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Title: Hypoxia During Anesthesia

Hypoxia During Anesthesia

Anesthesia providers make every effort to avoid hypoxemia because of the risk of irreversible damage to the myocardium, brain, and other end organs. Despite these efforts, hypoxemia continues to occur in the operating room at a high rate. Hypoxemia is one of the patients' most serious risks during anesthesia and surgical care. Pulse oximetry has become an essential component of operating room technology to detect, treat, and reduce the degree of intraoperative hypoxemia in the world.

Before the widespread of pulse oximetry in the 1980s and the establishment of anesthesia monitoring standards in the 1990s, hypoxemia was the leading cause of anesthesia-related mortality, since then, anesthesia-related mortality has dropped nearly 20-fold.

Causes of hypoxia during anesthesia

Causes of hypoxia in theatre – consider **'ABCDE'**

A. AIRWAY

1. An obstructed airway prevents oxygen from reaching the lungs.
2. The tracheal tube can be misplaced e.g. in the esophagus.
3. Aspirated vomit can block the airway.

B. BREATHING

1. Inadequate breathing prevents enough oxygen from reaching the alveoli.
2. Severe bronchospasm may not allow enough oxygen to reach the lungs nor carbon dioxide to be removed from the lungs.
3. A pneumothorax may cause the affected lung to collapse.
4. High spinal anesthesia may cause inadequate breathing.

C. CIRCULATION

1. Circulatory failure prevents oxygen from being transported to the tissues.

- Common causes include hypovolemia, abnormal heart rhythm, or cardiac failure.

D. DRUGS

1. Deep anesthesia may depress breathing and circulation.
2. Many anesthetic drugs cause a drop in blood pressure.
3. Muscle relaxants paralyze the muscles of respiration.
4. Anaphylaxis can cause bronchospasm and low cardiac output.

E. EQUIPMENT

1. Problems with the anesthetic equipment include disconnection or obstruction of the breathing circuit.
2. Problems with the oxygen supply include an empty cylinder.
3. Problems with the monitoring equipment include battery failure in the oximeter or a faulty probe.

Management of Hypoxia

A – Is the airway clear?

- Are there signs of laryngospasm? (mild laryngospasm – high pitched inspiratory noise; severe laryngospasm – silent, no gas passes between the vocal cords)

- Is there any vomit or blood in the airway?

Airway obstruction is the most common cause of hypoxia in theatre. Unrecognized inadvertent oesophageal intubation is a major cause of anesthesia morbidity and mortality. An intubated patient who has been previously well-saturated may become hypoxic if the tracheal tube becomes displaced, kinked, or obstructed by secretions.

Check the endotracheal tube and - 'If in doubt, take it out.'

B - Is the patient breathing adequately?

- Are the chest movements and tidal volume adequate, and symmetrical?
- Listen to both lungs – is there normal bilateral air entry? Are the breath sounds normal?
- Bronchospasm, lung consolidation/collapse, lung trauma,

pulmonary edema or pneumothorax may prevent oxygen from getting into the alveoli to combine with hemoglobin.

- Drugs such as opioids, poorly reversed neuromuscular blocking agents or deep volatile anesthesia may depress breathing. A high spinal anesthetic may paralyze the muscles of respiration. An infant's stomach distension from facemask ventilation may splint the diaphragm and interfere with breathing.
- The treatment should deal with the specific problem.

C - Is the circulation normal?

- Feel for a pulse.
- Check the blood pressure.
- Check the peripheral perfusion and capillary refill time.
- Observe for signs of excessive blood loss in the suction bottles or wound swabs.
- Is anesthesia too deep? Is there a high spinal block?
- Is venous return impaired by compression of the vena cava (gravid uterus, surgical compression)?
- Is the patient in septic or cardiac shock?

Normally inadequate circulation is revealed by the pulse oximeter as a loss or reduction of pulsatile waveform or difficulty getting a pulse signal.

D - Drug effects

Check that all anesthesia drugs are being given correctly.

- Excessive halothane (or other volatile agents) causes cardiac depression.
- Muscle relaxants will depress the ability to breathe if not reversed adequately at the end of surgery.
- Opioids and other sedatives may depress breathing.
- Anaphylaxis causes cardiovascular collapse, often with bronchospasm and skin flushing (rash). This may occur if the patient is given a drug, blood, or artificial colloid solution that they are allergic to. Some patients are allergic to latex rubber.

* In anaphylaxis: what is the management?

1. Stop administering the causative agent.
2. Administer 100% oxygen.

3. Give intravenous saline starting with a bolus of 10ml/kg.
4. Administer adrenaline and consider giving steroids.
5. Bronchodilators and an antihistamine.

E - Is the equipment working properly?

- Is there a problem with the oxygen delivery system to the patient?
- Check for obstruction or disconnection of the breathing circuit or tracheal tube.
- Check that the oxygen cylinder is not empty.
- Check that the central hospital oxygen supply is working properly.

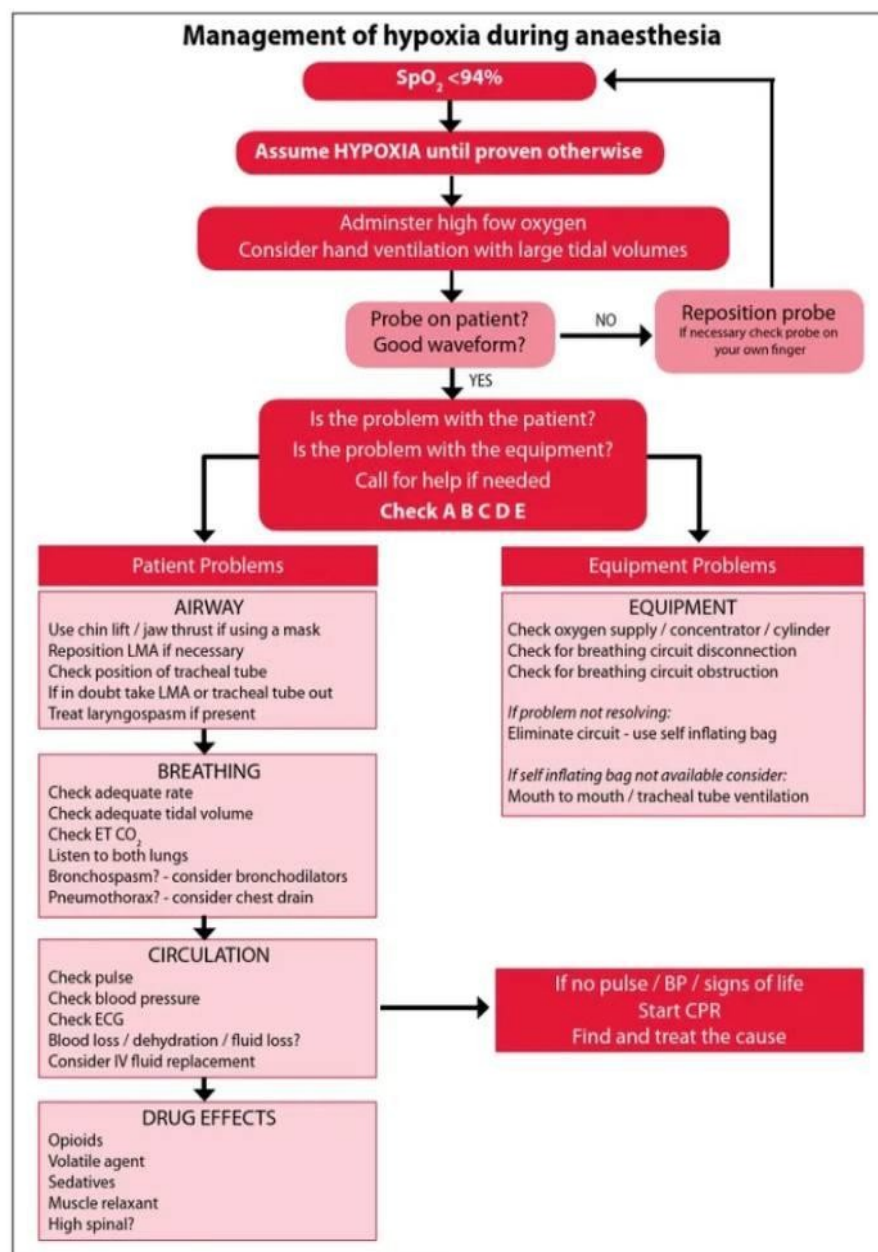


Figure 1. Available for download at: www.update.anaesthesiologists.org

Hypercapnia and Hypocapnia

Hypercapnia

Hypercarbia, or hypercapnia, occurs when levels of CO₂ in the blood become abnormally high (Paco₂ >45 mmHg).

Causes of hypercapnia

A. Increased CO₂ Production

1. Hyperthermia
2. Thyrotoxicosis
3. Shivering
4. Seizures
5. Intravenous sodium bicarbonate administration
6. CO₂ insufflation (laparoscopy)
7. Release of extremity tourniquets

B. Decreased CO₂ Elimination

1. **Hypoventilation**: e.g., decreased minute ventilation, Increased airway resistance (bronchospasm, endobronchial intubation), residual neuromuscular blockade, high spinal anesthesia.
2. **Increased dead space ventilation**: e.g. COPD, pulmonary embolus, ARDS, Application of positive end-expiratory pressure.
3. **Rebreathing of carbon dioxide**: e.g. Inadequate freshgas flow, Exhausted CO₂ absorber, Excessive circuit dead space.

C. Increased Carbon Dioxide Delivery to the Lungs

1. Increased cardiac output
2. Right-to-left shunts

Physiologic Effects

1. Cardiovascular

⌘ **Systemic hypertension**

⌘ **Tachycardia**

⌘ **Dysrhythmias**

⌘ **Hypotension (if Paco₂ is very high)**

2. Pulmonary

⌘ **Tachypnea (Paco₂ 45-90 mmHg)**

⌘ **Respiratory depression (Paco₂ >90 mmHg)**

⌘ **Bronchodilation**

3. Neurologic

⌘ **Increased cerebral blood flow**

⌘ **Increased intracranial pressure**

⌘ **Central depression (if Paco₂ is very high)**

4. Metabolic

⌘ **Acidosis**

⌘ **Compensatory metabolic alkalosis**

⌘ **Hyperkalemia**

Hypocapnia

Hypocapnia, or hypocapnia, occurs when levels of CO₂ in the blood become abnormally low (Paco₂ <35 mmHg).

Causes of hypocapnia

A. Increased Carbon Dioxide Elimination

Hyperventilation

Decreased dead space ventilation

Decreased CO₂ rebreathing

B. Decreased Pulmonary Perfusion

Decreased cardiac output

Pulmonary embolism

C. Decreased Carbon Dioxide Production

Hypothermia

Deep anaesthesia

Hypothyroidism

Decreased metabolism

D. Airway/Equipment Problems

Oesophageal intubation

Accidental extubation OR circuit disconnection

Physiologic Effects

1. Cardiovascular:

Decreased myocardial oxygen supply

Increased risk of coronary artery vasospasm

Increased myocardial oxygen demand

2. Neurologic:

Decreased cerebral blood flow

Decreased cerebral oxygen delivery

Decreased intracranial pressure

3. Metabolic/hematologic:

Respiratory alkalosis

Increased intracellular calcium concentration

Increased platelet count and aggregation

MCQ TEST

- 1- Causes of hypoxia under general anesthesia(all true except one)
 - a) Pneumothorax.
 - b) Laryngospasm.
 - c) Anaphylaxis.
 - d) Inadequate reversal of muscle relaxant
 - e) Drugs like salbutamol.
- 2- Management of hypoxia during anesthesia
 - a) Reposition of LMA.
 - b) Reposition of probe of oximeter.
 - c) Check blood pressure.
 - d) Fluid replacement.
 - e) All the above
- 3- An intubated patient developed rapid desaturation (all the following true except one)
 - a) Check the position of tube.
 - b) The most common cause is esophageal intubation.
 - c) Check blood pressure.
 - d) Check ECG
 - e) Give long-acting muscle relaxant.
- 4- hypocapnia
 - a) occurs when levels of CO₂ in the blood become abnormally low (Paco₂ <35 mm Hg).
 - b) Also called hypocarbia.
 - c) Caused by hypoventilation.
 - d) Increased risk of coronary artery vasospasm
 - e) Decreased ICP.
- 5- Physiological effects of hypercapnia (all true except one)
 - a) Tachycardia.
 - b) Hypotension.
 - c) Alkalosis.
 - d) Increased ICP.
 - e) Hyperkalemia.

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GOOD LUCK

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