of otolaryngologic critical care, including such issues as the impact of comorbid conditions frequently found in patients undergoing otolaryngologic surgery, complications, and resource use. Several specific procedures and diagnoses associated with otolaryngology are reviewed.

Head and neck cancers make up 3% of all new cancer diagnoses. Epidermoid cancers of the larynx, oropharynx, oral cavity, and hypopharynx compromise the majority of these cancers [1,2]. These malignancies tend to occur in older patients, with a mean age of 64 reported [3]. With increasing age comes an increased incidence of comorbid medical conditions. Jan et al reported that 75% of patients over 80 years of age undergoing head and neck surgery also had concurrent major medical illnesses; 43% received an American Society of Anesthesiology classification of 3 or 4 [4]. The risk factors for head and neck cancer and alcohol and tobacco use are also risk factors for cardiovascular and pulmonary illnesses. An increased occurrence of myocardial infarction (MI) in patients with squamous cell cancer of the oropharynx, lung, and uroepithelial system compared with patients with other cancers has been reported. Cigarette smoking may be the common risk factor linking squamous cell cancers to coronary artery disease and MI [5]. Cardiac disease is reported in 24% of head and neck patients [6], and 13.8% have a history of MI. [7] Analysis of the Coronary Artery Surgery Study (CASS) database reveals an increased occurrence of perioperative MI in head and neck surgical patients with coronary artery disease who received medical therapy rather than coronary artery bypass graft surgery. Perioperative MI developed in 4.4% of patients managed with medical therapy, 0.5% of patients who underwent coronary artery bypass graft surgery (CABG), and 2.2% of patients without coronary artery disease. From this study, head and neck surgery was identified as one of the noncardiac surgeries associated with increased cardiac risks for patients with known coronary artery disease [8]. The fact that ophthalmologic and brain surgery were included under the category of head and neck cancer somewhat limits the interpretation of this study. Hypertension has been noted in 33% of patients undergoing surgery for head and neck cancer [3,6,7]. Hypertension was reported to be one of the multivariate predictors of 30-day death or MI after higher-risk noncardiac surgery [8].

Between 75% and 82% of patients undergoing head and neck surgery for malignancy have a history of smoking [3], and of those 61% had used tobacco for more than 40 years [6]. Arriaya et al reported that of 384 patients undergoing total laryngectomy, 68.8% had chronic obstructive pulmonary disease (COPD), and 9.6% had severe COPD. Up to 15% of these patients developed major respiratory complications, such as pneumonia or > 12 hours of ventilator dependence postoperatively. Of these patients, 31% developed minor pulmonary complications, such as rales, rhonchi, or wheezing, which required a change in postoperative therapy [7]. Cigarette smoking, along with the number of pack-years smoked, has been shown to be among the principal risk factors for the development of postoperative pulmonary complications in head and neck surgical patients [9]. Prospectively, the preoperative Rozien classification of dyspnea (FEV1< 70% predicted, peak expiratory flow rate < 65% predicted, and room air Pa2 < 77 mm Hg) have been associated with the development of postoperative pulmonary complications [10,11]. An increased occurrence of postoperative pulmonary complications has been reported in patients over 65 years of age. An increased number of comorbid conditions rather than chronological age alone may account for this finding. Evaluation of the CASS database reveals that cigarette smoking was identified as one of the multivariant predictors of 30-day death or MI after high-risk noncardiac surgery [8].

A history of alcohol abuse is present in 33% to 35% of patients undergoing surgery for head and neck cancer [3,6]. In one study, 24.5% of patients were abusing alcohol at the time of surgery [7], establishing these patients for being at increased risk for the development of alcohol withdrawal syndromes in the perioperative period. Diabetes mellitus is reported in 14% of patients. A second primary cancer is found in 8% of patients. The majority of second cancers involve the head and neck or lung. Because of the effect of the tumor on ability to eat or the effects of pre-operative radiation or chemotherapy, a > 10% weight loss is noted in 7% or preoperative patients [6].

Studies evaluating postoperative morbidity and mortality are limited by the potential bias associated with single reporting of the procedures in question or by the limitations inherent in single-center studies. The definition of morbidity also varies between studies. In 2001, Bhattachyra et al [12] extracted a head and neck surgical database from the National Hospital Data Survey (NHDS) database, which contains representative proportions of inpatient admissions encompassing hospitals of different sizes and geographic locations, including academic, tertiary referral, and community hospitals. According to this database, a primary head and neck procedure was performed in 3309 patients. The overall mortality rate was 2.11%, with a major morbidity rate of 3.55%. Death occurred in 12.96% of patients who experienced a complication, whereas only 1.71% of patients without a major complication died. Table 1 lists the incidence of major morbidities and associated mortality rate.

Table 1. Mortality and morbidity data for head and neck surgery patients

Morbidity	Overall incidence (%)	Mortality rate with morbidity	pX2
Acute myocardial infarction	0.33	0	0.65
Acute cerebrovascular accident	1.53	1.67	0.46
Pulmonary embolism	0.08	33.33	0.09
Pneumonia	3.26	10.94	<0.001
Acute renal failure	0.84	48.48	<0.001

Adapted from Bhattacharyya N, Fried MP. Benchmarks for mortality, morbidity, and length of stay for head and neck surgery procedures. Arch Otolaryngol Head Neck Surg 2001;127:127–3.

Pneumonia was the most frequent morbidity, occurring in 3.26% of patients, and was associated with a mortality rate of 10.94%. Although acute renal failure was uncommon, its development was associated with a mortality rate of 48.48%. Data classified by surgical site show that surgery involving the pharynx had the highest morbidity rate, with 9.3% of patients developing a major morbidity. Esophageal surgery had the highest mortality, with a mortality rate of 8.3% [12].

Data regarding the impact of age on outcome and morbidity has been inconsistent. In 217 patients over 65 years of age who underwent surgery for an attempt at cure of head and neck cancer, the overall mortality rate was 4%, whereas for patients over 75, the mortality rate was 6%. Although patients over 75 accounted for 77% of the total deaths, 90% of deaths occurred in patients with Stage 3 and 4 disease. For longer-term follow-up, 3- and 5-year survival was not statistically different between patients older or younger than 81 years of age [13]. Thus, although there may be a chance that older patients may be at increased risk for postoperative morbidity and mortality, elderly patients may derive significant long-term benefit from the surgery. More specifically, a patient's comorbidities and functional status as opposed to chronological age seem to correlate best with the development of postoperative complications and mortality. A poor American Society of Anesthesiology Class or a poor Specific Activity Scale (SAS) functional class has been shown in several studies to be among the strongest predictors of developing postoperative complications [3,13]. Histories of hypertension and current alcohol abuse have also been significantly associated with the development of postoperative medical complications. In a study of 119 patients undergoing head and neck oncologic surgery, 24% developed at least one postoperative medical complication. Eighty-nine percent of complications occurred in patients with a SAS functional Class of 3 or 4, active alcohol abuse, or physical findings of cirrhosis [3].

A large body of literature concerning the use of critical care by otolaryngologic patients is lacking. Furthermore, the development of a complication does not necessarily equate with the need for critical care services. Postoperative admissions to an ICU may reflect the need for frequent observation not available on a surgical floor as opposed to the rigorous monitoring one often associates with critical care. The use of critical care is influenced by an institution's practice pattern, including the availability of step-down or more enhanced care units where observation of grafts and airways can safely be accomplished. For example, Hanna has evaluated the impact of a clinical pathway for patients undergoing a laryngectomy at the University of Arkansas [14]. Pathway guidelines required that patients with otherwise uncomplicated conditions recover in a step-down unit or in the recovery room overnight. According to this protocol, patients were transferred to the ICU only when a specific indication developed, such as respiratory or hemodynamic instability. After implementation of the pathway, ICU use fell from 47% to 21%. Furthermore, the pathway resulted in decreased costs without an increase in morbidity or mortality. The decrease in ICU use resulted in a 22% total cost savings.

Strauss attempted to evaluate the availability of step-down units to otolaryngologic patients. A survey was mailed to 110 university otolaryngology programs throughout the United States to assess the availability and use of intermediate care beds for otolaryngology patients. Responses were received from 56 programs. Thirty programs had access to intermediate care units, five were dedicated to the care of otolaryngology patients, and the rest of the units were surgical or mixed medical/surgical intermediate care units. Strauss calculated a $35,762 cost savings for the first 168 patients cared for after an otolaryngology intermediate care unit was opened at his hospital [15]. These studies suggest that the use of intermediate care units or enhanced floor care can decrease ICU use for a significant percentage of postoperative head and neck patients while realizing significant cost savings without compromising patient care.

Downey retrospectively evaluated ICU use by head and neck cancer patients at Memorial Sloan Kettering Cancer Center. Patients undergoing major head and neck surgery were monitored postoperatively for 6 to 12 hours in the recovery room. Patients were then transferred to a floor with staff trained in the postoperative care of these patients. During a 1-year period, 37 (1.5%) patients undergoing head and neck surgical procedures required admission to the ICU, and an additional 6 patients undergoing medical therapy of head and neck malignant disease required admission to the ICU. Respiratory complications necessitated ICU admission in 16 patients, with 14 requiring mechanical ventilation, 13 (93%) of whom were weaned from mechanical ventilation. Of the patients admitted to the ICU with respiratory complications, 81% were eventually discharged, and 19% died during the hospitalization. Thirteen patients (31%) were admitted with cardiac disorders, including arrhythmias, congestive heart failure, MI, hypotension, and cardiac arrest. Six of these patients required inotropic support, and 69% of these patients were discharged. In addition, 19 patients were admitted because of surgical complications, and 14% were admitted secondary to nonsurgical complications. The median length of stay in the ICU was 2 days. The fact that only 1.5% of postoperative patients required ICU admission illustrates the positive impact that the availability of enhanced floor care can have on ICU use. Overall, 76% of the patients were discharged after their ICU admission, suggesting that meaningful benefit can be derived from ICU care for these patients [16].

Thyroidectomy

Thyroid gland dysfunction is common in the general population as suggested by a study in which 11.7% (elevated in 9.5% and decreased in 2.2%) of 25,862 subjects were tested at a statewide fair in Colorado [17]. In the United States, more than 80,000 thyroid gland procedures occur annually [18]. Total thyroidectomy remains the procedure of choice for many surgeons; however, studies have suggested that minimally invasive thyroid surgery (ie, videoscopically assisted hemithyroidectomy) is safe and effective in patients with limited disease. Conventional thyroidectomy remains a technically challenging procedure with the potential for serious complications.

A recently published paper reviewed the NHDS database and examined 517 patients who underwent total thyroidectomy during 1995 to 1999 [18]. Surgical indications for total thyroidectomy were thyroid malignancy (52.6%), clinically significant goiter (21.3%), thyrotoxicosis (11.2%), thyroiditis (6.6%), benign disease (5.6%), unknown (1.7%), and parathyroid disease (0.6%). With the carcinoma cases, regional node dissection was performed when clinically indicated. A retrospective study of three Australian hospitals from 1991 to 1998 identified 20 patients admitted for emergent thyroidectomy. The indications for surgery were obstructive airway symptoms (65%), thyrotoxicosis (30%), and obstructive venous symptoms (5%). Obstructive symptoms were caused by multinodular goiters in six subjects, follicular cancer in two subjects, thyroid lymphoma in one subject, and arterial laceration in one subject. In another subject, venous obstruction was secondary to an infiltrating metastatic renal cell cancer. Thyrotoxicosis was attributed to amiodarone in three subjects and Grave disease in three subjects. Nineteen subjects underwent thyroidectomy, with one patient dying pre-operatively of cardiopulmonary arrest (5% mortality for the group) [19]. When compared with a similar elective group, surgical morbidity was higher. Small sample size limits this study but does not remove the importance for clinicians to recognize and appropriately manage these rare, life-threatening scenarios.

Hypocalcemia is the most common complication seen immediately after total thyroidectomy, occurring in 1% to 40% of subjects [18]. With respect to this, the incidence of unintentional parathyroid gland removal during routine thyroidectomy was assessed in a retrospective review of 220 patients from 1997 to 1999 [20]. In this study, pathology specimens were reviewed and confirmed that 9% of the patients had inadvertent parathyroid gland excision. None of these patients had temporary or permanent hypocalcemia [20]. Furthermore, temporary and permanent recurrent laryngeal nerve paralysis occurs in approximately 0.5% and 3% of patients, respectively [21]. In an analysis of over 15,000 patients who underwent surgery for benign thyroid diseases, recurrent laryngeal nerve dissection significantly reduced the risk of temporary and permanent recurrent laryngeal nerve injury (RLNI). Rates for permanent RLNI ranged from 0% to 1.1% in this series [22]. Death rates related to thyroidectomy occurred in 0.08% and 0.2% of patients reviewed from two large studies [18,22]. Rates of MI, stroke, and pneumonia were 0.2%, 0.6%, and 0.6%, respectively [2]. Other complications reported postoperatively were hematoma or hemorrhage (1.0%), chyle leak (0.25%), abscess (0.5%), and wound infection (0.2%) [18,22].

Post-thyroidectomy pain is secondary to incision of superficial and deep neck structures, intraoperative neck positioning, and wound drainage [23]. Nonsteroidal anti-inflammatory drugs, acetaminophen, and various opioids are the traditional management options for postoperative pain. The role of bilateral cervical plexus blocks (BSCBs) in reducing post-thyroidectomy pain was recently addressed in a double-blind study. A total of 90 patients were randomized to a saline group (n = 42) or a Bupivacaine group (n = 48). Subcutaneous ingestion of 0.25% Bupivacaine (10 mL per side) with 1:200,000 epinephrine into the neck was performed to obtain adequate cervical plexus block. The study concluded that BSCBs significantly reduced pain intensity post-thyroidectomy; however, BSCBs did not provide optimal pain relief alone and if, used, should be implicated into a multimodal approach [23].

Parathyroidectomy

Primary hyperparathyroidism (PHPT) is the most common cause of hypercalcemia in the outpatient population. Approximately 100,000 new cases of PHPT occur each year in the United States, with 1 case per 1000 men and 2 to 3 cases per 1000 women reported [24]. The majority of patients with PHPT are female (75%), and most are postmenopausal. A single, benign adenoma is responsible for 80% to 85% of cases of PHPT. Multiglandular disease and parathyroid carcinoma are responsible for the remaining cases [25]. PHPT is a relatively common disease that deserves frequent review.

The decision to operate on asymptomatic patients with PHPT remains controversial. In 1990, the NIH Consensus Development Conference defined selection criteria for performing surgery in asymptomatic patients with hyperparathyroidism [26]. Indications for surgery are:

1. Serum calcium 1.0 to 1.6 mg/dL over accepted normal range of 11.4 to 12.0 mg/dL
2. History of life-threatening hypercalcemia
3. Creatinine clearance reduced by 30% compared with age-matched normal subjects
4. 24-hour urine calcium excretion > 400 mg
5. Nephrolithiasis detected by abdominal radiograph
6. Reduced bone mass as determined by direct measurement (> 2 standard deviations below age-, gender-, and race-matched control subjects)
7. Medical surveillance is not desirable or suitable:

   Patient requests surgery

   Reliable follow-up is unlikely

   Co-existent illness complicates management

Patients < 50 years old

The conference did not address the management of patients with PHPT and less specific symptoms, such as weakness, fatigue, depression, polyuria, and back pain. In 1999, a 10-year prospective study was published and addressed the ongoing debate regarding the need to perform parathyroidectomy in all patients with PHPT. This study concluded that parathyroidectomy resulted in normalization of serum calcium levels and increases in bone mineral density (ie, 12% ± 3% increase in lumbar spine after 10 years and 14% ± 4% increase in femoral neck after 10 years) in patients with symptomatic and asymptomatic PHPT. In addition, 27% of asymptomatic patients with PHPT who did not undergo surgery did have some progression of their disease, defined as having at least one new indication for parathyroidectomy [27].

Total parathyroidectomy using a bilateral approach is still preferred by many surgeons. In experienced hands, cure rates have been reported to range from 95% to 99% [28]. Minimally invasive parathyroid surgeries have evolved over the past two decades and include unilateral, radio-guided, and endoscopic approaches. Parathyroid gland radionuclide scanning using technetium-99m–labeled sestamibi, high-resolution ultrasonography, and rapid parathyroid hormone assays have made it possible to localize adenomas in 80% to 90% of patients [29,30]. Despite requiring preoperative localization studies and intraoperative PTH monitoring to differentiate single from multi-glandular disease, targeted parathyroidectomy has gained considerable popularity for patients with limited disease. Minimally invasive techniques may be an efficacious option with fewer complications, shorter hospital stays, and more cosmetically pleasing results compared with conventional parathyroidectomy [28]. More studies are needed to assess postoperative outcomes and the cost-effectiveness of targeted parathyroidectomy. Ethanol ablation is another possibility in a selected patient population with recurrent hyperparathyroidism. Cure rates are significantly lower compared with surgery and require collaborative decision-making from multiple clinicians [24].

The gravest complications resulting from parathyroidectomy include persistent vocal cord paralysis secondary to recurrent laryngeal nerve injury and permanent hypocalcemia. In skilled hands, less than 1% to 4% of patients experience these problems [31]. Less than 1% of patients experience wound infection, cervical hematoma, and poor cosmesis. Other rare complications may include pneumothorax, bleeding, pneumonia, traumatic intubation, anesthesia reactions, and death [28]. Surgical failure or so-called "persistent disease" occurs in 2% to 8% of patients as a result of unrecognized parathyroid hyperplasia or ectopic parathyroid tissue. Recurrent hyperparathyroidism occurs in 2% to 16% of patients, with a differential diagnosis including unresected hyperplastic glands, parathyroid carcinoma, second adenoma, and miliary parathyromatosis [31]. Patients should be placed in a monitored setting after total parathyroidectomy to be observed for serious post-operative complications, including symptomatic hypocalcemia, bleeding, vocal cord paralysis, and laryngospasm [31].

There are several signs and symptoms characteristic for hypocalcemia. Neuromuscular irritability can present as perioral paresthesias, tingling of the fingers and toes, and tetany. Chovstek's sign is observed when percussion of the facial nerve results in ipsilateral contraction of the facial muscles. Trousseau's sign is observed when 3 minutes of occlusive pressure with a blood pressure cuff results in carpal spasm with or without pain [8]. ECG changes consistent with hypocalcemia include prolonged QT intervals, marked QRS, and ST changes that may be confused with a conduction abnormality or an acute MI. Ventricular tachycardia and congestive heart failure have been reported as complications of hypocalcemia, but these are rare. Severe symptomatic hypocalcemia requires emergent therapy to prevent seizures and death from laryngeal spasm [31]. Patients who develop sudden hypocalcemia after parathyroidectomy should be treated with intravenous calcium and with oral or intravenous calcitriol [32]. If symptoms are mild, oral elemental calcium (1 to 2 g daily) and oral calcitriol (0.25 to 2.0 É g daily) is recommended. In severe symptomatic hypocalcemia, intravenous 10% calcium gluconate (10 to 20 mL over 10 to 20 minutes) followed by a continuous intravenous calcium infusion (100 mL of 10% calcium GLUCONATE = 8.9 mg calcium/mL in 500 to 1000 mL of D5W) is recommended. Typically, 1 to 2 mg calcium/kg/hr is the required dose. The intravenous drip should be weaned off over 24 to 48 hours as oral calcium and vitamin D compound therapy is established. Serum calcium levels should be monitored every 3 to 4 hours during intravenous infusion therapy. The goal of therapy is to control symptoms while preventing moderate to severe reductions in serum calcium levels [25].

Acute epiglottitis

Acute epiglottitis resulting from inflammation and edema of the epiglottis can result in life-threatening airway obstruction. Inflammation can also occur in the arytenoid cartilage, false vocal cords, or pharyngeal wall, resulting in acute supraglottitis. Acute epiglottitis had traditionally been thought of as predominantly a disease of children resulting from infection by *Haemophilus influenza*type B (Hib). With the introduction of Hib vaccine in the mid 1980s, the incidence of acute epiglottis in the pediatric population has decreased to an annual incidence of 0.3 to 0.6 per 100,000 [33,34]. However, the incidence in adults may be increasing. In a retrospective study on the occurrence of acute epiglottitis over 18 years, Mayo-Smith reported a 31% rise in incidence when comparing the first 3 years to the last 3 years of the study [33]. Greater awareness and recognition of acute epiglottitis in adults most likely accounts for this trend. Incidence rates in adults vary from 2 to 3 cases per 100,000 [34,35], and case fatality rates of 0% to 7.1% have been reported [33,35,37,38]. Positive blood cultures are found in 12% to 26% of adults with acute epiglottis [33,35,38], although Hib accounts for the majority of positive cultures. Bacteremia is less common in adults than children, and, in addition to Hib, numerous other infectious and noninfectious etiologies for acute epiglottitis have been identified. A variety of other pathogens, including Group A beta-hemolytic streptococcus, non-group A beta–hemolytic *Streptococcus*, *Staphylococcus aureus*, S*treptococcus pneumonia*, and *Candida albicans*, have been found. In culture-negative cases, the possibility of viral infections also exists. Noninfectious etiologies have included trauma, caustic ingestion [39], and thermal injuries sustained during the smoking of illegal drugs [33,40].

For adults, the mean age at presentation ranges from 42 to 50 years [35,41]. A slight male predominance has been noted [33,35,36]. Cigarette smoking is more frequent in these patients than in the general population [33,35]. A slight seasonal variation has inconsistently been reported [37,42]. Adults typically present after approximately 2 days of symptoms, and sore throat and odynophagia are reported by 91% to 100% of patients [33,35,36]. Other signs and symptoms, along with the frequency in which they occur in adults, are listed in Table 2. Because of a larger and more rigid trachea and because of relatively less lymph tissue, adults are less likely than children to present with dyspnea, drooling, and stridor.

Table 2. Signs and symptoms of acute epiglottitis and corresponding frequency in adults

Sign/symptom	Frquency
Muffled voice	54–79
Pharyngitis	57–73
Fever	54–70
Pharyngitis	57–73
Tenderness of anterior neck	79
Dyspnea	29–37
Drooling	22–39
Stridor	12–27

Adapted from[33,35,36,38]

Thickening of the epiglottis is the classic radiographic finding and is present on 73% to 86% of lateral neck radiographs. The fact that supraglottitis can present with little epiglottic edema may contribute to this finding [36]. To provide a more quantifiable evaluation of the lateral neck radiograph, Nezmek et al proposed comparing the width of the epiglottis to the anterior posterior width of the 4th cervical vertebral body. In patients without significant degeneration of the boney anatomy, this ratio should not be greater than 0.33. With this diagnostic threshold, a sensitivity of 96% and specificity of 100% for the diagnosis of acute epiglottitis was found in a retrospective review of 27 patients. Other radiographic findings strongly suggestive of acute epiglottitis and supraglottitis include enlargement of aryepiglottic folds, arytenoid enlargement, prevertebral soft tissue swelling, and an emphysematous epiglottitis [43]. Because the lateral neck radiograph has sensitivity as low as 75%, laryngoscopy should be used to evaluate patients with a clinical suspicion of acute epiglottitis but with a negative neck radiograph. Direct or indirect laryngoscopy can be used to confirm the diagnosis and follow the patient's clinical response. A “cherry red” epiglottitis is the classic finding, and most patients have supraglottic inflammation and edema. Laryngoscopic examination does not seem to precipitate acute airway obstruction [33,36].

In retrospective reviews, 15% to 20% of patients with epiglottitis require an artificial airway [33,35,36]. An artificial airway is clearly indicated in patients with actual or impending airway obstruction; however, a surgical airway is not required in all patients. Oral, nasal tracheal, and fiberoptic techniques have been used to successfully secure an airway [33,35,36,41,44]. Compared with orotracheal or nasotracheal intubation, tracheostomy is associated with longer duration of the artificial airway and longer hospital and ICU stays [33,35]. Because of the risk of sudden obstruction and occlusion, the most skilled clinician should perform the intubation, and, ideally, a full airway team with an anesthesiologist and otolaryngologist should be present.

There is no consensus concerning airway management for patients with mild to moderate respiratory distress. In these situations, up to 20% of patients require an artificial airway. However, there is no indication to intubate all patients. Up to 5.9% of adult patients who do not receive an artificial airway as part of their initial management later require placement of an artificial airway [33]. Numerous retrospective studies have attempted to identify clinical features that could be used to identify patients who will deteriorate and require an artificial airway. Unfortunately, no one factor or combination of factors has been consistently shown to identify these patients. Drooling and stridor have not been consistently shown to be a risk factor for the need for intubation [33,36,41], although dyspnea has been more consistently shown to be associated with the need for an artificial airway. [33] In a retrospective review of 51 patients, dyspnea had a positive predictive value 62% for an artificial airway, whereas the negative predictive value was 100% [35]. The need to sit upright [36], bacteremia [33], and a rapid onset of serious symptoms have been associated with the need for airway intervention [33,38,45]. The majority of clinical detonations and need for an artificial airway occurs within 12 hours of presentation [33]. Rapid deterioration associated with adverse outcomes while patients were in radiology, being transported, or in the ICU [33,46] has been reported and reinforces the need for close monitoring and the need for immediate access to personnel and the equipment necessary to rapidly secure an artificial airway.

Most patients receive a second or third generation cephalosporin with activity against beta lactamase-producing *H influenza*. Aerosolized racemic epinephrine is often prescribed, although its efficacy is unclear. During retrospective reviews, steroids have been given to 24% to 61% of adult patients. No statistical differences in the number of airways placed, duration of ICU stay, duration of hospitalization, and duration of intubation was found when comparing patients who received steroids with those who did not receive steroids [33,35]. Potential infectious complications include abscess formation, cellulitis, and pneumonia.

Sinusitis

Evaluation for nosocomial sinusitis in critically ill patients often occurs as part of the evaluation of persistent fever that cannot be attributed to another source. ICU surveillance data collected through the National Nosocomial Infection Survey System (NISS) between 1992 and 1997 found that 4% of all nosocomial infections originated in the ear, eyes, nose, or throat. Sinusitis accounted for 64% of these infections [47]. The reported incidence of sinusitis in critically ill patients varies widely. Differences in imaging techniques, study protocols, diagnostic criteria, patient populations, and failure to distinguish radiographic abnormalities consistent with sinusitis from microbiologically confirmed sinusitis accounts for this variability. In a prospective study of 338 patients admitted to an ICU, in which radiographic abnormalities and positive cultures obtained from culture of maxillary sinus discharge or aspirate were required to diagnosis sinusitis, the cumulative incidence of sinusitis was 7.7%, or 12 cases per 1000 patient days [48].

The principal mechanism responsible for the development of nosocomial sinusitis is impaired drainage of the paranasal sinuses via their ostia secondary to mechanical obstruction, such as that arising from a nasal endotracheal tube or nasogastric tube. Mucosal irritation and resulting edema may also lead to ostial obstruction. Rouby reported that after 7 days, 95% of patients with nasal tracheal endotracheal and nasogastric tubes had radiographic evidence of sinusitis by CT scan. Only 25% of the patients with oral endotracheal and oral gastric tubes had radiographic evidence of sinusitis [49]. Supine management with impaired sinus drainage may also predispose the critically ill patient to develop sinusitis. Other reported risk factors include nasal colonization with enteric Gram-negative bacilli, sedative use, and a Glasgow coma score ≤ 7 [48].

One of two criteria must be fulfilled to meet the NISS diagnosis for nosocomial sinusitis. The first criterion requires positive microbiologic cultures from purulent material obtained from a sinus cavity. The second set of criteria include, in the absence of an obvious etiology, fever > 38°C, pain or tenderness over the involved sinus, headache, purulent nasal discharge or nasal obstruction, and at least one of either positive transillumination or a positive radiographic examination [50]. The diagnosis of sinusitis in critically ill patients is often difficult because patients may be unable to complain of headache, earache, facial pain, sore throat, nasal discharge, and cough, which are typically associated with the outpatient diagnosis of acute bacterial sinusitis. Purulent nasal discharge may be found in only 25% of patients with nosocomial sinusitis [51]. Diagnosis of nosocomial sinusitis in the critically ill patient typically involves radiographic evaluation. Ultrasound, portable radiographic studies, and CT have been used. Because of the limitations of portable radiographic studies, CT is more commonly used. The presence of an air fluid level or opacification of a sinus is sensitive for the diagnosis of sinusitis; however, only 40% to 50% of patients with radiographic evidence of sinusitis have positive cultures of material obtained by puncture technique or aspiration with irrigation [49,52,53]. Practice parameters published by the Society of Critical Care Medicine recommend that patients who have findings consistent with sinusitis and with a strong clinical suspicion undergo puncture and aspiration of the sinus under sterile conditions. These recommendations were felt to be reasonably justifiable by available scientific evidence and strongly supported by expert critical care opinion [54]. Aerobic Gram-negative bacilli and Gram-positive cocci account for the majority of positive cultures [55,56]. Twenty-five percent to 82% of cultures are polymicrobial [48,49]. Anaerobic bacteria have been cultured in up to 60% of cases [57]. Yeast have been cultured in up to 18% of the cases [49].

Treatment of sinusitis consists of removal or repositioning of obstructing foreign bodies. Appropriate antibiotics, ideally based on microbiologic studies, should be administered. Although aerosolized nasal decongestants are often given, their actual value is unclear because there are no randomized controlled studies that have prospectively evaluated the role of sinus drainage, although some experts suggest that sinus drainage leads to a quicker resolution of symptoms [56]. Drainage should be considered in patients who do not respond to a trial of conservative management. The response to sinus drainage is variable. In one study, 47% of the patients with radiographic- and microbiologically proven sinusitis who underwent maxillary sinus drainage had resolution of their sepsis. The majority of patients in whom sepsis did not resolve after drainage also had evidence of infection at other sites [49].

Ludwig's angina

Ludwig's angina is a potentially life-threatening cellulitis involving the submandibular, sublingual, and submental spaces. Before the availability of antibiotics, edema frequently led to upper airway obstruction, and a mortality rate of 50% was reported. With the advent of antibiotic therapy, mortality has decreased to 8% [58]. Odontogenic infection, most commonly involving the lower second and third molars, is the most common etiology, accounting for approximately 80% of cases. The roots of the second and third lower molars are located just below the mylohyoid ridge. Abscesses of these teeth can perforate the lingual plate of the mandible. Perforation allows direct spread of infection to the submandibular, sublingual, and submental spaces. Other less common etiologies include fracture of the mandible, floor of the mouth trauma, and sialadenitis [58,59].

The majority of patients with Ludwig's angina were previously healthy with minimal to no comorbid conditions. Diabetes mellitus, alcoholism, neutropenia, glomerulonephritis, and aplastic anemia may predispose to the development of Ludwig's angina. Tooth pain or recent history of extraction (79%), neck swelling (71%), dysphagia (52%), neck pain (33%), and dysphonia or dysarthria (18%) are the most frequent symptoms. 72% of patients present with respiratory symptoms, including dyspnea, tachypnea, and stridor. Fever (89%), bilateral submandibular swelling (99%), and an elevated or protruding tongue (95%) are found in the majority of patients. Trismus occurs in 51% of patients, and the white blood cell count is elevated in 86% of all those afflicted [58]. Infections of the submandibular space may spread into the retropharyngeal space, and pneumonia, septic pulmonary emboli, empyema, mediastinitis, pericarditis, and empyema are potential complications [60,61]. Streptococci, staphylococci, and bacteroides are the most commonly cultured organisms. Polymicrobial cultures are found in 50% of cases. Gram-negative bacteria, such as *Klebsiella* species, *H influenza*, *Proteus* species, and *Pseudomonas aeruginosa*, have also been cultured [58,60].

Treatment consists of antibiotics, surgical drainage of abscesses, and airway management. Combinations of high-dose penicillin, clindamycin, and metronidazole are often prescribed. Surgical drainage is indicated if suppurative infection develops and if the presence of fluctuance, crepitus, and soft-tissue gas mandate the need for surgical intervention. Computer axial tomography can be used to help identify these suppurative complications. Surgical drainage has been required in 45% to 65% of patients [58,62]. To ensure adequate drainage, infected teeth should also be extracted. Moreland reported that 42% of patients required tracheotomy [58]. Endotracheal intubation or tracheostomy was performed in 35% of patients with Ludwig's angina [62]. The decision to secure an artificial airway must be individualized. The condition of the patient along with the availability of resources and personnel necessary to immediately secure the airway must be considered. Because of the risk of rapid airway compromise, patients should be admitted to a location where the equipment and personnel for monitoring and securing the airway are available [63].

Tracheostomy

Tracheostomy is an ancient surgical procedure that was first depicted in Egyptian tablets dating from 3600 BC [64]. Modern surgical tracheostomy is attributed to Chevalier Jackson, who first described the technique in 1909 [65]. In surgical tracheostomy (SgT), a horizontal incision is made approximately 1 to 2 cm above the sternal notch. Division of two tracheal cartilages (usually rings 2 and 3) is performed in a longitudinal (vertical) manner to insert the tracheostomy appliance [66]. Indications for tracheostomy include partial or complete airway obstruction; prolonged endotracheal intubation; access for clearing pulmonary secretions; and to provide an airway during surgical procedures involving the face, neck, or upper airway.

Bedside percutaneous tracheostomy (PcT) has been proposed as an alternative to surgical tracheostomy in intubated adult patients. Shelden et al first reported percutaneous tracheostomy method in 1955 [67]. Four known methods of percutaneous tracheostomy exist: Toye, guide wire dilator forceps, Rapitrac, and percutaneous dilational tracheostomy [68]. The most extensively studied method, percutaneous dilational tracheostomy, was described in 1985 by Ciaglia [69]. The technique involves a tracheal puncture between the second and the fourth tracheal ring and introducing a guide wire into the trachea and enlarging it by means of the Seldinger technique using multiple dilators.

PcT has become attractive because it is often easier and faster to perform, requires a smaller skin incision, is associated with less bleeding and a lower risk of infection, and results in fewer cosmetic deformities. In addition, PcT may be performed in the ICU, thereby obviating the need for transport to an operating room. Furthermore, some small series suggest lower resource consumption. Common complications occurring during the perioperative period are listed in Table 3. Complications occurring > 24 hours after the procedure are listed in Table 4.

Table 3. Perioperative complications for surgical versus percutaneous tracheostomy

Complication	Surgical tracheostomy (%)	Percutaneous tracheostomy (%)
Hemorrhage	1.4	1.4
Subcutaneous emphysema	0.2	1.0
False passage	0.1	1.6
Difficult tube placement	0.06	2.2
Pneumothorax	0.7	0.6

Adapted from Dulguerov P, Gysin C, Perneger TV, et al. Percutaneous or surgical tracheostomy: a meta-analysis. Crit Care Med 1999;27:1617–25.

Table 4. Postoperative complications occurring > 24 hours after procedure for surgical versus percutaneous tracheostomy

Complication	Surgical tracheostomy (%)	Percutaneous tracheostomy (%)
Hemorrhage	3.2	2.3
Wound infection	2.7	1.0
Tracheal stenosis	0.2	1.0

Adapted from Dulguerov P, Gysin C, Perneger TV, et al. Percutaneous or surgical tracheostomy: a meta-analysis. Crit Care Med 1999;27:1617–25.

Significant higher complications related to false passage or difficult tube placement occur with the percutaneous technique. This is not surprising because SgT is done under direct vision of the anterior wall, whereas PcT is a relatively blind procedure. Tracheoinnominate fistula is a rare but serious complication that may result from erosion of innominate artery by tracheostomy prosthesis. This is more likely to occur if the tracheostomy is placed too low. The patient usually presents with sudden exsanguinating hemorrhage after one or more previous sentinel hemorrhages. Bleeding may be controlled initially by inflating the cuff on the endotracheal tube to tamponade and decrease the bleeding. Definitive treatment involves surgical ligation of the innominate artery.

Tracheal stenosis is a late complication that results from granulation tissue formation because of tracheal irritation from an indwelling endotracheal tube. Pathogenesis is directly proportional to pressure necrosis. Clinical features include dyspnea on exertion, stridor or wheezing, and episodes of obstruction with small amounts of mucus. Direct or indirect endoscopy and fluoroscopy may be needed for diagnosis. Plateau-like flattening of inspiratory and expiratory limbs may be seen on spirometry studies, suggesting fixed upper airway obstruction. Management in mild cases is conservative, but severe cases may require surgical reconstruction.

The majority of the complications associated with both methods are minor, and the overall mortality rate is approximately 0.2%. Several authors have studied the percutaneous technique relative to surgical tracheostomy, but there is no consensus on the advantage of one method over the other. Nevertheless, a trend toward lower complications in the perioperative period has been noted with SgT compared with PcT (3% versus 10%); however, a higher complication rate has been seen in the postoperative period with surgical technique (10% versus 7%) [70]. No significant mortality benefit has been seen with one technique over the other. Percutaneous tracheostomy is suitable for most intubated adult patients in the ICU setting who require a tracheostomy. SgT should be the preferred modality in patients with large strumas and in patients with extremely short, thick necks.

Summary

In this chapter we have reviewed the complicated medical conditions that exist in many head and neck surgical patients. Common surgical procedures that frequently require postoperative monitoring and several infectious disorders requiring intensive care unit admission were also reviewed. Intensivists need to be familiar with these procedures and diseases. Collaboration with the surgical specialist is required to optimize patient care.