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Preoperative Evaluation of the Patient With Pulmonary Disease*

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Preoperative pulmonary evaluation is important in the management of patients with lung disease who are undergoing elective cardiothoracic or noncardiothoracic surgery. In some instances, preoperative pulmonary evaluations may also contribute to the management of patients being considered for urgent surgery. The incidence of postoperative pulmonary complications (PPCs) is high and is associated with substantial morbidity and mortality, and prolonged hospital stays. Perioperative pulmonary complications in patients undergoing elective noncardiothoracic surgery can be more accurately predicted than in patients undergoing elective cardiothoracic surgery. Effective strategies to prevent complications in the postoperative period are few. Incentive spirometry and continuous positive airway pressure are the only modalities of proven benefit. Identifying patients who are at risk for the development of PPCs and managing their underlying modifiable risk factors aggressively prior to surgery is essential.

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Key words: elective surgical procedures; lung diseases; postoperative care; postoperative complications; preoperative care

Abbreviations: ASA = American Society of Anesthesiology; CABG = coronary artery bypass graft; CPAP = continuous positive airway pressure; CPRI = cardiopulmonary risk index; DLCO = diffusing capacity of the lung for carbon monoxide; ILD = interstitial lung disease; IS = incentive spirometry; OSA = obstructive sleep apnea; PFT = pulmonary function test; POSSUM = physiological and operative severity score for enumeration of mortality and morbidity; PPC = postoperative pulmonary complication; RCT = randomized controlled trial

Although the ability to predict whether postoperative pulmonary complications (PPCs) will develop in a given patient undergoing surgery is good, a pulmonary risk assessment is frequently not performed for a number of reasons including the following: (1) an inadequate understanding of exactly

what such an assessment can predict; (2) the absence of specific guidelines describing which tests should be performed in which patients; and/or (3) indecision about whether postoperative care should include approaches to reducing PPCs in all patients, regardless of their potential risk. This review will discuss current preoperative pulmonary evaluation strategies that are supported by the existing literature, focusing on new developments in the past 2 to 4 years.

When nonelective surgery is indicated, preoperative pulmonary risk assessment is generally not helpful as, by definition, a nonelective procedure must be undertaken regardless of the risk. The single exception to this opinion might be a patient with massive hemoptysis (that is uncontrolled despite attempts at bronchial or pulmonary arterial embolization), who, because of severe obstructive or restrictive pulmonary disease, has a sufficiently high risk of postoperative mortality that the surgery would be considered

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futile. Unfortunately, in this setting, only preexisting studies can be used to make this judgment as patients are generally too unstable to assess their pulmonary function accurately.

When elective resectional thoracic surgery is being considered, surgery should be precluded if the predicted postoperative lung function would be too minimal to support an independent lifestyle and the resumption of activities of daily living. When elective nonthoracic surgery is being considered, preoperative risk assessment can predict which patients have an increased risk of PPCs developing, thereby identifying those patients who should be treated more aggressively with respect to reducing this risk.

DISCUSSION

Incidence

The reported incidence of PPCs in patients undergoing noncardiothoracic surgery varies widely (from 2 to 19%),¹ in part because the definitions of a PPC have varied (Table 1).² In patients undergoing cardiothoracic surgery, the incidence ranges from 8 to 39%.³ Regardless of the type of surgery performed, PPCs prolong the hospitalization.⁴

Risk Factors

Preoperative and intraoperative risk factors for PPCs are summarized in Table 2. Although many studies have tried to develop preoperative predictors of PPCs, accurate and validated indexes have only been found for patients undergoing noncardiothoracic surgery by the National Veterans Affairs Surgical Quality Improvement Program. A good medical history

Table 1—PPCs*

General complications
Atelectasis
Infection
Bronchitis
Pneumonia
Bronchospasm
Pulmonary embolism
Exacerbation of underlying chronic lung disease
Respiratory failure and prolonged invasive or noninvasive ventilation
OSA
ARDS
Specific cardiothoracic surgical complications
Phrenic nerve injury
Pleural effusion
Bronchopleural fistula
Sternal wound infection and empyema
Gastroesophageal anastomotic leak
Postoperative arrhythmias

*Adapted and modified from Swenson.²

Table 2—Risk Factors for PPCs*

Preoperative risk factors
COPD
Age
Inhaled tobacco use
NYHA class II pulmonary hypertension
OSA
Nutrition status
Intraoperative risk factors
Site of surgery
General anesthesia
Pancuronium use
Duration of surgery
Emergency surgery

*NYHA = New York Heart Association.

should be obtained from all patients with attention to documenting any smoking history and recognized occupational exposures, seeking evidence of respiratory symptoms, limited exercise capacity, preexisting lung disease and/or recent respiratory infections. The physical examination should screen for cardiopulmonary disorders. This information, together with selected laboratory testing, allows the patient's risk for the development of PPC to be estimated. The American Society of Anesthesiology (ASA) physical status classification (Table 3)⁵ is also a useful tool to predict the rate of PPCs. A stepwise strategy for preoperative pulmonary assessment is outlined in Figure 1.

Pulmonary Function Testing

While screening pulmonary function tests (PFTs) [*ie*, spirometry with or without measurement of the diffusion capacity of the lung for carbon monoxide (DLCO)] accurately identify patients who are not likely to survive resectional thoracic surgical procedures, and those who will not have a prolonged survival following lung vol-

Table 3—ASA Physical Status Classification*

ASA Class	Definition	Rates of PPCs by Class, %
I	A normally healthy patient	1.2
II	A patient with mild systemic disease	5.4
III	A patient with severe systemic disease that is not incapacitating	11.4
IV	A patient with an incapacitating systemic disease that is a constant threat to life	10.9
V	A moribund patient who is not expected to survive for 24 h with or without operation	NA
VI	A declared brain-dead patient whose organs are being removed for donor purposes	NA

*NA = not available. Adapted and modified from Qaseem et al.⁵

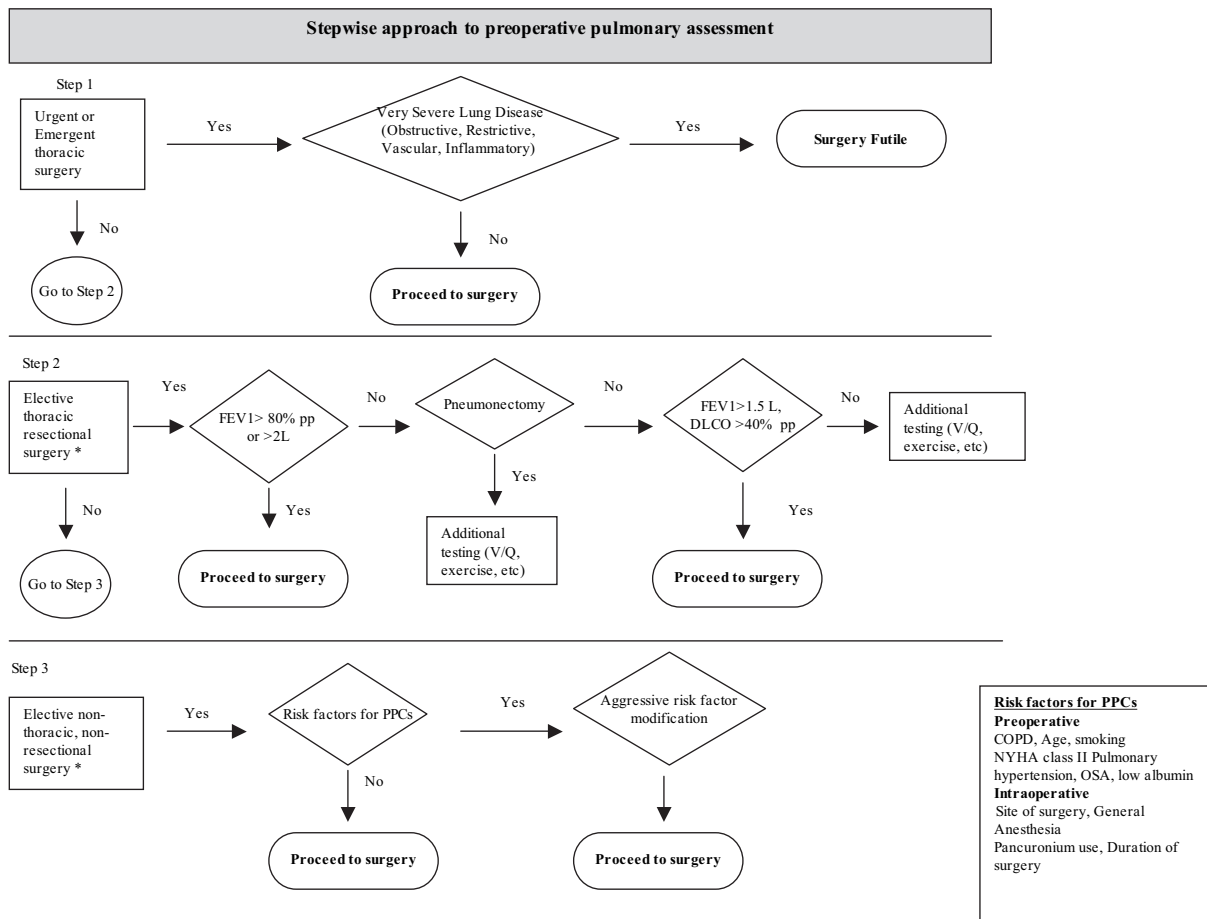


FIGURE 1. Stepwise approach to preoperative pulmonary assessment. V/Q = ventilation-perfusion scan; see Table 1 for expansion of abbreviation.

ume reduction surgery,^{6,7} the role of preoperative pulmonary function assessment for patients undergoing other types of operations is less clear,⁸⁻¹⁰ as there is no lower limit of FEV₁ below which a PPC will definitely occur and PPCs can occur even when the preoperative FEV₁ is normal. In addition, PPCs only rarely result in postoperative mortality, so most types of surgery will be performed in most patients even if they have an increased risk for the development of a PPC. In addition, as above, while knowing that the risk of PPCs is increased would raise the level of concern for, and the attention paid to, preventive measures, in reality these interventions should be carried out in all postoperative patients, irrespective of their individual PFT results.

Chest Radiographs

Radiographs are commonly ordered as a preoperative study regardless of whether there is concern about a preexisting pulmonary disease. One review¹¹ found a lower rate of PPCs in patients who received

preoperative chest roentgenograms (12.8% vs 16%), but, interestingly, the results only altered management in 1 to 4% of the patients.

Serum Albumin and BUN

The National Veterans Affairs Surgical Risk Study found that serum albumin level was a strong predictor of 30-day mortality and was independently associated with a 22 to 44% incidence of PPCs when it was < 3.5 g/dL. The association between an increase in all-cause mortality and a decrease in serum albumin level was linear. A BUN level of < 8 or > 21 mg/dL was also associated with an increased risk of PPCs.

PATIENT-RELATED RISK FACTORS

Asthma

Although earlier evidence suggested that asthma was a risk factor for PPCs, this has not been confirmed in more recent studies.^{1,8} Continuing to treat

patients to achieve their best personal peak flow prior to undergoing an elective surgery remains a common-sense approach, however. Bronchospasm can develop in patients with bronchial hyperreactivity after undergoing tracheal intubation, and these patients may benefit from short-acting β_2 -agonists and systemic adrenal corticosteroid pretreatment daily for 5 days.¹²

COPD

COPD is a well-known independent risk factor for the development of PPCs after thoracic or nonthoracic surgery.^{1,8,10} Although there is no incremental risk with an increasing severity of airflow limitation in patients undergoing noncardiothoracic surgery, such an association has been found in patients undergoing thoracic surgery.¹⁰ COPD also increases the risk of postoperative arrhythmias in patients undergoing cardiothoracic surgery.¹⁰

Smoking

A history of smoking increases the risk of PPCs for patients undergoing surgery, and the risk is increased for current smokers.¹³

Age

Being > 65 years of age increases the risk of PPCs in patients undergoing nonthoracic surgery.⁸

Pulmonary Hypertension

A review of patients with pulmonary hypertension (defined as a right ventricular systolic pressure of > 35 mm Hg) undergoing noncardiac surgery found that having a New York Heart Association functional class > 2, a history of pulmonary embolus, or obstructive sleep apnea (OSA) increased the risk of postoperative congestive heart failure, cardiac ischemic events, arrhythmias, strokes, respiratory failure (the most frequent morbidity), hepatic dysfunction, renal dysfunction, or the need for postoperative inotropic or vasopressor support. Easily identifiable factors associated with mortality in this study were right-axis deviation on the ECG, right ventricular hypertrophy by two-dimensional echocardiography, or having a history of pulmonary embolus. Lack of nitric oxide availability, use of intraoperative dopamine or epinephrine, or having a right ventricular systolic pressure/systolic BP ratio of ≥ 0.66 also portended increased perioperative morbidity and mortality.¹⁴

Patients with pulmonary hypertension who cannot walk > 332 m during a 6-min walk test have a higher mortality rate than those who can.¹⁵ The presence of

a pericardial effusion, the amount and presence of septal shift, or an enlarged right atrium seen on an echocardiogram are also predictors of a worse postoperative prognosis. Exactly which patients should undergo a 6-min walk test and/or an ECG has not been determined, but presumably the need to obtain these studies should be predicated on the findings of the routine preoperative history and physical examination. If a patient has known pulmonary hypertension, knowing their response to vasodilator therapy preoperatively may be helpful relative to managing their perioperative and postoperative problems.

Interstitial Lung Disease

Three studies have assessed the preoperative evaluation of patients with interstitial lung disease (ILD). The first study¹⁶ found that having grade 3 or 4 dyspnea at rest (using the American Thoracic Society shortness-of-breath scale) resulted in a higher mortality rate from surgical lung biopsy, and those with a $\text{PaCO}_2/\text{PaO}_2$ ratio of > 0.72 had the greatest predictive value. Other studies^{17,18} have found that having either a low DLCO or an FEV_1 or $\text{FVC} < 60\%$ predicted identified patients who were poor surgical candidates. However, no relationship has been seen between operative outcomes and preoperative dyspnea.

ILD patients with a composite physiologic index (an index calculated from the PFTs) of > 40 have a > 50% chance for the development of postoperative lung injury, and the composite physiologic index correlates more strongly with this PPC than with the severity of the ILD as quantified by either a CT scan or the result of any individual PFT.¹⁸ The above studies were designed to assess the postoperative risk of ILD patients undergoing lung resection or biopsy. Whether they accurately reflect the risk associated with general surgery remains to be determined. The possibility of pulmonary hypertension should also be considered in patients with ILD as this is a common sequela of end-stage disease and presents an additional complicating factor (see "Pulmonary Hypertension" section).

OSA

Although all patients undergoing surgery should be screened for OSA by clinical evaluation, it has not been determined whether more sensitive testing is needed. It is not known whether optimizing the treatment of patients with known OSA prior to surgery might improve outcomes. A questionnaire seeking sleep apnea symptoms was proposed by Meoli and colleagues,¹⁹ but has not been validated as a preoperative screening tool.

A study of 170 patients undergoing bariatric surgery found that while only 15% of patients carried

the diagnosis of OSA, the true prevalence, as documented by polysomnography, was 77%.²⁰ The prevalence in the general surgical population has been estimated to be 1 to 9%.²¹ Whether establishing the diagnosis of OSA prior to surgery using polysomnography reduces postoperative morbidity or mortality has not been investigated. Numerous studies have shown, however, that the presence of OSA correlates with increased postoperative morbidity and mortality. The preoperative treatment of OSA may reduce these risks perhaps by earlier institution of treatment with continuous positive airway pressure (CPAP).

The practice guidelines from the ASA²² state that the literature is insufficient to determine which patients with OSA can safely undergo outpatient surgery. They support performing outpatient procedures when local or regional anesthesia is delivered but recommend against performing airway surgery on an outpatient basis.

OTHER RISK FACTORS

The type of surgery is a strong independent predictor of PPCs, with the highest risk being for patients undergoing abdominal aortic aneurysm repair. Functional capacity, emergency surgery, duration of anesthesia, impaired sensorium, congestive heart failure, and weight loss are also independent risk factors for PPCs.

PERIOPERATIVE ISSUES IN PATIENTS UNDERGOING THORACIC SURGERY

Pulmonary Resection

The preoperative evaluation of patients with lung cancer involves determining the type and extent of the tumor as well as the patient's cardiopulmonary reserve so as to estimate the maximum chance for survival. In 2003, the American College of Chest Physicians published evidence-based guidelines⁶ on the diagnosis and management of lung cancer that included a series of recommendations regarding the use of a preoperative physiologic evaluation (Table 4).

Numerous studies have tried to predict the patients in whom PPCs will develop after undergoing thoracotomy. The European Thoracic Surgery Database project²³ analyzed 3,426 patients retrospectively for risk factors associated with in-hospital death. Although only 66 patients (2%) died, the degree of dyspnea (using the British Medical Research Council classification), ASA score, class of procedure, and age were all independently associated with in-hospital death. Smaller studies^{24,25} have found that an increased preoperative level of

Table 4—Preoperative Physiologic Assessment of Lung Cancer Patients Undergoing Lung Resection*

Age is not a contraindication for lung resection surgery
Preoperative cardiac evaluation is needed according to established guidelines
Spirometry should be performed in patients being considered for resection, if FEV ₁ > 80% predicted or > 2 L, the patient is suitable for pneumonectomy without further evaluation; if the FEV ₁ > 1.5 L, the patient is suitable for lobectomy without further evaluation
Patients with evidence of ILD on radiographs or undue dyspnea on exertion should have DLCO measured even though FEV ₁ may be adequate
If either the FEV ₁ or DLCO is < 80% predicted, postoperative lung function should be predicted on the basis of additional testing
Exercise testing is indicated preoperatively in patients with a % ppo FEV ₁ < 40% predicted or % ppo DLCO < 40% predicted

*ppo = predicted postoperative.

fibrinogen and lactate dehydrogenase were associated with increased perioperative morbidity. Other studies^{23,26} have confirmed that the extent of the tumor, the duration of surgery, the presence of heart disease, and older age are all associated with increased morbidity.

Preoperative cardiopulmonary reserve has been quantified in studies of stair climbing, the shuttle walk correlations of diffusion capacity with exercise, and the use of percent predicted values in place of absolute values in the measurement of maximum oxygen consumption. Brunelli and colleagues^{27–30} found that the results of a stair-climbing test accurately predicted PPCs in patients who had an FEV₁ of < 40% predicted and in those > 70 years of age. A prospective study³¹ of the shuttle walk test in 139 patients assessed for lung cancer surgery failed to predict PPCs. Wang³² found that the absence of an increase in the DLCO with exercise was 78% sensitive and 100% specific for predicting PPCs. The percent predicted maximum oxygen consumption accurately predicted PPCs in a series of patients undergoing thoracic surgery for lung cancer.³³ Accordingly, exercise capacity assessed in one of a variety of ways except for shuttle walk test seems to accurately predict PPCs in patients with compromised pulmonary function.

A number of scoring systems have been developed in an attempt to provide a comprehensive approach to the preoperative assessment of patients with pulmonary disease undergoing thoracic surgery including the Physiologic and Operative Severity Score for Enumeration of Mortality and Morbidity (POSSUM) and the Cardiopulmonary Risk Index (CPRI). One study³⁴ compared a new, simplified strategy for preoperative evaluation, called expiratory volume age diffusion capacity, with POSSUM

and CPRI, and found that POSSUM scores did not differentiate between patients who did and did not experience PPCs; while the expiratory volume age diffusion capacity score predicted the development of PPCs but not mortality, and CPRI identified patients in whom PPCs developed as well as both fatal and nonfatal non-PPCs. Finally, Santos-Garcia and colleagues³⁵ found that a neural network predicted postoperative morbidity with 98% accuracy using gender, age, body mass index, presence of ischemic heart disease, cardiac arrhythmia, diabetes mellitus, chemotherapy, tumor staging, extent of resection, preoperative FEV₁ and the predicted postoperative FEV₁ (both expressed as percent predicted), the need for perioperative blood transfusion, and whether the resection involved the chest wall as components of this network.

PPCs can be reduced by focusing on modifiable risk factors. Two modifiable risk factors that have received attention are alcohol use and pulmonary rehabilitation. Preoperative alcohol abuse is an independent risk factor for acute lung injury in the setting of thoracic surgery (odds ratio, 1.87; 95% confidence interval, 1.09 to 4.56)³⁶ and has also been linked to major postoperative infectious complications, respiratory failure, and increased hospital costs.³⁷ Whether quitting or decreasing alcohol use preoperatively alters the incidence of PPCs has not been assessed.

In a 2005 study,³⁸ 22 lung cancer patients with airflow limitation who received pulmonary rehabilitation had shorter hospital stays and improved postoperative FEV₁ values compared with a group of historical control subjects who actually had higher preoperative FEV₁ values. Pulmonary rehabilitation included exercise training, nutrition education, sexual activity counseling, extensive medication, training on breathing techniques, as well as group behavior therapy. Each of these components requires different time commitments from both the patients and the health-care providers. The components of pulmonary rehabilitation that are critical to the success of pulmonary rehabilitation in reducing PPCs have not been determined.

CARDIAC SURGERY

Cardiac surgery in patients with lung disease is associated with a high rate of PPCs (*ie*, postoperative arrhythmias¹⁰) and with increased mortality. The etiology has been attributed to the altered lung and chest wall mechanics associated with sternotomy,³⁹ the adverse effects of cardiopulmonary bypass, and/or thermal injury of the phrenic nerve.⁴⁰ Severe airflow limitation or functional impairment is not a

contraindication for cardiac surgery, however, as a long-term benefit has been demonstrated in these patients.⁴¹

Minimally invasive direct coronary artery bypass graft (CABG) surgery has been used successfully in patients with severely limited functional capacity, but one study⁴² found no differences in postoperative pulmonary outcomes in patients undergoing on-pump CABG surgery vs off-pump CABG surgery (although the patients who underwent off-pump surgery had better gas exchange and were extubated earlier, but had a greater reduction in postoperative respiratory compliance). Intensive preoperative inspiratory muscle training may reduce PPCs in patients undergoing CABG surgery.⁴³ Preoperative spirometry may be a useful tool for identifying patients at risk for complications if findings are abnormal; however, the degree of abnormality is not a good predictor of PPCs in these patients.⁴⁴

ESOPHAGECTOMY

Esophagectomy is associated with an extremely high risk of PPCs. A multicenter prospective study⁴⁵ of 1,777 patients undergoing surgical resection of the esophagus reported a 21% incidence of pneumonia and a 16% incidence of respiratory failure. Preoperative factors associated with PPCs were increasing age, dyspnea, diabetes mellitus, COPD, alkaline phosphatase level of > 125 U/L, lower serum albumin concentrations, increased complexity scores, and decreased functional status. Intraoperative risk factors included the need for blood transfusion and longer operative times. A trial of 220 patients with adenocarcinoma of the mid-to-distal esophagus or the gastric cardia involving the distal esophagus randomized to undergo esophagectomy via a transhiatal approach vs a transthoracic approach showed a lower incidence of PPCs (27% vs 57%, respectively; $p < 0.001$) with the transhiatal approach.⁴⁶

RISK-REDUCTION STRATEGIES

Interventions aimed at decreasing PPCs should begin prior to the operation and continue through the perioperative and postoperative periods.⁴⁷ These interventions should be carried out regardless of the risk of the development of PPCs. Table 5 provides a brief overview of the available strategies having a proven benefit.

Smoking Cessation

Patients enrolling in a smoking cessation program beginning 6 to 8 weeks prior to undergoing elective

Table 5—Proven Risk-Reduction Strategies

Preoperative
Smoking cessation 6–8 wk before undergoing surgery
Inspiratory muscle training
Intraoperative
Use of neuromuscular agents other than pancuronium
Postoperative
IS
CPAP

orthopedic surgery had a reduced need for postoperative ventilatory support.⁴⁸ Similar reductions were not observed in an older study in patients who stopped smoking 2 weeks before undergoing elective thoracic or nonthoracic surgery, or in patients undergoing thoracotomy for lung cancer who had quit smoking > 2 months prior to undergoing surgery.⁴⁹ While it appears that smoking cessation a minimum of 6 weeks prior to elective surgery may reduce PPCs, randomized controlled trials (RCTs) designed to assess the effect of different durations of smoking cessation would be extremely difficult to conduct.

Preoperative Corticosteroids and Bronchodilators

Silvanus and colleagues¹² found fewer instances of bronchospasm during intubation in patients with bronchial hyperreactivity who were naïve to bronchodilators when they were pretreated daily for 5 days with albuterol and methylprednisolone. Whether this benefit extends to patients who use bronchodilators in the long term has not been assessed.

Anesthesia and Analgesia

Anesthetic and analgesic agents may contribute to the development of PPCs by decreasing respiratory muscle tone and/or by augmenting airway closure generating atelectasis. Ketamine is the only anesthetic agent that does not cause intraoperative atelectasis.⁵⁰ A large systemic review by Rodgers and colleagues comparing the effect of general anesthesia, and epidural or spinal anesthesia on postoperative complications in patients undergoing various nonthoracic surgical procedures found a reduced incidence of postoperative respiratory depression in patients receiving epidural or spinal anesthesia with or without general anesthesia vs general anesthesia alone, but no difference in the rate of postoperative pneumonia. A metaanalysis by Urwin and colleagues looking at the incidence of postoperative pneumonia in patients undergoing hip surgery found no differences among the various approaches to anesthesia. Accordingly, regional anesthesia has not been clearly

established as an approach for reducing PPCs. Berg and colleagues found that the incidence of postoperative residual neuromuscular blockade was higher in patients receiving pancuronium and that those with residual blockade had an increased incidence of postoperative pneumonia. Although Gust and colleagues found that patient-controlled analgesia (with or without the use of nonsteroidal antiinflammatory drugs) decreased postoperative atelectasis in patients undergoing CABG surgery compared to nurse-controlled analgesia, two subsequent reviews^{51,52} and one well-designed RCT by Norris and colleagues failed to confirm this finding.

Surgical Techniques

Studies examining the incidence of PPCs in newer surgical techniques (*eg*, laparoscopic) vs older ones frequently employ historical control subjects or other types of nonrandomized design. Accordingly, good evidence favoring one type of surgical approach over another is lacking, although clinical experience suggests that laparoscopic techniques are preferable.

Increasingly, cardiothoracic surgical techniques are being modified to utilize robotics and smaller incisions to minimize disruption of thoracic cage. Two retrospective studies^{53,54} looking at these techniques showed a lower incidence of postoperative respiratory failure, chest tube duration, and 30-day in-hospital mortality rate compared with historical control subjects. RCTs using these techniques would be needed for a more definitive conclusion.

Lung-Expansion Maneuvers

Lung expansion has been advocated to decrease the risk of PPCs since the adverse effects of surgery on lung and chest wall mechanics predispose patients to atelectasis and retained secretions. Deep-breathing exercises decrease PPCs in patients undergoing elective upper abdominal surgery in addition to decreasing atelectasis and improving pulmonary function in patients undergoing CABG surgery.⁵⁵ Both a systematic review by Overend and colleagues and an RCT by Gosselink and colleagues found no benefit for incentive spirometry (IS) over other means of accomplishing lung expansion in preventing PPCs. RCTs examining the effect of CPAP therapy on patients undergoing both thoracic and nonthoracic surgery have consistently shown that CPAP therapy decreases PPCs.^{56–58} One small RCT⁵⁹ found no benefit for bilevel positive airway pressure therapy on postoperative pulmonary function following gastric bypass surgery for the treatment of obesity.

In summary, all modalities of lung expansion seem to be equally effective in preventing PPCs, with the role

of IS remaining unclear. CPAP therapy may be reserved for patients unable to perform deep-breathing exercises or to use IS.

Other Strategies

Neither total parenteral nutrition nor pulmonary artery catheterization⁶⁰ decreases the incidence of PPCs. A review⁶¹ examining the effect of prophylactic nasogastric decompression after abdominal operations found no benefit for routine use.

CONCLUSIONS

Preoperative pulmonary evaluation is a critical step in managing patients with lung disease who are undergoing elective surgeries. PPCs can be predicted more accurately in patients undergoing elective noncardiothoracic surgery than in patients undergoing elective cardiothoracic surgery. There are few effective strategies for preventing complications in the postoperative period. Risk stratification is effective in patients undergoing thoracic resectional and lung volume reduction surgeries; however, such a strategy is lacking in patients undergoing other surgeries. Identifying patients who are at risk for the development of PPCs and managing their underlying modifiable risk factors aggressively prior to surgery and in the perioperative period are essential.

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