Perioperative management of the patient with respiratory disease

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Abstract

Respiratory complications are common, representing 10% of all postoperative complications and accounting for significant morbidity, mortality and financial cost. Patients with respiratory disease can be identified preoperatively from a clinical history. Preoperative evaluation should focus on diagnosis and medical optimization of the patient's physical status. Risk stratification of patients allows counselling and consent, planning of perioperative care including anaesthetic management and possible modification of surgical procedure to reduce risk. The aim of the perioperative period is successful surgery without postoperative respiratory complications. Patients should be monitored and complications actively sought and promptly treated to reduce their impact and increase the likelihood of a good outcome. Postoperative level 2 or 3 care allows for the more rapid detection of physiological disturbance and prompt treatment.

Keywords Cardiopulmonary exercise testing; early warning scoring systems; postoperative levels of care; preoperative assessment; pulmonary function testing; respiratory failure; respiratory pathology; respiratory physiology; risk stratification; spirometry

Introduction

The overall risk of developing a major complication or dying during admission for surgery in the UK is less than 1%.[1] However, approximately 25,000 patients die every year in the UK after a surgical procedure and 80% of these deaths occur in the 10% of 'high-risk' patients. This group has a hospital mortality or major complication rate of 10–15%. In the UK, high-risk surgery mortality is three- to eightfold higher than in the USA.[2]

Respiratory disease is common in the UK, responsible for around 1 in 5 deaths. Given its essential physiological role, it is unsurprising that respiratory disease ranks highly as a cause or contributor to death in the early postoperative period. The 2011 National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report[1] identifies co-existing respiratory disease as being both the most common co-morbidity associated with mortality and accounting for the highest number of perioperative deaths.

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Applied physiology and pathology

Given the heterogeneity of conditions described as 'respiratory disease', it is useful to review applied physiology, pathology and the relevance of investigations of the respiratory system. The respiratory system anatomically consists of the upper and lower airways, the alveoli, pulmonary vasculature, the thoracic cage and the diaphragm. Functionally the respiratory system achieves oxygenation of haemoglobin in the blood and excretion of carbon dioxide by the following mechanisms.

Inspiration

- An increase in thoracic volume (caused by diaphragmatic contraction and outward rib movement) generates a negative intra-thoracic pressure and air movement into the lungs. This outward movement of the chest requires compliant tissues. The energy used by the respiratory muscles is termed 'work of breathing'.
- Airflow is opposed by resistance, in the form of friction from the airways. This friction may be increased by airway narrowing.
- 'Gas exchange' is the transfer of oxygen from the alveoli to pulmonary capillaries and the simultaneous opposite movement of carbon dioxide. The movement of gases is driven by a pressure gradient and will be reduced if the respiratory membrane is inflamed or fibrosed. Adequate gas exchange requires alveoli to be ventilated and perfused, referred to as V/Q matching.

Expiration

- In health at rest this is a passive process. The respiratory muscles relax and the elastic tissue of the lungs recoils to reduce the volume of the chest, increasing the intra-thoracic pressure and expelling alveolar gas.
- In disease states that increase airway resistance or cause a loss of elastic tissue, expiration becomes active and requires the use of accessory respiratory muscles, increasing the work of breathing. If the process continues there may incomplete expiration, resulting in air becoming trapped in alveoli which become unavailable for gas exchange.

The healthy respiratory system has a number of protective mechanisms. The gag reflex prevents entry of foreign material. Mucus produced in the larger lower airways traps foreign material, which is then escalated to the pharynx by ciliated epithelium; clearing of mucus is assisted by coughing. In addition there are phagocytic cells, including mast cells, present in the alveoli as a further barrier against foreign pathogens. Table 1 highlights the common chronic respiratory conditions, their pathological classification and the effects on the respiratory system.

Surgery triggers the neuro-hormonal stress response, the magnitude of which is proportional to the stimulus. This requires an increase in cardiorespiratory work as the patient becomes catabolic. The surgical patient with respiratory disease may be unable to meet these increased metabolic demands, leading to a failure of oxygen delivery and consequent organ damage. This is worsened with the addition of:

- the supine position, which causes a reduction in functional residual capacity, alveolar collapse and atelectasis
- hypoventilation, caused either by neurological impairment or drugs

Pathophysiology of common chronic respiratory conditions

Classification	Condition	Pathology	Features
Obstructive	COPD	Bronchospasm Mucus hypersecretion Air trapping	Chronic productive cough, wheeze, exertional dyspnoea. Recurrent sepsis Reduced FEV_1 Reduced FEV_1/FVC
	Asthma	Reversible bronchospasm	Provoked wheeze, cough. Reversible reduction in PEFR, FEV_1
Restrictive	Musculoskeletal deformity	Ineffective chest wall movement	Exertional dyspnoea, fatigability.
Extrinsic	Neuromuscular conditions	Reduced compliance Poor expansion Reduced cough	Reduced RV, FRC and TLC
Intrinsic	Idiopathic fibrosis Connective tissue disease Sarcoidosis Drug-induced lung disease	Respiratory membrane destruction Loss of elastic tissue Reduced lung compliance	Progressive dyspnoea, non-productive cough. Reduced RV, FRC and TLC FEV_1/FVC maintained Reduced DLCO
Occupational	Asbestosis Pneumoconiosis Farmer's lung Bird Fancier's lung	Multiple: • Acute bronchospasm • Occupational asthma • Parenchymal inflammation • Fibrosis	Reversible bronchospasm Progressive dyspnoea Reduced RV, FRC, TLC FEV_1/FVC maintained Reduced DLCO
Congenital	Cystic fibrosis	Obstructive airways Bronchiectasis Parenchymal destruction Bacterial colonization Pulmonary hypertension, right heart failure.	Exertional dyspnoea, productive cough, recurrent sepsis. Reduced FEV_1, reduced FEV_1/FVC Pancreatic insufficiency Malnourishment
Suppurative	Bronchiectasis	Permanent dilatation of bronchi Impaired mucus clearance Plugging of airways Bacterial colonization	Cough, excess sputum production, dyspnoea, wheeze, recurrent sepsis.
Smoking	Toxin	Increased COHb Reduced oxygen carriage Irritable airways Mucus hypersecretion Ciliary immobility Alveolar collapse	Productive cough, dyspnoea, recurrent sepsis. Reduced FEV_1 Cardiovascular disease GI ulceration and anastomotic leak Thrombotic tendency

COHb, carboxyhaemoglobin; COPD, chronic obstructive pulmonary disease; DLCO, diffusion capacity for carbon monoxide; FEV_1, forced expiratory volume in 1 second; FRC, functional residual capacity; FVC, forced vital capacity; GI, gastrointestinal; PEFR, peak expiratory flow rate; RV, residual volume; TLC, total lung capacity.

Table 1

- mucus hypersecretion
- alveolar oedema which accompanies the generalized inflammatory response.

The cumulative effect of these processes is to reduce the capacity for gas exchange. The patient becomes more susceptible to organ failure and sepsis at a time when natural defences are also breached by endotracheal tubes, arterial lines, central lines, urinary catheters and surgical instruments.

Assessment

Although the term 'respiratory disease' encompasses a number of conditions with varying aetiology, pathophysiology and management therapies, the general approach is similar regardless of the diagnosis: identification, investigation, optimization, risk stratification and planning. Whilst planned surgery allows for this, in an emergency there is unlikely to be time to fully optimize a medical condition. Obtaining a history and results of investigations will allow identification and stratification of the high-risk patient with appropriate planning of care.

Identification, investigation and optimization

Most patients will have a known diagnosis, but patients may present at pre-assessment with undiagnosed respiratory disease. A clinical history should be taken paying particular attention to