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Pulse oximetry is a vital tool in patient assessment. Nurses must use the correct procedure and be aware of situations where accuracy of reading may be compromised

Using pulse oximetry to assess oxygen levels

In this article...

- › What pulse oximetry measures and the most useful reading
- › Indications for using pulse oximetry
- › Understanding the limitations of pulse oximetry

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Detecting low oxygen levels in patients is important but not always easy; central cyanosis – when a patient's lips, tongue and mucus membranes acquire a blue tinge – can be missed, even by skilled observers, until significant hypoxaemia is present. Pulse oximetry can be undertaken to measure a patient's oxygen levels and help identify earlier when action must be taken. This article outlines the procedure and its limitations, as well as the circumstances in which it should be used.

Pulse oximetry is a simple, non-invasive method of measuring oxygen levels and can be useful in a variety of clinical settings to continuously or intermittently monitor oxygenation.

An oximeter is a device that emits red and infrared light, shone through a capillary bed (usually in a fingertip or earlobe) onto a sensor (Fig 1). Multiple measurements are made every second and the ratio of red to infrared light is calculated to determine the peripheral oxygen saturation (SpO₂). Deoxygenated haemoglobin absorbs more red light and oxygenated haemoglobin absorbs more infrared light.

In the 1970s it was discovered that red/infrared wavelength absorption could be calculated from pulsatile blood flow and the term "pulse oximeter" was coined. However, early devices were cumbersome, inaccurate and prohibitively expensive (Tremper 1989). By the early 1980s, more

accurate devices were developed, which led to pulse oximeters being introduced into clinical practice.

Indications for use

Cyanosis was traditionally the primary clinical sign of hypoxaemia but early studies found that even skilled observers are not consistently able to detect central cyanosis (a blue tinge to the lips, tongue and mucus membranes) until oxyhaemoglobin saturation is <80% (Hanning and Alexander-Williams, 1995). At this level, organ function, including brain, heart and kidneys, may be compromised. Factors such as ambient light, skin pigmentation and peripheral perfusion all affect the ability to identify cyanosis but pulse oximetry enables clinically important low-tissue oxygenation to be identified earlier.

Pulse oximetry should be available for use in all clinical settings where hypoxaemia may occur and is used to:

- › Assess breathless patients or those who are acutely ill, including those who have acute confusion;
- › Provide an objective indication of the severity of an acute respiratory episode and need for hospital admission – for example, exacerbation of chronic obstructive pulmonary disease, asthma (British Thoracic Society and Scottish Intercollegiate Guidelines Network, 2014; National Institute for Health and Care Excellence, 2010) or pneumonia (NICE, 2014);
- › Determine the need for emergency oxygen therapy in acute illness (O'Driscoll et al, 2008);
- › Provide a continuous oxygen saturation recording, for example, during anaesthesia or sedation, or in the

5 key points

1 Pulse oximetry is a non-invasive procedure that is used to assess patients' oxygen levels

2 It should be available in all clinical settings where hypoxaemia may occur

3 Pulse oximetry enables early identification of hypoxia

4 It requires good pulsatile blood flow

5 Nurses should record whether the patient is breathing room air or oxygen when the reading is taken, along with other factors that may affect accuracy

FIG 1. OXIMETER



assessment of oxygenation during sleep studies;

- » Undertake routine monitoring in chronic respiratory disease to screen for suitability for assessment for domiciliary oxygen therapy (BTS, 2015; NICE, 2010);
- » Guide titration of oxygen therapy during acute illness (O'Driscoll et al, 2008) or for domiciliary use (BTS, 2015). Additional monitoring with arterial blood gas sampling may be required where patients are at risk of type 2 (hypercapnic) respiratory failure.

Pulse oximetry does not give a measure of arterial blood oxygen content or ventilation; oxygen delivery to the tissues is dependent on adequate ventilation and circulation. However, oximetry can add to the clinical picture to aid diagnostic and treatment decisions.

Limitations

Pulse oximetry requires a good pulsatile blood flow and no interference with measurement of light absorption and detection. Pulse strength can be checked by ensuring the recorded heart rate correlates with a manual pulse rate; some devices have a pulse amplitude indicator in addition to a pulse detector. Where a good signal is obtained, pulse oximetry readings are accurate within saturation range of 70-100% but cannot be relied on outside of this range.

Common causes of inaccuracy include:

- » Poor peripheral circulation:
 - » Cold peripheries
 - » Constriction, for example, from blood pressure cuff, tight clothing or tight oximeter probe
 - » Poor perfusion due to hypovolaemia, marked hypotension or cardiac arrhythmias, peripheral vascular disease
- » Raynaud's syndrome
- » Motion artefact:
 - » Gross movement may cause loss of signal
 - » Fine vibration may interfere with accuracy
- » Carbon monoxide/smoke inhalation/intravenous dyes (for example, methylene blue) used in diagnostic tests:
 - » Carboxyhaemoglobin (from carbon monoxide) is detected as oxyhaemoglobin and will overestimate true oxygen saturation
- » Ambient light interference:
 - » Light emitters and detectors must be directly opposite each other and light should only reach the detector via

tissues. Inappropriately sized probes or excessive ambient light may result in inaccuracies

- » Interference with transmission/detection of light signals:
 - » Dirty probe sensors
 - » Nail varnish/synthetic nails
- » Anaemia/skin discolouration (very dark skin/jaundice) may affect readings, but is rarely clinically significant.

Pulse oximetry supports rather than replaces comprehensive assessment and examination. Results should be interpreted with clinical judgement in the context of the patient's existing diagnoses, presenting symptoms and other findings (Holmes et al, 2013; Kelly, 2008).

Procedure

The correct procedure that should be followed when conducting pulse oximetry is detailed in Box 1.

Competencies

A range of competencies relate to the safe undertaking of pulse oximetry:

- » Be aware of, and understand, local infection control policy/guidelines in relation to monitoring equipment;
- » Demonstrate a basic understanding of how oxygen saturations are derived;
- » Be able to discuss the indications for, and limitations of, pulse oximetry;
- » Demonstrate an ability to use a pulse oximeter safely and effectively, selecting the appropriate probe and device for the clinical situation;
- » Demonstrate accurate documentation of results.

Health professionals should be able to demonstrate competence before undertaking and interpreting pulse oximetry. **NT**

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BOX 1. THE PROCEDURE

- Ensure oximeter is in good condition and probe sensor is cleaned according to local infection control policy/manufacture's guidance
- Explain procedure to the patient and gain consent where possible
- Select the most appropriate probe for the site chosen; in adult patients, the most common sites are the fingertip and earlobe. Using the incorrect probe will lead to inaccuracies in the readings obtained
- Consider choice of device:
 - Fingertip devices with integrated sensor and display may be appropriate for spot checks of SpO₂ (Fig 1)
 - Handheld devices with detachable sensor allow the most appropriate probe to be selected
 - Wrist-worn devices have a sensor attached by a short cable and are useful for overnight oximetry and exercise testing
 - Desktop/bedside devices may be more appropriate in the acute setting for continuous monitoring
- Ensure the chosen site is warm and well perfused
- Apply the probe to the site, ensuring the sensor is correctly positioned
- Ask the patient to rest the hand with the sensor on it down gently to reduce interference of motion
- Check the pulse strength signal and ensure the pulse-rate reading correlates with the manual pulse
- Allow the pulse oximeter to remain in situ for at least five minutes to ensure it equilibrates
- Document the reading, noting whether the patient is breathing room air or oxygen, then record the oxygen delivery device used and flow rate or percentage. Note any other factors that may influence accuracy, such as movement, cold hands etc
- In acute illness, resting saturations are usually most useful, but in non-acute settings, oximetry may be used during exercise testing to determine exertional desaturation. Record whether the readings have been taken at rest or during/after activity in addition to inspired oxygen/air

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