Preoperative Evaluation of Patients with Pulmonary Disease

Series Editor:
Gregory Kane, MD, FACP, FCCP
Program Director
Internal Medicine Residency
Associate Professor of Medicine
Division of Pulmonary and Critical Care
Jefferson Medical College
Philadelphia, PA

Table of Contents

Introduction ............................................. 2
Terminology and Evaluation Process .......... 2
Preoperative Evaluation Prior to Nonthoracic Surgery 3
Preoperative Evaluation Prior to Thoracic Surgery 8
Conclusion ............................................. 11
References ............................................ 11

Cover Illustration by mb cunney
INTRODUCTION

The preoperative evaluation of patients undergoing nonthoracic surgery or pulmonary resection is an important skill for the practicing pulmonary physician. Patients at risk for pulmonary complications following surgery include those with chronic lung disease or asthma, heavy smokers, persons of advanced age, obese patients, and patients with recent upper respiratory infections. Potential complications include atelectasis, pneumonia, and respiratory failure. The development of pneumonia is an important outcome because it may lead to respiratory failure and is associated with a high morbidity and mortality.1 Patients also may be at risk for postoperative deep vein thrombosis (DVT) and pulmonary embolism (PE). It is the responsibility of the pulmonary consultant to determine which patients will benefit from prophylaxis. The evaluation of patients prior to pulmonary resection is complicated by the possibility that functional pulmonary parenchyma will be resected during the surgical procedure, resulting in reduced lung function. The physician performing the preoperative evaluation must estimate the patient’s postoperative lung function and consider this information when determining whether surgery should proceed.

This manual reviews the preoperative assessment and management of patients with pulmonary disease in the context of common surgical scenarios.

TERMINOLOGY AND EVALUATION PROCESS

Historically, internists have been called on to provide clearance for patients scheduled to undergo a surgical procedure. However, the term clearance is not preferred because it implies that patients cleared will avoid complications altogether. It is preferred instead that the consulting physician designate the patient as being at low risk, mildly increased risk, moderately increased risk, or significant risk based upon underlying disease and the planned surgery.

In delineating the role of the internist or subspecialist in a preoperative evaluation, Merli and Weitz2 emphasize the importance of clear communication with surgical colleagues. Specifically, they recommend determining the question, establishing urgency, providing specific recommendations, communicating with the team, and providing follow-up as key components of the process. These suggestions form the basis of the “10 Commandments for the Medical Consultant” (Table 1).3

The assessment tools used for preoperative evaluation of patients with pulmonary disease include a careful history with attention to functional status, physical examination with assessment for complications of pulmonary disease (eg, cor pulmonale), radiographic imaging, complete pulmonary function studies, measures of arterial blood gases, and echocardiography. In all patients with underlying pulmonary disease, a single chest radiograph (posteroanterior and lateral views) and spirometry should be obtained at baseline. The need for further studies is dictated based upon the radiograph and spirometry results, the relative degree of pulmonary reserve, and the type of procedure. In specialized settings, exercise testing may add further information. The findings gathered from the preoperative assessment are synthesized with evidence from the literature on patient- and procedure-related factors that increase risk for postoperative complications. Based on this information, the physician can perform risk stratification for individual patients undergoing proposed surgical procedures. With the patient’s estimated risk and expected benefit of the procedure, the medical team can determine whether surgery should proceed as planned. The pulmonologist should consider following patients postoperatively to help identify complications early.
Case 1 Presentation

An 81-year-old man who is a current smoker and has a history of advanced chronic obstructive pulmonary disease (COPD) presents for pulmonary evaluation prior to a planned procedure to repair a documented abdominal aortic aneurysm (*Figure 1*). The aneurysm is not amenable to endovascular repair because it involves the takeoff of the renal arteries. On examination, blood pressure is 150/90 mm Hg, pulse is 105/min and regular, and respirations are 20 breaths/min. The chest is hyperinflated and breath sounds are diminished. Cardiac tones are distant and heard best at the subxiphoid area. The enlarged abdominal aorta is palpable in the midline. There is trace lower extremity edema. Neurologic examination is normal. The forced expiratory volume in 1 second (FEV1) is 0.94 L without change after administration of a bronchodilator. Chest radiograph confirms hyperinflation without infiltrate, mass, or effusion. The maximum diameter of the abdominal aorta is 6.0 cm.

- What procedure-related factors should be considered in this patient’s assessment?

It is essential for the consulting physician to have a detailed understanding of the type of procedure that is planned. The principal respiratory problems encountered postoperatively after abdominal surgery are atelectasis, poor clearance of secretions, and pneumonia, which are a result of impaired diaphragm function due to pain. Thus, the location of the procedure (near the diaphragm or in the lower abdomen) will affect the postoperative course of patients at risk for respiratory complications undergoing abdominal procedures.

Mohr and Jett found a higher complication rate among patients undergoing upper abdominal procedures, including abdominal aortic aneurysm repair, with a complication rate that ranged between 17% and 76%. Steiner et al found a very low rate of complications in patients who underwent laparoscopic cholecystectomy compared with those who underwent a standard surgical incisional approach. Lower abdominal procedures generally are considered to have a low rate of pulmonary complications. Although trials prospectively comparing surgical approach are lacking, it appears that abdominal aortic aneurysm repair in the open method and upper abdominal procedures are associated with the highest rate of complications. These data suggest that a laparoscopic approach should be used for patients with borderline respiratory status whenever feasible.

During the past 2 decades, a number of studies have evaluated the effect of the type of anesthesia on outcomes in patients undergoing abdominal procedures. Two recent studies demonstrated a reduced mortality...
rate in a general population of patients receiving neuroaxial blockade for surgery, including spinal anesthesia or epidural anesthesia, as compared to general anesthesia. In a study involving nearly 500 patients, those who received general anesthesia had mortality rates up to 9%, while there were no deaths in patients who received a spinal anesthetic. In a more recent comprehensive review, neuroaxial blockade was associated with a reduced rate of pneumonia (39% risk reduction) and a markedly reduced rate of respiratory depression (59% risk reduction). These findings, however, were not confirmed in a broader population of patients with other general medical illnesses, such as obesity, diabetes, or coronary artery disease. Based on these studies, the greatest risk for abdominal surgery is for patients undergoing upper abdominal surgery, and the risk is increased for patients who receive general anesthesia. Spinal or epidural (both neuroaxial blockades) anesthesia is associated with lower complication rates.

What is this patient’s risk for postoperative pneumonia?

PNEUMONIA RISK INDEX

To enhance the quantitative assessment of postoperative risk, Arozullah and colleagues developed and validated a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. Participants in the National Veterans Affairs Surgical Quality Improvement Program. Ann Intern Med 2001;135:853.

Table 2. Postoperative Pneumonia Risk Index

<table>
<thead>
<tr>
<th>Category/Risk Factor</th>
<th>Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of surgery</td>
<td></td>
</tr>
<tr>
<td>Abdominal aortic aneurysm</td>
<td>15</td>
</tr>
<tr>
<td>Thoracic</td>
<td>14</td>
</tr>
<tr>
<td>Upper abdominal</td>
<td>10</td>
</tr>
<tr>
<td>Neck/neurosurgery</td>
<td>8</td>
</tr>
<tr>
<td>Vascular/emergency</td>
<td>3</td>
</tr>
<tr>
<td>General anesthesia</td>
<td>4</td>
</tr>
<tr>
<td>Transfusion &gt; 4 units</td>
<td>3</td>
</tr>
<tr>
<td>Age, yr</td>
<td></td>
</tr>
<tr>
<td>&gt; 80</td>
<td>17</td>
</tr>
<tr>
<td>&gt; 70–79</td>
<td>13</td>
</tr>
<tr>
<td>&gt; 60–69</td>
<td>9</td>
</tr>
<tr>
<td>&gt; 50–59</td>
<td>4</td>
</tr>
<tr>
<td>General health</td>
<td></td>
</tr>
<tr>
<td>Dependent/partially dependent</td>
<td>10/6</td>
</tr>
<tr>
<td>Weight loss &gt; 10% in past 6 months</td>
<td>7</td>
</tr>
<tr>
<td>Current smoker/drinker (&gt; 2 per day)</td>
<td>3/2</td>
</tr>
<tr>
<td>History</td>
<td></td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>5</td>
</tr>
<tr>
<td>Stroke</td>
<td>4</td>
</tr>
<tr>
<td>Altered mental status</td>
<td>4</td>
</tr>
<tr>
<td>Long-term steroid use</td>
<td>3</td>
</tr>
</tbody>
</table>


Table 3. Risk Stratification for Postoperative Pneumonia Predicted by Preoperative History

<table>
<thead>
<tr>
<th>Risk Class (No. of Points)</th>
<th>Rate of Pneumonia in Development Cohort</th>
<th>Rate of Pneumonia in Validation Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (0–15)</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td>2 (15–25)</td>
<td>1.19</td>
<td>1.18</td>
</tr>
<tr>
<td>3 (26–40)</td>
<td>4.0</td>
<td>4.6</td>
</tr>
<tr>
<td>4 (41–55)</td>
<td>9.4</td>
<td>10.8</td>
</tr>
<tr>
<td>5 (&gt; 55)</td>
<td>15.8</td>
<td>15.9</td>
</tr>
</tbody>
</table>


The patient in case 1 has several risk factors that increase his risk for postoperative pneumonia, including his age (17 points for age > 80 years), type of surgery.
(15 points for abdominal aortic aneurysm surgery), smoking status (3 points for being a current smoker), and underlying disease (5 points for COPD). With a total of 50 points, this patient has a 9.4% risk of pneumonia; patients in this risk class have a subsequent mortality rate (exclusive of other nonpulmonary risks) of approximately 2%. This prediction assumes that cardiac risks are addressed and do not represent a problem. Although the patient’s risk for pneumonia is high, it is likely balanced by the risk of mortality from aneurysm rupture. Surgery could be contemplated if the patient quits smoking. While smoking cessation would not change his risk class (47 versus 50 points), there might be benefits in clearance of secretions and in wound healing. Arozullah and colleagues did not directly address the impact of smoking cessation in their analysis. The most beneficial length of abstinence from smoking prior to surgery will be addressed in the following section.

**EFFECT OF SMOKING ON SURGICAL OUTCOME**

**Case 2 Presentation**

A 63-year-old woman who is healthy but suffers from severe degenerative joint disease involving the hip presents for preoperative pulmonary assessment prior to undergoing hip surgery. She is a current smoker and smokes 1 pack of cigarettes daily. She is unable to walk significant distances because of severe hip pain. Physical examination reveals a blood pressure of 130/70 mm Hg, pulse of 90 bpm, and respirations of 18 breaths/min. Lungs are clear and cardiac rhythm is normal. There are no murmurs or gallops noted. There is no edema. Spirometry shows mild obstruction, but FEV₁ is 2.1 L. The FEV₁/forced vital capacity (FVC) ratio is 67%. The diffusing capacity of lung for carbon monoxide (DLCO) is preserved. There is no oxygen desaturation during walking.

- **What are the benefits of smoking cessation before surgery?**

  Because smokers with degenerative joint disease may have limited functional status due to musculoskeletal symptoms, spirometry is helpful to detect underlying obstructive lung disease. In this patient, the lung disease is not severe enough to significantly reduce the FEV₁, although the FEV₁/FVC ratio does confirm airflow obstruction. Historically, general measures to prevent pulmonary complications have included smoking cessation of at least 3 weeks’ duration, incentive spirometry, and bronchodilator therapy for patients with obstructive lung disease. These measures were based on an early publication from Stein and Cassara.¹¹ More recently, there has been interest in evaluating the length of time that smokers would need to discontinue their habit in order to maximize the postsurgical outcome. In a prospective study of 200 patients, the postoperative pulmonary complication rate was 11.1% for persons who had quit smoking for more than 6 months compared with 14.5% for persons who had quit for more than 2 months but less than 6 months.¹² Current smokers had a 33% complication rate. In contrast, the rate was highest (57%) for patients who had quit for less than 2 months. Thus, a longer time quitting (>6 months) is associated with a better outcome. Patients quitting for less than 2 months may have included some high-risk patients requiring surgical procedures who were unable to postpone surgery for longer intervals.

  Moller and colleagues designed a randomized clinical trial on an intention-to-treat basis to evaluate an intensive smoking cessation program versus usual care in an orthopedic population.¹³ Patients were enrolled in an intensive smoking cessation program that included sophisticated counseling, pharmacologic therapy, and careful follow-up or received usual care with simple advice to quit. Patients in the active treatment arm had a lower rate of any postoperative complication (18% versus 52%) and experienced a much lower rate of wound complication (5% versus 31%). The number needed to treat to avoid 1 wound-related complication was only 4. This finding was based on the intention-to-treat analysis and not on outcomes in those who actually achieved abstinence. These data demonstrate that patients undergoing orthopedic procedures can achieve a much lower rate of wound complication by entering an intensive smoking cessation program. The ideal interval would be as long as 6 months prior to an elective surgery, such as hip repair. Given the costs and complication rate, one could argue that such elective procedures should be entertained only after smoking cessation. Whether these data extend to other surgical procedures needs to be confirmed.

  The setting of a planned elective surgery may provide an excellent opportunity to address smoking cessation given an expected increase in the patient’s willingness to quit. The pulmonologist should emphasize the benefits to the patient’s overall health as well as the chance for improved surgical outcome. Pharmacotherapies that can serve as adjuncts to counseling and advice are outlined in Table 4. Elective orthopedic procedures are well suited for smoking cessation given the obvious flexibility of the surgical timing. Such flexibility is limited when dealing with surgery for malignancy or symptomatic ailments. In case 2, the patient should be advised to quit and referred to an intensive smoking cessation program. The patient should be advised of
the benefits of cessation to her overall health, surgical outcome, and wound healing.

**PULMONARY RISKS OF CARDIAC SURGERY**

**Case 3 Presentation**

A 65-year-old man with diabetes undergoes cardiac catheterization because of a change in his angina symptoms and is found to have 3-vessel coronary disease with a mildly reduced ejection fraction. The patient has been a long-standing smoker (1 package a day for over 40 years) and has documented COPD with an FEV₁ of 1.0 L. Physical examination shows a blood pressure of 160/80 mm Hg, pulse of 90 bpm, and respirations of 14 breaths/min. There is no jugular venous distention, ascites, or edema. Cardiac examination shows no right ventricular lift or heave. Lung examination reveals expiratory rhonchi. Resting arterial blood gas analysis shows a pH of 7.38, PCO₂ of 42 mm Hg, and PaO₂ of 63 mm Hg. The cardiac silhouette is enlarged on chest radiograph.

- **Can this patient safely undergo coronary artery by-pass grafting?**

The prediction of postoperative pulmonary complications after coronary artery bypass grafting (CABG) can be challenging. In general, bypass surgery in patients with chronic lung disease is well tolerated, except in patients with the most severe obstructive lung disease. A study that analyzed a cohort of 2200 Medicare beneficiaries who underwent CABG in the mid 1980s found that patients with a history of COPD had an 8.2% incidence of adverse events, including atrial fibrillation and respiratory failure requiring reintubation. Patients without COPD had an incidence of adverse events of 4.3%. The overall mortality in this study was 6.6% at 30 days.¹⁴

It appears that patients who have COPD but who do not have severe carbon dioxide retention or cor pulmonale may well be acceptable candidates for cardiac bypass surgery, but they do have increased risk.

The presented patient has advanced COPD and thus has an increased risk for complications. While the complication rate would be higher (8% versus 4%) based upon the published Medicare data, this moderately increased risk might well be tolerated when the risks of either left main coronary disease or triple vessel coronary disease with reduced left ventricular systolic function are considered. Given the absence of hypercapnic respiratory failure or cor pulmonale (indicating that COPD is not endstage), surgery can proceed recognizing the increased, but not intolerable, complication rate. The patient should receive aggressive preoperative pulmonary care, including smoking cessation, counseling, bronchodilator therapy, and incentive spirometry.

**PERIOPERATIVE ASTHMA MANAGEMENT**

**Case 4 Presentation**

A 45-year-old woman with moderate asthma is
admitted to the hospital emergency department because of right lower quadrant pain and fever. She currently is receiving a low dose of inhaled steroids (fluticasone, 100 µg) twice daily and a long-acting bronchodilator (salmeterol, 50 mg) twice daily for control of her asthma. Her last flare of asthma was 2 months ago when she received a 2-week burst of oral prednisone, starting at 60 mg and tapering down over a 14-day period. During the past several weeks, her asthma has been well controlled and she has been active and exercising. She has not needed to use her β2-agonist inhaler in more than 2 weeks. She has never been hospitalized. Her last emergency department visit was more than 5 years ago.

Peak flow rate is 425 L/min, which is close to her baseline rate of 450 L/min. Blood pressure is 130/70 mm Hg, pulse is 105 bpm, respirations are 18 breaths/min, and temperature is 102.5°F. Emergency department evaluation reveals rebound tenderness. White blood cell count is elevated at 16,500/mm³ with increased band forms. The hemoglobin, platelet count, and SMA-7 serum testing results are normal. Computed tomography (CT) scan confirms suspected acute appendicitis. The chest radiograph shows no abnormality.

The operating room is prepared in anticipation of emergent appendectomy. Because of the patient’s history of asthma, a consultation with a pulmonologist is requested for preoperative assessment. The patient is seen in the emergency department on a weekend, and spirometry is not available.

• How should this patient’s asthma be managed in the perioperative period?

This patient has mild-moderate asthma that recently has been under good control. Because the surgery is emergent and necessary, the challenge for the consulting pulmonologist is to maximize her lung function, prevent adrenal insufficiency, and prevent flare of asthma during the postoperative period.

A number of studies have demonstrated that high doses of inhaled corticosteroids have the potential to suppress the pituitary-adrenal axis over time and might limit the adrenal gland’s ability to respond to stressful situations. Under such circumstances, administration of perioperative glucocorticoids should be considered to prevent adrenal insufficiency. In this case, the patient is taking 200 µg of fluticasone, a low-dose of inhaled corticosteroid, which is well below the maximum approved dose of 1000 µg. A roughly equivalent dose in other delivered formulations (eg, metered dose inhaler) includes fluticasone 44 µg 2 puffs twice daily (176 µg of fluticasone per day). Thus, given the patient’s low dose of inhaled corticoid steroid, she likely would not require parenteral glucocorticoids to prevent hypoadrenalism in the perioperative period. However, the recent burst of prednisone within the past 3 months could be problematic. It is recommended that any asthma patient who requires oral or systemic steroids during the previous 6 months and needs general anesthesia should receive parenteral steroids to prevent adrenal insufficiency. This patient should receive perioperative steroids to prevent hypotension or hypoadrenalism. Hydrocortisone 100 mg intravenously every 8 hours beginning prior to surgery is recommended. The patient should be followed during the perioperative period to note whether hypotension or sepsis syndrome develops. If the patient remains free from these complications, the steroids should be tapered rapidly.

Continued treatment with inhaled steroids and as-needed bronchodilators should continue in the perioperative period. Minor flares of asthma can be treated with bronchodilator therapy. Significant flares may require additional or aggressive use of intravenous steroids. In these circumstances, the severity of the asthma flare and the risk of steroid therapy in the postoperative period must be weighed on a case-by-case basis.

• Does this patient require prophylaxis of deep vein thrombosis?
PROPHYLAXIS OF DEEP VEIN THROMBOSIS

The prevention of DVT and PE is an important issue and is the responsibility of the pulmonary consultant, particularly in patients undergoing surgery. The American College of Chest Physicians (ACCP) reviewed the literature on the risks of venous thromboembolism and its prevention in general surgical patients in its Consensus Conference on Antithrombotic Therapy.17 The ACCP analyzed trials that examined baseline risks in untreated (no prophylaxis) patients and compared these risks to trials of patients receiving a variety of prophylactic strategies. Based on this data, the consensus panel made recommendations regarding which patients are likely to benefit from DVT prophylaxis. Their recommendations are reviewed in Table 5.

The degree of risk for DVT varies based on the procedure and the characteristics of the patient.18 In practice, the clinician can determine the risk by evaluating the patient’s history and age and considering the type of procedure to be performed. Patients at low risk for complications include those undergoing a minor surgical procedure who are under 40 years of age with no clinical risk factors. Young patients undergoing minor surgical procedures are the only patients who would not require specific prophylaxis against DVT. Patients undergoing moderate, high-risk, or very high-risk procedures have a significant incidence of calf venous thrombosis and subsequently an additional risk of proximal DVT and PE. These patients should receive prophylaxis with either subcutaneous heparin, intermittent pneumatic compression boots, low-molecular-weight heparin, or warfarin, depending on the clinical scenario.

The case patient is at high risk on the basis of her age (over 40 years) and the nature of the abdominal procedure (a high-risk surgery). Patients with her characteristics undergoing this type of procedure would have an incidence of DVT of 4% to 8% and an incidence of PE of 2% to 4%.17 In this scenario, prophylactic therapy should be started 2 hours prior to surgery and continued for 5 to 7 days.16

PREOPERATIVE EVALUATION PRIOR TO THORACIC SURGERY

EVALUATION OF PATIENTS WITH LUNG CANCER

Case 5 Presentation

A 65-year-old man with a long history of COPD presents with a left hilar mass and palpable left supraclavicular adenopathy. CT scan shows subcarinal and pretracheal lymph nodes that measure 1.3 cm. The diagnosis of adenocarcinoma is established at bronchoscopy. Transtracheal fine needle aspiration of lymph nodes in the subcarinal and pretracheal regions are
both negative for malignancy. The FEV₁ is 1.1 L on maximal bronchodilator therapy.

- **How should the evaluation of this patient proceed?**

The preoperative evaluation in patients with lung cancer must take into account the prospect that viable lung tissue may be resected along with tumor. Thus, clinicians must be concerned not only with complete resections of tumor but also with how the resection will affect the patients’ lung function. Decisions regarding surgery are generally based upon both the preoperative evaluation of anatomic resectability and operability. Resectability is based upon staging, which should be established pathologically with mediastinal exploration. The determination of operability is based upon the candidate’s FEV₁ and functional status. In general terms, patients who are good candidates for surgery must have a resectable stage tumor (principally clinical stage I or II and selected stage IIIA tumors) and acceptable functional status with a predicted postoperative FEV₁ of at least 0.8 to 1.0 L.

### Determining Resectability

Once a diagnosis of lung cancer has been established, the next step in the diagnostic evaluation is accurate staging. Staging is based in part on radiographic imaging. Routine staging studies should always include a CT scan of the thorax with images from the lung apices through the adrenal glands. Figure 2 shows an asymptomatic adrenal metastasis noted on routine CT scan of a patient with lung cancer. Additional testing, such as bone scan and central nervous system imaging, should be obtained based on operator preference but more importantly on patient symptoms. Patients with suspicious bone pain or any neurologic abnormality should undergo imaging. Definitive staging of the mediastinum can be achieved only with mediastinoscopy despite the current availability of positron emission tomography scan, although this scan may provide additional clues to the presence or absence of mediastinal metastases. Table 6 shows current staging criteria for non–small cell lung cancer. The stage should be confirmed pathologically prior to thoracotomy, even when there is suspicion of advanced disease.

In the patient presented, the mediastinal nodes have been staged via bronchoscopy. However, the palpable supraclavicular node is of concern. If there is tumor in this node, the cancer stage would be IIIB and this patient would not benefit from resection. This lymph node must be aspirated or excised for complete staging prior to consideration of any surgical resection. If the results of this evaluation are negative, the evaluation for operability can continue.

### Determining Operability

Because surgery represents the only curative approach based on currently available therapies, every opportunity to operate should be implemented. It is the responsibility of the consulting pulmonologist to exclude those patients with excessive risk based upon lung function testing, blood gas measurements, and exercise testing. Patients with advanced stage disease or unacceptable lung function could be candidates for radiotherapy or chemotherapy. Patients with hypercapnic respiratory failure are not good candidates for resection, but hypoxia may not preclude surgery.

The assessment of operability begins with maximal medical therapy to optimize bronchopulmonary hygiene, bronchodilation, and functional status preoperatively. It is very difficult to accurately predict the postoperative FEV₁ prior to surgery, and expected lung function following surgery can only be estimated. It is generally accepted that patients can undergo pneumonectomy if the baseline FEV₁ is greater than 2 L. Lobectomy can proceed if baseline FEV₁ is greater than 1.2 L. When lung function is borderline, additional pulmonary function testing can be utilized, including measurement of maximum voluntary ventilation (MVV) and DLCO, but these measures have less predictive value.
value. Values greater than 50% of predicted for MVV and 60% of predicted for DLCO are considered favorable. Other strategies include performing ventilation-perfusion (V/Q) scanning to more accurately assess the anticipated effect that resection of lung tissue may have on lung function. Evidence of carbon dioxide retention or complicating pulmonary hypertension preoperatively generally preclude aggressive or extensive surgical resection.

An assessment of exercise capacity is perhaps a more rational approach to assessing operability since exercise can simulate the stress of surgery and offer greater predictive value in terms of a patient’s ability to compensate under stress. Exercise testing can be done with a simple stair climb or in a more sophisticated manner with measurement of maximal oxygen uptake during a formal cardiopulmonary exercise test. Patients whose maximum oxygen consumption (VO₂ max) is more than 20 mL/kg/min have been shown to experience benefic...
the lowest complication rates, whereas patients with $\text{VO}_2$ max below 10 mL/kg/min have the highest rate of complications. Quantitative V/Q scanning can be used to provide a more accurate assessment of the relative proportion of lung function that would be lost with lobectomy or pneumonectomy. For example, if the $\text{FEV}_1$ was 2.0 and pneumonectomy was required, a V/Q scan might demonstrate that the portion of the lung to be resected accounts for only 30% of the total lung function. Therefore, the estimated postoperative $\text{FEV}_1$ would be 1.4 L, a result that is more than satisfactory.

Prior to excluding patients from surgery based upon poor $\text{FEV}_1$ or functional status, maximal medical therapy must be prescribed. Table 7 outlines common classes of therapeutic drugs used for treating COPD. Therapies include bronchodilator therapy (combined sympathomimetic and anticholinergic agents) and mucolytic therapy. Exacerbations of COPD should be treated and resolved prior to final evaluation. Selected individual patients, in particular those with a significant bronchodilator response, may benefit from inhaled steroids, and a trial seems warranted. Randomized trials, however, of such an approach preoperatively have not been conducted.

At 1.1 L, the case patient has a borderline $\text{FEV}_1$. Quantitative V/Q scanning could help predict the anticipated loss in lung function after resection, and measures of MVV and DLCO also would be helpful. If these measures are greater than 50% and 60% predicted, respectively, this patient would be an acceptable candidate for surgery. If the MVV and DLCO are borderline or conflicting, an exercise test could help provide data for a decision.

Case 5 Follow-up

Results of MVV and DLCO are 55% and 65%, respectively. The patient is highly motivated and undergoes exercise testing with favorable results. $\text{VO}_2$ max is 22 mL/kg/min. Because all possible lymph node metastases (enlargement on CT) have been evaluated and found to be negative, surgery can now proceed. The resection will include further lymph node dissection.

CONCLUSION

In conducting a preoperative assessment of patients with pulmonary disease, the pulmonologist can apply available evidence to arrive at a reasonable assessment of risk. Upon viewing the patient and the nature of the surgical problem, the consultant can then assess the risk-benefit ratio to provide the best recommendations. The pulmonologist should consider following patients postoperatively to help identify complications early.

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