Inhalant Anesthesia: From the Machine to the Brain

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I. Delivery system of inhalant anesthetics
   a. Medical gas source
   b. Anesthetic machine
   c. Breathing system
   d. Waste gas scavenging

II. Medical gas source
   a. Gas pipeline system
      i. Liquid oxygen
      ii. Manifolds of large oxygen tanks (G or H cylinders)
      iii. Station outlets are equipped with non-interchangeable gas specific connectors to connect the gas supply to an anesthetic machine
      iv. High pressure system
   b. Individual oxygen cylinders (E cylinder) attached to an anesthetic machine
   c. Cylinders are connected to the anesthetic machine via hanger yokes
   d. Hanger yokes have a pin index safety system to ensure that only an oxygen cylinder can be secured to an oxygen hanger yoke
   e. The E cylinders are also under high pressure.

III. Oxygen pressure regulator
   a. The pressure regulator will reduce the pressure of the oxygen exiting the cylinder or station outlet to a constant pressure of approximately 50 psi
   b. Produce a safe operating pressure, prevent flowmeter fluctuations as cylinders empty, and decrease the sensitivity of the flowmeter's indicator to movements of the control knob
   c. Decrease to pressure form the pipeline or cylinder to an operating level
   d. Intermediate pressure system.

IV. Flowmeter
   a. To be read in either ml/min or L/min
   b. Controls the rate that oxygen will be delivered and allows for precise control of oxygen delivery
   c. Each flowmeter is comprised of a tube, an indicator, and a scale
      i. Calibrated as a unit for 760mmHg and 20 degrees C (68 F), and should not be interchanged
   d. The lowest mark on the scale is the first accurate reading
      i. The float should be read at the top of the indicator, except for the ball float which is read at the diameter of the ball

V. Vaporizer
   a. Designed to volatilize liquid anesthetics and to deliver clinically useful concentrations of anesthetic vapor using oxygen as the carrier gas
   b. Precision vaporizers dilute the high concentration of anesthetic vapor from the vaporization chamber to a clinically usable, relatively safe concentration
   c. Usually vaporizers-out-of-circle (VOC).
   d. These vaporizers are agent specific, usually variable bypass, and the anesthetic concentration can be changed relatively quickly

VI. Oxygen flush valve
   a. Supplies high flow rates (35 to 75 L/min) to the common gas outlet
   b. The flow bypasses the anesthetic vaporizer and, therefore, dilutes the anesthetic gas within the breathing system
   c. It is possible to overpressurize the breathing system very quickly and should not be used with a non-rebreathing system

VII. Common gas outlet
   a. Will connect to the fresh gas inlet of the breathing circuit (non-rebreathing or rebreathing)

VIII. Fresh gas inlet
   a. Oxygen and inhalant will enter the breathing system via the fresh gas inlet

IX. Rebreathing or circle breathing systems

a. Deliver anesthetic and oxygen to the patient, remove carbon dioxide from the exhaled gases, and provide a means to ventilate the patient
b. The circle systems are the more complex of the two systems (more components) and use chemical absorbents to remove CO2 and return gases to the patient
c. All circle systems have the same basic components that are arranged to move gases (both inhaled and exhaled) in only one direction
d. Oxygen and inhalant enters the breathing system through the fresh gas inlet and flows to the inspiratory one-way valve
    i. Valve is responsible for directing gases towards the patient on inspiration and aids in preventing rebreathing of gases
    ii. Most unidirectional valves have a dome and disc construction
    iii. The valves add to the resistance of breathing and need to be regularly inspected
e. Inspiratory limb of the breathing tubes
    i. Corrugated plastic (to reduce the likelihood of kinks) and are flexible, low-resistance conduits between the Y-piece and the one-way valves
    ii. Although the tubes have a low resistance, they do still add resistance to the breathing system
    iii. They should have an internal diameter greater than the patient's ET tube minimize the additional resistanc
    iv. Breathing tubes do not add to dead space if the one-way valves are fully functional
    v. The breathing tube will then connect to the Y-piece
f. Y-piece
    i. Connects the endotracheal tube connector to the breathing tubes
    ii. Will contribute to mechanical dead space
g. Expiratory limb of the breathing tubes
h. Expiratory unidirectional valve
i. Adjustable pressure limiting valve (APL) or pop-off valve
    i. The APL valve vents gases to the waste gas scavenging system to prevent the buildup of pressure and allows for rapid elimination of anesthetics from the system
    ii. The scavenging system should safely remove vented inhalants as to not contaminate the workplace
    iii. Should vent gases at a pressure of 1-2 cm H2O when fully opened, and it should remain open except during positive pressure ventilation
j. Reservoir bag is located in conjunction with the APL valve
    i. The bag provides a reservoir tidal volume for the patient and should be approximately 6 times the patient's tidal volume
    ii. When the pop-off is closed, the reservoir bag allows for assisted ventilation
k. Pressure manometer
    i. Positioned on top of the CO2 absorber - should be used when giving a breath to ensure excessive pressure is not generated within the breathing system
l. CO2 absorber
    i. The CO2 absorber's function is to eliminate CO2 from the exhaled gases so that no CO2 may circulate back to the patient
    ii. The CO2 is eliminated through a chemical reaction that causes the absorber granules to change color and produce heat
    iii. Canister should be warm to the touch if the granules are working
    iv. The airspace between the CO2 granules (roughly 50% of the canister's volume) should be greater than the patient's tidal volume
    v. Any gases passing through the absorber will combine with gases from the fresh gas inlet and be re-circulated back to the patient

X. Non-rebreathing or non-circle systems

a. Deliver anesthetic and oxygen to the patient, remove carbon dioxide from the exhaled gases, and provide a means to ventilate the patient
b. Mapleson systems
c. Eliminates all exhaled gases from the breathing circuit and does not make use of a CO2 absorber

d. Compared to the circle system, a non-rebreathing system has less resistance to breathing, allows for rapid alterations in anesthetic concentrations, is lightweight, and the system is inexpensive
e. Its disadvantages are that, although the equipment is inexpensive, it is more expensive to use due to higher gas flow rates and a grater loss of heat and humidity
f. The non-rebreathing systems use high fresh gas flow rates to flush exhaled gases from the system
g. There are no one-way valves or absorbers with the non-rebreathing systems
h. An APL valve and scavenger are used with these system

XI. Inhalants to the brain

a. Inhalant anesthetics are drugs that are inhaled into the respiratory system of the patient in the form of vapors or gases
b. To produce their effects, they must be absorbed from the alveoli of the lungs into the blood stream and carried by the blood to the brain of the patient
c. The reverse will be true when an animal is recovering from an inhalant anesthetic