



**World Health  
Organization**

**Patient Safety**

A World Alliance for Safer Health Care

# Using the Pulse Oximeter

## Tutorial 2 – Advanced

# Pulse oximetry – advanced

In this lesson you will learn about:

- Using an oximeter correctly
- What can interfere with an oximeter
- Maintaining a pulse oximeter
- Managing a falling SpO<sub>2</sub> during anaesthesia

# Putting on the probe

- The probe should be put on the patient correctly to ensure the oximeter works correctly
- The oximeter is supplied with a finger probe. For some oximeters ear probes are also available and are also described here.
- Probes are carefully designed so that they can shine light through the finger and detect it on the other side.
- Probes are fragile and must be used carefully.

# What do you think of these two probes?



This probe is well positioned on the finger. The finger fits well and the probe is not too tight (which would constrict the circulation) or too loose (may fall off or let other light in).



This probe has been put on the large toe and is incorrectly positioned as the toe is too big for the probe. Forcing the probe on to a large digit in this way will damage it.

In addition the circulation in the digit may be reduced and the light inadequately detected.

The probe should be repositioned!



## Paediatric probes

Paediatric probes are made for small children (less than a year old). Alternatively an adult probe can be tried on the thumb or big toe.

Some adult probes may be turned around – see figure

If a good signal is obtained the oximeter is working



# Ear probes





# Ear probes

Ear probes are made to be used on the ear lobe. In small babies ear probes can be used on the cheek from inside to outside the mouth provided the probe is clean.

The earlobe is very susceptible to vasoconstriction due to cold or hypovolaemia. Sometimes the circulation can be improved by gently rubbing the ear lobe and then re-applying the probe.



# What can prevent a pulse oximeter reading accurately?

Write down 5 factors that might stop a pulse oximeter reading accurately.



# Answers

- Nail varnish or pigment on finger
- Bright light on the probe
- Patient movement
- Poor perfusion
- Carbon monoxide poisoning

# Nail varnish

This is picture of nail varnish – why does it interfere with pulse oximetry?

The colour can absorb light emitted by the oximeter and interfere with the detection of oxygenated haemoglobin.

It is always best to remove nail varnish from one finger. In emergencies the probe may be turned sideways. Use another site if possible.



# Here are two patients with henna pigmentation on their fingers

What do you think will happen to the oximeter reading?



The oximeter may detect a pulse but is unable to measure SpO<sub>2</sub> due to the pigment blocking the signal.

Select a toe or ear lobe instead!



## Bright light

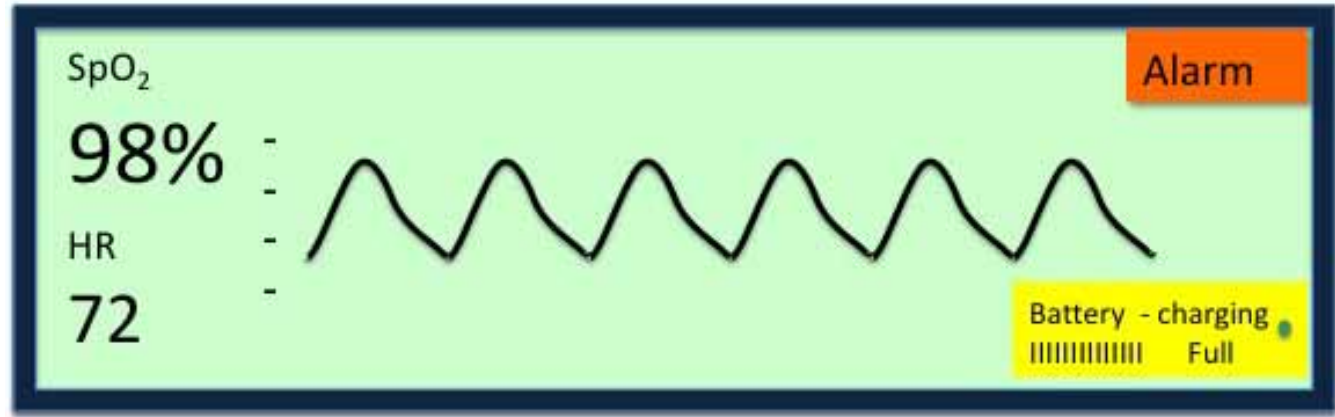
Bright light such as sun light or the operating light on the probe may interfere with the light detector and cause inaccuracy.

Note that the probe has soft rubber to shield it from light.

Be careful with positioning the probe – it does not have to be covered, just avoid direct bright light!



# Movement



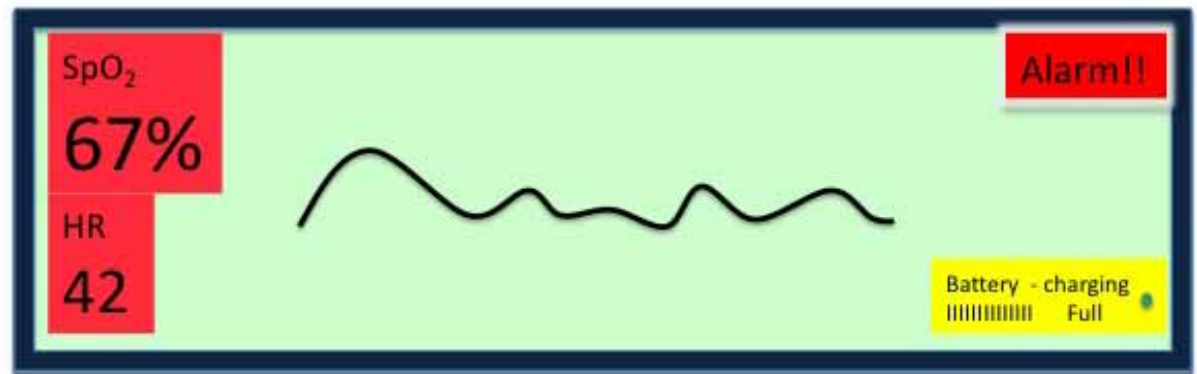
Here is an oximeter attached to a patient.  
The SpO<sub>2</sub> is 98% and pulse 72bpm.

The trace shows a waveform with a regular pulse.

What is the difference with this trace and the next picture?



## Movement



Notice the pulse waveform is erratic and not being well detected.

This is the same patient but has now started shivering which can result in an abnormal reading and cause confusion.

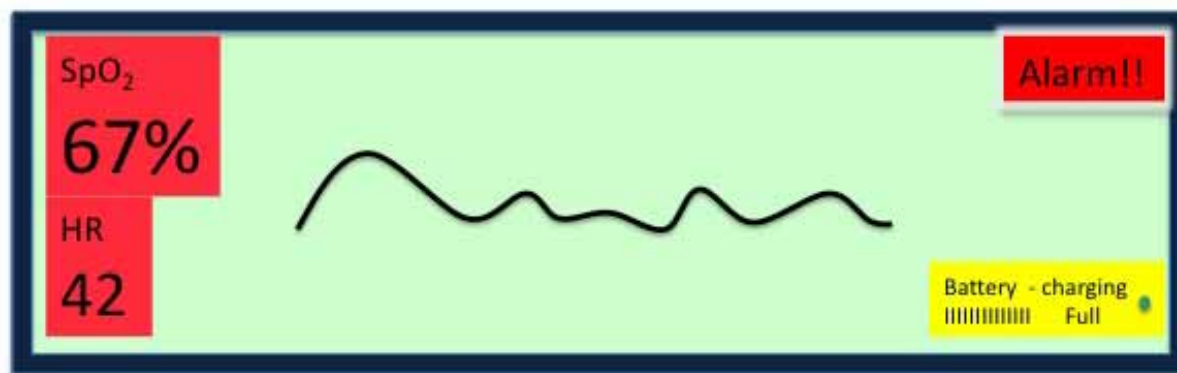
Hold the hand steady or wait until the patient has stopped shaking and recheck.

Shivering is a common problem in recovery, but not common in theatre.

**Check the patient carefully before deciding the oximeter is not correct!**

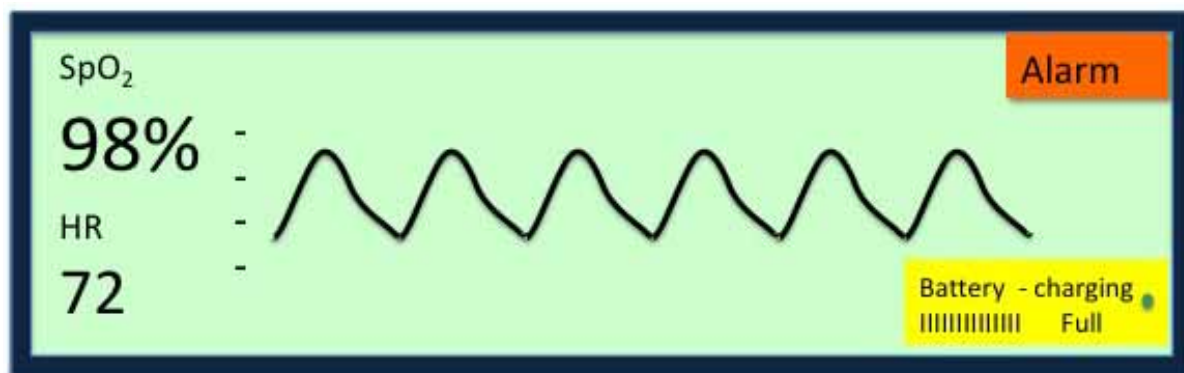
# How can you check if an oximeter is working?

If you are concerned whether an oximeter is working correctly - how could you check it?



# Is the probe working?

Put the probe on your own finger and check it is working!



# Perfusion

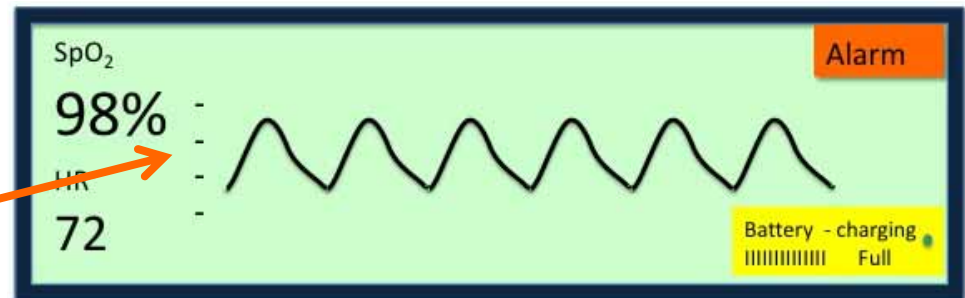
Oximeters need a flow of blood through the finger to function.

Some oximeters give an indication of the blood flow detected.

In this oximeter there is a scale which is an indication of the blood flow. Sometimes these have numbers on them.

Why might this scale be important during anaesthesia?

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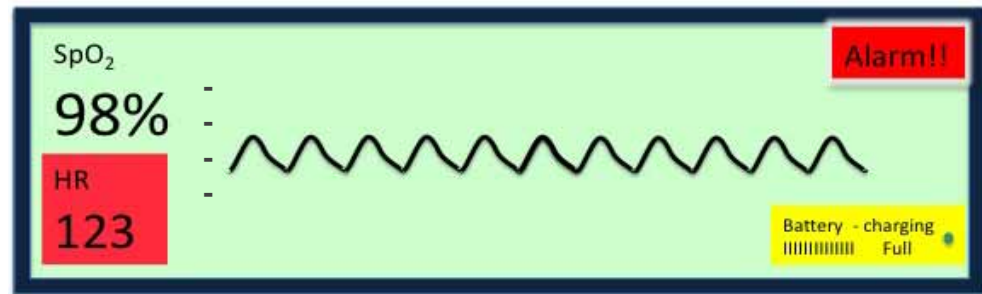
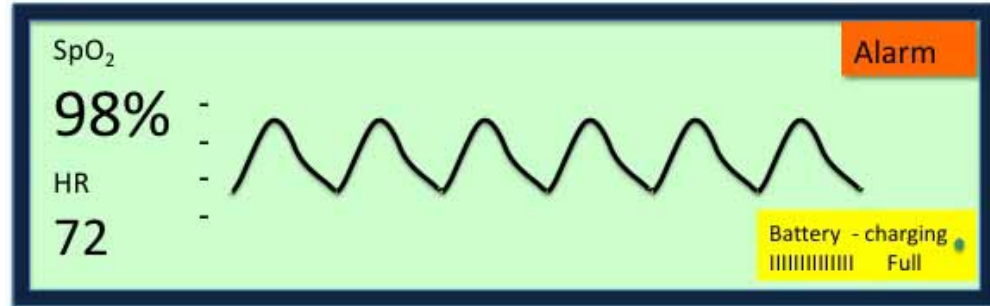
# Perfusion

Why might this scale be important during anaesthesia?

If the blood flow to the finger changes - usually due to peripheral vasoconstriction from cold or hypovolaemia, it can be seen on the monitor.

Here is the same patient after losing blood during a prolonged laparotomy.

The pulse rate is faster and there is less peripheral blood flow being detected by the oximeter.



# Carbon monoxide poisoning

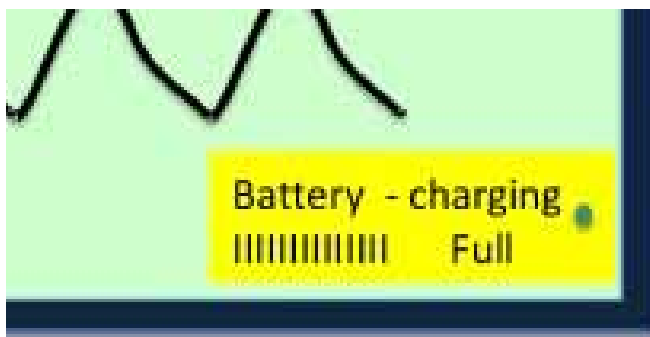
Patients involved in fires, or who have inhaled smoke may have significant amounts of Hb combined with carbon monoxide (CO).

Most oximeters cannot detect this and tend to exaggerate the SpO<sub>2</sub>



# Caring for your oximeter

- Keep the battery fully charged!!



# Caring for your oximeter

When the probe gets dirty  
clean it gently with a damp  
cloth or alcohol swab





# Caring for your oximeter

Position safely to avoid dropping or damage from spillages. Consider connecting to a pole or trolley using the connector supplied with the oximeter.

# Caring for your oximeter

When connecting your probe, or the lead, always insert the plug correctly. Check carefully to avoid damage.

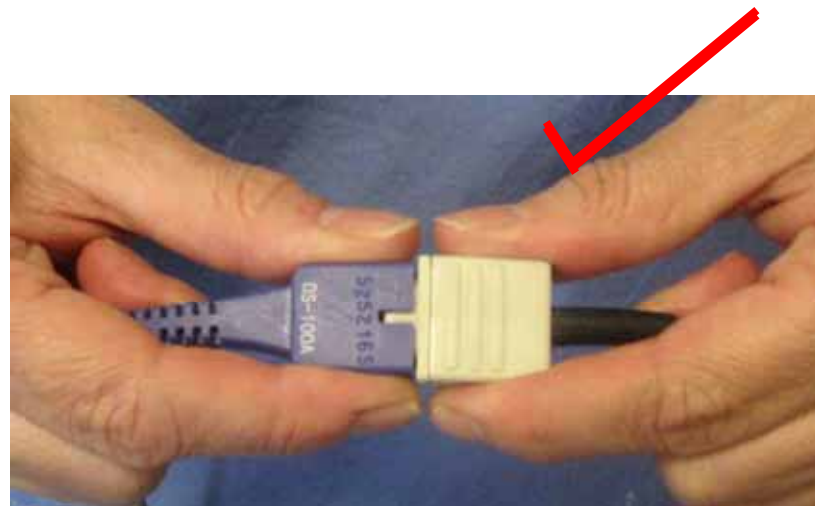
Note that the lead only ever inserts one way – check the shape before inserting



# Caring for your oximeter

When disconnecting and connecting probe, grip the plug firmly and not the cable.

If the cable is pulled, small wires inside will break



# Caring for your oximeter

When disconnecting and connecting probe, grip the plug firmly and not the cable.

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# Caring for your oximeter

When not in use, always coil the lead and position the probe where it cannot be damaged.



Too tight a coil will damage the lead.



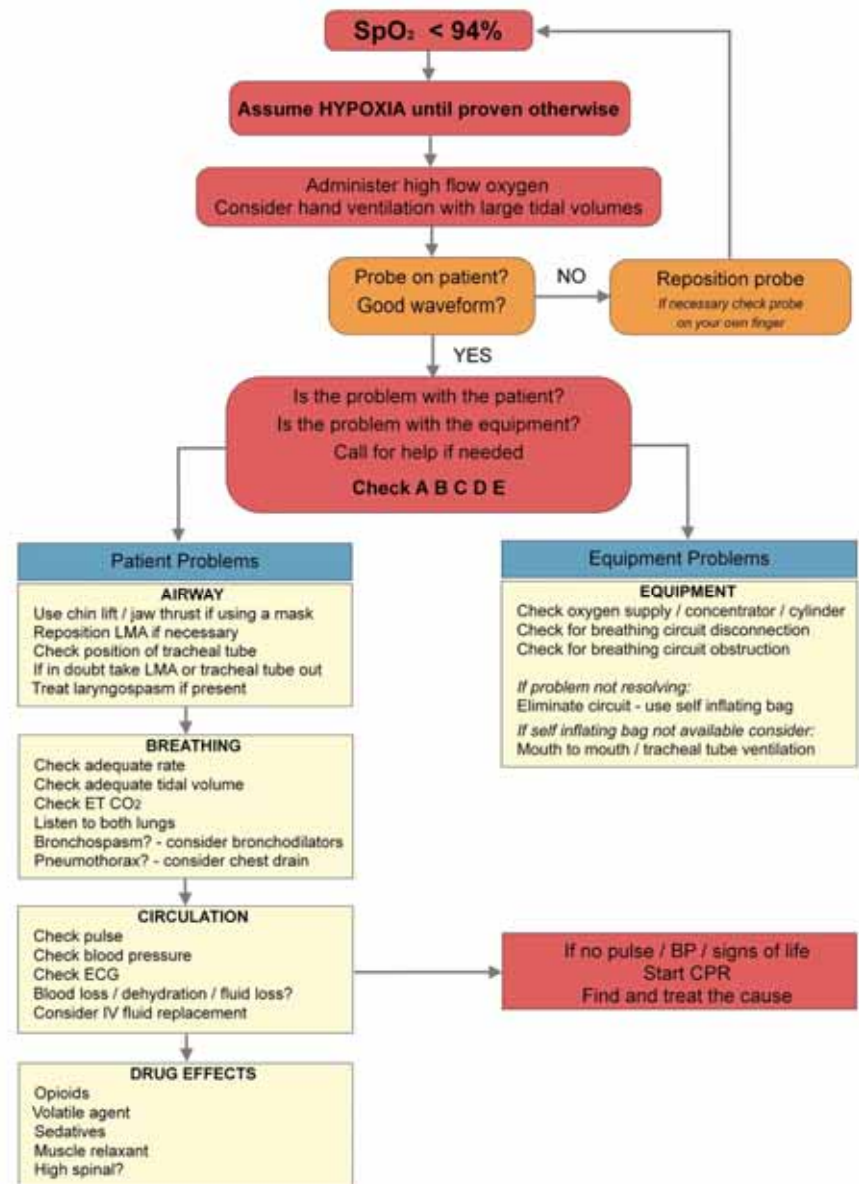
Leaving the lead dangling will result in damage.

# What should we do if the patient becomes hypoxic?

The next slide describes an action plan to deal with hypoxia  
By using the plan, a logical approach to solving a problem is followed.

- Study the next slide for a few minutes

# Action plan for SpO<sub>2</sub> < 94%



# What is the normal level of SpO<sub>2</sub> during anaesthesia?

1. 85 - 89%
2. 90 - 94%
3. 95 - 99%
4. 100%

Select one answer



# What is the normal level of SpO<sub>2</sub> during anaesthesia?

1. 85 - 89%
2. 90 - 94%
3. 95 - 99%
4. 100%

Select one answer

Normal SpO<sub>2</sub> is 95% or above.  
During anaesthesia this should be maintained.

This means we need to be concerned with SpO<sub>2</sub> readings of below 95%

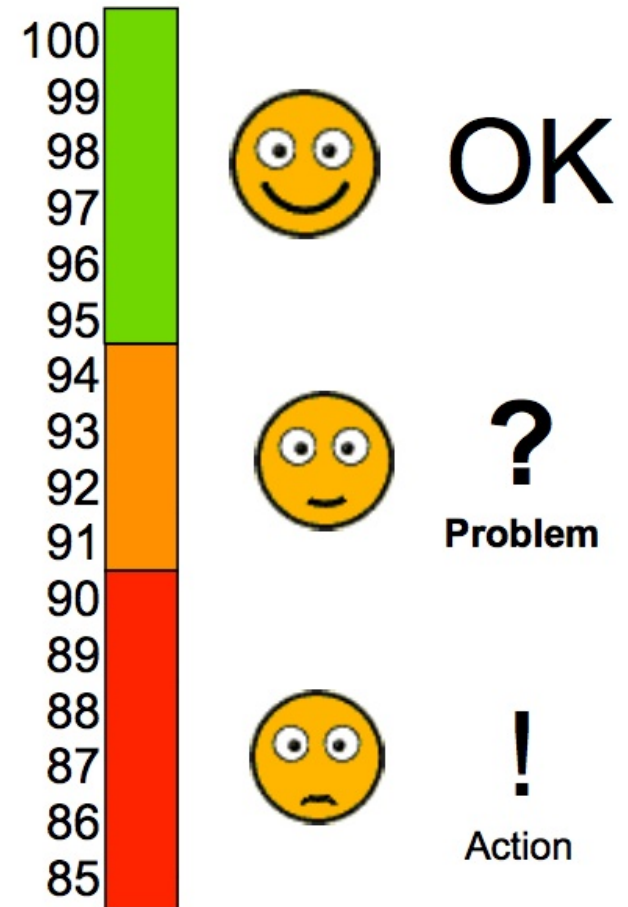
The action plan helps us plan what to do when the SpO<sub>2</sub> is less than 94%

All anaesthetists should start to investigate why the SpO<sub>2</sub> is 94% or below during or after anaesthesia.

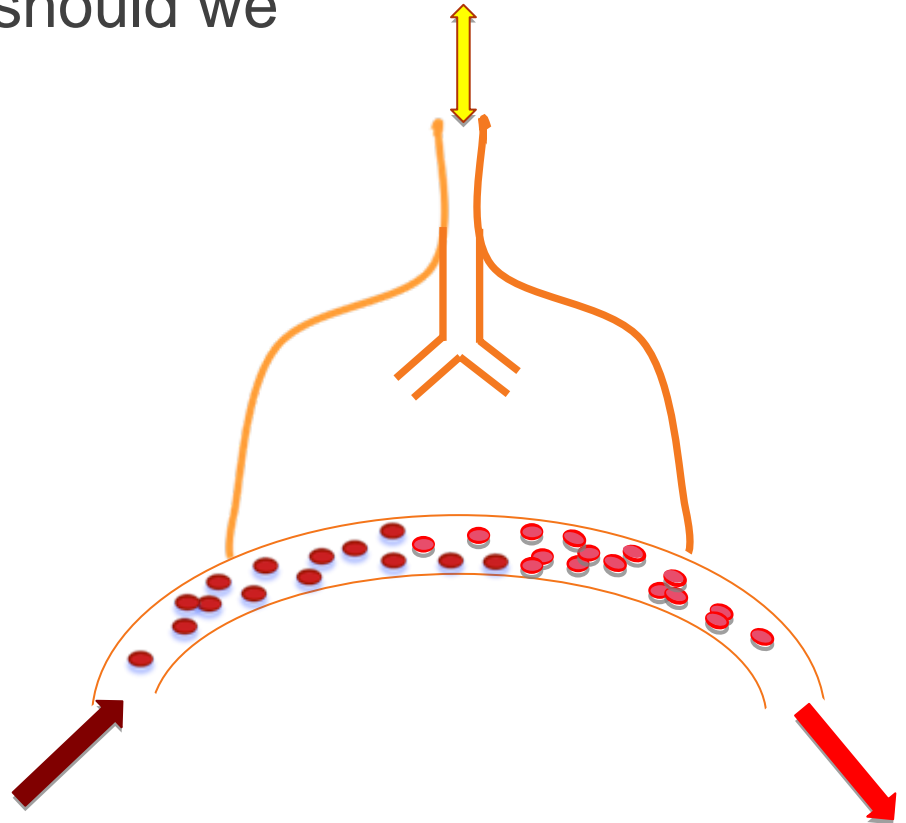
When the SpO<sub>2</sub> falls below 90%, the patient is becoming seriously hypoxic and the WHO pulse oximeter will alarm.

**Urgent action is needed!**

Saturation %



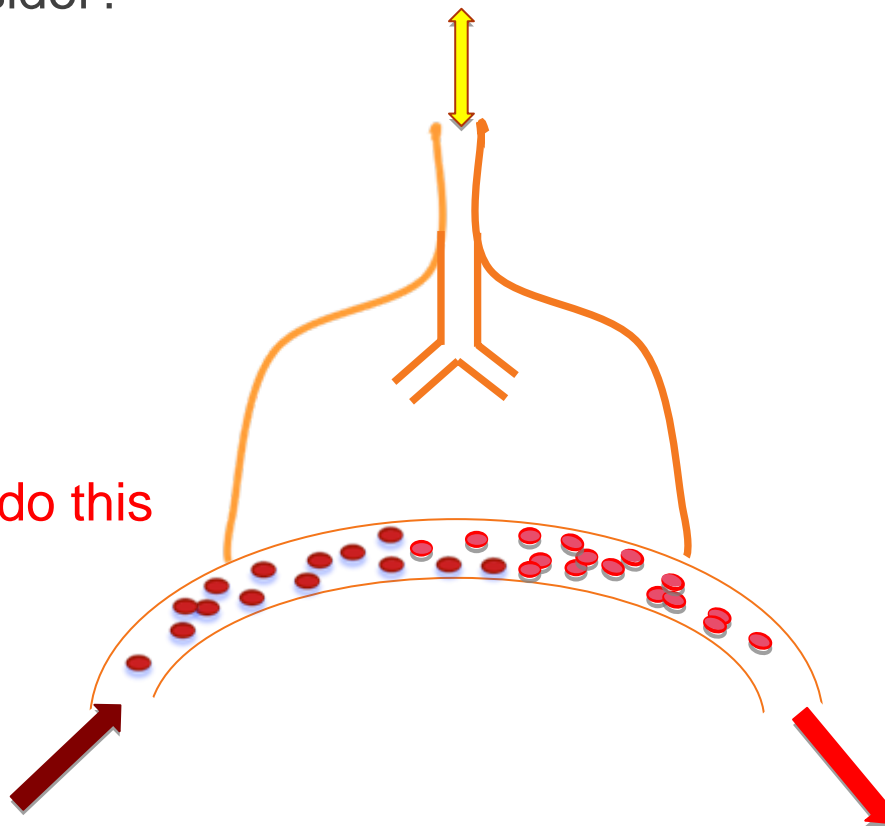
When a patient becomes hypoxic during anaesthesia what should we consider?



When a patient becomes hypoxic during anaesthesia what should we consider?

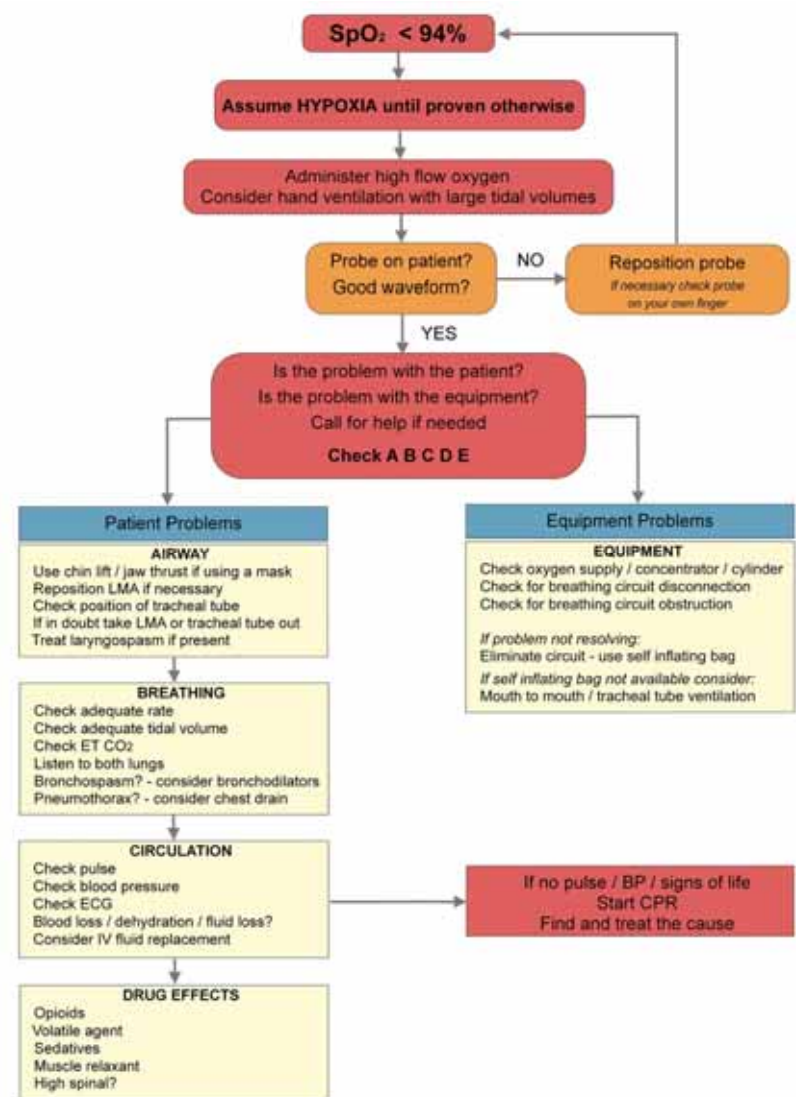
- A = Airway
- B = Breathing
- C = Circulation
- D = Drugs
- E = Equipment

The action plan shows us how to do this during anaesthesia



# Action plan for $SpO_2 < 94\%$

The next few slides will look at each part of the plan in turn and describe how to use it



# Immediate checks

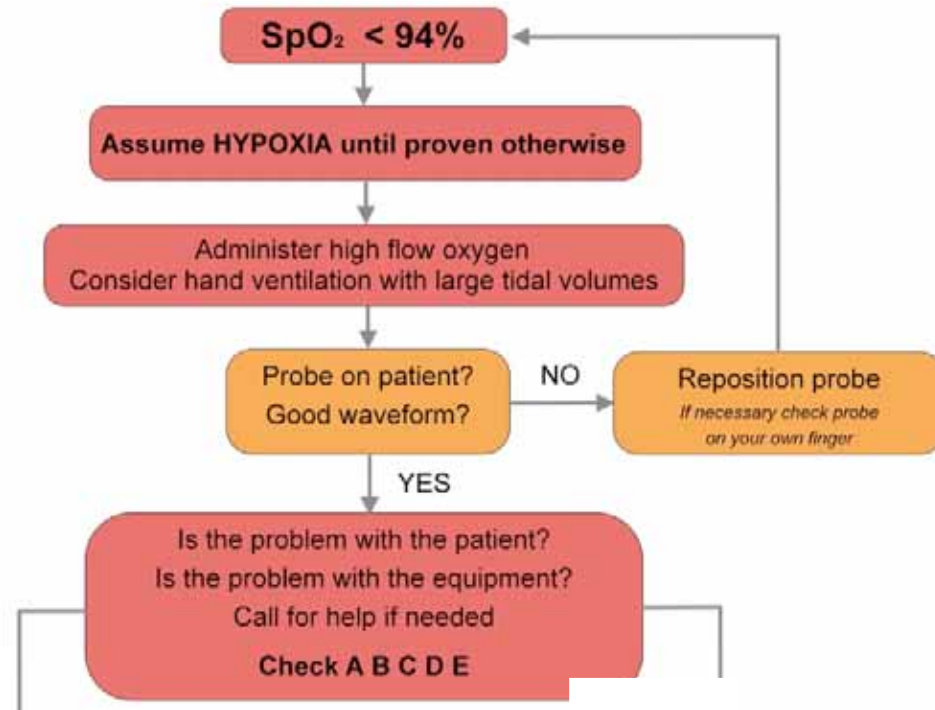
Immediately the SpO<sub>2</sub> falls below 95% start to check the patient.

## ACTION:

- Increase the oxygen flow
- Ventilate the patient by hand to make sure the lungs are filling with oxygen

## Now – start to solve the problem:

- Check the probe is on correctly
- Is the problem with the patient or equipment?
- Call for help if needed

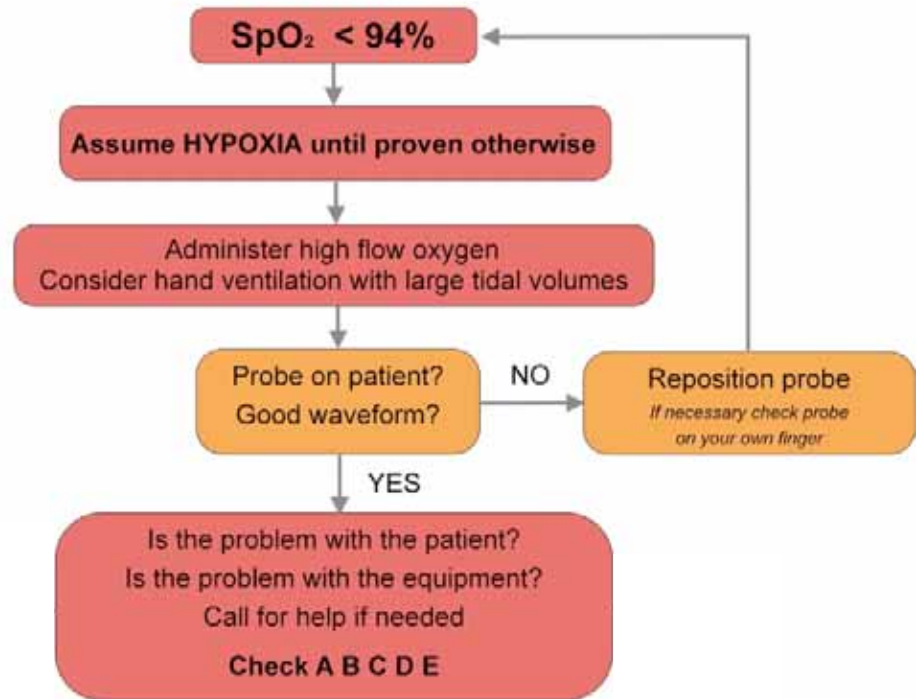


## Check ABCDE

# Immediate checks

Always call for help early. Hypoxia worsens rapidly and needs emergency treatment. It is better to call someone unnecessarily than not to have help with a deteriorating patient.

# HELP!!

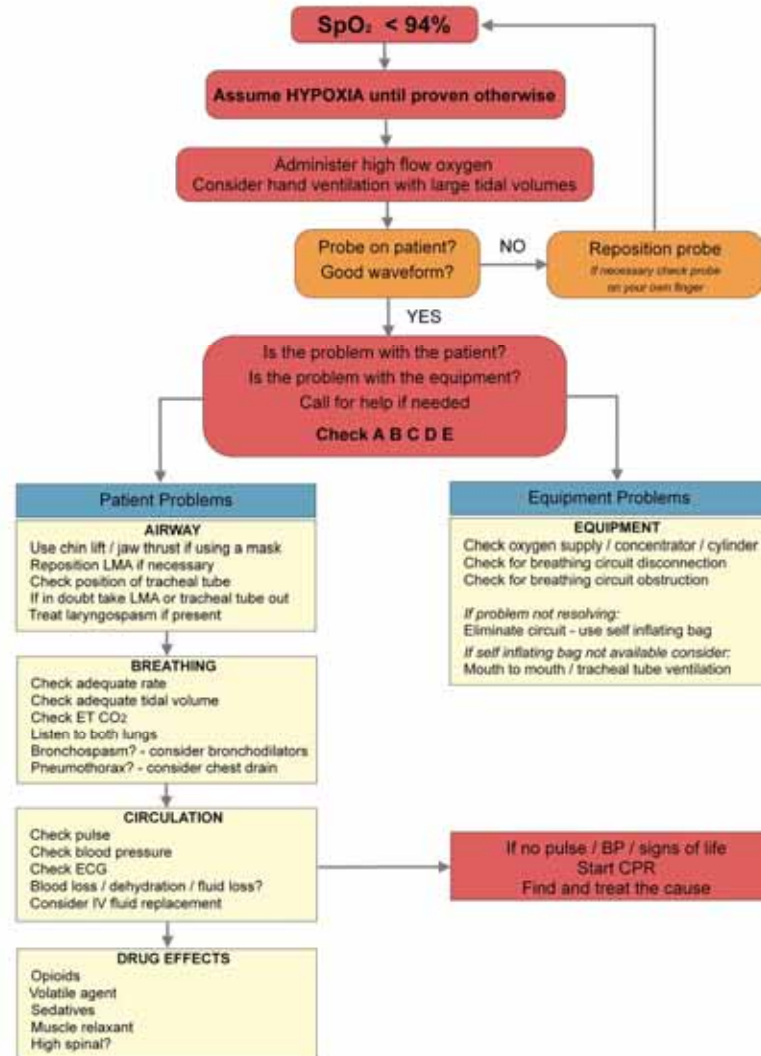


# Action plan for $SpO_2 < 94\%$

The next set of actions check ABCDE rapidly.

Using the plan will remind you to check everything and manage the patient logically.

The treatment will depend on whether the problem is in the patient or the equipment. This is a crucial decision to make.





# Patient Problems

# Airway

## **AIRWAY**

Use chin lift / jaw thrust if using a mask  
Reposition LMA if necessary  
Check position of tracheal tube  
If in doubt take LMA or tracheal tube out  
Treat laryngospasm if present

**The most common cause of hypoxia in theatre is airway obstruction or inadequate breathing!**

# Breathing

## BREATHING

Check adequate rate

Check adequate tidal volume

Check ET CO<sub>2</sub>

Listen to both lungs

Bronchospasm? - consider bronchodilators

Pneumothorax? - consider chest drain

**The most common cause of hypoxia in theatre is airway obstruction or inadequate breathing!**

# Circulation

## CIRCULATION

Check pulse

Check blood pressure

Check ECG

Blood loss / dehydration / fluid loss?

Consider IV fluid replacement

An inadequate circulation may be caused by a number of factors -

**Can you write some causes down?**

# Circulation

## CIRCULATION

Check pulse

Check blood pressure

Check ECG

Blood loss / dehydration / fluid loss?

Consider IV fluid replacement

An inadequate circulation may be caused by a number of factors - can you write some causes down?

Hypovolaemia, cardiac failure, sepsis, arrhythmia, anaesthesia overdose.

# Circulation

## CIRCULATION

Check pulse

Check blood pressure

Check ECG

Blood loss / dehydration / fluid loss?

Consider IV fluid replacement

Normally circulation failure presents as a deteriorating pulse signal which the oximeter finds difficult to pick up peripherally.

In shocked patients oxygenation in the lung becomes less efficient and it is common for the SpO<sub>2</sub> to fall.

# Circulation

## CIRCULATION

Check pulse  
Check blood pressure  
Check ECG  
Blood loss / dehydration / fluid loss?  
Consider IV fluid replacement



If no pulse / BP / signs of life  
Start CPR  
Find and treat the cause

If no pulse is present –  
start CPR and diagnose the problem

# Drugs

## DRUG EFFECTS

Opioids  
Volatile agent  
Sedatives  
Muscle relaxant  
High spinal?

Anaesthesia drugs may cause respiratory depression, muscle weakness or paralysis.

A high spinal may cause respiratory failure.



# Equipment Problems

What sort of problems with the anaesthesia equipment might cause hypoxia?

# Equipment

## EQUIPMENT

Check oxygen supply / concentrator / cylinder  
Check for breathing circuit disconnection  
Check for breathing circuit obstruction

*If problem not resolving:*

Eliminate circuit - use self inflating bag

*If self inflating bag not available consider:*

Mouth to mouth / tracheal tube ventilation

Check the equipment carefully for leaks and blockages. If a fault is discovered, disconnect the patient and ventilate by hand using a self-inflating bag. If no other means of ventilation is available, expired air ventilation from your mouth to the tracheal tube or patient's mouth may be lifesaving.

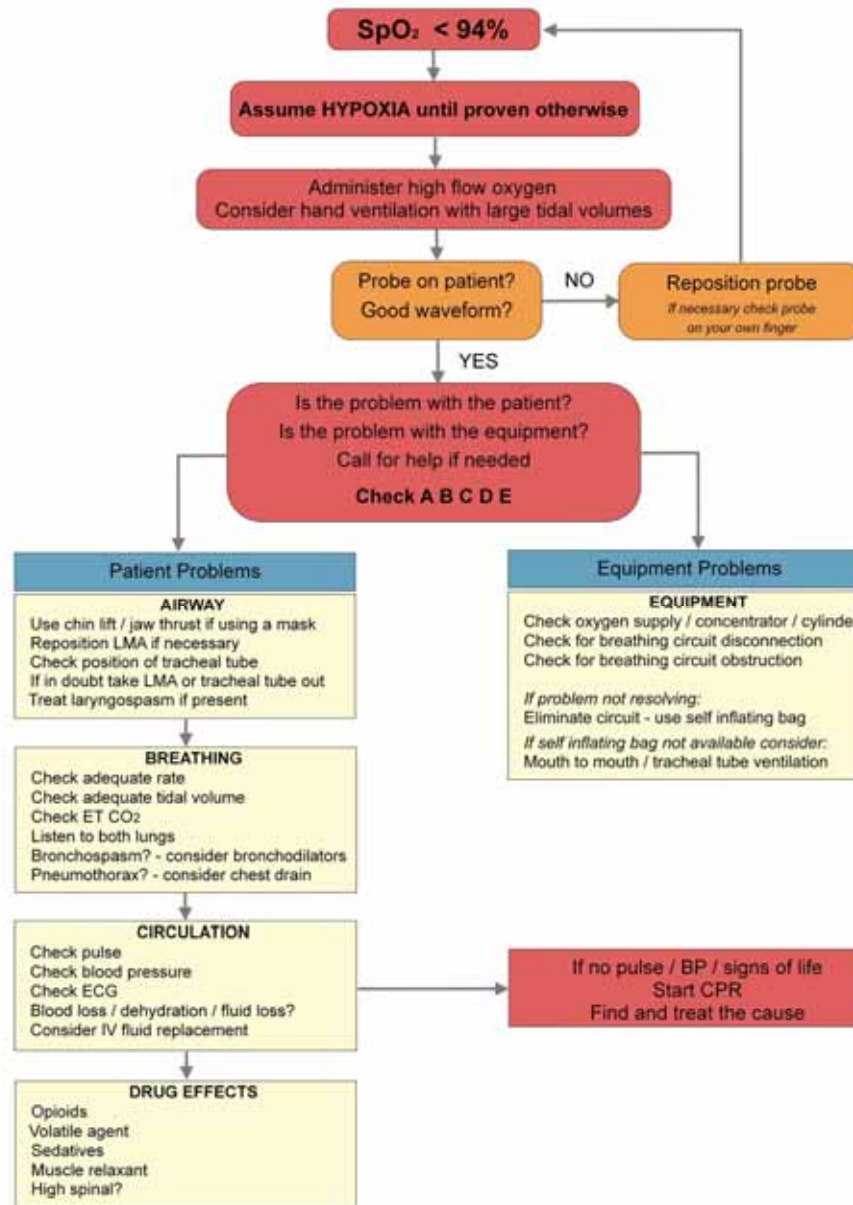


Now try to draw the whole plan for treating hypoxia from memory!



Did you get it correct?

If you did – give yourself a round of applause!!



# Summary

- Oximeters are essential during anaesthesia
- Oximeters and probes need looking after carefully
- Certain factors can interfere with oximeters
- When the SpO<sub>2</sub> starts to fall – take action!
- Use the plan to help you!
  - Immediate checks
  - Airway
  - Breathing
  - Circulation
  - Drugs
  - Equipment

