Using an oximeter

Tutorial 1 – the basics
The Pulse Oximeter

In this tutorial you will learn about:

• What the pulse oximeter measures
• How oxygen is supplied to the tissues
• How a pulse oximeter works
• How to detect hypoxia during anaesthesia
The pulse oximeter
This is the Lifebox oximeter in use – examine it carefully
What do the two numbers indicate?
• The oxygen saturation is 97%
• The heart rate is 107 beats per minute
What is oxygen saturation?

Red blood cells contain haemoglobin which carries oxygen. When haemoglobin is carrying oxygen it is described as “saturated with oxygen”.
What is oxygen saturation?

- Oxygen is carried in the red blood cells attached to haemoglobin molecules.
- The oxygen saturation is a measure of how much oxygen the haemoglobin is carrying.
Why is arterial blood bright red and venous blood dark red?
Why is arterial blood bright red and venous blood dark red?

The colour of blood depends how much haemoglobin is saturated with oxygen.

• Arterial blood is fully saturated with oxygen and is bright red
• Venous blood has less oxygen and is dark red
Why is oxygen vital for life?
Why is oxygen vital for life?

• All tissues in the body depend on oxygen for survival.
• The brain is damaged very quickly if the supply of oxygen to the tissues is interrupted.

• A shortage of oxygen in the tissues is called hypoxia.

• When a patient is hypoxic their tissues lose the bright red appearance of being well oxygenated and become dark red or look blue.
How is oxygen supplied to the tissues?
Oxygen supply to the tissues

- There is 21% oxygen in the air that we breathe.

- Air is breathed into the lungs by the action of the diaphragm and other respiratory muscles drawing in air through the upper airways.

- In the alveoli (air sacs of the lung) oxygen passes into the blood and combines with haemoglobin.
Oxygen supply to the tissues

• Arterial blood is pumped to the tissues by the heart

• The tissues receive oxygen from haemoglobin in the capillary networks in each organ

• The cells burn the oxygen and create carbon dioxide which is returned to the lungs in venous blood and excreted in the exhaled gas
Lung-Circulation Unit

This diagram represents the lung and upper airway and the pulmonary blood flowing through the lungs.
Lung-Circulation Unit

Oxygen in the air is breathed into the lung

Carbon dioxide is breathed out
Blood is oxygenated in the lungs and is pumped by the heart to the tissues. 98% of haemoglobin in arterial blood is saturated with oxygen.
Lung-Circulation Unit

Venous blood from the tissues has delivered some of its oxygen to the tissues.

Normally only 75% of the haemoglobin in venous blood is saturated with oxygen.
What can happen during anaesthesia that might cause problems with oxygen supply to the tissues?
What can happen during anaesthesia that might cause problems with oxygen delivery to the tissues?

• The patient becomes unconscious and may lose the ability to keep a clear airway

• Anaesthesia drugs may affect oxygen delivery to the tissues:
  • Depressed breathing
  • Reduced cardiac output

• Patients may have other problems that interfere with oxygenation:
  • Hypovolaemia - reduced cardiac output
  • Pneumonia
How can we detect hypoxia during anaesthesia?
How can we detect hypoxia during anaesthesia?

- The presence of cyanosis indicates that the blood is not being oxygenated effectively.
Where should you check for cyanosis?
In which patients may it be difficult to see cyanosis?
Where should you check for cyanosis?
In which patients may it be difficult to see cyanosis?

• Cyanosis is best seen in the tongue

• It is harder to detect cyanosis in darker skinned people

• It is harder to detect cyanosis in anaemic patients as they have low levels of haemoglobin and their blood is not a strong colour in the tissues.
How does an oximeter work?
How does an oximeter work?

A pulse oximeter has two parts

• The probe
• The monitor

• The patient must have a pulse for the probe to pick up a signal
• The pulse wave must be displayed on the monitor for the reading to be reliable
How does an oximeter work?

- Note the bright red light coming from one side of the probe.

- What is this red light for?
How does an oximeter work?

All pulse oximeter probes have light emitting diodes (LEDs) which shine two types of red light through the tissue.

The sensor on the other side of the tissue picks up the light that is transferred through the tissues.

The oximeter can then determine the $\text{SpO}_2$ of arterial blood in the peripheral circulation.
What do you notice about this oximeter trace?

SpO₂ 67%
HR 42

Alarm!!

Battery - charging

Full
What do you notice about this oximeter?

The pulse rate is 42 beats per minute
The SpO₂ is only 67% - dangerous hypoxia!

What do you think of the pulse waveform?
What do you notice about this oximeter?

The trace is erratic and suggests that either the pulse is weak or the patient is moving. Both of these may cause false readings.
Compare these two traces:

Erratic trace

Normal trace for comparison
What is the best way to detect hypoxia?

• A skilled anaesthetist?

OR

• A pulse oximeter?
The **pulse oximeter** is the best way to detect hypoxia

- The pulse oximeter provides an early warning - as soon as the SpO₂ changes
- It has an audible tone

The anaesthetist can hear the pulse rate and SpO₂. The oximeter allows the anaesthetist to concentrate on looking after the patient.

- Pulse oximeters have made anaesthesia **much safer**
- But remember......the oximeter only works if it can detect a pulse.
The sound of the pulse oximeter in theatre is a vital safety signal.

Never turn off the pulse sound!
What level of SpO$_2$ is important during anaesthesia?
What level of $\text{SpO}_2$ is important during anaesthesia?

- The $\text{SpO}_2$ should always be 95% or greater during anaesthesia for patients of all ages.

- When the $\text{SpO}_2$ falls below 90%, the patient is becoming seriously hypoxic. This needs immediate attention.

- Start to check the patient if the $\text{SpO}_2$ falls to 94% or below.
Revision

1. What is the normal haemoglobin saturation in arterial blood?

2. What does SpO₂ stand for?
Revision

1. What is the normal haemoglobin saturation in arterial blood?
   • In arterial blood, haemoglobin is normally 95 – 99% saturated with oxygen.

2. What does SpO$_2$ stand for?
   • Peripheral haemoglobin oxygen saturation.
Revision

3. What happens to the SpO₂ if the patient is given 100% nitrous oxide to breathe?

3. What happens to SpO₂ if the patient stops breathing?
3. What happens to the SpO$_2$ if the patient is given 100% nitrous oxide to breathe?
   • The nitrous oxide dilutes and replaces the oxygen in the lung causing a severe shortage of oxygen in the lung and potentially fatal hypoxia

4. What happens to SpO$_2$ if the patient stops breathing?
   • The SpO2 will fall as the blood no longer receives oxygen from the lungs
Summary – in this tutorial you have:

• Learnt how an oximeter works
• Learnt how oxygen is supplied to the tissues
• Understood how anaesthesia may interfere with oxygen supply to the tissues
• Understood how to detect hypoxia under anaesthesia