

## Perioperative Evaluation and Management of the Patient with Pulmonary Disease

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Routinely when we are asked to evaluate a patient for a surgical procedure, we immediately think about cardiac risk factors and how to modify them. But what can we do for a patient with pulmonary disease? Some of the more serious complications are pneumonia, bronchospasm, hypoxia requiring oxygen supplementation, and prolonged mechanical ventilation. What are the risk factors for these pulmonary complications? What kind of testing can help identify patients at risk? What be done to modify their risk factors? We will try to answer these questions in this section.

### Risk Factors

#### Smoking

Smoking related pulmonary dysfunction is a major cause of pulmonary complications after surgical procedures. Chronic cigarette smoking damages the ciliated epithelium and the tracheobronchial tree. This can lead to obstruction in the bronchioles and increases the chances of infection, which if progressive leads into chronic obstructive pulmonary disease. Chalon et al looked at the correlation of cytological damage from smoking and post-operative pulmonary complication. He found a steady rise in the percentage of complications after operations as cigarette smoking increased, from 7.9% in non-smokers to 43% in heavy smokers.<sup>1</sup> For this reason, it will make sense to recommend that smokers should stop smoking prior to surgical procedures. Buist et al documented improvement in small airway function, but it took 8 weeks to notice changes.<sup>2</sup> Clinically, Warner et al found a threefold decrease in the incidence of pulmonary complications after 8 weeks of smoking cessation.<sup>3</sup> Current data also shows an increase in pulmonary complications if patients stops smoking less than 8 weeks before surgery. For those who stopped smoking less than 8 weeks before surgery, those who stopped closest to surgery were more likely to experience pulmonary complications.<sup>4,5</sup> More recently, Nakagawa et al showed that smoking abstinence of at least 4 weeks was necessary to reduce the incidence of pulmonary complications. In this study, they only separated patients as current smokers, abstinent for 2-4 weeks, and abstinent for over 4 weeks.<sup>6</sup> In addition, Kotani et showed that smokers had a decrease ability to mount effective pulmonary immune defenses that may last for as long as 6 months after stopping cigarette use.<sup>7</sup>

#### COPD

Patients with COPD are at increased risk of post-operative pulmonary complications.<sup>1,3</sup> Kroenke et al showed a 32% morbidity and 5% mortality in patients with severe airflow obstruction undergoing different types of surgeries. It was also found that the location and duration of the surgical procedures affected the outcome. Patients having abdominal procedures were shown to have a higher incidence of complications. In addition, longer surgeries had more pulmonary complications. During this study, 5 out of 10 patients died after CABG.<sup>8</sup> No further studies have been done to show the morbidity and mortality in patients with COPD undergoing CABG.

Aggressive pre-operative management of COPD has been shown to be necessary to decrease complications.<sup>9</sup> In this study, patients benefited from pre-operative pulmonary preparation by receiving oral bronchodilator therapy, use an expectorant, postural drainage, cough training, nebulized bronchodilator therapy and antibiotics for purulent sputum. It was implied that sputum mobilization was the main benefit resulting in reduced infection and atelectasis. Therefore aggressive management of COPD using current guidelines is recommended.<sup>10-11</sup> This includes inhaled bronchodilators like ipratropium and beta-adrenergic receptor-agonist, theophylline for refractory cases, and corticosteroids for those patients that have responded to steroid use in the past. Theophylline compared to placebo has been showed to improve pulmonary function tests (PFTs).<sup>12-13</sup> In addition theophylline has been showed to increase diaphragmatic strength.<sup>13</sup> Corticosteroids improve pulmonary function in 11% of patients with COPD. Therefore, patients that have responded well in the past to corticosteroids should be treated, especially those with moderate to severe symptoms.<sup>14-15</sup>

Antibiotics should be reserved for patients who have signs of infections. The most frequent cause of COPD exacerbations is bronchitis. For this reason, McIntyre in a review of the evidence for the management of COPD favors the use of antibiotics in COPD exacerbations.<sup>16</sup>

#### Asthma

Earlier studies had shown an increase incidence of intra-operative bronchospasm in patients with asthma. However, Gold et al did not note any difference in the severity of asthma symptoms and complications.<sup>17</sup> More recently, Warner et al showed that the frequency of bronchospasm and laryngospasm was low. However, they demonstrated

that patients had more complications if they had recently used anti-asthmatic drugs, had recent symptoms or had received therapy in a medical center.<sup>18</sup> Like patients with COPD, aggressive management of asthma symptoms is recommended prior to surgical procedures including treatment with corticosteroids if necessary. A short course of corticosteroids does not increase the incidence of infections.<sup>19</sup>

#### General Health Status

Poor general health is a risk factor for pulmonary complications. The American Society of Anesthesiologists system which classifies patients from being healthy (class 1) to moribund (class 5), is a predictor for pulmonary complications.<sup>18-20</sup> In addition, Nezu et al showed that poor nutritional status was a predictor for postoperative complications in patients with COPD.<sup>21</sup>

#### Age

Some studies using logistic regression analysis demonstrated that age is an independent risk factor.<sup>22</sup> However, there have not been any randomized studies that prove that age is an independent risk factor. Djokovic et al showed that if separated by the American Society of Anesthesiologists class, elderly patients had the same pulmonary complication rate as younger patients.<sup>23</sup>

#### Obesity

Obesity can profoundly alter pulmonary function and diminish exercise capacity by its adverse effects on respiratory mechanics, resistance within the respiratory system, respiratory muscle function, lung volumes, work and energy cost of breathing, control of breathing and gas exchange. Obesity places the patient at risk for aspiration pneumonia, pulmonary thromboembolism, respiratory failure, sleep apnea and obesity hypoventilation syndrome.<sup>24-25</sup> However, there have not been studies that support obesity as an independent risk factor for pulmonary complications after surgery. Obese patients had no increase in pneumonia, bronchospasm, atelectasis, or respiratory failure compared to patients with normal weight.<sup>26-27</sup>

#### Sleep Apnea

Sleep Apnea is a common problem. Recognition of sleep apnea could be important for the management in the perioperative period as well as the postoperative period. Patients with sleep apnea will present difficulty with tracheal intubation or airway management.<sup>28</sup> Even though there are studies that showed that it is safe for patients with sleep apnea

to be sedated for procedures<sup>29</sup>, there are also studies that showed that patients with sleep apnea are at increase risk for irregularities of respiratory pattern associated with the use of opioid analgesics that can contribute to periods of apnea and hypoxia.<sup>30-31</sup> Gupta et al showed that the use of CPAP at home was protective for patients with sleep apnea.<sup>32</sup>

#### Site and type of surgery

There are different mechanisms by which pulmonary function is affected during surgery. The supine posture during surgery decreases lung volume. Anesthetic agents impair respiratory muscle function, alter gas exchange, and impair mucociliary clearance mechanism.<sup>33</sup> Abdominal and thoracic surgical procedures reduce vital capacity and functional residual capacity.<sup>34-35</sup> Ford et al showed that patients undergoing upper abdominal surgeries had a marked decrease in diaphragmatic function, total lung capacity, forced expiratory volume in one second and vital capacity. Nine out of ten patients developed atelectasis, and the alveolar-arterial oxygen difference widened in all patients.<sup>36</sup>

Abdominal surgeries had a much higher incidence of pulmonary complications than non-abdominal surgeries. Surgeries that were non-abdominal and non-thoracic appeared to have very low post-operative pulmonary complications. These surgeries included hemorrhoidectomies, thyroidectomy, major limb amputations and mastectomies. In an addition, upper abdominal surgeries had twice as many pulmonary complications as lower abdominal surgeries.<sup>37</sup>

Thoracotomy, even without lung resection, causes chest wall injury and a decrease in chest wall compliance. There is a reduction in vital capacity and a predisposition to alveolar hypoventilation and hypoxemia.<sup>38-39</sup>

Laparoscopic cholecystectomy has been shown to result in less pulmonary complications. This is probably related to a decrease muscle trauma and manipulation of abdominal organs.<sup>40</sup>

#### Duration of surgery

Duration of the procedure was second to site of operation as a risk factor for pulmonary complications.<sup>22</sup> Wightman showed that surgeries that lasted more than 30 minutes had a higher rate of pulmonary complications.<sup>37</sup> Kroenke et al also demonstrated that pulmonary complications increased with increased duration of surgery. This study classified surgeries as less than 1 hour, 1 to 2

hours, 2 to 4 hours, and more than 4 hours. The rates of pulmonary complications were 4%, 23%, 38%, and 73% respectively.<sup>8</sup> More recently Glaspole et al showed that for lung volume reduction surgeries, procedures lasting more than 210 minutes were associated with significant increases in perioperative morbidity and mortality.<sup>41</sup>

**Pre-operative testing**

Chest X-ray

Few studies have distinguished the outcome of routine chest X-ray from chest X-rays that were performed for an indication. Routine chest X-rays are reported abnormal in 2.5%-37% of cases, but only lead to a change in clinical management in 0-2.1% of cases.<sup>42</sup> Moreover, the incidence of asymptomatic pulmonary disease is very low.<sup>43</sup>

Recommendations for chest X-rays.

1. Not indicated as part of a routine pre-operative evaluation.
2. Not indicated solely on advanced age.
3. Indicated for patients undergoing intra-thoracic surgical procedures.
4. Indicated on patients with signs or symptoms of active pulmonary disease.
5. Indicated on recent immigrants from third world countries.

Pulmonary function test

The ACP in a position paper in 1990 recommended the use of preoperative spirometry in patients undergoing lung reduction surgeries and in patients who smoke and have respiratory complaints who are undergoing thoracic and upper abdominal

surgeries.<sup>44-45</sup> The evidence for preoperative pulmonary function testing is predominately in lung reduction surgery. Olsen et al's criteria for identifying patients at high risk in lung resection, are FVC < 50% predicted, FEV1 <50%, and DLCO <50% of predicted.<sup>46</sup> Gass et al suggested a higher risk of pulmonary complications if FEV1 or FVC was less than 70% of predicted or the ratio of FVE1 to FVC is 65% of predicted.<sup>47</sup> Recently the national emphysema treatment trial research group looked at patients who were high risk of death after lung volume reduction surgery. They found that patients with an FEV1 of no more than 20% of predicted and either homogeneous emphysema or a carbon monoxide diffusing capacity of no more than 20% of predictive had a 35% mortality rate and only 33% of the patients showed some improvement in their functional status after the procedure.<sup>48</sup>

Recently, different studies have looked at the DLCO as a risk for pulmonary complications. It has been found that even with a normal spirometry a decrease DLCO can predict the presence of emphysematous changes.<sup>49</sup> In addition, Norris et al found that an increase in alveolar dead space can predict pulmonary complications.<sup>50</sup>

Routine arterial blood gases do not predict postoperative pulmonary complications. There is some evidence that a PCO2 >45mm Hg increases pulmonary risk.<sup>46</sup> However, a more recent prospective study did not show that an elevated PCO2 was a risk factor for patients undergoing lung reduction surgery.<sup>51</sup>

American College of Physicians recommendations for preoperative testing<sup>44</sup>

Type of surgery	Spirometry	Arterial blood gases
Lung resection	All patients	All patients
CABG	Smokers and patients with dyspnea	Smokers and patients with dyspnea
Upper abdominal	Smokers and patients with dyspnea	Smokers and patients with dyspnea
Lower abdominal, head and neck, orthopedic	Some patients with suspected lung disease or who need strenuous rehabilitation	

## **Risk reduction strategies**

### Lung expansion maneuvers

Lung expansion maneuvers decrease the incidence of post-operative pulmonary complications. Different maneuvers have been evaluated including CPAP, incentive spirometry, deep breathing exercises and forceful coughing. All of these procedures decrease significantly the duration of hospital stay, pneumonia, and atelectasis. There is no difference in the incidence of pulmonary complications between any of these procedures, which implies that frequency and supervision from a respiratory therapist is more important than a specific procedure.<sup>9,22,52</sup> CPAP, although not frequently used, offers the advantages of requiring no effort from the patient and being a painless procedure.<sup>52</sup> The disadvantage of using CPAP is cost and the requirement of having specially trained personnel. It is also important to start teaching patients lung expansion maneuvers prior to their surgical procedures. Thorens observed that patients that were untreated had a 47% complication rate compared 27% on patients that were treated post-operatively. The rate decreased to 12% for those patients that initiated treatments prior to their surgeries.<sup>53</sup>

### Pain control

Pain aggravates pulmonary complications because it discourages the patient from taking deep inspirations, coughing effectively and cooperating with respiratory therapy. Tsui et al found that adequate postoperative analgesia is associated with lower cardiopulmonary complications on patients undergoing transthoracic esophagectomy.<sup>54</sup>

## **Recommendations**

### Pre-operative

1. Obtain a complete history and physical exam, especially emphasizing on the pulmonary risk factors.
2. Chest X-ray in patients at high risk and in patients with active pulmonary symptoms.
3. Pulmonary function test is recommended in patients undergoing lung resection procedures and in patients who smoke and have pulmonary disease.

4. Encourage smoking cessation at least 8 weeks before surgery. There are immediate benefits of smoking cessation like wound healing, but pulmonary complications increase if the patient stops smoking less than 8 weeks before surgery.
5. Aggressive management of COPD and asthma including short course of corticosteroids if necessary.
6. Treat infections prior to surgical procedures.
7. Start teaching patients about lung expansion maneuvers.

### Intra-operative

1. It is not our role as medical consultants to decide on the type and location of surgery. However, in high-risk patients laparoscopic surgeries and when available alternative surgeries to upper abdominal and thoracic surgeries should be considered.
2. When possible, recommend that the duration of surgery be shortened.

### Post-operative

1. Respiratory therapy is recommended. Either deep breathing techniques with forceful coughing or use of incentive spirometry is beneficial. CPAP should be use in selected patients.
2. Recommend pain control. Avoid over-sedation.

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