SAWA UNIVERSITY

جامعة ساوة الاهلية
كلية التقنيات الصحية والطبية
قسم التخدير - اللجنة العلمية

مادة أسس التخدير 1 الكورس الاول

Anesthetic crisis

Hypoxia and Malignant hyperthermia

Sawa University — جامعـــــة ســـــــاوة الاهلية

College of health and medical techniques — كليـــــة التقنيـــات الصحيـة والطبيـة

Department of Anesthesia — قسم تقنيـــات التخديـــــر

Second .. Stage. — المرحلـــــــــــة .الثانية .

نظـــــــري ... محاضرة رقم10

Theoretical ..... Lecture No.10

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What is the difference between hypoxia and hypoxaemia?

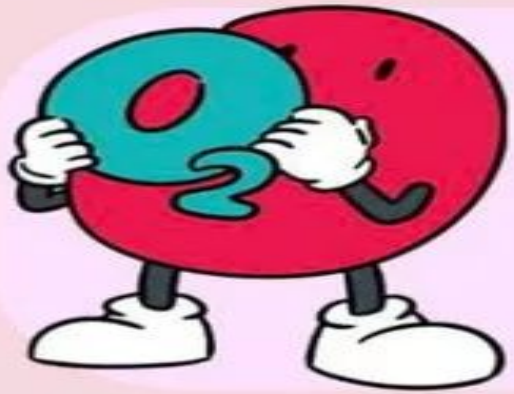
Hypoxia vs Hypoxaemia

HYPOXIA

Hypoxia is a condition where there's an inadequate supply of oxygen to the body's tissues and organs, there are 4 types:

1. Hypoxic hypoxia
2. Anaemic hypoxia
3. Circulatory hypoxia
4. Histotoxic hypoxia

HYPOXAEMIA



Hypoxaemia refers to low oxygen levels in the bloodstream. Causes include:

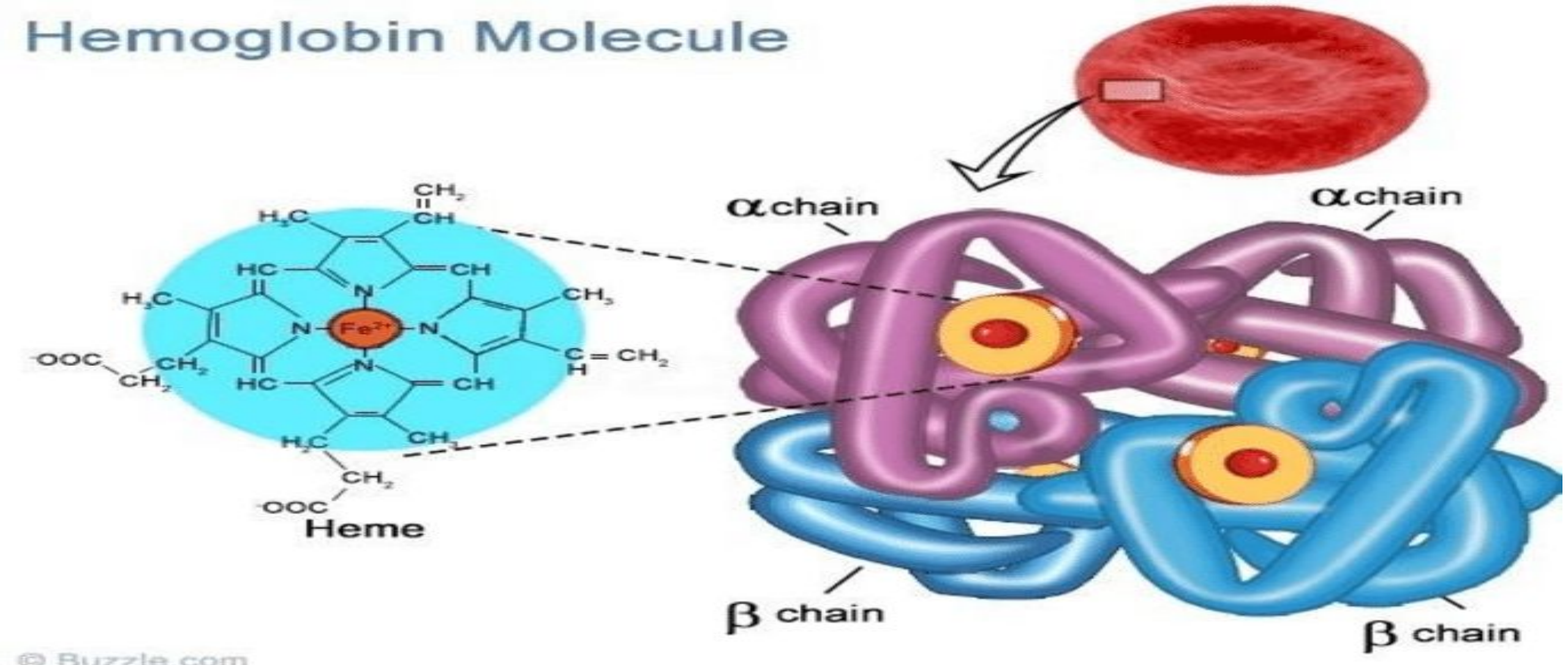
- Respiratory issues
- Cardiovascular problems
- Altitude
- Anaesthesia

What is oxygen saturation (SpO2)?
What is the normal range for SpO2?

- Peripheral Oxygen saturation (SpO2) is a measurement of how much oxygen your blood is carrying as a percentage of the maximum it could carry.
- For a healthy individual, the normal SpO2 should be between 95% to 100%.
- At the molecular level, hemoglobin consists of (4) globular protein subunits. each subunit is associated with a heme group. each molecule of hemoglobin subsequently has four heme-binding sites readily available to bind oxygen .Hemoglobin is capable of carrying up to (4) oxygen molecules.

- SpO2 values below 95% (90.1%-94.9%) are considered to be **abnormal**, and caution should be taken at these values.
- Patients with an SpO2 reading of less than 90% are said to be **hypoxemic**.
- Patients with an SpO2 reading of less than 85%would be **severely hypoxemic**.
- These patients would most likely need an **external oxygen supply**
- Hypoxia In its extreme form, where **oxygen** is entirely **absent,** the condition is called **anoxia.**

Haemoglobin (HB) is a protein that carries oxygen in the blood. It is found inside red blood cells and gives them their red colour



What is the difference between SaO2, SvO2 and SpO_2 ?

- SaO_2 (arterial oxygen saturation, as determined by an **arterial blood gas test** (ABG)
- value below 90% indicates hypoxemia
- Hypoxemia due to low SaO_2 is indicated by cyanosis.
- SvO2 (venous oxygen saturation) is the percentage of oxygenated hemoglobin returning to the right side of the heart
- SvO_2 typically varies between 60% and 80%.

A lower value indicates that the body is in lack of oxygen and ischemic diseases occur.

- SpO_2 (Peripheral oxygen saturation) is typically measured at a **fingertip,** an **earlobe** or an **infant's foot** using a **pulse oximeter** and it is approximation to SaO_2 { **Arterial oxygen saturation measured at the periphery is known as SpO2}**

❑ SPO2 values of **95% to 100**% are generally considered **normal**.

✔ Values **under 90%** could quickly lead to a serious deterioration in status

✔ **Values under 70% are life-threatening**.

Signs of altered oxygen saturation include :

✔ Low blood pressure (BP)

✔ Increased respiratory rate (RR)

✔ increased pulse rate (PR)

Other signs of altered oxygen saturation that would indicate checking Spo_2 are :

✔ Altered respiratory rate and depth of rhythm

✔ Unusual breath sounds

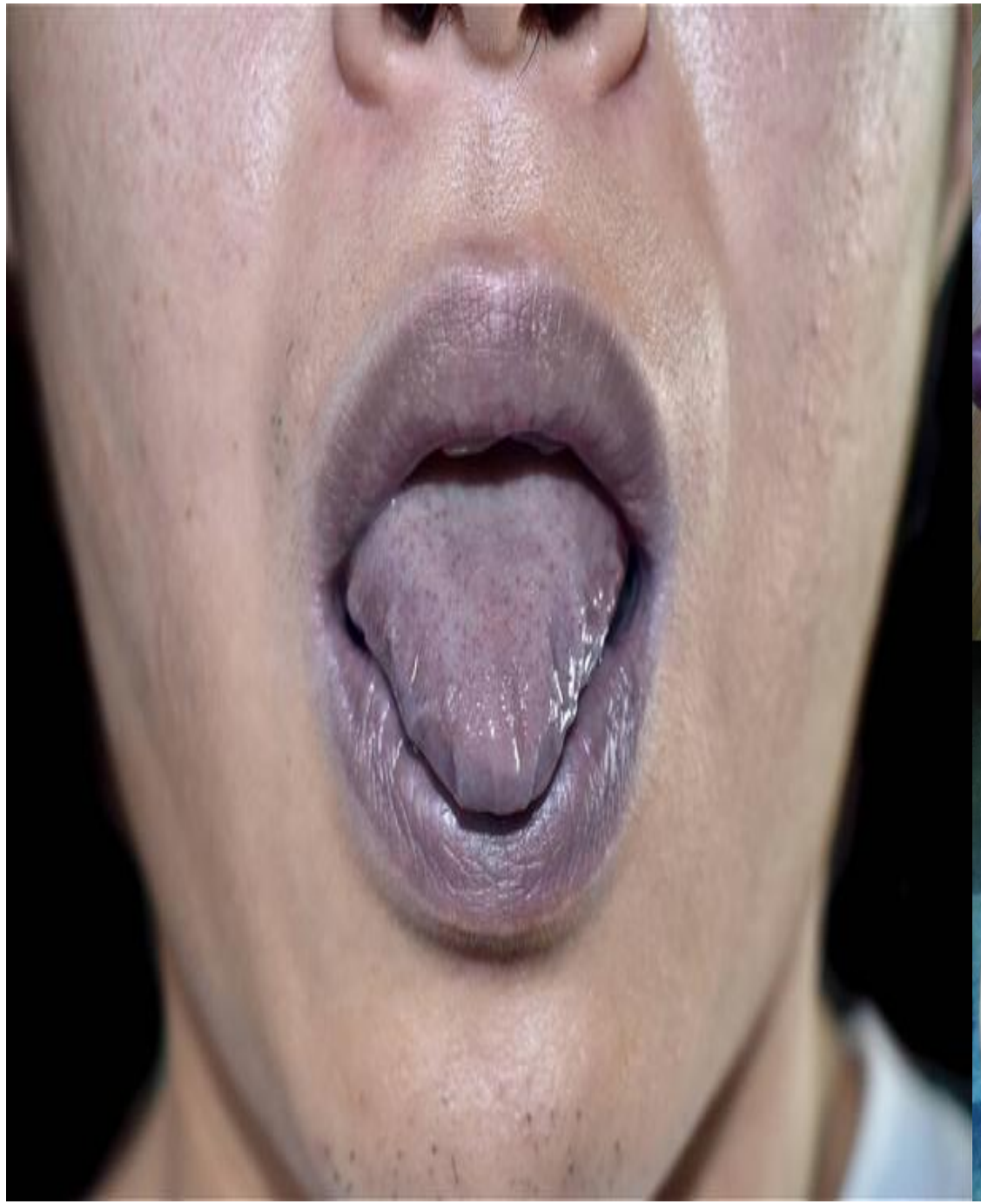
✔ Cyanotic appearance of nail beds, lips, or mucous membranes

✔ Dusky skin

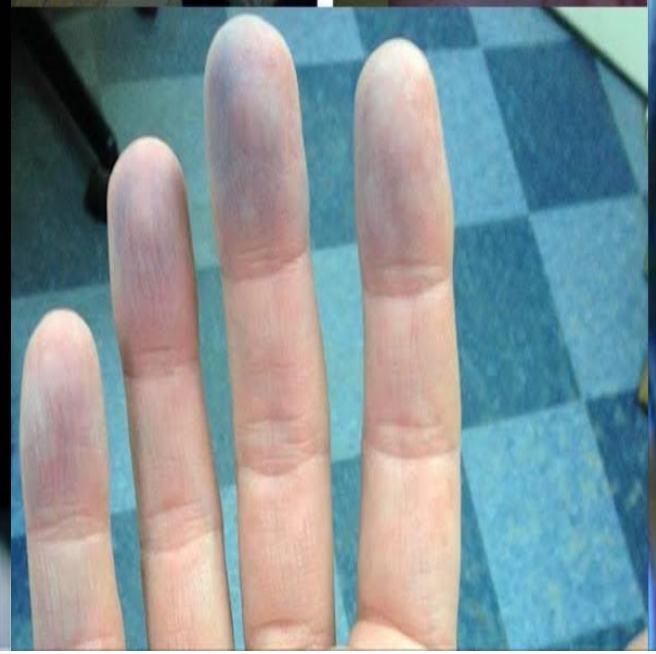
✔ Confusion

✔ Decreased level of consciousness(DLOC)

✔ Dyspnea.



CYANOSIS



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 of Circulatory failure include :

- Hypovolemia , Abnormal heart rhythm , 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 air way 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

✔ Pneumothorax

All 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.

Malignant hyperthermia:

Malignant hyperthermia (MH) is a hypermetabolic response to:

- **potent inhalation agents** (such as **halothane, sevoflurane**, **desflurane,Isoflurane**)
- **The depolarizing muscle relaxant (succinylcholine)**
- Rarely, in humans, to stresses such as vigorous exercise and heat.

As almost all patients who are MH susceptible have no phenotypic changes without anesthesia,

It is impossible to diagnose susceptibility without either the exposure to the "trigger" anesthetics or by specific diagnostic testing.

The key diagnostic features include:

1. An unexplained elevation of expired carbon dioxide
2. Muscle rigidity and rhabdomyolysis,
3. Hyperthermia, acidosis and hyperkalemia.

Diagnostic criteria:

The diagnosis of MH is based on clinical presentation or laboratory testing

The principal diagnostic features of MH are:

- **Unexplained elevation of end-tidal carbon dioxide (ETCO2) concentration,**
- **Muscle rigidity, tachycardia, acidosis, hyperthermia, and hyperkalemia**.

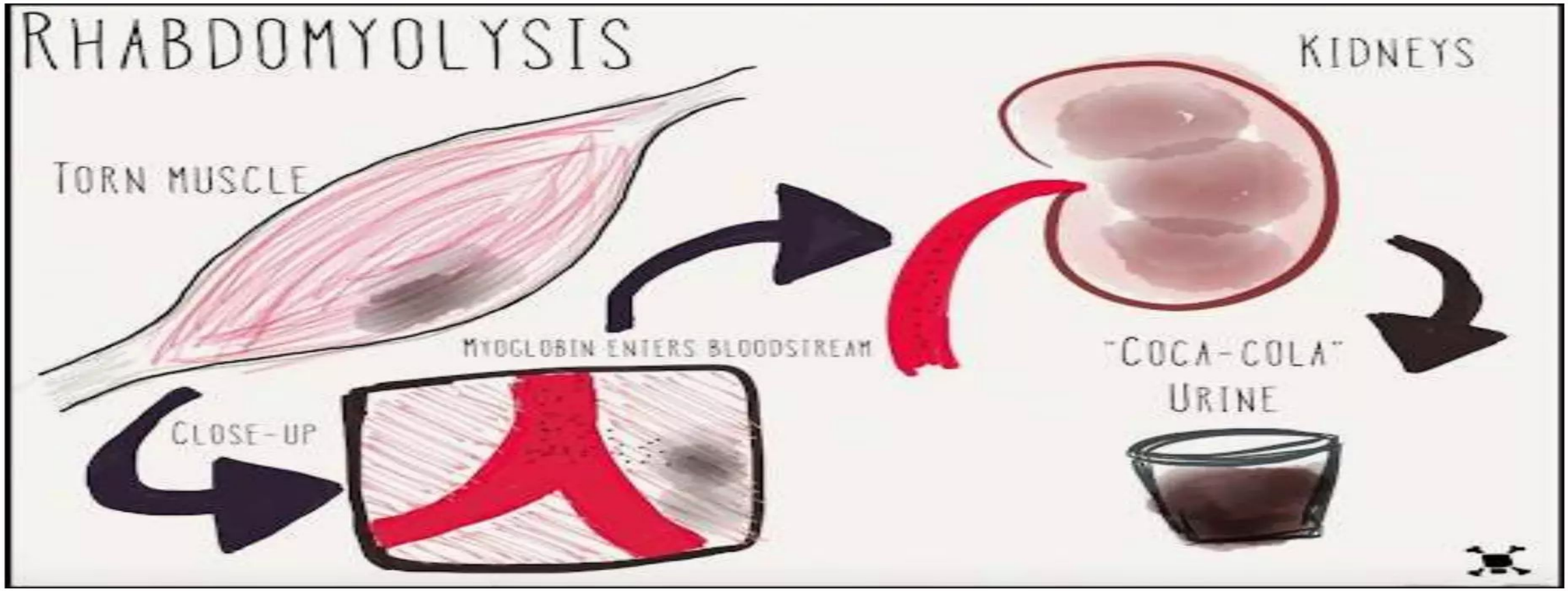
The variability in the order and time of onset of signs often makes the clinical diagnosis rather difficult.

Table 1

Criteria used in the Clinical Grading Scale for Malignant Hyperthermia

Clinical Finding	Manifestation
Respiratory acidosis	End-tidal CO_2>55 mmHg; $PaCO_2$>60 mm Hg
Cardiac involvement	Unexplained sinus tachycardia, ventricular tachycardia or ventricular fibrillation
Metabolic acidosis	Base deficit >8 m/Eql pH<7.25
Muscle rigidity	Generalized rigidity; severe masseter muscle rigidity
Muscle breakdown	Serum creatine kinase concentration >20,000/L units; cola colored urine; excess myoglobin in urine or serum; plasma [K+] >6 mEq/L
Temperature increase	Rapidly increasing temperature; T >38.8°C
Other	Rapid reversal of MH signs with dantrolene. Elevated resting serum creatine kinase concentration.
Family history	Consistent with autosomal dominant inheritance

RHABDOMYOLYSIS



Signs suggesting possible MH

Early	*Developing*	*Late*
Elevated $EtCO_2$	Acidosis	Cola-coloured urine
Masseter spasm	Temperature rise	↑↑CK
Tachycardia	CVS instability arrest	Coagulopathy
Arrhythmias	Hyperkalaemia	↓SpO_2

If there is a malignant hyperthermia pre-prepared 'box' in the hospital, use it and follow the **task card system**.

If not, prioritize treatment: **D**antrolene
Anaesthesia
Supportive therapy

Dantrolene requires dedicated staff to prepare. It is dissolved in **sterile water**.

TIVA – use propofol TCI 4mcg/ml or 30–50ml/hr in adult.

Hyperkalaemia is treated according to protocol – see tab 21.

Diuresis is maintained using **0.5g/kg of mannitol**. *Aim for >2ml/kg/hr with a pH>7.0.*

Consider the treatment of acidosis with **8.4% $NaHCO_3$** *only* if there is associated hyperkalaemia.

Active cooling includes:

Intra-abdominal lavage (saline at 4°C)
Cool IV fluids
Cool sponging and ice packs
Lowering theatre temperature

Blood chemistry includes FBC, electrolytes, ABG's, CK, clotting profile and myoglobin levels.

Steps for treating Malignant Hyperthermia

- Emergency page to staff anaesthesiologist
- Discontinue the triggering agents
- Discontinue the surgical procedure as quickly as possible
- Start TIVA(Total Intravenous anaesthetic agents)
- Hyperventilate with 100% Oxygen at high flow rate

Steps for treating Malignant Hyperthermia

- Give Dantrolene sodium 2.5 mg/Kg I.V
- Obtain Labs(ABGs,Electrolytes,CK,serum/urine myoglobin,Coagulation parameters)
- Treat Hyperkalemia :Calcium chloride,Glucose,Insulin
- Treat Metabolic Acidosis: Bicarbonate:1-2 mEq/kgs

Steps for treating Malignant Hyperthermia

- Incase of hyperthermia: cool patient

  cold IV fluids(normal saline),Apply ice packs to groin ,axilla ,nasogastric lavage with cold solution
- Foley catheter for urine output
- ICU admission

Cooling Techniques for Hyperthermia

MALIGNANT HYPERTHERMIA TREATMENT

"Some Hot Dude Better Give Iced Fluids Fast!"

- **S**top triggering agents
- **H**yperventilate/ Hundred percent oxygen
- **D**antrolene (2.5mg/kg)
- **B**icarbonate
- **G**lucose and insulin
- **I**V Fluids and cooling blanket
- **F**luid output monitoring/ Furosemide/ **F**ast heart (tachycardia)

Any questions?