Evidence-Based Patient Safety Advisory: Patient Assessment and Prevention of Pulmonary Side Effects in Surgery. Part 2—Patient and Procedural Risk Factors

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Summary: Several factors may increase a patient's risk for perioperative pulmonary complications. This practice advisory provides an overview of the preoperative steps that should be performed to ensure appropriate patient selection and patient safety with regard to pulmonary complications. Procedural and patient-related risk factors are discussed, as are recommendations for perioperative management and strategies for minimizing complications. (*Plast. Reconstr. Surg.* 124 (Suppl.): 57S, 2009.)

Perioperative pulmonary complications occur in all surgical settings and may occur as frequently as cardiac complications during or after various types of surgery.[1,2] These complications may include pneumonia, respiratory failure with prolonged mechanical ventilation, bronchospasm, atelectasis, and exacerbation of underlying chronic lung disease.[3] At times, predictors of these complications may go undetected during patient assessment, leading to the onset of pulmonary problems during or after surgery. Therefore, surgeons should become familiar with risk factors for perioperative pulmonary complications and assess for these factors during the preoperative evaluation.

A variety of factors have been associated with perioperative pulmonary complications. Procedural factors such as surgical site (especially thoracic and abdominal) can compromise respiratory function.[4] Plastic surgical procedures near these anatomical areas (e.g., breast procedures and abdominoplasty) can contribute to various pulmonary side effects. Also concerning is the potential for surgical fires, which can affect the airway and have devastating consequences.[5] Patient characteristics such as comorbidities, American Society of Anesthesiologists classification, age, and smoking status can increase a patient's risk of pulmonary complications.[3,6–8] In rare instances, perioperative pulmonary complications have been reported in young, healthy, adult, athletic male patients.[9] A thorough assessment of procedural and patient characteristics will allow the physician to determine the most appropriate surgical setting and operative plan for the patient, potentially reducing the risk of pulmonary complications during or after surgery.

In an effort to ensure patient safety in the ambulatory surgery setting, the American Society of Plastic Surgeons (ASPS) Patient Safety Committee sought to develop a practice advisory to assist decision-making with regard to perioperative pulmonary complications. This advisory, which is published in two parts, provides an overview of the preoperative steps that are recommended to ensure appropriate patient selection for the ambulatory surgery setting, and provides recommendations for reducing the risk of these complications. Part 1 of the advisory focuses on obstructive sleep apnea and obstructive lung disease (see Haeck et al., "Evidence-Based Patient Safety Advisory: Patient Assessment and Prevention of Pulmonary Side Effects in Surgery.

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Part 1—Obstructive Sleep Apnea and Obstructive Lung Disease," in this issue), whereas the current advisory, Part 2, discusses various procedural and patient-related factors that may predispose patients to perioperative pulmonary complications.

This patient safety advisory was developed through a comprehensive review of the scientific literature and a consensus of the Patient Safety Committee. The supporting literature was critically appraised for study quality according to criteria referenced in key publications on evidence-based medicine.[10–14] Depending on study design and quality, each reference was assigned a corresponding level of evidence (I through V) with the ASPS Evidence Rating Scales (Table 1),[15] and the evidence was synthesized into practice recommendations. The recommendations were then graded (A through D) with the ASPS Grades of Recommendation Scale (Table 2)[16]; grades correspond to the levels of evidence provided by the supporting literature for that recommendation. Practice recommendations are discussed throughout this document, and graded recommendations are summarized in Appendix A.

DISCLAIMER

Practice advisories are strategies for patient management, developed to assist physicians in clinical decision-making. This practice advisory, based on a thorough evaluation of the present scientific literature and relevant clinical experience, describes a range of generally acceptable approaches to diagnosis, management, or prevention of specific diseases or conditions. This practice advisory attempts to define principles of practice that should generally meet the needs of most patients in most circumstances. However, this practice advisory should not be construed as a rule, nor should it be deemed inclusive of all proper methods of care or exclusive of other methods of care reasonably directed at obtaining the appropriate results. It is anticipated that it will be necessary to approach some patients' needs in different ways. The ultimate judgment regarding the care of a particular patient must be made by the physician in light of all the circumstances presented by the patient, the diagnostic and treatment options available, and available resources.

This practice advisory is not intended to define or serve as the standard of medical care. Standards of medical care are determined on the basis of all the facts or circumstances involved in an individual case and are subject to change as scientific knowledge and technology advance, and as practice patterns evolve. This practice advisory reflects the state of knowledge current at the time of publication. Given the inevitable changes in the state of scientific information and technology, periodic review and revision will be necessary.

Table 1. Evidence Rating Scale for Studies Reviewed

Level of Evidence	Qualifying Studies
I	High-quality, multicentered or single-centered, randomized controlled trial with adequate power; or systematic review of these studies
II	Lesser quality, randomized controlled trial; prospective cohort study; or systematic review of these studies
III	Retrospective comparative study; case-control study; or systematic review of these studies
IV	Case series
V	Expert opinion; case report or clinical example; or evidence based on physiology, bench research, or "first principles"

PROCEDURAL RISK FACTORS

Pneumothorax

Pneumothorax, the accumulation of gas within the pleural space, is a rare but potentially serious respiratory complication associated with several surgical procedures including breast augmentation, breast reduction, abdominoplasty, intercostal blocks, and harvesting of rib grafts and latissimus dorsi flaps.[17–23] In an outcomes study of ambulatory surgery procedures, 1.4 percent of significant sequelae were reported to be pneumothoraces, occurring most often during breast augmentation and augmentation-related procedures.[17] Complications of pneumothorax can occur immediately or even hours after a traumatic event.[24]

Pneumothorax can be caused by a number of factors, either patient-related or iatrogenic. Some patients can present with preexisting lung perforations, such as ruptured pulmonary blebs/bullae that occur as part of chronic obstructive pulmonary disease, or pulmonary tuberculosis. These can progress to spontaneous pneumothorax.[25] Catamenial pneumothorax, or air in the pleural space coinciding with the onset of menses, may be related to endometriosis and can occur as a result of perforations in the diaphragm or pulmonary, pleural, or diaphragmatic endometriosis.[26] A complete medical history and physical examination can alert the surgeon to a patient at risk for this.

Iatrogenic causes of pneumothorax may include intraoperative laceration of the fascia or pleura, needle puncture at the time of local injection, barotrauma (i.e., air forced into the pleu-

Table 2. Scale for Grading Recommendations

Grade	Descriptor	Qualifying Evidence	Implications for Practice
A	Strong recommendation	Level I evidence or consistent findings from multiple studies of levels II, III, or IV	Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present.
B	Recommendation	Levels II, III, or IV evidence and findings are generally consistent	Generally, clinicians should follow a recommendation but should remain alert to new information and sensitive to patient preferences.
C	Option	Levels II, III, or IV evidence, but findings are inconsistent	Clinicians should be flexible in their decision-making regarding appropriate practice, although they may set bounds on alternatives; patient preference should have a substantial influencing role.
D	Option	Level V: Little or no systematic empirical evidence	Clinicians should consider all options in their decision-making and be alert to new published evidence that clarifies the balance of benefit versus harm; patient preference should have a substantial influencing role.

ral cavity as a result of increased air pressure in the surgical pocket), and positive pulmonary pressure during surgery (e.g., from high-pressure ventilation, plugged exit valve, or increased pressure during change of oxygen tank).[24,27,28] To reduce the risk of iatrogenic pneumothorax, the surgeon or anesthesiologist performing intercostal blocks should consider using smaller needles for local anesthesia. These should be placed tangentially to the chest wall when infiltrating anatomical locations adjacent to the pleural space.[24] To avoid fascial and pleural trauma, the surgeon should be aware of the potential for thin or absent intercostal muscles in some patients.[27] In addition, during breast procedures, the use of a drainage tube during insertion of the implant may allow for escape of excess air from the surgical pocket, thereby reducing the risk of barotrauma.[28]

Abdominoplasty

Although rare, abdominoplasty has been associated with respiratory events, such as decreases in arterial blood gases, atelectasis, chest pain, abnormal breath sounds, dyspnea, cyanosis, hypoxemia, pulmonary embolus, and pneumothorax.[17,29–32] Muscle plication and abdominal binders that can compress the abdominal cavity may interfere with respiratory mechanics.[33] Changes in pulmonary compliance (>9 ml/cmH_2O) can occur after abdominal plication and may be predictive of respiratory complications.[29] If large pulmonary compliance changes have occurred during surgery, thorough postoperative pulmonary monitoring is recommended.[29] In addition, abdominal compression garments, which are often used after abdominoplasty, may not be appropriate for patients at increased risk of perioperative pulmonary complications.

It is unclear whether preexisting conditions increase the risk of pulmonary complications after abdominoplasty. In one study, all patients who had histories of smoking, obesity, or lung disease had perioperative pulmonary complications.[33] However, in a recent study of obese, multiparous patients undergoing abdominoplasty with muscle plication, minimal changes in intraabdominal pressures and minimal to negligible changes in intrathoracic pressures were observed.[30] In addition, no statistically significant changes in pulmonary function were observed in these patients who presented with bronchial asthma. However, it is important to note that pulmonary function was assessed with pulmonary function tests and peak airway pressures, which may be insufficient measures of acute respiratory changes that could lead to postoperative pulmonary morbidity.[31]

Airway and Operative Field Fires

Over 100 operating room fires occur in the United States each year. Surgical fires are particularly pertinent to this report because of the devastating impact they can have on the respiratory system: one-third of surgical fires reportedly affected the airway or oropharynx.[5]

The risk of surgical fire increases with the simultaneous use of an oxidizer, an ignition source, and a fuel source—the three elements of the fire triangle. Figure 1 depicts the surgical fire triangle and examples of common oxidizers, ignition sources, and fuel sources used in the operating room.

Oxygen and nitrous oxide are common oxidizers. High concentrations of oxygen can accumulate in the surgical setting, particularly under drapes or in the airway, creating highly flammable conditions.[34] Oxygen concentrations as low as

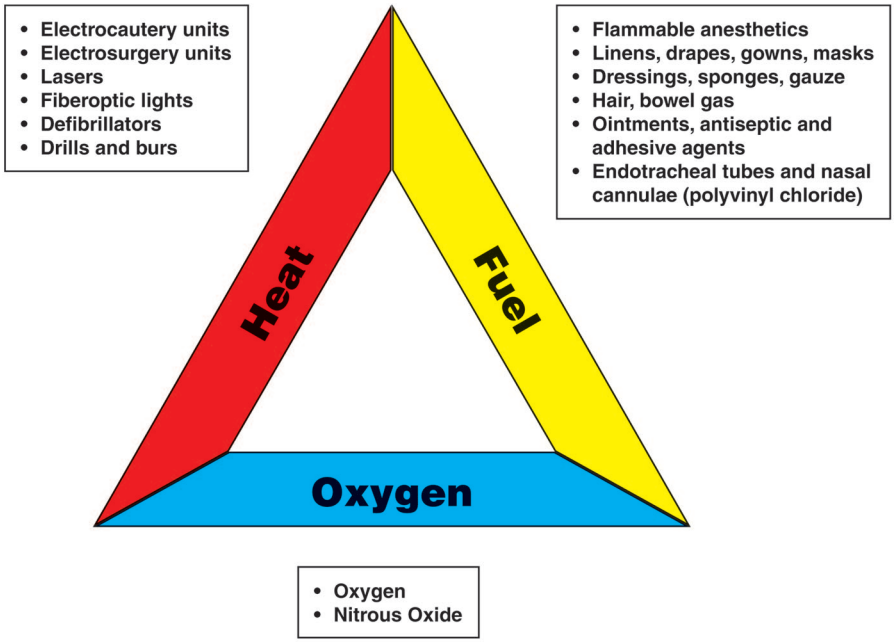

Fig. 1. The surgical fire triangle and examples of common oxidizers, ignition sources, and fuel sources used in the operating room.

25% can support combustion of surrounding materials.[35] Endotracheal tubes made of polyvinyl chloride have been known to burn in 26% oxygen.[36] If supplemental oxygen is necessary, the patient should be administered the lowest possible inspired oxygen concentration for adequate saturation.[37] If possible, supplemental oxygen should be discontinued at least 1 minute before and during the use of potential ignition sources near the head and neck. In addition, "tenting" of drapes should be avoided to decrease the accumulation of oxygen under the drapes.[36] If possible, the use of nitrous oxide should be avoided, as it is also an oxidizer that can support combustion during surgery.[5,36,37] If the use of oxygen and/or nitrous oxide is unavoidable, separate suction should be used to scavenge for excess gases that could be leaking into the oropharynx.[38] Alternative methods of anesthesia should be considered. For head and neck laser resurfacing, in particular, intravenous sedation and localized nerve blocks are recommended because they may significantly reduce the need for supplemental oxygen.[35,37]

Electrocautery and electrosurgery units, lasers, fiberoptic light sources, defibrillators, drills, and burs can act as ignition sources for surgical fires. Contact between these ignition sources and potentially flammable materials should be avoided. When using fiberoptic light sources, the source should be activated only after all cable connections have been made; it should be put in standby mode before cable disconnection. When performing electrocautery, electrosurgery, and laser surgery, units should be activated only when the tips are in view and in direct proximity to the surgical site; units should be deactivated and put in standby mode when not in active use. Electrosurgical electrodes should be placed in a holster or other location away from the patient when not in immediate use.[38]

Although flammable anesthetics are rarely used in surgical facilities today, there are a variety of other sources that can fuel fires, such as linens, dressings, drapes, sponges, hair, bowel gas, ointments, antiseptics, adhesive agents, and both endotracheal tubes and nasal cannulae, especially those made with polyvinyl chloride.[5,36] Materials such as towels, gauze sponges, and cotton pledgets should be moistened to prevent ignition of surrounding drapes and airway devices.[5,35–37] Whenever possible, water-soluble products should be used instead of alcohol-, oil-, or petroleum-based products, which have been shown to fuel surgical fires.[39–41] Endotracheal tubes, especially those made of polyvinyl chloride, may be wrapped with aluminum foil or moistened gauze sponge; or, if applicable, a metal or laser-safe endotracheal tube should be used.[36]

Surgical fires are preventable, and several measures can be taken to avoid their occurrence.

All members of the surgical team should be aware of the factors that can contribute to fires in the operating room and during specific types of surgery. Constant communication between the surgeon, anesthesia provider, and surgical nursing staff is essential in preventing the simultaneous use of oxidizers, ignition sources, and fuel sources.

PATIENT-RELATED RISK FACTORS

American Society of Anesthesiologists Classification

The American Society of Anesthesiologists classification may be predictive of perioperative pulmonary complications.[3,6] In the past, only class 1 patients were considered for outpatient operations; however, now, with improvements in monitoring and medications, even class 3 or 4 patients may be candidates for outpatient operations, provided that their medical conditions are well controlled and stable.[42]

The anesthesia provider and surgeon are responsible for selecting the appropriate facility for each patient and therefore should assign the American Society of Anesthesiologists physical classification rating (Table 3). This rating should be based on a combination of the preoperative history and physical examination, comorbidities, laboratory results, and the medical specialist's evaluation. If there is any doubt regarding the classification, the surgeon should consult with an anesthesiologist.

Smoking

Smoking is a major cause of morbidity and mortality worldwide. In the United States, approximately 20 percent of deaths are attributable to cigarette smoking, most as a result of smoking-related conditions such as lung cancer, coronary heart disease, chronic obstructive pulmonary disease, and other airway obstruction.[43] Over 44 million adults in the United States smoke[43]; therefore, it is very likely that many patients presenting for outpatient and ambulatory surgery will be past or current smokers.

Smoking contributes to perioperative pulmonary complications.[44–46] In particular, perioperative pulmonary complications have been shown to be four times more frequent in current smokers than in people who have never smoked, and may include intraoperative sputum, cough, laryngospasm, bronchospasm, apnea, breath-holding, postoperative pneumonia, and the need for postoperative mechanical ventilation.[7,44,47,48] As smoking can impair the pulmonary immune response, postoperative pulmonary infections are also possible.[49]

Although current smokers are at highest risk of perioperative pulmonary complications, past smokers may still be at risk if the amount of time since they last smoked was not sufficient to clear the lungs and return pulmonary function to an optimal level.[7,50] In some cases, ex-smokers can have irreversible lung damage that predisposes them to these complications.[48] Other factors that can influence a smoker's risk of these complications include the number of pack-years smoked (≥40 pack-years), and the presence of respiratory conditions such as chronic obstructive pulmonary disease and chronic cough.[8,48,51,52] In nonsmokers, even exposure to secondhand smoke has been shown to increase the risk of perioperative pulmonary complications.[48,53]

Smoking cessation is often recommended to patients having surgery, but the optimal duration of preoperative cessation is unclear. Recent recommendations for optimal cessation times range between 4 and 8 weeks, although study results vary as to the effectiveness of these time periods.[47,50,54] The American Society of Anesthesiologists suggests that cessation even 24 hours before surgery and 7 days after surgery can be beneficial.[55]

Reports indicate lower incidences of perioperative pulmonary complications in patients who stop or reduce smoking before surgery. In a multicenter, randomized, controlled trial, patients who were randomized to receive preoperative smoking intervention (i.e., counseling, nicotine replacement, and either cessation or reduction of smoking) 6 to 8 weeks before surgery had fewer complications than control patients who did not receive the intervention.[56] In a retrospective review of patients who underwent urogynecologic surgery, smokers who stopped smoking for at least 1 month before and 1 month after surgery had an incidence of smoking-potentiated complications (which included perioperative pulmonary complications) similar to that of nonsmokers, suggesting that perioperative cessation can have beneficial effects.[57]

Paradoxically, cessation has also been shown to increase the incidence of perioperative pulmonary complications, although this may be attributable to an inadequate amount of smoke-free days before surgery and a transient increase in mucus secretion and/or nicotine withdrawal, which is often experienced by smokers during the initial smoke-free days.[7,44] Another possible explanation is that high-risk patients, who are already at

Table 3. ASA Physical Classification Rating*

ASA Class	Description	Examples
1	A fit patient with no underlying systemic disease and taking no medications	• A 43-year-old woman for bilateral breast enhancement • A 32-year-old man for cosmetic rhinoplasty • A 16-year-old girl for earlobe reconstruction from congenital anomaly • A 26-year-old man for back lipoma excision
2	A patient with mild systemic disease, e.g., slightly limiting organic heart disease, mild diabetes, essential hypertension or anemia, obesity (by itself), chronic bronchitis, or any healthy individual younger than 1 yr or older than 70 yr	• Patients who smoke, drink alcohol frequently or excessively, or use street drugs • Patients who are obese • Patients who have any of the following, but under control without systemic compromise: diabetes, hypertension, asthma, gastroesophageal reflux disease, peptic ulcer disease, hematologic disorders, arthritis, neuropathy • Patients with anatomical abnormalities of significance to health, such as hiatal hernia, difficult airways, nondebilitating heart anomaly, Down syndrome • Patients with mild psychiatric illness that is under control (e.g., depression, anxiety disorder, and bipolar disorder) • Patients with a remote history of coronary artery disease and no other systemic illnesses whose progress afterward showed no further chest pain and documented good exercise tolerance • A 4-month-old infant for cleft palate repair • A 73-year-old woman for bilateral breast enhancement • A 21-year-old woman for breast augmentation with truncal obesity • A 43-year-old woman for bilateral breast enhancement who smokes and has chronic obstructive pulmonary disease • A 32-year-old asthmatic man for cosmetic rhinoplasty
3	A patient with a systemic disease or multiple significant mild systemic diseases, organic heart diseases, severe diabetes with vascular complications, moderate to severe degrees of pulmonary insufficiency, angina pectoris, or healed myocardial infarction	• Any third-degree or fourth-degree burn patient who is hemodynamically stable and undergoing graft surgery • A 16-year-old woman for earlobe reconstruction after congenital anomaly, with a symptomatic ventricular septal defect • A 26-year-old man for back lipoma excision, with controlled end-stage renal disease • A 53-year-old man for liposuction, who is hypertensive and has occasional chest pain • A 32-year-old man for cosmetic rhinoplasty, who frequently has sickle cell crisis, with hematocrit of 16 • A patient who is morbidly obese with OSA
4	Organic heart disease showing marked signs of cardiac insufficiency; persistent anginal syndrome; active myocarditis; advanced degrees of pulmonary, hepatic, renal, or endocrine insufficiency	• A 71-year-old woman for bilateral breast enhancement under general anesthesia who is asthmatic, smokes, and has chronic obstructive pulmonary disease • A 16-year-old girl for earlobe reconstruction from congenital anomaly, with a cyanotic heart anomaly • A 53-year-old man for liposuction who is hypertensive and has had congestive heart failure within the past 6 mo

ASA, American Society of Anesthesiologists; OSA, obstructive sleep apnea.
*Examples of ASA classifications created by Rebecca S. Twersky, M.D., member of the ASPS Task Force on Patient Safety in Office-Based Surgery Facilities and chair of the ASA Committee on Ambulatory Surgical Care. Dr. Twersky is professor of anesthesiology and vice-chair for research, State University of New York Health Science Center at Brooklyn, and medical director, Long Island College Hospital, Brooklyn, New York.

increased risk of perioperative pulmonary complications, may be more likely than healthy patients to stop smoking before surgery and may experience these complications as a result of their poor health rather than the effects of recent smoking cessation.[7] Despite these findings, smoking cessation is thought to be associated with improvements in pulmonary physiology; however, the benefits may take weeks or months to become apparent. In one study, it took more than 9 weeks of cessation before pulmonary surgery for the incidence of perioperative pulmonary complications in smokers to reach that of people who had never smoked.[50]

Several options are available to surgical patients who agree to preoperative smoking cessation. Counseling and behavioral interventions, nicotine replacement therapy (i.e., gum, transdermal patch, nasal spray, inhaler, and sublingual tablets/lozenges) and drugs such as bupropion

hydrochloride (Zyban; GlaxoSmithKline, Greenville, N.C.) and varenicline (Chantix; Pfizer U.S. Pharmaceuticals, New York, N.Y.) have been shown to promote smoking cessation.[58–63] The physician should discuss these options with the patient to determine which would be most appropriate for the patient's health status, the surgical procedure, and the timing of surgery.

Young, Healthy, Athletic, Adult Male Patients

Reports have indicated that young, healthy, athletic, adult male patients may be at increased risk of postoperative pulmonary edema secondary to postextubation laryngospasm. Although only a few cases have been reported in the literature, physicians at one institution saw seven cases within a 24-month period.[9] Likely, these events were caused by excessive negative intrathoracic pressure generated by forced inspiration against a closed glottis. Treatment included oxygen, diuretics, reintubation, and/or positive-pressure ventilation. One patient, in whom the problem was not immediately diagnosed, required emergent intubation and 3 days of mechanical ventilation.

CONCLUSIONS

Pulmonary complications can occur in all surgical settings. As the demand for surgery increases, so does the need for guidelines regarding patient selection and perioperative management. Although most studies report on pulmonary complications in hospital-based settings, the evidence has shed light on risk factors for perioperative pulmonary complications and strategies that can reduce these risks, even in ambulatory settings. A complete preoperative evaluation is an important component of the patient selection process. Understanding the procedural and patient-related risk factors will help determine the most appropriate surgical setting. A successful operative plan is one that incorporates risk assessment, risk reduction strategies, and appropriate treatment methods, should complications occur.

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Appendix A. Summary of Recommendations for Preventing Perioperative Pulmonary Complications in Plastic Surgery

Recommendations	Supporting Evidence	Grade
PNEUMOTHORAX		
Patient selection		
• Medical history should include questions about cigarette smoking and preexisting conditions such as lung diseases, pneumothorax, and presence of blebs/bullae. • Physical examination should include lung assessment. • Inform patient/family of this risk.	25, 26	D*
Preoperative		
• Ensure access to a Heimlich valve intracatheter or pigtail catheter for treatment of potential tension pneumothorax.	Expert opinion	D
Intraoperative		
• The use of small needles, placed tangentially to the chest cavity, should be considered for infiltration of local anesthesia into anatomical locations adjacent to the pleural space. • Assess area for thin or absent intercostal muscles (leaving fascia exposed). • If the fascia is traumatized, close small defects with purse-string or interrupted suture over a small catheter (withdraw catheter during deep inspiration delivered by positive-pressure ventilation or with a Valsalva maneuver if performed under intravenous sedation and local anesthesia).	24, 28	D*

(*Continued*)

Appendix A. (*Continued*)

Recommendations	Supporting Evidence	Grade
• If intercostal muscles are thin or absent, insertion of a drainage tube into surgical pocket may be considered to reduce pressure and prevent air dissection into pleural cavity. • If a change of oxygen tank is needed during surgery, the endotracheal tube should be detached from the anesthesia machine to prevent delivery of increased air pressure to the patient.		
Postoperative • If fascia/pleura was traumatized intraoperatively, a chest radiograph may be necessary. • If the patient complains of shortness of breath/difficulty breathing following procedure, breath sounds and oxygen saturation should be assessed before discharge. • If there is a suspicion of pneumothorax, a chest radiograph should be obtained. • If pneumothorax occurs, follow an acceptable treatment plan (e.g., inserting chest tube or Heimlich valve). • Patient/family should be instructed to monitor for shortness of breath and difficulty breathing after discharge.	24, 25	D*
ABDOMINOPLASTY • Pulmonary function should be assessed for entire perioperative period. • If the patient is at increased risk for PPCs, abdominal compression garments may not be appropriate.	29, 30, 33	D*
AIRWAY AND OPERATIVE FIELD FIRES Preoperative • The surgeon, anesthesia provider, and all members of the surgical staff should be apprised of the surgical plan with respect to the use of potential oxidizers, ignition sources, and fuel sources. • Drapes should be positioned to prevent accumulation of oxidizers under the drapes and should not be placed on patient until flammable preparations have dried. • Moistened towels should be placed around the face and neck if a laser is used on the face or oral region. • If endotracheal intubation is necessary, the use of metal or laser-safe tubes should be considered if appropriate for the procedure, or the tube should be wrapped in a nonflammable material such as aluminum foil or moistened gauze, cotton, or sponges. • If supplemental oxygen is required, the lowest oxygen concentration needed to provide adequate saturation should be considered. • If possible, nitrous oxide anesthetics should be avoided and alternatives such as intravenous sedation and localized blocks should be considered. • If the use of oxygen and/or nitrous oxide is unavoidable, a separate suction tube is recommended for scavenging excess gases in the oropharynx.	34, 35, 39–41	D*
Intraoperative • The surgeon, anesthesia provider, and other surgical staff should communicate effectively to avoid simultaneous use of potential oxidizers, ignition sources, and fuel sources. • If possible, oxygen administration should be discontinued at least 1 min before and during the use of potential ignition sources (e.g., electrocautery and electrosurgical units, lasers, and fiberoptic lights). • Potential ignition sources should be placed in standby mode when not in immediate use.	34, 35, 39–41	D*

(*Continued*)

Appendix A. (*Continued*)

Recommendations	Supporting Evidence	Grade
SMOKING		
Patient selection		
• The patient should be asked about smoking history, including number of pack-years; if the patient is not a smoker, the patient should be asked whether anyone in the household smokes.	7, 45, 46, 48–50, 53, 56	B
• The patient should be asked about comorbidities that could exacerbate the effects of smoking (e.g., airway obstruction, COPD, chronic cough).		
Preoperative		
• Preoperative smoking cessation should be recommended and should depend on the patient's overall health and the surgical procedure; optimal timing of cessation has not been fully determined and varies from 24 hr before surgery to 6–8 wk before surgery.	7, 50, 56	B, C
• The physician should discuss available options to aid in smoking cessation: counseling and behavioral interventions, nicotine replacement (i.e., gum, transdermal patch, nasal spray, inhaler, and sublingual tablets/lozenges), and drugs such as Zyban (bupropion hydrochloride) and Chantix (varenicline).	58–63	A
Postoperative		
• Continued smoking cessation should be recommended (at least 7 days after surgery).	Expert opinion	D

PPCs, periprocedural complications; COPD, chronic obstructive pulmonary disease.
*Evidence composed of level IV and V evidence.