VETERINARY ANESTHESIA SPECIALISTS LLC
comfort for all creatures

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ANESTHESIA EQUIPMENT: SAFETY CONSIDERATIONS FOR FELINE PATIENTS

Compare and contrast anesthesia breathing circuits:

	Non-rebreathing system	**Rebreathing system**
What is patient rebreathing?		
How does the circuit prevent patient from rebreathing CO_2?		
Minimum required **oxygen** flow rate		
Patient temperature conservation		
Resistance to breathing		
Dead space		
Time to change anesthetic depth		
Bottom line: Which circuit to choose for your patients?		
Very small < 3 kg		
Small – medium 3 – 10 kg		
Large > 10 kg		

Anesthetic equipment is considered "life-critical" because the health and well-being of patients and staff can be adversely affected if the equipment is not functioning optimally or is used incorrectly. The following safety concerns will be addressed in this lecture: 1) minimizing exposure to anesthetic waste gases, 2) ensuring appropriate delivery of oxygen and inhaled anesthetic, 3) elimination of carbon dioxide from the patient circuit, and 4) preventing physical harm to patients.

1. **Scavenging waste anesthetic gases**
   a. Active scavenging with pump or fan system is effective and reliable.
   b. Passive scavenging with F-AIR-type canisters or "hole-in-wall" is not reliable, and requires active monitoring of efficacy.
   c. Inhalant induction using a mask or box is not recommended because it exposes personnel to excess waste anesthetic gases and is dangerous for pets.
   d. Exposure of staff to low levels of inhalants can cause headaches, irritability, impaired mental function and decreased reproductive function.

2. **Vaporizer**
   a. Complex, precision instrument used to dilute and deliver precise amount of inhalant
   b. Verify vaporizer output and calibration every 6 – 12 months
   c. Full service (clean inside, replace parts, leak test and re-calibrate) every 1 – 3 years

3. **Anesthesia machine**
   a. Safety features to have on every anesthetic machine: manometer in rebreathing and non-rebreathing circuits, safety pop-off valves, top-mounted one-way valves for visibility, manufactured of non-corrosive material
   b. Low-pressure leak test machine with breathing circuit prior to every anesthetic
   c. Full service (clean inside, replace parts, low & high pressure leak test) every 6 – 12 months
   d. **Never use the oxygen flush valve with a patient attached** to the breathing circuit. High flow and high pressure of oxygen are applied directly to the patient's airways and will irreparably damage the lungs.

4. **Carbon dioxide elimination**
   a. Anesthesia machines and breathing circuits are designed to prevent patients from rebreathing CO_2 if used appropriately. The following features keep patients from rebreathing CO_2: 1) carbon dioxide absorbent granules (ex: Soda Sorb). 2) one-way valves, and 3) adequate oxygen flow rates for Non-Rebreathing circuits
   b. **Replace carbon dioxide absorbent granules after 6 – 8 hours of use.** Granules will become dry and absorb CO_2 from the air and, thus, need to be replaced every 2 weeks even if machine not used regularly.
   c. Monitor end-tidal and inspired CO_2 concentrations ($ETCO_2$ & $InspCO_2$) with a capnograph. If inspired CO_2 greater than 10 mmHg, then rebreathing of CO_2 is occurring → Check one-way valves; replace anesthesia machine if suspect depleted CO_2 absorbent granules because not safe to replace granules during anesthesia due to exposure to anesthetic gases; increase Oxygen flow rates in Non-Rebreathing circuits.

5. **Breathing circuits**
   a. Rebreathing circuits allow rebreathing of oxygen and inhalant. Depends upon functional one-way valves and CO_2 absorbent to prevent patient from rebreathing CO_2. Use rebreathing circuits for patients greater than 3 kg (7 lbs). Maintenance oxygen rates $\geq$30 ml/kg/min, but never less than 500 ml/min. Higher oxygen flow rates will not harm patients and can accelerate the rate of change in inhalant concentration in the anesthetic circuit. If you have active scavenge, you may need to use higher flow rates.
   b. Non-rebreathing (NRB) circuits depend upon high oxygen flow rates to prevent rebreathing of CO_2. Use NRB circuits for patients less than 3 kg (7 lbs). Oxygen flow rates should be $\geq$200 ml/kg/min, but never less than 500 ml/min. Higher flow rates will not harm patients. If you have active scavenge, you may need to use higher flow rates.
   c. **Never use the oxygen flush valve with a patient attached** to the breathing circuit. High flow and high pressure of oxygen are applied directly to the patient's airways and will irreparably damage the lungs.
   d. Minimize excess mechanical dead space – space where inspired and expired gases mix, but no gas exchange occurs. Dead space is found at the patient-end of breathing circuits, in elbow adapters and lengthy ETTs and causes rebreathing of CO_2 and decreases effective tidal volume available for gas exchange.

6. **Reservoir bags**
   a. Serve as reservoir of oxygen and inhalant, facilitate assisted ventilation, allow visual/tactile monitoring of RR, protect patients against excessive pressure in breathing circuit
   b. Appropriate reservoir bag size = at least 50 – 75 ml/kg

7. **Endotracheal tubes & technique for safe intubation/cuff inflation**
   a. Clear, cuffed endotracheal tubes (ETTs) with Murphy eye and valve on pilot balloon
   b. Red rubber ETTs are not recommended because 1) it is not possible to verify that the lumen is clear of debris, and 2) no valve on pilot balloon means very difficult to partially inflate cuff & cannot be fully submerged for cleaning
   c. Routine use of laryngoscope decreases laryngeal trauma, decreases time required to secure airway, allows examination of oral cavity and develops skill for emergency intubation
   d. Measure the length of the ETT (from nose to thoracic inlet) for each patient to prevent the tip from entering the thorax. Do not insert the end of the ETT past the thoracic inlet.
   e. **Avoid over-inflation of the endotracheal tube cuff.** Test the seal of the endotracheal tube cuff after intubation by delivering a breath to your patient and insuring that there is a slight leak at 20 cmH_2O but no leak at lower inflation pressures. In the absence of a manometer, verify that the cuff is sealed with delivery of a normal-sized breath. Do not use back pressure on the cuff syringe, or pressure in the pilot balloon to determine adequate cuff pressure – these indicators are associated with excessive cuff pressure that can damage the trachea.
   f. Disconnect the endotracheal tube from the anesthetic breathing circuit when moving patients or changing position to minimize the potential for tracheal tears.

Anesthesia Equipment Safety Resources

- Non-rebreathing circuit adapter with manometer: Bain circuit adapter, also known as Universal Control Arm. Order the adapter that comes with a Safety Pop-Off Valve. Source: Supera Anesthesia. http://www.superavet.com/accessories.html ph: 1-503-723-5068 or 877-620-1500 (toll-free in USA)
- Safety Pop-Off Valve by Supera Anesthesia: Compatible with nearly all anesthesia machines. Prevents inadvertent over-pressurization of patients. Source: Supera Anesthesia. http://www.superavet.com/accessories.html ph: 1-503-723-5068 or 877-620-1500
- Momentary Occlusion Valve (not the same as a Safety Pop-Off Valve): this occlusion valve connects to Pop-off Valve for Matrx (Midmark) anesthesia machines. Ph: 877-503-3756 Available through veterinary distributors.
- Endotracheal tubes: Clear, cuffed PVC ET tubes with Murphy eyes for sizes 2.5 thru size 10. Example: AirCare Tubes by Smiths-Medical. Available through veterinary distributors. Cuffed silicone tubes with Murphy eyes for sizes 11, 12, and 14. Manufacturer: Surgivet or Jorvet.