Managing hypoxia and hypercapnia

The main objective when treating hypoxia (a deficiency of oxygen in the tissues) and hypercapnia (a high concentration of carbon dioxide in the blood) is to give sufficient oxygen to ensure that the patient is safe and his or her condition does not deteriorate. However, while giving too little oxygen can result in hypoxia, which can result in death, excessive oxygen therapy can also be dangerous for some patients.

Many patients with chronic obstructive pulmonary disease (COPD) require controlled oxygen therapy because there is a risk that they will retain carbon dioxide and as a consequence develop respiratory acidosis which can be fatal. It is important to be aware that not all patients with COPD need a low concentration of oxygen, and oxygen concentrations of 24 per cent to 28 per cent are not always sufficient (Agusti et al, 1999).

**Respiratory failure** Respiratory failure is defined as having an arterial partial pressure of oxygen (PaO2) of less than 8 kilopascals (kPa) or arterial partial pressure of carbon dioxide (PaCO2) of greater than 6.7kPa. There are two classifications: type one or hypocapnic respiratory failure is defined by a PaO2 of less than 8kPa with normal or low PaCO2, and type two or hypercapnic respiratory failure is defined by a PaCO2 that is greater than 6.7kPa regardless of the PaO2.

**Type one respiratory failure** This is usually caused by a ventilation-perfusion mismatch. Although blood perfuses alveoli and is available for gaseous exchange, some of these alveoli are not being ventilated with air. There are a number of causes including asthma, pulmonary embolism, pneumonia, pulmonary fibrosis, adult respiratory distress syndrome and pneumothorax.

Treatment will depend on the initial cause, but a prime concern is the correction of hypoxaemia (a reduction of the oxygen concentration in the arterial blood). Patients should be treated with a high concentration of oxygen to establish a PaO2 of above 8kPa. Once this is achieved patients can be monitored with a pulse oximeter to ensure oxygen saturation is maintained above 92 per cent, as tissue hypoxia will not occur at this level.

**Type two respiratory failure** This is usually caused by alveolar hypoventilation, for example, a patient with an exacerbation of COPD may not be able to ventilate alveoli sufficiently to remove carbon dioxide due to obstructed airways and exhaustion. The causes of type two respiratory failure include neuromuscular disorders, opiate overdose, severe pneumonia, severe asthma, and sleep disordered breathing.

The treatment of type two respiratory failure depends on the cause. Patients who do not have COPD would not normally retain carbon dioxide, and may have developed type two respiratory failure because they are tired, exhausted or drowsy. The treatment in these cases is a high concentration of oxygen despite a high carbon dioxide level. Anaesthetic opinion should be sought to discuss the possibility of assisted ventilation.

**Management of COPD** A proportion of patients with COPD chronically retain carbon dioxide, and are hypoxic. In these cases the administration of too much oxygen can result in the patient retaining even more carbon dioxide. In all cases of hypoxia, oxygen saturation should be kept above 90 per cent, but for patients with COPD, oxygen saturation should not exceed 93 per cent as this increases the risk of hypercapnia and respiratory acidosis.

The percentage of administered oxygen required to achieve this is contentious, but it should be remembered that response to oxygen therapy is variable so it cannot be assumed that a given percentage of oxygen will have a specific effect on every patient (Murphy et al, 2001). This means that the common practice of administering an oxygen concentration of 24–28 per cent to patients with COPD may result in many patients remaining dangerously hypoxic. The correct approach is to give sufficient oxygen to ensure that an acceptable PaO2 or saturation is maintained, and this may mean giving a higher percentage than 28 per cent. The North West Oxygen Group (2001) guidelines suggest that COPD patients who are not in hospital, should commence oxygen therapy at a concentration of 40 per cent and titrate upwards if oxygen saturation falls below 90 per cent and downwards if the patient becomes drowsy or if the saturation exceeds 93–94 per cent. In hospital, oxygen therapy should be used to maintain an oxygen saturation of 90–92 per cent.

For some patients with COPD, maintaining a saturation of 90 per cent or a PaO2 of above 8kPa may result in a continued rise in carbon dioxide levels. In these cases, if blood pH drops below 7.35 or the patient becomes fatigued, non-invasive ventilation should be considered (BTS, 2002). For patients for whom mechanical ventilation is not considered appropriate, it...
is possible to lower the concentration of inspired oxygen further as this may prevent a further drop in pH. Maintaining a PaO₂ of 6.7kPa or above will prevent death from hypoxia in an emergency (Murphy et al, 2001).

Management in acute wards In the emergency or acute ward situation, if the patient is initially acidic or hypercapnic, blood gases should be repeated within 60 minutes. If inspired oxygen maintains or improves the PaO₂, without causing deterioration in pH the concentration of inspired oxygen can be increased and arterial blood gases checked until the PaO₂ is greater than 7.5kPa. Arterial blood gases should be repeated if the clinical situation deteriorates.

Oxygen delivery devices There is a variety of oxygen delivery systems:

- Nasal cannula provide low concentration oxygen between 24 and 35 per cent, but may deliver 40 per cent in some people. They are inexpensive, safe, and allow the patient to eat and drink. However, inspired oxygen concentrations vary from patient to patient, especially if the patient breathes through the mouth. They may cause drying of the mucous membrane and give the patient a sore nose. Cannula should not be used in emergency or trauma cases, but can be used to continue oxygen therapy during the administration of nebulised drugs with an air-driven device;

- High concentration or non-rebreathing masks can be used to deliver oxygen at concentrations between 60 and 90 per cent. They are effective in emergencies such as trauma, and for short-term treatment. They can be uncomfortable and claustrophobic, and may interfere with eating and communication;

- High flow devices (Venturi masks) can deliver a constant oxygen concentration irrespective of the patient’s breathing pattern. High flow devices can provide a number of different concentrations of oxygen ranging from 24 to 60 per cent. Airflow though the mask can also be increased in order to reduce the patient’s sensation of dyspnoea, but care should be taken to follow the instructions given with the device.

Prolonged administration of oxygen Exposure to high concentrations of oxygen over a prolonged period of time can result in life threatening oxygen toxicity. Exposure to 100 per cent oxygen should be limited to fewer than 24 hours whenever possible and reduced to 70 per cent within two days and 50 per cent in fewer than five days. Adults can breathe up to 50 per cent oxygen for prolonged periods without major lung damage (Scanlan et al, 1999).

The new British Thoracic Society/Scottish Intercollegiate Guidelines Network British Guideline on the Management of Asthma was published in February 2003 (see p44). Copies of the guidelines and the quick reference guide will be sent to all chest clinics, A&E departments and GP practices and are available on the BTS website: www.brit-thorax.org.uk along with educational material including posters and case studies. Copies of the quick reference guide are free from: bts@linneydirect.com. The guidelines can be purchased from British Medical Journal subscriptions on 0207 387 4499 priced £20.

A bulletin, Inhaler Devices for the Management of Asthma and COPD published by the NHS Centre for Reviews and Dissemination summarises the research evidence on the effectiveness of inhaler devices. The bulletin will be distributed to key NHS staff. To purchase a copy, contact the subscriptions department of the Royal Society of Medicine Press, PO Box 9002, London W1A 0ZA priced £10.

The Nursing Times Awards 2003 welcomes entries from nurses who specialise in the care of patients with respiratory disease. Award categories include: original research, cancer nursing, innovation in working with patients from different ethnic groups and innovation in your specialty. Scholarships will also be awarded.

For more information call Polly Read-Fleming on 020 7874 0542 and request an entry pack. Look out for more information on www.nursingtimes.net

This nursing exhibition will take place at the Windsor Hall, G-MEX Centre on 26–27 March. Seminars include: Recognising and Preventing Impending Cardiac Arrest, 11am and 4pm, 26 March and 10am and 1pm on 27 March. Resuscitation: skills update is at 11am and 2pm, 26 March. Entry is free, simply turn up and register or to register in advance visit www.nursingtimescareers.co.uk

The British Lung Foundation is staging Lung Marches throughout the UK on 14 and 15 June 2003 as part of its lung health awareness week. The aim of the marches is to make lung disease more visible. Petitions will be presented to local MPs, requesting effective lung health care services. For information about the Lung March organised in your area and to obtain a copy of the petition, contact Jo Bloom on 020 7831 5831.