

Anaesthesia in patients with Chronic Obstructive Pulmonary Disease
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Self-assessment

Please answer questions 1-3 true or false.

1. The following are true of chronic obstructive pulmonary disease (COPD):
 - a. It is a condition that is solely caused by cigarette smoking
 - b. Cessation of smoking improves post operative outcome
 - c. Presence of wheeze in a clinical examination is a useful marker of disease severity
 - d. Completely reversible airways disease is the hallmark of COPD
 - e. COPD and asthma are mutually exclusive conditions.

2. The following are true regarding COPD:
 - a. Patients with *cor pulmonale* should be given aggressive diuresis preoperatively to reduce peripheral oedema
 - b. High flow FiO₂ should be used with caution in COPD
 - c. Morphine is contraindicated in COPD as it causes respiratory depression and bronchospasm
 - d. Epidural anaesthesia is contraindicated in COPD as it may paralyse the intercostal muscles required for breathing
 - e. Interscalene nerve block may adversely affect patients with COPD

3. The following may benefit patients with COPD undergoing surgery:
 - a. Nebulised beta blocker
 - b. Oral steroids for stable COPD
 - c. Antibiotics for respiratory infection
 - d. Respiratory physiotherapy
 - e. A preoperative exercise regime

4. What signs and symptoms do patients with COPD have?
5. How do you treat patients who have an acute exacerbation of COPD?
6. What preoperative investigations would you consider for a patient with an FEV₁/FVC ratio of 60% and an FEV₁ that is 50% of the predicted value?
7. A 60 year old patient is listed for below knee amputation for peripheral vascular disease. He has moderate COPD, discuss which anaesthetic technique you would choose and why.
8. What are the problems of general anaesthesia in patients with COPD?

Introduction

Chronic obstructive pulmonary disease (COPD) is a very common respiratory disorder that affects many people across the world. The long term survival of patients with severe

COPD undergoing any type of surgery is poor (47% 2 year mortality) and they are at significant risk of postoperative morbidity, especially pulmonary complications. However with risk identification, pre-operative optimisation and appropriate anaesthetic management, the risks of developing postoperative pulmonary complications can be reduced even in patients with severe disease.

Pathophysiology of COPD

COPD is a generally progressive inflammatory disease of the lungs that is characterised by airflow limitation that is not fully reversible, and is often complicated by significant systemic manifestations and co-morbidities. The inflammation is usually secondary to inhaled noxious particles or gases, the most common of which worldwide is cigarette smoke.

The lung pathology in COPD is a combination of inflammatory small airways disease (obstructive bronchiolitis) and parenchymal destruction (emphysema). The relative contribution of these two processes and thus the resultant physiological abnormalities varies from person to person.

The small airways disease leads to obstruction and air trapping. This occurs chronically, but importantly also occurs dynamically under stress. The resulting dynamic hyperinflation adversely affects ventilation / perfusion (VQ) mismatching, the loading and mechanics of the respiratory muscles, and the sensation of dyspnoea.

The loss of lung parenchyma decreases gas transfer, reduces the pulmonary capillary bed and worsens VQ mismatching. Reducing the parenchymal support of the walls of the small airways contributes to the airflow limitation.

The end result of the VQ mismatching, decreased gas transfer and alveolar hypoventilation is hypoxaemia and sometimes hypercarbia. The hyperinflation causes marked dyspnoea even without a fall in PO_2 .

Importantly COPD patients can have significant extra pulmonary disease. This can be a direct result of COPD such as *cor pulmonale*, respiratory and skeletal muscle wasting and weight loss, or co-morbid diseases, especially cardiovascular, which are more prevalent in this population.

Clinical Features of COPD

The typical features of COPD are dyspnoea, wheeze and cough with or without sputum production. The onset of COPD is insidious and most patients are symptomatic either with cough or progressive dyspnoea long before they present to medical services. Therefore a diagnosis of COPD should be considered in all patients over forty years old with a significant smoking history (>10 pack years) who should be questioned about symptoms.

In the early stages of COPD the dyspnoea is usually associated with exertion. The breathlessness is characteristically differentiated from asthma by the lack of nocturnal symptoms (in early COPD), a lack of significant diurnal variability, a lack of association with allergy and its persistent and progressive nature. Be aware that asthma and COPD can co-exist in the same patient.

Patients with significant hyperinflation can often develop significant dyspnoea even with relatively normal spirometry. The dyspnoea is often accompanied by significant anxiety. In exacerbation breath stacking and dynamic hyperinflation results which, unless it is rapidly treated, can quickly lead to respiratory failure.

Conversely some patients have very poor respiratory function and have surprisingly few symptoms. They tolerate a significant degree of chronic hypoxia and often chronic hypercapnia. These patients are often very oxygen sensitive and can rapidly develop type II respiratory failure if given too much supplemental oxygen.

The mainstay of treatment of COPD is bronchodilation both for maintenance and for exacerbations. Both β -agonists and anticholinergics (ipratropium bromide and tiotropium bromide) are used; the latter are proposed to have an additional effect of relieving air trapping. Methylxanthines are controversial in COPD but they are widely used. Long term inhaled steroids are usually only indicated in patients with severe COPD and repeated exacerbations or who have co-existent asthma. Oral steroids have almost no role in maintenance of COPD but are important and beneficial in the treatment of exacerbations.

Preoperative assessment

History and examination

- Establish exercise tolerance, particularly hills and stairs (although reported levels of dyspnoea and disability may be inaccurate).
- Enquire about frequency of exacerbations, hospital admissions and previous requirements for invasive and non-invasive ventilation.
- A smoking history is vital, current and recent smokers are much more likely to develop postoperative pulmonary complications.
- Cough and particularly sputum production has been shown to be an independent risk factor for postoperative pulmonary complications in COPD.
- A clear history regarding co-morbid conditions is vital.
- Symptoms and signs of active infection should be sought including green or purulent sputum, increased dyspnoea, wheeze and signs of consolidation.
- Nutritional status should be assessed as patients with both high and low BMI have increased risk.

Investigations

Chest X-ray is useful to exclude active infection and occult malignancy. The presence of extensive bullous disease highlights the potential risk of pneumothorax.

ECG may reveal right heart disease (right ventricular hypertrophy or strain). Consider echocardiography.

Spirometry is used to clarify diagnosis and assess severity:

GOLD Classification of COPD (based on post bronchodilator FEV ₁)	
Stage I: Mild	FEV ₁ /FVC <0.70 FEV ₁ ≥ 80% predicted
Stage II: Moderate	FEV ₁ /FVC < 0.70 FEV ₁ 50 - 80% predicted
Stage III : Severe	FEV ₁ /FVC <0.70 FEV ₁ 30 - 50% predicted
Stage IV: Very Severe	FEV ₁ /FVC 0.70 FEV ₁ <30% predicted or FEV ₁ < 50% predicted and chronic respiratory failure

Gas transfer measurements can give additional information, especially if significant emphysema is suspected.

Simple exercise tests such as stair climbing and the 6 minute walk test are safe and simple to perform, and correlate well with more formal exercise testing.

Arterial blood gas measurement is useful: PaCO₂ > 5.9 kPa and PaO₂ <7.9 kPa (on room air) are both associated with a worse prognosis.

Preoperative optimisation

Preoperative optimisation can be divided into four main areas: smoking cessation, optimization of drug therapy, treatment of infection, and respiratory physiotherapy.

- **Smoking cessation.** Current smokers are at far greater risk of developing postoperative pulmonary complications. Smoking should be stopped at least eight weeks before surgery in order to obtain maximum benefit. There is some evidence to suggest that quitting or reducing cigarette consumption immediately before surgery is associated with increased risk of complications, although there are confounding factors.
- **Optimal drug treatment.** Some patients with COPD have a degree of reversible airways disease and even in those patients with no demonstrable reversibility

bronchodilators are indicated as they increase exercise tolerance even if there is no change in FEV₁. Almost all patients with COPD benefit from at least one dose of nebulised bronchodilator preoperatively. Some caution is needed as high doses of nebulised β -agonists can cause or exacerbate tachyarrhythmias and cause hypokalaemia. Nebulised anticholinergics can increase sputum viscosity.

- **Treatment of infection/ exacerbation.** Current infection or exacerbations are a contraindication to anaesthesia. They should be treated with both β -agonist and anticholinergic therapy, preferably in nebulised form, and a short course of systemic steroids. If the patient has signs of active infection such as viscous, green or brown sputum or worsening cough or dyspnoea this should be treated preoperatively with antibiotics. Prophylactic antibiotics over the operative course may be beneficial. Oral steroids are not recommended in stable COPD.
- **Physiotherapy.** Preoperative physiotherapy is important in sputum producing COPD patients to clear any retained sputum that may cause intraoperative bronchial plugging or pneumonitis.

There may also be a role for pulmonary rehabilitation, involving exercise training, patient education and psychological and behavioural interventions. This has been shown to improve symptoms and reduce length of hospital admission for exacerbation in COPD patients, but it is not yet as established as the above interventions.

Principles of perioperative anaesthetic management

Airway and ventilation

- **Bronchospasm** may occur on induction, during airway instrumentation and on extubation. Whilst in some patients this may be mild and transient, others may need aggressive administration of bronchodilators to prevent or treat acute hypoxaemia and hypercarbia. Avoidance of endotracheal intubation, if possible, may reduce the risk of bronchospasm. Extubation should be carried out with the patient awake and sitting up.
- **V/Q mismatch** increases under general anaesthesia and in the supine position due to cephalad movement of the diaphragm, which reduces the FRC towards closing capacity. Combined with atelectasis, this leads to worsening hypoxaemia. This is especially pronounced if the patient is obese or is in the Trendelenburg or lithotomy position. Supplemental oxygen and positive pressure ventilation may be necessary.
- **Sputum plugging** can be caused by excessive sputum production in an anaesthetised patient. This may lead to lobar collapse, causing ventilatory failure and high airway pressure. Saline nebulisation, endobronchial suctioning, and physiotherapy to clear the sputum plug are the treatment strategies. Inadequate analgesia and insufficient postoperative physiotherapy can lead to ineffective sputum clearance also causing sputum plugging and nosocomial chest infection. Patients with a tendency to produce sputum need to be identified preoperatively, given physiotherapy and adequate

postoperative facilities, such as the ICU or HDU. Postoperative chest infection must be promptly diagnosed and treated with antibiotics.

- **Pneumothorax** is more likely in patients with COPD; mechanical ventilation should be carefully set to minimise high airway pressure and avoid breath stacking. The respiratory rate should be low to allow increased expiratory time. The use of PEEP should be minimal.
- **Postoperatively**, patients may require increased monitoring and continued ventilatory support. Residual effects of general anaesthesia and sedation may result in hypoventilation causing hypercarbia and hypoxaemia. Whilst increasing inspired oxygen concentration may suffice in most patients, some will require regular arterial blood gas monitoring and further ventilatory support (non-invasive or invasive). Some patients have ventilatory drive which is dependent on hypoxia. In these patients high inspired oxygen levels may suppress respiratory drive causing hypoventilation and hypercarbia. Ideally patients at such risk should be placed in ICU/HDU. The issue of postoperative chest infection is already discussed under 'sputum plugging'.

Cardiovascular issues

Some patients with COPD develop *cor pulmonale*, characterised by right ventricular hypertrophy, dilatation and failure. In these patients adequate oxygen therapy is required to prevent any further increase in right ventricular afterload caused by hypoxic pulmonary vasoconstriction. Fluid balance is crucial as appropriate right ventricular preload is essential to produce adequate cardiac output where the right ventricular afterload is high. Conversely, in an overfilled right ventricle, the left ventricular filling will be compromised thereby affecting systemic output. Central venous pressure monitoring may be useful, although in the presence of tricuspid valve incompetence may not reflect the true right sided filling status. Patients with right sided heart failure are more likely to encounter ventricular and atrial arrhythmias.

Regional anaesthesia

Regional anaesthesia avoids many of the respiratory problems associated with general anaesthesia and has the added advantage of providing good postoperative analgesia. However patients must be able to tolerate lying flat. Most blocks can safely be performed with or without sedation. Interscalene block should be avoided as the resultant phrenic nerve palsy may further compromise respiratory function.

Analgesia

Effective analgesia is vital in order to optimise respiratory function, especially for patients who have undergone major abdominal or thoracic surgery. Lack of effective pain relief may result in diminished chest expansion and ineffective cough, leading to basal atelectasis, hypoxaemia and nosocomial infection. Epidural analgesia is particularly beneficial in patients with COPD, as it may prevent the problems described above and avoids the drowsiness and respiratory depression associated with the use of systemic opioids.

Thromboprophylaxis

Patients with COPD have an increased risk of developing venous thromboembolism, so appropriate thromboprophylaxis is important, along with early mobilisation and adequate hydration.

Summary

Patients with COPD vary in their presentation - from the asymptomatic and undiagnosed to those with a severely disabling systemic disease. All COPD patients undergoing surgery are at increased risk of postoperative complications and benefit from active management throughout the pre-, intra- and post-operative phases. We hope that this brief tutorial has helped you to identify these patients and to maximise their chances of an uncomplicated recovery.

Answers to self-assessment

1. FTFFF
2. FTFFT
3. FFTTT
4. to 8. See text.

References and further reading

- Seigne PW, Hartigan PM, Body SC. Anesthetic considerations for patients with severe emphysematous lung disease. *Int Anesthesiol Clin* 2000; 38: 1–23
- Henzler D, Rossaint R, Kuhlen R. Anaesthetic considerations in patients with chronic pulmonary disease. *Curr Opin Anaesthesiol* 2003; 16: 323–30
- National Heart, Lung, and Blood Institute and World Health Organization. Global initiative for chronic obstructive lung disease: global strategy for diagnosis, management, and prevention of chronic obstructive pulmonary disease. 2007 update. National Institutes of Health, Bethesda.
<http://www.goldcopd.com/Guidelineitem.asp?l1=2&l2=1&intId=989>
- Ferguson MK. Preoperative Assessment of Pulmonary Risk. *Chest* 1999;115:58-63
http://chestjournal.org/cgi/content/abstract/115/suppl_2/58S
- Wong et al. Factors Associated with Postoperative Pulmonary Complications in Patients with Severe Chronic Obstructive Pulmonary Disease. *Anesth Analg* 1995;80:276-84. <http://www.anesthesia-analgesia.org/cgi/content/abstract/80/2/276>