Oxygen Monitoring Devices

Types of Devices

Techniques

Problems

Evaluate patient’s status

Assess the effect of oxygen therapy

- O2 saturation
- PaO2
- FiO2 requirement

Determine if changes in patient’s therapy is indicated
Types of Devices

- Oxygen analyzers
- PCO2 measuring system
- PO2 measuring system
- Transcutaneous electrodes
- Pulse oximeter

Oxygen Analyzers

- Used for measuring the oxygen concentration of inspired gases
- 3 types
  - Paramagnetic
  - Electrical
  - Electrochemical
    - Galvanic
    - Polarographic

- Paramagnetic
  - Included for historical purposes
  - Developed in 1946 by Pauling
Oxygen Analyzers

- Paramagnetic

- Uses Pauling Principle or the Principle of Paramagnetism to measure oxygen concentration

- Oxygen is a paramagnetic gas

- If a magnetic field is present, O2 will be attracted to it and its molecules will align themselves with the north-south magnetic flux lines

- Other gases are ________________ by the magnetic field

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The paramagnetic oxygen sensor consists of a cylinder-shaped container inside of which is a small glass dumbbell.

- The dumbbell is filled with an inert gas such as nitrogen and suspended on a taut platinum wire within a non-uniform magnetic field.

- The dumbbell is designed to move freely as it is suspended from the wire.

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When a sample gas containing oxygen is sent through the sensor, the oxygen molecules are attracted to the stronger of the two magnetic fields. This causes a displacement of the dumbbell which results in the dumbbell ____________.

- The degree of rotation is dependant upon the partial pressure of oxygen and is converted to O2%
Oxygen Analyzers

- Beckman D-2 analyzer

**Paramagnetic**

- Disadvantages
  - Cannot be used to measure _____________ gas
  - Sample must be ________________
  - It is very delicate
  - Affected by changes in ________________

**Electrical**

- Operate on the principle of thermal conductivity and use an electronic device called a "___________."
- 2 parallel wires receive an electrical current from a battery
  - 1 of the wires is the reference wire exposed to room air
  - The other wire is in the gas sample chamber and exposed to the gas being measured
Oxygen Analyzers

Electrical

- In the sample chamber – if the O2 concentration is higher than room air → the wire cools → its __________ decreases
- The change in resistance is detected → converted to O2%

Advantages

- Unaffected by changes in ambient ________________

Disadvantages

- Can only measure static gases
- Produces ______________ – can’t be used in the presence of anesthetic gases
Oxygen Analyzers

- Electrochemical
  - Rely on an oxygen-mediated chemical reaction to produce a flow of current (electrons)
  - 2 types
    - Galvanic
    - Polarographic

Oxygen Analyzers

- Electrochemical – Galvanic
  - A gold electrode & a lead electrode are immersed in a potassium hydroxide bath
  - The gas sample is separated from the KOH bath by a semipermeable membrane made of Teflon

As O₂ diffuses through the membrane into the KOH bath – it reacts with H₂O & free electrons from the gold cathode to form hydroxyl ions (OH⁻)

The hydroxyl ions diffuse towards the lead anode forming lead oxide (PbO₂), H₂O & free electrons

The flow of the electrons produces electrical current in proportion to the O₂ concentration that is measured & converted to O₂%
Oxygen Analyzers

- Electrochemical – Galvanic
  - Example: Hudson Galvanic O2 Analyzer

Oxygen Analyzers

- Electrochemical – Polarographic
  - Also use an oxygen-mediated chemical reaction to produce electrical current but do have some differences
  - Contain a platinum cathode & a silver anode immersed in KOH bath
  - Also have a 9-V battery to polarize the silver anode → shorter response time

Oxygen Analyzers

- Electrochemical – Polarographic
  - Example: Teledyne
Oxygen Analyzers

- **Electrochemical Analyzers**
  - **Advantages**
    - Gas samples can be analyzed
    - Can be used with flammable gases
    - Used for intermittent or continuous monitoring
  - **Disadvantages**
    - The chemicals in the fuel cell are used
      - The cell "goes dead" and must be replaced.
      - To prolong the fuel cell life, it is important to keep the fuel cell capped so it is not continually exposed to room air
    - Affected by changes in ambient pressure
    - Also affected by __________

Must be calibrated to _________ and ______% O2

- In most cases, FiO2 is measured as close to the patient as possible

Documented as either % or FiO2

- Example: O2% - 40% or FiO2 - 0.40
- Not O2% - 0.40 or FiO2 – 40%
Pulse Oximeters

- Measures the % of oxygen-saturated \_\_\_\_\_\_ or % of oxyhemoglobin (oxyHb)
- Non-invasive
- Performed continuously or intermittently
- Utilizes technique called \_\_\_\_\_\_

Pulse Oximeters

- Spectrophotometry
  - Blood sample placed between infrared light source & a light detector using a probe

- Photodetector measures the amount of \_\_\_\_\_ light passing through the blood sample
- Desaturated Hb absorbs \_\_\_\_\_ light than saturated Hb
- Amount of light passing through is converted to a % reading, i.e. the % of Hb carrying O2
- Expressed as SpO2
- Also measures \_\_\_\_\_\_
Pulse Oximeters

- Does not measure Hb level
- Inaccurate if: poor blood flow, dark fingernail polish, bright ambient light
- Cannot differentiate between Hb carrying O2 and _______
  
  - If SpO2 = 95% & COHb = 25%

    % of Hb carrying O2 = ________%

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Co-Oximeters

- Table-top oximeter = __________________
- Also using spectrophotometry, measures
  
  - Hb
  - SaO2
  - COHb
  - MetHb
  - Other Hb's
  - Highly accurate
Pulse Oximeters

- Normal = ≥ ____% (sea level), ≥ ____% (Amarillo)
- Have an idea of the patient's PaO2 if we know the SO2

Blood Gas Analyzers

- Measure PO2, PCO2, pH, HCO3-
  - Arterial blood
  - Venous blood
  - Capillary blood
  - Pleural fluid

Transcutaneous Monitors

- Non-invasive
- Measure PaO2 and PaCO2 through the skin
- Utilizes a heated probe sealed to the skin
- Used mostly on infants
Paramagnetic gas = a gas that can be changed in position from its rested state with a ____________.

For example, if the gas was in a sealed glass tube → you could see it move or change in color when a magnet is close to it.

Oxygen is the most paramagnetic gas.