Abstract

Nurses have an important role in early identification of factors that can compromise oxygen delivery to the lungs and tissues in the body, and in ensuring that patients who may require supplemental oxygen therapy are assessed and managed safely and competently. This article provides an overview of the anatomy and physiology in relation to oxygen delivery to the lungs and tissues in the body, and outlines the common indications and contraindications for supplemental oxygen therapy. It also discusses the approaches that nurses can adopt to assess a patient’s clinical need for supplemental oxygen therapy, as well as the safety considerations required.

Aims and intended learning outcomes

This article aims to provide information regarding the safe and effective use of supplemental oxygen therapy. After reading this article and completing the time out activities you should be able to:

> Describe the anatomy and physiology in relation to oxygen delivery to the lungs and tissues in the body.
> Identify the common indications and contraindications for supplemental oxygen therapy.
> Discuss the monitoring of oxygen saturations and the factors that can affect pulse oximetry readings.
> Outline a systematic approach to patient assessment to establish a clinical need for supplemental oxygen therapy.
> Understand the safety considerations for supplemental oxygen therapy.

This article should be read alongside local policies and procedures and any national guidelines, such as those from the British Thoracic Society (O’Driscoll et al 2017) or the Thoracic Society of Australia and New Zealand (Beasley et al 2015). Since supplemental oxygen is a medicine and a medical gas, nurses involved in its use must be trained in its administration.

Introduction

Oxygen is essential for life. Efficient oxygen delivery to the lungs and tissues in the body is essential in health and in patients who are acutely unwell. These patients have an increased rate of metabolic activity or stress, and the body will attempt to manage the crisis and maintain homeostasis. This leads to an increase in the amount of oxygen required for aerobic metabolism (the process by which food substances such as fats and carbohydrates are broken down in the presence of oxygen to produce energy) and tissue survival (Margeson and Withey 2012). Oxygen delivery depends on adequate ventilation and gas exchange, and effective circulatory distribution. Without oxygen, cells die, and the body systems they support fail (Woodrow 2016). Oxygen reserve
in the tissues and lungs is minimal. Without sufficient oxygen delivery, tissue hypoxia may occur within four minutes (Ward et al 2015). However, tolerance to hypoxia differs in health and disease and organs and cells also vary significantly in their sensitivity to hypoxia (Leach and Treacher 2002). Box 1 provides definitions of terms related to oxygenation and respiratory failure, and Box 2 outlines common indications for supplemental oxygen therapy. Supplemental oxygen therapy is recommended for all patients who are acutely hypoxaemic and for many patients who are at risk of hypoxaemia. While considered a life-saving intervention, as a medical treatment, initial and ongoing assessment and evaluation is vital to ensure its use is safe and effective, because oxygen therapy can be detrimental to a patient’s health (Olive 2016). Furthermore, practice gaps exist among some nurses, such as lack of knowledge of correct oxygen prescribing or of oxygen delivery devices, which may lead to patients being harmed unintentionally (Cousins et al 2016). However, while oxygen is a treatment for hypoxia, it has no therapeutic value to a person with shortness of breath who has adequate levels of oxygen (Beasley et al 2015, O’Driscoll et al 2017). Supplemental oxygen therapy also does not treat the underlying causes of hypoxaemia. Nurses have a responsibility to ensure that oxygenation is optimised at pulmonary and cellular level as part of their duty of care to patients. This requires knowledge of respiratory and cardiac physiology, as well as selection of the appropriate equipment and delivery method for supplemental oxygen therapy. Ongoing assessment and evaluation of patients is required to ensure that the treatment is safe and effective, preventing further deterioration and a medical emergency. Box 3 lists the signs of deteriorating respiratory function.

Failure to administer oxygen appropriately can result in serious harm to the patient (Ridler et al 2014, O’Driscoll et al 2017). Box 4 shows the clinical hazards and risks associated with supplemental oxygen therapy and hyperoxaemia. Excessive oxygen administration in some patients who are at risk of hypercapnia, for example those with chronic obstructive pulmonary disease (COPD), morbid obesity or cystic fibrosis, may result in respiratory failure and possibly death (Austin et al 2010, Bourke and Burns 2015, Cousins et al 2016).

Supplemental oxygen therapy can be either transient or ongoing. Initial and ongoing assessment is essential to determine the length of time the oxygen therapy is required. Temporary therapy is usually used to prevent deterioration or death. Ongoing therapy may be used to maintain oxygenation, prevent relapse, or both (Cousins et al 2016). The length of time the patient needs oxygen therapy is determined by the underlying condition. In patients with acute respiratory failure (e.g. acute asthma, acute heart failure, upper respiratory tract infections), oxygen therapy is usually needed for a short period (Cousins et al 2016). In patients with chronic respiratory failure, oxygen therapy may be needed for longer periods (e.g. COPD). Patients should be assessed regularly to determine the need for ongoing oxygen therapy.

In patients who are not at risk of type II (hypercapnic) respiratory failure, the recommendations for target oxygen saturation ranges vary between professional bodies worldwide (Cousins et al 2016). For example, the British Thoracic Society (O’Driscoll et al 2017) guidelines recommend that oxygen should be prescribed to achieve a target oxygen saturation of 94-98% for most patients who are acutely unwell. However, in Australia and New Zealand the target oxygen saturation range is lower, at 92-96%. The rationale for this lower target is that it aims to reduce excessive use of high-concentration oxygen therapy, with the upper level of 96% aiming to avoid the risk of hyperoxia. The

**BOX I. Definitions of terms related to oxygenation and respiratory failure**

- **Hypoxaemia** – low partial pressure of oxygen in the blood (PaO2). Hypoxaemia can also be measured in relation to oxyhaemoglobin saturation or oxygen saturation within the arterial blood (SaO2). It occurs when PaO2 is ≤8kPa or SaO2 is ≤90%
- **Hypoxia** – occurs when oxygen supplies are insufficient to meet oxygen demands in a particular compartment, for example alveolar or tissue hypoxia. Supplemental oxygen therapy can only correct hypoxia resulting from hypoxaemia.
- **Hypercapnia** – occurs when partial pressure of carbon dioxide (PaCO2) is above the normal range of 4.6-6.1kPa. Patients with hypercapnia are considered to have type II respiratory failure, even if their oxygen saturation is within the normal range.
- **Type I respiratory failure** – hypoxia in the absence of hypercapnia
- **Type II respiratory failure** – hypoxia with hypercapnia
- **Hyperoxaemia** – high PaO2, in the blood, of ≥16kPa. The SaO2 will not change from 100%
- **Hyperoxia** – high oxygen content to the tissues and organs. The lungs is designed to manage concentrations of 21% of oxygen; when given in higher concentrations this may result in oxygen toxicity. A high concentration of oxygen can result in cellular injury through increased production of reactive oxygen species and free radicals, which can interfere with the function of intracellular macromolecules, resulting in cell death

(Adapted from O’Driscoll et al 2017)

**BOX 2. Common indications for supplemental oxygen therapy**

- **Critical illnesses requiring high levels of supplemental oxygen therapy**
  - Cardiac arrest or resuscitation
  - Shock
  - Sepsis
  - Major trauma
  - Major pulmonary haemorrhage
  - Major head injury
  - Drowning
  - Anaphylaxis
  - Carbon monoxide poisoning
- **Serious illnesses requiring moderate levels of supplemental oxygen therapy if the patient is hypoxaemic**
  - Acute hypoxaemia with the cause not yet diagnosed
  - Acute asthma
  - Pneumonia
  - Acute breathlessness as a result of lung cancer
  - Deterioration of lung fibrosis or other interstitial lung disease
  - Pneumothorax (collapsed lung)
  - Pleural effusions
  - Pulmonary embolism
  - Acute heart failure
  - Severe anaemia
  - Post-operative breathlessness

(Adapted from O’Driscoll et al 2017)

**TIME OUT 1**

Identify the common indications for supplemental oxygen therapy in patients you have cared for. What parameters were set to guide its use, such as target oxygen saturation ranges? If these vary between patients, can you consider why?

**Supplemental oxygen prescription and target oxygen saturation ranges**

It is recommended that supplemental oxygen is regarded as a prescription-only drug, which requires a prescription in all but emergency situations (Beasley et al 2015, Cousins et al 2016, Olive 2016, O’Driscoll et al 2017). A target oxygen saturation range should be included in the prescription, which aims to achieve a specified outcome, rather than specifying the oxygen delivery method alone.

In patients who are not at risk of type II (hypercapnic) respiratory failure, the recommendations for target oxygen saturation ranges vary between professional bodies worldwide (Cousins et al 2016). For example, the British Thoracic Society (O’Driscoll et al 2017) guidelines recommend that oxygen should be prescribed to achieve a target oxygen saturation of 94-98% for most patients who are acutely unwell. However, in Australia and New Zealand the target oxygen saturation range is lower, at 92-96%.
target range for those at risk of type II (hypercapnic) respiratory failure is 88-92% or should be patient-specific (Beasley et al 2015, O’Driscoll et al 2017).

It is recommended that the healthcare setting should have a standard oxygen prescription document or a specific oxygen section on the paper or electronic system (O’Driscoll et al 2017). The prescription should include the indication, mode of delivery, amount, and monitoring parameters, for example the target oxygen saturation range or arterial blood gas measurements, with the drug chart signed by the nurse accordingly. The prescription should stipulate the initial starting dose, including the delivery device and flow rate. If supplemental oxygen therapy is administered immediately without a prescription in an emergency, this intervention should be recorded afterwards in a similar way to the recording of all other emergency treatment (O’Driscoll et al 2017). Nurses must always adhere to the requirements in their clinical area.

In patients not at risk of type II (hypercapnic) respiratory failure with oxygen saturations of less than 85%, oxygen should be immediately initiated via a reservoir mask at 15 litres per minute (L/min) (Beasley et al 2015, O’Driscoll et al 2017). Arterial blood gas measurements, continuous monitoring of vital signs, including SpO₂, and prescription of the appropriate target oxygen saturation range, will be required once the patient has stabilised (Perkins et al 2015). When the patient has stabilised, the oxygen concentration can be adjusted downwards using a nasal cannula or simple face mask to maintain a target oxygen saturation of 94-98% (O’Driscoll et al 2017). In serious illness with hypoaxaemia but low risk of type II (hypercapnic) respiratory failure, oxygen therapy can be initiated via a nasal cannula at 2-6L/min or a simple face mask at 5-10L/min (Beasley et al 2015, O’Driscoll et al 2017). The patient must be monitored closely for signs of deterioration because they might require transfer to a critical care unit. The nurse should seek assistance from critical care specialists or other healthcare practitioners, where necessary.

### Anatomical and physiological aspects of respiration

It is important for nurses to have knowledge of the relevant anatomy, physiology and biochemistry of respiration and gas exchange, to enable them to understand the rationale and limitations of supplemental oxygen therapy. Respiration has four phases:

1. **Inspiration**
2. **Expiration**
3. **Pulmonary ventilation**
4. **Internal respiration**

#### Pulmonary ventilation

Pulmonary ventilation is the mechanism of breathing: inspiration

#### Internal respiration

Internal respiration involves the transport of gases.

### Key points

- Nurses have a responsibility to ensure that oxygenation is optimised at pulmonary and cellular level as part of their duty of care.
- Supplemental oxygen therapy is recommended for all patients who are acutely hypoxaemic and for many patients who are at risk of hypoaxaemia. While considered a life-saving intervention, as a medical treatment, initial and ongoing assessment and evaluation is vital to ensure its use is safe and effective.
- Excessive oxygen administration in some patients who are at risk of hypercapnia, for example those with chronic obstructive pulmonary disease, morbid obesity or cystic fibrosis, may result in respiratory failure and possibly death (Austin et al 2010, Bourke and Burns 2015, Cousins et al 2016).
- It is recommended that supplemental oxygen is regarded as a prescription-only drug, which requires a prescription in all but emergency situations (Beasley et al 2015, Cousins et al 2016, Olive 2016, O’Driscoll et al 2017). A target oxygen saturation range should be included in the prescription.

### BOX 3. Signs of deteriorating respiratory function

- Increased respiratory rate
- Decreased oxygen saturation
- Drowsiness
- Headache
- Facial flushing
- Tremor
- Elevated track-and-trigger system score, for example National Early Warning Score 2
- Increased need for supplemental oxygen therapy to maintain target oxygen saturation range
- Carbon dioxide retention, as indicated via arterial blood gas measurement
- Sweating
- Posture, for example if the patient is leaning forward and gasping for air
- Restlessness and confusion
- Distress
- Inability to speak in full sentences
- Use of accessory muscles for inspiration or expiration

(O’Driscoll et al 2017, Welch and Black 2017)

### BOX 4. Clinical hazards and risks associated with supplemental oxygen therapy and hyperoxaemia

**Clinical hazards associated with the practical aspects of supplemental oxygen therapy**

- Combustion and potentially dangerous when in contact with sources of ignition and flammable material
- Inability of healthcare practitioners to set flow correctly on oxygen cylinders
- Incorrect use of valve, for example if it is not opened correctly, causing failure to obtain or maintain oxygen flow
- Incorrect selection of cylinder, for example using the incorrect gas or cylinder size
- Unsafe storage, for example in areas which are not secure, inadequately ventilated or at risk of extremes of temperature

**Risks associated with supplemental oxygen therapy and hyperoxaemia**

- Loss of hypoxic drive
- Oxygen toxicity and alveolar damage
- Coronary and cerebral vasoconstriction
- Reduced cardiac output
- Delay in recognition of clinical deterioration
- Potentially harmful for patients with mild or moderate stroke
- Supplemental oxygen therapy can be harmful in some types of poisoning, for example paraquat (a type of pesticide) or acid aspiration
- Rebound hypoxaemia
- Worsening ventilation-perfusion (V/Q) mismatch

(Cousins et al 2016, O’Driscoll et al 2017)
Partial pressure gradients and gas exchange

Ventilation-perfusion coupling

Air flows in and out of the lungs as a result of pressure differences between the atmosphere and the gases inside the lungs (Bourke and Burns 2015, Credland 2017). The work of breathing is the amount of energy required to overcome airway resistance and lung compliance (the lung's ability to stretch and expand).

Airway resistance is caused by inelastic surfaces, as well as the narrowed diameter of the airways, which slow down the flow of gases. The tension of the alveoli also influences pressure, which prevents the expansion of the alveoli. Pulmonary surfactant reduces the surface tension so that the alveoli do not collapse during expiration.

Lung compliance is also important in gas flow. The more the lungs can stretch, the greater the potential volume of the lungs. The greater the volume of the lungs, the lower the air pressure within the lungs (Bourke and Burns 2015, Marieb and Hoehn 2015).

Any interference with these actions may impair normal ventilation and effective oxygenation. Pulmonary diseases are categorised as obstructive or restrictive, depending on how the underlying cause affects normal ventilation. Asthma, bronchitis and COPD are common conditions where airway resistance and lung compliance have to be overcome, increasing the work of breathing so much that one third or more of the total body energy is used for ventilation (Bourke and Burns 2015, Marieb and Hoehn 2015). Therefore, in addition to supplemental oxygen therapy, the patient’s underlying condition may also require treatment. For example, in acute asthma, where there is airway inflammation and smooth muscle contraction resulting in airway obstruction, the wall of the airway becomes thickened by oedema. In severe cases, this can lead to fibrosis of the wall and fixed narrowing of the airway (Bourke and Burns 2015). A bronchodilator and anti-inflammatory drugs may be required in addition to oxygen therapy in these cases, or some form of respiratory support. Sputum clearance techniques such as the active cycle of breathing technique or oscillating positive expiratory pressure therapy may also be required (Bourke and Burns 2015).

External respiration

External respiration is the exchange of oxygen and carbon dioxide between the alveoli and pulmonary capillary blood across the respiratory membrane. This is mainly influenced by (Marieb and Hoehn 2015, Tortora and Derrickson 2017):

- Partial pressure gradients and gas solubilities.
- Thickness and surface area of the respiratory membrane.
- Ventilation-perfusion coupling – matching alveolar ventilation with pulmonary blood perfusion.

In healthy lungs, the respiratory membrane is thin, allowing efficient gas exchange. An increase in the thickness of the alveolar-capillary membrane, for example resulting from pulmonary oedema or fibrosis, or a decrease in the surface area of the membrane, for example pneumonectomy, pulmonary embolus or emphysema, decreases the rate of diffusion of oxygen and carbon dioxide. Oxygen therapy may augment the rate of diffusion across the alveolar capillary membrane by increasing the concentration gradient (O’Driscoll et al 2017). Tumours, mucus or inflammation also reduce surface area by blocking gas flow into the alveoli (Stacy 2014, Marieb and Hoehn 2015) and therefore may also require treatment to correct or stabilise the underlying cause.

External respiration is increasingly effective when there is an adequate supply of oxygen and blood. The alveoli must be well-ventilated to ensure a sufficient supply of oxygen. Oxygen therapy is only effective when alveolar capillary units have some functional ventilation (O’Driscoll et al 2017). At the same time, pulmonary blood flow must be sufficient for gas exchange to occur. This perfect match between ventilation and perfusion is known as the ventilation-perfusion (V/Q) ratio. Disruptions to the pulmonary blood flow or ventilation is known as a V/Q mismatch. The V/Q ratio is significantly affected by hypoxia. Low oxygen levels in one area of the lung have a direct vasoconstrictor effect on the pulmonary artery supplying that area. This has the beneficial effect of diverting blood away from the area of the lung that is inadequately ventilated towards the area that is well ventilated, maintaining efficient gas exchange (hypoxic pulmonary vasoconstriction) (Bourke and Burns 2015, O’Driscoll et al 2017). However, in severe pneumonia, this may not be effective and supplemental oxygen therapy is recommended (O’Driscoll et al 2017), alongside antibiotics and other interventions.

Appropriate positioning of the patient is vital to maximise ventilation. Where possible, the patient should ideally be assisted into an upright position, supported with pillows. An upright position may improve oxygenation by encouraging perfusion, thus promoting gas exchange (Margereson and Withey 2012, O’Driscoll et al 2017). This alone may correct hypoxia, reducing the need for supplemental oxygen therapy.

Internal respiration

Internal respiration is the gas exchange that occurs between the body tissues and the blood. At this level, gas exchange occurs by simple diffusion as a result of a partial pressure gradient. The aim of supplemental oxygen therapy is to increase oxygen delivery to the tissues. Hypoxaemia may be caused by respiratory conditions where there is inadequate oxygenation at the alveolar level, such as pneumonia or pulmonary embolism, causing disruptions in gas exchange that subsequently cause tissue hypoxia. This type of hypoxaemia may be treated with oxygen therapy.

The administration of supplemental oxygen therapy in other conditions, such as severe anaemia or insufficient cardiac output, is less effective; in such cases it is more important to treat the underlying condition than to administer oxygen to a patient with low oxygen saturation. The delivery of oxygen to the tissues is intimately related to the adequate flow of oxygenated blood. It is necessary to ensure that sufficient cardiac output is maintained.
output is maintained and that patients have adequate circulatory blood volume, venous return and myocardial function. In addition, to optimise oxygen delivery from the lungs to the tissues, it is essential to treat conditions that impair delivery of oxygen to the lungs, such as upper airway obstructions, bronchoconstriction, secretions or pulmonary oedema (O’Driscoll et al 2017).

**Transport of gases**
Transport of gases refers to the movement of oxygen and carbon dioxide to and from the tissue cells. For the exchange of oxygen and carbon dioxide to occur, both gases must be transported between the external and internal respiration sites. These gases require a specialised transport system for most of the gas molecules to be moved between the lungs and other tissues. Haemoglobin is the main vehicle to transport oxygen and carbon dioxide. The patient’s oxygen saturations indicate the degree to which the haemoglobin contained in the red blood cells has bonded with oxygen molecules.

**Measuring oxygen saturations**
The measurement of oxygen saturations via pulse oximetry (SpO₂) is considered a fundamental vital sign (Beasley et al 2015), and is often referred to as the ‘fifth vital sign’ (O’Driscoll et al 2017). It should be performed in all patients who are breathless and/or acutely unwell.

Patients receiving supplemental oxygen therapy should undergo regular SpO₂ monitoring, as determined by the prescriber and in accordance with local and national guidelines. They should have their SpO₂ monitored for at least five minutes after commencing supplemental oxygen therapy. The frequency of subsequent SpO₂ measurements will depend on the patient’s condition and their stability, as well as the nurse’s clinical judgement. For example, patients who are critically ill should have their SpO₂ monitored continuously and recorded every few minutes, whereas patients with mild breathlessness may require monitoring hourly or as indicated by a track-and-trigger system score such as the National Early Warning Score 2 (Royal College of Physicians 2017).

Pulse oximetry readings can be affected by several factors, as outlined in Box 5. For example, in patients with anaemia, oxygen saturation of the available haemoglobin will be normal, even when the amount of haemoglobin in the blood is reduced. Therefore, the patient may be hypoxaemic despite having normal oxygen saturations (O’Driscoll et al 2017). The presence of carbon monoxide may falsely elevate SpO₂ measurements, since oxygen is displaced from haemoglobin by carboxyhaemoglobin, but this registers falsely as adequate oxygen saturation.

In patients who are acutely unwell, an arterial blood gas analysis should be undertaken, which is considered the gold standard in assessing respiratory failure. Arterial blood gas analysis enables a more accurate reading of oxygen saturations within the arterial blood (SaO₂) compared with SpO₂, and also measures the partial pressure of oxygen (PaO₂), partial pressure of carbon dioxide (PaCO₂), pH or hydrogen level, and, in some devices, haemoglobin and electrolytes. Arterial blood gas analysis enables diagnosis of respiratory or metabolic acidosis or alkalosis, which may further guide the supplemental oxygen therapy required, as well as any additional interventions.

**TIME OUT 2**
While pulse oximetry is a quick and easy way to measure oxygen saturations, there are several factors that can affect the accuracy of its readings. Using the information in Box 5, can you identify any clinical situations where caution would be required in interpreting these readings?

**Assessing the need for supplemental oxygen therapy**
Respiratory assessment of a patient enables healthcare practitioners to determine if there is adequate gas exchange, that tissues are effectively oxygenated, and that carbon dioxide is being excreted. Therefore, respiratory assessment is essential in determining if the patient has a clinical need for supplemental oxygen therapy and can also assist with evaluating the effects of the intervention. Assessing the patient’s external respiration includes recording their respiratory rate, pattern, depth and effort. Assessing the patient’s internal respiration involves examining their skin colour for signs of cyanosis, measuring SpO₂, and checking their organ function, for example assessing for any neurological impairment.

Where possible, taking the patient’s medical and social history is important in a respiratory assessment (Bourke and Burns 2015) to identify any long-term illnesses or factors affecting their respiratory function, such as smoking. It is also important for the nurse to be aware of any existing oxygen requirements that the patient has, for example home oxygen and/or non-invasive ventilation. Before the nurse begins the assessment, they should identify any special considerations that might be affecting the patient’s respiration and breathing, such as those listed in Box 6.

An assessment using the ABCDE (airway, breathing, circulation, disability and exposure) approach and the ‘look, listen and feel’ approach is recommended (Box 7) (Margereson and Withey 2012, Smith and Rushton 2015, Resuscitation Council (UK) 2016).
Welch and Black 2017). The following sections outline some of the important aspects of using the ABCDE approach to assess an adult patient with breathing difficulties in an acute setting.

**Airway**
To inspire oxygen, independently or with assistance, the patient’s airway must be patent. In an individual who is conscious, the simplest way to assess airway patency is by talking to them. However, if the patient is unconscious or unable to maintain their airway, it is crucial to open their airway using the head-tilt chin-lift manoeuvre — unless the patient has, or is suspected of having, a cervical spine injury — and summon immediate assistance.

**Breathing**
If any airway obstruction is identified, this must be addressed without delay before continuing with the assessment. In addition to oxygen therapy, the patient may require bronchodilators or oropharyngeal suctioning to clear the airway (O’Driscoll et al 2017).

**Circulation**
If the work of breathing is inadequate to achieve effective ventilation, this is considered a medical emergency. In such cases, medical staff must be alerted and oxygen must be delivered using a bag-valve-mask to ensure the patient is adequately oxygenated.

The nurse should also assess the patient’s SpO2, use of accessory muscles in the neck and chest indicating increased respiratory effort, and the patient’s position, for example if they are leaning forward or lying supine. They may indicate that the patient feels short of breath. The patient’s respiratory rate should also be assessed for one full minute to ensure an accurate measurement. It is important to note that a patient’s breathing may change if they are aware that it is being monitored. It is suggested that the patient’s pulse should be palpated for two minutes, counting their pulse rate for the first minute and their respiratory rate for the second minute (Dougherty and Lister 2015). Symmetry of chest movement should also be assessed to check that both lungs are adequately ventilating.

The normal respiratory rate is 12-20 breaths per minute in adults. Assessing the patient’s respiratory rate and patterns can assist with diagnosing a range of conditions that are not always respiratory in nature, although might require supplemental oxygen therapy.

The use of oxygen therapy can reduce breathlessness in patients who are hypoxaemic; however, it has not been proven that it consistently relieves breathlessness in patients who are non-hypoxaemic (Beasley et al 2015, O’Driscoll et al 2017). Use of a handheld fan or opening a window may be considered to relieve breathlessness. The patient may experience anxiety because they feel short of breath, which may itself lead to shallow breaths and hypoxia, requiring supplemental oxygen until their anxiety is reduced.

Appropriately trained healthcare practitioners should undertake auscultation to assess for abnormal breath sounds, such as: crackles, which might indicate pneumonia or pulmonary oedema; wheezing, which might indicate obstruction or lung disease, for example asthma; and reduced sounds, which might indicate atelectasis, pleural effusions or other issues that may affect gas exchange (Bourke and Burns 2015, Welch and Black 2017). A chest X-ray may also be beneficial in diagnosing any changes to respiratory function, which must be reviewed by a healthcare practitioner who is competent in performing this task.

If palpation of the patient’s chest and abdomen may identify factors influencing respiratory function, such as equal rise and fall of the chest, abdominal distention, chest wall motion and depth of inspiration. Collecting a sputum sample could assist in diagnosing the underlying cause of the patient requiring supplemental oxygen therapy, for example if an infection is present.

**Circulation**
Circulation may be affected by changes to respiratory function, venous return, ventricular filling and heart rate. Therefore, it is important to complete a full set of observations, including heart rate, blood pressure and temperature. The patient’s capillary refill time may also be assessed, and, in critical care or high dependency units, central venous pressure may be monitored if the patient has a central venous catheter in place. With increased work of breathing, the heart rate can increase significantly as a compensatory mechanism, which may affect the cardiac output. However, profound hypoxaemia may cause bradycardia and arrhythmias. In respiratory deterioration there may also be hypotension with haemodynamic instability, so the patient’s blood pressure should also be monitored (Margereson and Withey 2012).

**Disability**
The patient’s level of consciousness...
should be assessed because neurological signs of confusion, drowsiness and weakness may be indicators of hypoxaemia or hypercapnia (Welch and Black 2017). The nurse should check whether the patient has a hearing impairment, if there is a language barrier or if they do not understand what is being asked, rather than assuming they are confused. The nurse should also be aware that any signs of distress and agitation that the patient is exhibiting may be as a result of fear and anxiety, and not hypoxaemia.

Exposure

Assessing the patient’s skin pallor can be a useful indicator of hypoxaemia, although cyanosis is a late sign of respiratory dysfunction. Peripheral cyanosis is recognised as a blueish-colour of the skin and mucous membranes resulting from hypoxaemia and may be visible at the patient’s nail beds, earlobes or fingertips. However, peripheral cyanosis alone is an unreliable sign of hypoxaemia because it can be present in other conditions, such as polycythæmia (Baernstein et al 2008, Margereson and Withey 2012). Central cyanosis can present as blue lips and buccal mucosa and may be observed when more than 5g/dL of haemoglobin is unsaturated or the patient’s SpO₂ is below 85% (Bourke and Burns 2015, Welch and Black 2017). However, patients with severe anaemia might not exhibit central cyanosis even if they are severely hypoxic (Bourke and Burns 2015, Welch and Black 2017).

**TIME OUT 3**

Consider the ABCDE approach to patient assessment. How might respiratory function affect each aspect? Discuss with a colleague

**Patient safety considerations**

Nurses who are involved in administering and titrating supplemental oxygen must be trained to use the equipment safely, following local policies, guidelines and safety legislation, which may be included as part of medical gas training. The nurse should also be able to select the appropriate equipment for administering supplemental oxygen based on knowledge of its risks and benefits, assess the suitability of the oxygen delivery devices for individual patients, and recognise the need for alterations in oxygen therapy or medical review.

It is also important to consult local policies and procedures, as well as national devices safety updates, such as those from the Medicines and Healthcare products Regulatory Agency in the UK (www.gov.uk/government/organisations/medicines-and-healthcare-products-regulatory-agency) or the Therapeutic Goods Administration in Australia (www.tga.gov.au).

**Conclusion**

Nurses have an important role in the use of supplemental oxygen therapy in acute settings, including assessing patients who might require this treatment. Therefore, they should have an understanding of the theoretical, practical and evidence-based principles of oxygen administration and titration, as well as the necessary safety considerations. This will enable them to recognise and reduce potential hazards and complications, and to ensure that the patient care they provide is safe and effective.

**TIME OUT 4**

Consider how ensuring the safe and effective use of supplemental oxygen therapy relates to The Code: Professional Standards of Practice and Behaviour for Nurses and Midwives (Nursing and Midwifery Council 2015) or, for non-UK readers, the requirements of your regulatory body.

**TIME OUT 5**

Now that you have completed the article, reflect on your practice in this area and consider writing a reflective account: rcni.com/reflective-account

References

Supplemental oxygen therapy

TEST YOUR KNOWLEDGE BY COMPLETING THIS MULTIPLE-CHOICE QUIZ

1. Which of the following is a common indication for supplemental oxygen therapy?
   a) Cardiac arrest
   b) Major pulmonary haemorrhage
   c) Anaphylaxis
   d) All of the above

2. What is one sign of deteriorating respiratory function?
   a) Increased oxygen saturation
   b) Use of the accessory muscles for inspiration or expiration
   c) Reduced National Early Warning Score
   d) Increased energy

3. Supplemental oxygen:
   a) Never requires a prescription
   b) Requires a prescription if administered at high levels, but not if administered at moderate levels
   c) Is a prescription-only drug, except in an emergency
   d) Must never be administered without a prescription

4. Type II respiratory failure is defined as:
   a) Hypoxaemia with hypercapnia
   b) High oxygen content to the tissues and organs
   c) Hypoxaemia in the absence of hypercapnia
   d) Oxygen saturation of 100%

5. Which of the following is not a potential risk associated with supplemental oxygen therapy and hyperoxaemia?
   a) Loss of hypoxic drive
   b) Worsening ventilation-perfusion (V/Q) mismatch
   c) Rebound hypoxaemia
   d) Increased cardiac output

6. The pulmonary ventilation phase of respiration refers to:
   a) The mechanism of breathing: inspiration and expiration
   b) The exchange of oxygen and carbon dioxide between the alveoli and pulmonary capillary blood across the respiratory membrane
   c) The movement of oxygen and carbon dioxide to and from the tissue cells
   d) The gas exchange that occurs between the body tissues and the blood

7. Which of these factors can affect the accuracy of pulse oximetry readings?
   a) Anaemia
   b) Peripheral vasconstriction
   c) Nail varnish or false nails
   d) All of the above

8. As part of the exposure stage of a respiratory assessment using the ABCDE approach, healthcare practitioners should assess:
   a) Airway patency
   b) Skin pallor for signs of cyanosis
   c) Level of consciousness
   d) Respiratory rate

9. Which statement is false?
   a) Arterial blood gas is more accurate than pulse oximetry in measuring oxygen saturations within the arterial blood than pulse oximetry
   b) Arterial blood gas analysis enables diagnosis of respiratory or metabolic acidosis or alkalosis
   c) Arterial blood gas is less invasive, time-consuming and expensive compared with pulse oximetry
   d) Arterial blood gas measures partial pressure of oxygen and partial pressure of carbon dioxide in addition to oxygen saturation

10. What is one strategy that can be considered to relieve breathlessness?
    a) Close any open windows
    b) Use a handheld fan
    c) Assist the patient into a supine position to maximise ventilation
    d) Encourage the patient to undertake strenuous exercise

How to complete this quiz

This multiple-choice quiz will help you to test your knowledge. It comprises ten questions that are broadly linked to the CPD article. There is one correct answer to each question.

» You can test your subject knowledge by attempting the questions before reading the article, and then go back over them to see if you would answer any differently.

» You might like to read the article before trying the questions.

Subscribers making use of their RCNi Portfolio can complete this and other quizzes online and save the result automatically. Alternatively, you can cut out this page and add it to your professional portfolio. Don’t forget to record the amount of time taken to complete it.

Further multiple-choice quizzes are available at rcni.com/cpd/test-your-knowledge

This multiple choice quiz was compiled by Alex Bainbridge

The answers to this multiple-choice quiz are:

1. d 2. b 3. c 4. a 5. d
6. a 7. d 8. b 9. c 10. b

This activity has taken me minutes/hours to complete. Now that I have read this article and completed this assessment, I think my knowledge is:

Excellent ☐ Good ☐ Satisfactory ☐ Unsatisfactory ☐ Poor ☐

As a result of this I intend to: ________________________________