ANAESTHESIA FOR THE PATIENT WITH RESPIRATORY DISEASE

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INTRODUCTION

Patients with respiratory disease have an increased chance of developing complications perioperatively. Most problems are seen postoperatively and are usually secondary to shallow breathing, poor lung expansion, basal lung collapse and subsequent infection. To minimise the risk of complications these patients should be identified preoperatively and their pulmonary function optimised. This involves physiotherapy, a review of all medications and may require the help of a respiratory physician. Elective surgery is postponed until the patient is ready.

In the general surgical population thoracic and upper abdominal procedures are associated with the highest risk (10-40%) of pulmonary complications. The benefits of the proposed surgery must therefore be weighed against the risks involved.

GENERAL CONSIDERATIONS

General health status

The American Society of Anesthesiologists classification (1 to 5) correlates well with the risk of post-operative pulmonary complications. Poor exercise tolerance also predicts those at risk.

Smoking

Active and passive smokers have hyper-reactive airways with poor muco-ciliary clearance of secretions. They are at increased risk of perioperative respiratory complications, such as atelectasis or pneumonia. It takes 8 weeks abstinence for this risk to diminish.

Even abstinence for the 12 hours before anaesthesia will allow time for clearance of nicotine, a coronary vasoconstrictor, and a fall in the levels of carboxyhaemoglobin thus improving oxygen carriage in the blood.

Obesity

The normal range for BMI (Body Mass Index - defined as weight (Kg) divided by the square of the height (m) is 22-28. Over 35 is morbidly obese. Normal weight (Kg) is height (cm) minus 100 for males, or height minus 105 for females.

Obese patients may present a difficult intubation and have perioperative basal lung collapse leading to postoperative hypoxia. A history of sleep apnoea may lead to post-operative airway compromise. If practical obese patients should lose weight preoperatively, and co-existent diabetes and hypertension stabilised.

Physiotherapy

Teaching patients in the preoperative period to participate with techniques to mobilise secretions and increase lung volumes in the postoperative period will reduce pulmonary complications. Methods employed are early mobilisation, coughing, deep breathing, chest percussion and vibration together with postural drainage.

Pain Relief

Effective analgesia is important as it allows deep breathing and coughing and mobilisation. This helps prevent secretion retention and lung collapse, and reduces the incidence of postoperative pneumonia. Epidurals appear particularly good at this for abdominal and thoracic surgical procedures, although they are not available everywhere *(see Epidural analgesia section).*

The method of postoperative analgesia should always be discussed with the patient before surgery.

Effects of General Anaesthesia

These are relatively minor and do not persist beyond 24 hours. However, they may tip a patient with limited respiratory reserve into respiratory failure.

- Manipulation of the airway (laryngoscopy and intubation) and surgical stimulation may precipitate laryngeal or bronchial spasm.
- Endotracheal intubation bypasses the filtering, humidifying and warming functions of the upper airway allowing the entry of pathogens and the drying of secretions. Adequate humidification and warming of the anaesthetic gases with a Heat and Moisture Exchanger (HME) is ideal.
- Volatile anaesthetic agents depress the respiratory response to hypoxia and hypercapnia, and the ability to clear secretions is reduced. Functional residual capacity (FRC) decreases and pulmonary shunt increases; these are unfavourable changes leading to hypoxia and occur especially in lithotomy and head-down positions, and in the obese.
- Intermittent positive pressure ventilation causes an imbalance in ventilation and perfusion matching in the lung, and necessitates an increase in the inspired oxygen concentration.

- Excessive fluid therapy can result in pulmonary oedema in patients with cardiac failure.
- Neuromuscular blockade is reversed before extubation. In the recovery room residual effects of anaesthesia depress upper airway muscular tone, and airway obstruction may occur.

Anaesthetic Drugs

- The intravenous induction agents thiopentone, propofol and etomidate produce an initial transient apnoea. Ketamine preserves respiratory drive and is better at maintaining the airway, although secretions increase.
- Thiopentone increases airway reactivity.
- Volatile anaesthetics depress respiratory drive in decreasing order as follows: Enflurane>Desflurane>Isoflurane> Sevoflurane>Halothane.

  Ether however stimulates respiratory drive and increases minute ventilation. It is, however, irritant to the airway, stimulates saliva production and may induce coughing.
- Atracurium and tubocurare release histamine and may result in bronchospasm. They are best avoided in asthma.
- Opioid drugs and benzodiazepines depress respiratory drive and response to hypoxia and hypercapnia. Morphine may result in histamine release and occasionally bronchospasm. Non-steroidal anti-inflammatory drugs (NSAIDS) may exacerbate asthma. Pethidine is a useful alternative analgesic for asthmatics.

Effects of Surgery

- To immobilise upper abdominal and thoracic incisions and limit pain, patients splint these areas postoperatively with their intercostal and diaphragmatic muscles. This limits their ability to take deep breaths and increases the risk of postoperative pulmonary complications. Surgery on the limbs, lower abdomen or body surface surgery has less effect.
- A laparotomy may remove fluid or masses that cause diaphragmatic splinting and respiratory difficulty. However, gas (especially nitrous oxide) and fluid may accumulate within the bowel and peritoneal cavity exacerbating post-operative distension and splinting.
- Surgery lasting more than 3 hours is associated with a higher risk of pulmonary complications.
- Postoperatively, return of lung function to normal may take one to two weeks.

PREOPERATIVE PREPARATION

General assessment

This involves history, examination and investigation.

History. Ask about symptoms of wheeze, cough, sputum production, haemoptysis, chest pain, exercise tolerance, orthopnoea and paroxysmal nocturnal dypsnoea. The diagnosis of chronic chest complaints such as asthma or bronchiectasis is often known. Present medication and allergies are noted, and a history of smoking sought. Previous anaesthetic records may be available and can help in planning care.

Examination. Inspect for cyanosis, dyspnoea, respiratory rate, asymmetry of chest wall movement, scars, cough and sputum colour. Percussion and auscultation of chest may suggest areas of collapse and consolidation, pleural effusions, pulmonary oedema or infection. Cor pulmonale may be evident as peripheral oedema and raised jugular venous pressure. A bounding pulse and hand flap may indicate carbon dioxide retention, and enlarged lymph nodes in the neck may suggest lung cancer.

Investigations. Leucocytosis may indicate active infection, and polycythaemia chronic hypoxaemia. Arterial blood gases should be performed in patients who are dyspnoeic with minimal exertion and the results interpreted in relation to the inspired oxygen concentration. Preoperative hypoxia or carbon dioxide retention indicates the possibility of postoperative respiratory failure which may require a period of assisted ventilation on the Intensive Care Unit.

Pulmonary function tests, if available, provide baseline pre-operative measurements. The chest clinic will have charts to compare these results against those predicted for the patients age, sex and weight. The results are also compared against the patient's previous records to assess current disease control.

- FEV1.0 (Forced Expiratory Volume in 1 second) and FVC (Forced Vital Capacity) are commonly measured. A reduction in the FEV1.0:FVC ratio indicates obstructive airways disease. (The normal is 0.75 (75%) or more). A reduction in FVC occurs in restrictive lung disease.
- An FEV1.0 or FVC less than 70% of predicted, or an FEV1.0:FVC ratio less than 65%, is associated with an increased risk of pulmonary complications.

Chest X-rays may confirm effusions, collapse and consolidation, active infection, pulmonary oedema, or the hyperinflated lung fields of emphysema.

An electrocardiogram may indicate P-pulmonale, a right ventricular strain pattern (dominant R waves in the septal leads) or right bundle branch block.

Pre-medication

In patients with poor respiratory function premedication (if used) must not cause respiratory depression. Opiates and benzodiazepines can both do this, and are best avoided if possible, or used with caution. Humidified oxygen may be administered *(see Oxygen therapy section).*

Anticholinergic drugs (e.g. atropine) may dry airway secretions and may be helpful before ketamine or ether.

Specific Respiratory Problems

Coryza (common cold)

Most patients with minor upper respiratory infections but without fewer or productive cough can have elective surgery. However, patients with underlying respiratory disease or those having major abdominal or thoracic surgery should be postponed.

Respiratory tract infections

Patients with fever and productive cough should be treated before undergoing elective surgery as there is an increased risk of postoperative pulmonary complications. When these patients present for emergency surgery a course of antibiotics should be administered.

Asthma

Asthma causes hyper-responsive airways with oedema, inflammation and narrowing due to smooth muscle spasm. It is characteristically reversible, unlike chronic obstructive pulmonary disease. Elective cases should not be undertaken unless asthma is well controlled, and the anaesthetist will need to be informed of poorly controlled and severe asthmatics in advance. A consultation with a respiratory physician may be useful. In poorly controlled asthma a short course of steroids is often effective in improving control of the disease. Patients on preoperative steroids will need extra perioperative supplementation if they are taking more than the equivalent of 10mg of prednisolone a day.

Preoperative assessment

- The disease is assessed by the frequency and severity of attacks, including hospital and intensive care admissions, and by drug history. The patient will be able to say how good (or bad) their asthma is. Examination may reveal expiratory wheezes, use of accessory muscles or an over-distended chest. Peak expiratory flow rates (PEFR) pre- and post-bronchodilator should be measured, although trends in PEFR are more useful (the patient may have their own PEFR records). Baseline spirometry, (FEV1.0 and FEV1.0:FVC ratio) is also helpful.
- Blood gas analysis is usually reserved for severe disease (breathlessness on minimal exertion).
- Before surgery, patients should be free of wheeze, with a PEFR greater than 80% of the predicted or personal best value. Severe asthmatics may require their inhalers being changed to nebulisers. Similarly inhaled steroid dose may have to be increased or oral steroids commenced (Prednisolone 20-40mg daily) one week prior to surgery - consult a respiratory physician early.

Perioperative management

- Consider converting inhaled beta 2 agonists such as salbutamol to the nebulised form. Give nebulised salbutamol (2.5-5.0mg) with premedication.
- Avoid aspirin or NSAIDs and any other allergens known to the patient. If applicable local or regional anaesthesia used alone will avoid the problems of general anaesthesia. However, if general anaesthesia is required, the addition of regional techniques can reduce operative volatile anaesthetic and post operative opioid requirements and the likelihood of respiratory complications.
- Ketamine and all the volatile agents are bronchodilators. Airway manipulation should be kept to a minimum and take place only under adequate anaesthesia.
- Controlled ventilation with the use of neuromuscular blocking drugs will be needed for major or long procedures. In cases with severe airways obstruction the ventilator rate may have to be sufficiently low to allow the slow expiration of asthma. Atracurium and tubocurare should be avoided as they release histamine. This is also true of morphine - pethidine is often preferred in patients who are wheezy on presentation.
- Residual neuromuscular blockade must be fully reversed, and extubation can occur when

spontaneous ventilation is resumed and oxygenation is adequate.

Postoperative care

- Adequate analgesia is vital.
- Humidified oxygen is continued for up to 72 hours following major abdominal or thoracic surgery *(see Oxygen therapy section)*, together with regular physiotherapy until the patient regains mobility.
- Maintenance of hydration with intravenous fluids is required until oral intake is sufficient.
- Usual anti-asthmatic medications are resumed immediately. This may require intravenous steroids to temporarily replace oral *(see Steroid supplementation section)* and nebulised bronchodilators to replace inhalers if the patient cannot take a deep breath, or pulmonary function has deteriorated after surgery.
- Failure to ensure adequate postoperative oxygenation and ventilation may require admission to an intensive care area for a period of assisted ventilation.

Chronic obstructive pulmonary disease (COPD)

The main problems are airflow obstruction (usually irreversible), mucus hypersecretion and repeated infections. The ASA grade correlates with the risk of postoperative pulmonary problems.

If reversibility is demonstrated by spirometry (i.e. an increase in FEV1.0:FVC ratio after bronchodilator), it is treated as for asthma. A trial of a week's course of systemic steroids (Prednisolone 20-40mg daily) is used if nebulisers fail to treat wheeze. Antibiotics are only used if a change in sputum colour suggests active infection. Right and left ventricular failure is treated with diuretics. Physiotherapy will clear chest secretions and the patient is encouraged to stop smoking.

Preoperative arterial blood gas estimation is required in the patient who has difficulty climbing one flight of stairs, or who has cor pulmonale. Postoperatively, these patients may need ventilating for 1-2 days on an intensive care unit following thoracic or high abdominal surgery. The best predictor of the need for postoperative ventilation is the arterial PaO_2, and whether the patient is dyspnoeic at rest.

Otherwise, perioperative considerations are the same as for asthma, except that the chances of post-operative pneumonia (pyrexia, purulent sputum) are high and will require early treatment with amoxycillin, trimethoprim or clarithromycin.

Postoperatively, care is required with oxygen supplementation as some COPD patients rely on relative hypoxia for respiratory drive. *(see Oxygen therapy section).*

Restrictive pulmonary disease

Restrictive disease is either intrinsic, such as pulmonary fibrosis related to rheumatoid arthritis or asbestosis, or extrinsic, such as caused by kyphoscoliosis or obesity. Oxygenation may be impaired at the alveolar level and because of poor air supply to it. Steroids are the usual treatment for fibrotic disease.

Intrinsic Disease

- The anaesthetist should be alerted early. Preoperatively obtain spirometry, arterial blood gases, lung volume and gas transfer measurements, if not done in the previous 8 weeks. A reduced PaO_2 indicates severe disease. The chest physician may suggest an increase in steroid dose.
- Steroid supplementation will be required over the operative period *(see Steroid supplementation section).*
- Postoperatively, supplemental oxygen is given to keep SpO_2>92%, and respiratory infection is treated early.

Extrinsic Disease

- The restrictive deficit here leads to rapid, shallow breathing, often relying on diaphragmatic movement to be effective. This poses problems for breathing and sputum clearance postoperatively, especially following thoracic or upper abdominal incisions.
- Blood gases remain normal until disease is severe and $PaCO_2$ rises.
- Postoperatively, vigorous physiotherapy and adequate analgesia are vital. The patient may require ICU or HDU care if postoperative hypoxia, fatigue or carbon dioxide narcosis occur.

Bronchiectasis and Cystic Fibrosis

Prior to surgery therapy is maximised using a course of intravenous antibiotics, physiotherapy, nebulised bronchodilators and an extra 5-10mg/day of oral prednisolone, if taking long term steroids. This involves discussion with the patient's chest physician. Elective surgery is postponed if respiratory symptoms are present.

Postoperatively continue intravenous antibiotics and regular physiotherapy until discharge. The chest physician should be involved in any respiratory problems, and adequate nutrition is resumed as early as possible.

Tuberculosis

The patient with active pulmonary tuberculosis may be wasted, febrile and dehydrated. Production of sputum and haemoptysis may cause segmental lung collapse and blockage of the endotracheal tube. Humidification of anaesthetic breathing systems is therefore important, and inspired oxygen concentration will have to be increased. Appropriate intravenous fluids are given to rehydrate the patient. *Anaesthetic equipment must be sterilised after use* to prevent cross infection of tuberculosis to other patients.

ANAESTHESIA - TECHNIQUES

Perioperatively, continuous clinical observation of the patient is combined with monitoring appropriate to the case being undertaken. Hence, the patient's colour and respiratory rate and pattern is observed, and the pulse volume and rate palpated (during anaesthesia it may be easier to palpate the facial, superficial temporal or carotid artery). Monitoring involves pulse oximetry, electrocardiogram, non-invasive blood pressure recordings and, if available, end-tidal carbon dioxide measurement.

A preoperative pulse oximeter measurement of peripheral oxygen saturation *in air* is useful, and the perioperative inspired oxygen concentration must be sufficient to maintain this. Those patients at greatest risk of perioperative pulmonary complications will benefit from regular blood gas analysis using an indwelling arterial catheter.

The technique of anaesthesia chosen is the one considered to carry the lowest risk of perioperative pulmonary complications. The following points should be considered:

- **Regional anaesthesia** will avoid the pulmonary complications of general anaesthesia, but its use is limited by the duration of local anaesthetic activity, and to certain areas of the body, i.e. face, eyes and limbs.
- **Spinal/Epidural anaesthesia.** High spinal and epidural techniques impair intercostal muscle function and result in a decrease in FRC and an increased risk of perioperative basal atelectasis and hypoxia. There is no clear evidence that these techniques result in fewer respiratory complications than after general anaesthesia, although avoiding tracheal intubation may decrease the risk of postoperative bronchospasm.
- Low spinal and epidural techniques can be used for surgery below the umbilicus and on lower limbs without pulmonary impairment. However, under general anaesthesia, this kind of surgery has a low risk of pulmonary complications. As such there is little to choose between these two techniques. When planning to use spinal or epidural anaesthesia ensure that the patient will be able to lie flat for an extended period.
- **Ketamine anaesthesia** maintains some of the airway and cough reflex. Ventilation is not depressed, but there is an increase in salivation such that atropine premedication is required. Without muscular relaxation and endotracheal intubation, the airway remains vulnerable to aspiration of vomited or regurgitated gastric contents. Ketamine as the sole anaesthetic agent is therefore not used in the patient with a full stomach, and is most commonly used for surgery of the face, limbs or perineum, where muscular relaxation is not required.
- **Controlled ventilation.** Endotracheal intubation using muscle relaxants and controlled ventilation will be necessary during head, neck and ear, nose and throat surgery. Here the airway must be secured at the beginning of surgery as access to it will be difficult when surgery has commenced. Also, the trachea is at risk of soiling from blood. Similarly, during thoracic or abdominal surgery muscle relaxation will be required to enable controlled ventilation, and endotracheal intubation will protect against tracheal aspiration of gut contents. When patients require surgery in the prone position airway access will be difficult, and endotracheal intubation and controlled ventilation will be required.
- **Spontaneous ventilation** employing a facemask avoids airway instrumentation, although leaves the airway unprotected. If available, the laryngeal mask does not stimulate the larynx, but does offer some protection for the trachea. This technique is only used for minor surgery of the limbs or body surface of short duration (less than 2 hours), when the patient can breath comfortably in the supine position or on their side. Prolongation of spontaneous ventilation anaesthesia may lead to respiratory depression and delayed recovery.

POSTOPERATIVE CARE

The patient with underlying respiratory disease is at increased risk of postoperative pulmonary complications. This is particularly so in smokers, or after upper abdominal or thoracic surgery. The airway is vulnerable for up to 24 hours, and hypoventilation can occur for up to 3 days.

In the recovery room, the airway is kept patent, and adequate ventilation and oxygenation ensured before discharge to the ward. All neuromuscular paralysis must be reversed. If there are problems the patient will need to go to the HDU or ICU. Otherwise, the patient is kept warm and well hydrated, and fluid balance charts commenced.

Oxygen therapy

- Following minor surgery hypoxia may occur for the first hour or two after surgery. Oxygen should therefore administered until the patient is fully awake and recovered from the anaesthetic.
- After major surgery hypoxia can occur for up to for 3 days, particularly at night. This tendency is worse in patients who are receiving opioids by any route. This can put the patient with chest disease or ischaemic heart disease, at risk. Oxygen (2-4L/min by nasal cannulae) should be given over this period to those at risk.
- Some patients with very severe COPD depend on hypoxia to maintain ventilatory drive. It is difficult to diagnose but all affected patients will have had severe COPD for many years. This situation is very unusual, particularly in the developing world and hypoxia should always be treated immediately. If a patient like this presents, the inspired oxygen concentration shold be monitored and repeat arterial blood gas estimations carried out to guide the level of oxygen treatment tolerated by the patient (*see Acute Oxygen Treatment*).

Pain Relief

Effective analgesia reduces the incidence of postoperative respiratory complications. Opioids may be required for 48-72 hours after major surgery.

- Intravenous opioid boluses can be titrated against pain in the recovery room, whilst observing for respiratory depression. This can be used as a guide to the dose of intramuscular opioid that may be given in relative safety on the ward. Continuous infusions of intravenous opioids demand very close supervision, as the risk of respiratory depression is significant.
- The combination of opioids with rectal or oral drugs, such as paracetamol or non-steroidal anti-inflammatory agents (NSAIDs), gives particularly good analgesia whilst reducing opioid side effects.
- If available, patient controlled analgesia (PCA) systems allow the patient to titrate opioid requirements to their pain. They give good quality analgesia and a fixed lockout period should prevent respiratory depression.

Epidural analgesia

The use of postoperative thoracic epidural analgesia for abdominal and thoracic surgical procedures results in good quality analgesia, with few respiratory complications. However, there is no clear evidence to demonstrate its superiority over other analgesic techniques, and it is not available everywhere.

The combination of low concentrations of local anaesthetic with low doses of opioids in an epidural infusion results in the best analgesia for the fewest side effects (i.e. opioid induced respiratory depression and local anaesthetic toxicity). For example give 50ml of 0.167% bupivacaine containing 5mg diamorphine given as an epidural infusion at a rate of 0-8ml/hr.

Whilst postoperative opioid analgesia is administered the patient must be observed in an area with sufficient medical and nursing skills, and staffing levels. Complications that may arise are then noted promptly and the appropriate help called. Regular observations are made of blood pressure, pulse, oxygenation (using a pulse oximeter), respiratory rate, conscious level and analgesia. Protocols may be used to guide nursing staff in the administration of analgesia, the observations required and when to call for help.

Physiotherapy

Teaching patients in the preoperative period to participate with techniques to mobilise secretions and increase lung volumes in the postoperative period, will reduce pulmonary complications. Methods employed are coughing, deep breathing, early mobilisation, and chest percussion and vibration together with postural drainage.

Steroid supplementation

The brittle asthmatic or severe COPD patient may benefit from a course of prednisolone (20-40mg daily) during the week before surgery. Seek the advice of the patient's chest physician.

Patients who have received a course of steroids in the 6 months before surgery, or who are on maintenance

therapy of greater than 10mg of prednisolone a day, are presumed to have adreno-cortical suppression. Perioperative steroid supplementation will be required.

- Intravenous hydrocortisone 100mg 8 hourly is given starting with the premedication. Over the next 5 days this is tapered to their normal daily dose, where 100mg intravenous hydrocortisone is equivalent to 25mg oral prednisolone.
- Intravenous steroids must replace oral whilst these cannot be taken.

Prophylaxis of venous thromboembolism

Prophylactic measures should begin before surgery in those at risk and continued until early mobilisation reduces the risk of postoperative deep vein thrombosis and pulmonary embolism. Regular subcutaneous heparin and anti-embolism stockings are commonly used.

Nutrition

Patients with severe respiratory disease are often malnourished and weak. This is associated with increased risk of postoperative infection, an increase in length of hospital stay and increased mortality. Therefore, early resumption of normal oral intake of food is important. If this is delayed postoperatively (more than 5 days) enteral feeding will be required.

POSTOPERATIVE RESPIRATORY PROBLEMS

Breathlessness usually indicates respiratory difficulty and hypoxia, but can be due to pain, anxiety, sepsis, acidosis and anaemia due to bleeding. Initial treatment is to ensure a patent airway and give a high percentage of humidified oxygen by facemask. This is guided by pulse oximetry to maintain a peripheral saturation adequate for the patient (usually > 92%). The cause is then sought by history, examination and chest X-ray, and treated.

Stridor

The postoperative airway may be compromised because of the residual effects of anaesthesia (in particular opioid or midazolam sedation), by vomit, or by surgical complications. After thyroid/parathyroid surgery recurrent laryngeal nerve palsy may cause vocal cord palsy, and cervical haematoma cause airway compression. The airway must be re-established using standard techniques. Laryngeal surgery may cause airway oedema. This may respond to nebulised adrenaline 2.5-5mg and intravenous dexamethasone 4-8mg.

Atelectasis and pneumonia

Wound splinting, pain, dehydration, and immobility lead to collapse and atelectasis of basal lung segments in the hours after surgery, which will be clearly seen on chest X-ray. A poor cough may lead to retention of secretions. The mainstays of treatment are good analgesia, humidified oxygen, careful fluid balance, physiotherapy and early mobilisation. Suctioning through a minitracheostomy can remove secretions.

Infection and pneumonia may intervene. The patient usually becomes febrile with purulent sputum (often not coughed up effectively) and a neutrophil leucocytosis. Consolidation is seen on the chest X-ray. (Widespread bronchopneumonia is much more common than lobar pneumonia).

Supplemental oxygen is given by facemask to maintain adequate peripheral saturations. Sputum and venous blood specimens are sent for microscopy, culture and sensitivity testing. Regular physiotherapy is required, and supplemental intravenous fluids to replace losses due to fever. Appropriate antibiotic therapy will depend on microbiological results and local prevalences of organisms, but cefotaxime or cefuroxime, and gentamicin are often used.

Bronchospasm

This may be a due to an exacerbation of pre-existing asthma, perioperative pulmonary aspiration of blood or vomit, or a reaction to a drug. Pulmonary oedema or pulmonary embolus may mimic bronchospasm, and if suspected are treated *(see below).*

The patient will be dyspnoeic, tachypnoeic and using their accessory muscles. Speaking is difficult, and an expiratory wheeze is audible on auscultation. A quiet chest is ominous as it may represent very little airflow taking place. A chest X-ray is useful to exclude pneumothorax, but may show collapsed areas following pulmonary aspiration. Arterial blood gas hypercarbia indicates fatigue, and imminent respiratory collapse.

Treatment is high flow oxygen by mask, nebulised salbutamol 2.5-5mg (initially every 15 minutes, unless severe tachycardia occurs), nebulised ipratropium bromide (Atrovent) 250-500mcg 6 hourly, and intravenous hydrocortisone 200mg. For patients *not* usually taking oral theophyllines, consider addition of intravenous aminophylline (5mg/kg over 15 minutes, followed by an infusion at 0.5mg/kg/hr). Nebulised adrenaline 2.5mg may be used when salbutamol is not

available. Intramuscular adrenaline 0.5mg may be used with extremely severe bronchospasm, and may be repeated. Respiratory failure can occur rapidly, so equipment for sedation, re-intubation and assisted mechanical ventilation should be prepared. This will enable tracheal suction if aspiration is suspected.

Pulmonary oedema

Intraoperative fluid overload, ARDS and failure of the left ventricle (typically in patients with ischaemic heart disease), may all result in pulmonary oedema. ARDS is discussed below.

The patient is dyspneoic, cyanosed, clammy, sweaty and tachycardic. Pink frothy sputum indicates severe pulmonary oedema. The jugular venous pressure is raised and there are coarse bibasal inspiratory crepitations on auscultation, or a "cardiac" wheeze. Chest X-ray shows bilateral, midzone, fluffy infiltrates and upper lobe blood diversion. The patient is sat up, and intravenous fluids stopped. Give high flow oxygen by facemask, intravenous diuretics (e.g. frusemide 50mg – consider a urinary catheter), and, if systolic blood pressure > 90mmHg, 2 puffs of sublingual GTN (glyceryl trinitrate). Intravenous diamorphine 2.5-5mg (or 5 –10mg of morphine) can also reduce preload, but observe for sedative side effects. If the above fail, application of CPAP (Continuous Positive Airways Pressure) 5-10cm H_2O, by tight fitting facemask, is often helpful. An ECG may show signs of perioperative myocardial ischaemia, and a new murmur may indicate acute cardiac valvular dysfunction.

Pneumothorax

This may occur as a complication of surgery, central line placement or follow positive pressure ventilation in a patient with asthma or COPD. The patient will be breathless and often complains of pain over the affected lung. There is diminished air entry and hyper-resonance on percussion, and if severe, tracheal deviation away from the pneumothorax, raised jugular venous pressure and cardiovascular collapse; these are signs of tension pneumothorax and require immediate life-saving treatment.

In stable patients the chest X-ray will confirm the diagnosis. There is no time to do this if tension pneumothorax is suspected. Immediate insertion of a large 14-guage intravenous cannula into the pleural cavity at the second intercostal space, mid-clavicular line will be followed by a whoosh of air as the pneumothorax is decompressed.

Small pneumothoraces (<20% of the lung field), without patient compromise, may be observed until resolution. Larger pneumothoraces will require placement of an intercostal chest drain attached to an under water seal.

Pulmonary embolus

This is rare in the recovery room. Embolus can be due to thrombus, air, fat or tumour. Massive embolus will result in cardiorespiratory arrest. A small embolus results in dyspnoea, pleuritic chest pain, haemoptysis and tachycardia. There may be signs of DVT (Deep Vein Thrombosis), and a pleural rub. Arterial blood gases typically show hypoxia, and hypocarbia of hyperventilation. A chest X-ray is more helpful in excluding other diagnoses (e.g. pneumothorax), but may show a wedge shaped pulmonary infarct. The commonest ECG finding is a sinus tachycardia, but right ventricular stain or an S1-Q3-T3 pattern (S wave in lead 1, Q wave in lead 3, and T wave in lead 3) may be seen.

Treatment is 100% humidified oxygen by facemask, and analgesia with intravenous morphine (5-10mg). Consideration is given to anticoagulation with intravenous heparin. This involves discussion with the surgical team as it may be contraindicated postoperatively. An alternative, to prevent recurrence of pulmonary embolus, is an inferior vena caval filter. If a V/Q (Ventilation/Perfusion) scan is available this will confirm the diagnosis.

ARDS (Acute Respiratory Distress Syndrome)

ARDS develops after a variety of major insults including shock, sepsis, pancreatitis, massive blood transfusion and multitrauma. Oxygenation is poor (and not the result of cardiac failure) and the X-ray shows widespread pulmonary infiltrates of alveolar oedema. Onset is generally within 24 hours of the insult. The patient may require mechanical ventilation on the ICU, with application of PEEP (Positive End Expiratory Pressure) and high inspired oxygen concentrations. Steroids are not useful in the early stages.

Further Reading

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