Guidelines for the use of Pulse Oximeters

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Introduction

Pulse oximeters are simple and relatively cheap devices that provide a measure of oxygenation quickly, cheaply and painlessly. However, like most medical measuring devices, they need to be used properly to avoid giving misleading information and the results need to be interpreted correctly. This document gives information on how to use pulse oximeters correctly, and some information on how to interpret results. The information does not replace the need to be familiar with guidelines on managing hypoxaemia in asthma, COPD, pneumonia or other cardiorespiratory disorders

How to use a Pulse Oximeter safely

Pulse oximeters measure saturation spectrophotometrically. One side of the probe emits light; the other side has a detector. The device may be fooled by nail polish/false nails and ambient light

- Remove nail polish on the finger used for measuring. Acrylic nails will also adversely affect the result
- Strong ambient light may affect readings
- Ensure correct probe type is used (finger probes may not be used on other sites for example the ear)

Pulse oximeters require a pulse waveform. Cold fingers, poor circulation or low blood pressure will affect readings. Squeezing the probe or raising the arm may reduce the pulse wave, and affect the signal

- Ensure there is an indicator on the oximeter confirming a good signal (a regular waveform on the display or flashing light – depending on the model)
- Count the patient's pulse manually and confirm the heart rate on the oximeter is within 4-5 beats per minute
- Warm the hands (or apply vasodilating cream) if the signal is poor
- Avoid squeezing the finger with the probe, the hand should be roughly level with the heart
- The reading takes time to stabilise. The oximeter should be in place for at least a minute, or longer if the reading is not stable

Cautions

Most pulse oximeters can not distinguish between different types of haemoglobin. High levels of carbon monoxide will cause high levels of carboxyhaemoglobin which will be mostly interpreted as oxyhaemoglobin by the device. Carbon monoxide levels may be high after exposure to fires, leaking gas appliances and even cigarette smoking

- Do not rely on pulse oximeters if there is a suspicion of carbon monoxide poisoning as the results may appear normal in a dangerously hypoxaemic individual

Usually it is the resting saturation that is of interest. Exercise can cause a drop in saturation lasting for several minutes

- Make sure the patient has been resting for at least five minutes prior to measurement
- Saturation readings are uninterpretable if the inspired oxygen level is not known. Saturation changes quickly with changes in supplemental oxygen
- When documenting saturation always comment on whether the reading was on air or supplemental oxygen, and at rest or on exertion
- Wait 5-10 minutes after a change in oxygen therapy for the saturation to stabilise

Interpretation of Saturation

Blood gases or pulse oximetry?

Taking a blood gas sample involves a painful arterial puncture but provides an accurate measure of oxygen content of blood. Both PaO2 and SaO2 can be measured. Limitations include:

- The sample only reflects the last few minutes of cardiorespiratory function
- An expensive blood gas analyser is required to analyse the sample
- Competency based training is required to perform the arterial stab

Pulse oximetry is cheap, painless and non-invasive. Monitoring change in oxygenation after treatment is straight forward. Limitations include:

- Inaccurate results (see "How to use a Pulse Oximeter safely" (above)
- Inability to measure ventilation (below)

Technical Terms

Central Cyanosis

- Blue discoloration of the lips/tongue due to high levels of circulating deoxyhaemoglobin
- Occurs when saturation drops below about 80% but detection is dependent on ambient light, and the patient's total haemoglobin. It is an unreliable sign

SpO_2

- Percentage of haemoglobin in arterial blood which is saturated with oxygen, measured by a pulse oximeter

PaO_2

- partial pressure of oxygen in arterial blood measured in kilopascals (kPa) by a blood gas analyser

SaO_2

- Percentage of haemoglobin in arterial blood which is saturated with oxygen, measured by a blood gas analyser on an arterial blood sample

FiO_2

- Strictly the fraction of inspired oxygen – 0.5 is 50% oxygen, air is 0.21

Respiratory Failure

- Usually defined as PaO_2 below 8.0 kPa (on air)
- Type 1 (hypoxic respiratory failure) has normal or low $PaCO_2$
- Type 2 (ventilatory failure) has high $PaCO_2$

What is Normal?

- A healthy person at sea level should have a saturation of 95% or more

Measuring Ventilation?

- Pulse oximeters give very limited information on ventilation (which is normally assessed using arterial blood gas analysis)
- Given sufficient supplemental oxygen, a person can be apnoeic and maintain normal saturation
- If saturation is 95% or more while breathing air, ventilation is likely to be normal
- If saturation is below 95% or the patient is breathing supplemental oxygen, no information about ventilation can be derived and blood gas sampling is required

Significance of Ventilation in the Acute Setting

- Type 1 respiratory failure (also known as hypoxic respiratory failure) is usually treated with oxygen therapy and prognosis is related to the underlying pathology. Aim to maintain saturation of 94-98%
- Type 2 respiratory failure (also known as ventilatory failure) is commonly due to an exacerbation of COPD, although it can occur in other cardiorespiratory and neuromuscular conditions. Prognosis is often related to the severity of the ventilatory failure and urgent treatment is required. Treatment with oxygen has the potential to worsen the situation. Refer to condition specific guidelines, but usually controlled oxygen to maintain saturation in the range of 88% to 92% is an appropriate aim of oxygen therapy.

Oxygen and Breathlessness

- When assessing breathless patients using pulseoximetry, it is important to consider that hypoxaemia,and breathlessness are not always closely related. Patients may be very breathless with normal saturation, or not breathless with low saturations
- Oxygen therapy is a treatment for hypoxaemia,and in the presence of normal saturation gives littlebenefit for breathlessness
- Treatment of hypoxaemia requires oxygen therapy. The urgency of providing oxygen to breathless & hypoxaemic patients depends on whether the patients is experiencing a flare up of respiratory symptoms, or is in their usual stable condition. (See next section)
- Treatment of breathlessness will need to be directed at the underlying problem e.g. bronchodilators, steroids and/or antibiotics for COPD or pulmonary rehabilitation for deconditioning.

Acute versus Chronic Setting

- In the acute phase, with an unstable patient, hypoxaemia requires urgent treatment to improve oxygen delivery to metabolising tissues. Tissue hypoxia can cause lactic acidosis and sudden deterioration
- However, in some patients, especially those with COPD, there is a risk that oxygen therapy may aggravate ventilatory failure. In these patients a target saturation of 88% - 92% may be appropriate
- In most other circumstances a target saturation of 94%-98% is reasonable
- In the chronic setting, where a stable patient is having a routine assessment, hypoxaemia does not usually require urgent treatment. A very low saturation (below 85%) should prompt an urgent referral for respiratory outpatient review. Having a record of a patient's usual saturation is useful, as a sudden drop should prompt a search for a cause or even an admission if the patient is unwell
- In the long term, continuing hypoxaemia will cause pulmonary hypertension and right heart failure, so a resting saturation of 92% or less should prompt referral to a respiratory unit for assessment for long term oxygen therapy
- Resting saturation above 92% but with desaturation of more than 4% on exertion should also prompt referral to a respiratory unit for assessment for ambulatory oxygen although the evidence for benefit is sparse.

Summary

- Pulse oximeters provide a cheap, quick and non-invasive method of assessing oxygenation
- There are a number of technical points which must be understood before an accurate saturation can be reliably obtained
- Interpretation of the results requires an understanding of the patient's condition and importantly whether the patient is unstable and acutely unwell or whether they are in a stable phase of a chronic illness.

References

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- An outcomes strategy for people with chronic obstructive pulmonary disease (COPD) and asthma in England https://www.gov.uk/government/publications/an-outcomes-strategy-for-people-with-chronic-obstructive-pulmonary-disease-copd-and-asthma-in-england
- NICE COPD Quality Standards (QS 10) http://guidance.nice.org.uk/QS10

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