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**ANESTHESIA DRUGS & TECHNIQUES**

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Definition of Parts to Your Anesthesia Machine

1. **Inhalation Valve**: Located on the front of the machine. It opens to allow inhaled gas to get to the patient and stops exhaled gas.

2. **Exhalation Valve & Bag Mount**: Located on the front of the machine. It has two functions: (a) closes to not allow rebreathing of CO₂ and opens to allow exhaled gas to get to absorbent. (b) where rebreathing bag is located.

3. **Pressure Manometer**: Located on the top right of machine. This device has three main functions; (a) used to pressure test your machine for leaks. (b) provide a visual to see if pressure is building inside the patient. (c) used for a gauge when assisting the patients’ breathing so as not to over pressurize.

4. **Absorber Canister**: Located under the manifold system. Used to filter out the exhaled CO₂.

5. **Pop-off Valve**: This device is designed to release pressure from your machine.

6. **Flush Valve**: Located beside the flowmeter. This device is used to oxygenate the patient. Also, by design it will automatically bypass the vaporizer without having to shut the vaporizer off.

7. **Flowmeter**: The standard flowmeter reads from 200CC to 4 LPM (200CC-1 LPM is in 100cc increments); It takes the pressure and cuts it from 50 PSI to LPM.

8. **Female Endcap**: Connects to most vaporizers on the inlet side.

9. **Male Endcap**: Connects to most vaporizers on the outlet side.
Set Up and Operation Instructions

1. Remove all parts from the container to ensure all parts have been received.
   *
   * 5 Castered base
   * 1 Pole
   * 1 Anesthesia Head Assembly
     1. Gas Management Block
     2. Flowmeter assembly
     3. Drive Pin
   * Absorber canister
   (OPTIONAL)
   * E-Cylinder Manifold Assembly
   * Mayo Shelf / Tray
   * Top Shelf
   * Anesthesia Vaporizer

NOTE: PLEASE SEE DIAGRAM (1) FOR THE FOLLOWING INSTRUCTIONS

2. Wheels are in base but be sure they have not slipped out, uneven wheels can cause unit to be unbalanced.

3. Insert the beveled end of the pole into the base and snug it down.

If Using Optional Mayo Tray
Slide the mayo tray shelf (#16) down over the pole and set down approximately 5" and tighten set screw (#17) with tool provided. At a later time you can adjust the tray to a desired height. (See Diagram # 3)

If Using Optional Shelf
Hold shelf up and align with holes in the back of the machine. Be sure to use the spacers provided (#5) before tightening the screws down.

4. Pull the drive pin (#6) and place the anesthesia head assembly on top of the pole (#13).

5. Using the nuts and bolts provided, place the vaporizer (#9) onto the mounting plate (#7), it may be necessary to put the endcaps on first on some style vaporizers before tightening the vaporizer down. NOTE: Be sure to press and turn the endcaps (#s 10-11) to be sure there are no leaks.

6. Fill the absorber canister (#18) with absorbent leaving 1/2" from the top.
   IMPORTANT: Be sure to place finger over hole when filling, absorbent in hole will keep unit from sealing.
7. To attach the canister to the machine, locate the guide pin on the side of the canister. Match the guide pin with the cut out slot on the underneath side of the block (#21) and tighten the threaded rod(#23).

*IMPORTANT: Do not overtighten canister, finger tight will seal.*

8. Place hose coming from the large tank or piped in oxygen onto oxygen connection port located on the back of the machine. *(See Diagram #2)*

9. If using E-Cylinder Regulator Assembly, remove the two screws on the unit, place manifold as high as possible and re-tighten screws. Be sure when hanging the tanks they hang between the legs of the base. If you have difficulty getting manifold lined up it may be necessary to remove the pole from the base and slightly rotate.(Diagram #3)

10. Take hose coming off of manifold and connect to the oxygen port.(See Diagram #3)

---

**Your Machine is Now Ready for Testing**

1. Place the Universal F Circuit provided with the unit onto the machine. The main housing labeled Inspiratory attaches to the Inspiratory valve (#20), the short flex line circles down and attaches to the Expiratory valve (#19).
   
   *Note: This is a rebreathing circuit and recommended use on animals over 10 lbs.*

2. Place your thumb over the end of the circuit where the endotracheal tube connects.

3. Close the pcp-off valve down turning clockwise (#24).

4. Make sure absorber canister is sealed finger tight (#18) with guide pin located in slot.

5. Depress the flush valve (#3) and build pressure in unit to 20 CMH2O on pressure manometer (#22).

6. Place flowmeter (#2) on 200 cc's (.2 lpm), pressure in machine should stay steady or start to climb. If machine is building pressure or staying steady at 20, machine is ready for use. If pressure is falling you have a leak somewhere in the machine.

7. If pressure is falling refer to the trouble shooting guide (pg. #6).
Using Modified Jackson Rees Circuit (See Diagram #2)

1. Locate the NRB (Non-Rebreathing Block).

2. Remove the MJR (Modified Jackson Rees Circuit) from the bag.

3. Next locate the clear 72" fresh gas line on the circuit.

4. Remove the 15mm adapter that is downstream of the vaporizer on the NRB.

5. Place the end of the 72" clear hose into the NRB, you are now bypassing the absorber on the machine and delivering fresh gas through the circuit.

6. Place the 1/2 liter bag provided with the unit onto the corrugated tubing of the MJR below the section marked (Thumb Slide Valve--Open / Closed).

7. The thumb slide valve located on the main housing acts as a pop-off valve. Remember, the valve should be kept in the open position unless you are giving the animal a breath.

NOTE: The non-rebreathing system should be used on animals that are 10 lbs and under.
Basic Operation
of
Your Anesthesia Machine

After your anesthesia machine has been assembled and you have gone through the pressure test, your machine is now ready for use. If this is your first time using gas anesthesia or your first time using Halothane or Isoflurane it might be a good idea to read the information provided throughout this manual. Because all agents react differently and not all animals react the same under anesthesia, it is important to know all of the factors.

Over the past few years you have heard several different methods of delivering gas anesthesia. Whether it be an open system, closed system, semi-open system, semi-closed system, high flow system, low flow system, the preparation and first few minutes of anesthesia are pretty similar. The following information will help you determine what you will be comfortable using. The number one problem most veterinarians encounter today is not enough oxygen flow in the first few minutes. It is crucial to get enough agent into the patient to maintain them throughout the procedure. A big misconception is, that if, "I turn up the dial on the vaporizer, I am giving the patient a higher percentage". However, turning up the agent at low flows does not increase the percentage a great deal. By turning up the flow of oxygen more agent will enter the patient. In fact, one formula devised by Dr. David Brunson of the University of Wisconsin, Dept. of Anesthesia, calls for 2.5 lpm at 2.5% for 5 minutes during induction. This procedure should help make for smoother maintenance during surgery.

To operate the machine simply connect your hoses and bag and turn on the oxygen at your tank. Determine the amount of oxygen you wish to flow and dial in the correct lpm flow. Next, depress the button on the vaporizer and dial in the percentage you wish to use. Remember to keep an eye on your pressure manometer and do not let too much pressure build up in the system. Your pop-off valve or relief valve will help you control that pressure. If you need to give a breath to the patient turn the pop-off valve to the closed position and squeeze the bag. After giving the animal a breath be sure to readjust the pop-off valve.
## Troubleshooting Guide

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>No oxygen through O2 flowmeter</td>
<td>*Check O2 cylinder.</td>
</tr>
<tr>
<td></td>
<td>*Check that all high pressure hoses are connected</td>
</tr>
<tr>
<td>Machine fails pressure test</td>
<td>*Check tightness of absorber canister.</td>
</tr>
<tr>
<td></td>
<td>*Check for loose soda lime granules around seal.</td>
</tr>
<tr>
<td></td>
<td>*Check that center hole in absorber canister is free from soda lime dust.</td>
</tr>
<tr>
<td></td>
<td>*Check that the vaporizer caps are firmly in place.</td>
</tr>
<tr>
<td></td>
<td>*Check for punctures around machine nipple hoses.</td>
</tr>
<tr>
<td></td>
<td>*Check rebreathing bag and circuit hoses.</td>
</tr>
<tr>
<td>Pole does not fit firmly into base</td>
<td>*Check gently on top of pole toward base.</td>
</tr>
<tr>
<td>Patient does not respond to agent</td>
<td>*Check anesthetic agent level in vaporizer.</td>
</tr>
<tr>
<td></td>
<td>*Pressure test machine.</td>
</tr>
<tr>
<td></td>
<td>*Verify vaporizer is working.</td>
</tr>
<tr>
<td></td>
<td>*Refer to agent manufacturers recommendations on flows and use.</td>
</tr>
<tr>
<td>Rebreathing bag does not inflate</td>
<td>*If active gas evacuation is being used, check for too much draw.</td>
</tr>
<tr>
<td></td>
<td>*Check anesthesia machine flowmeter.</td>
</tr>
<tr>
<td>Rebreathing bag over inflates</td>
<td>*Check size of bag</td>
</tr>
<tr>
<td></td>
<td>*Check flow setting on vaporizer</td>
</tr>
<tr>
<td></td>
<td>*Pop-off valve is closed.</td>
</tr>
</tbody>
</table>

For other service questions contact your
Jorgensen Represenitive
Diagram of Machine
Diagram # 2

IN
OUT

OXYGEN CONNECTION

NRB

PLUMBING DIAGRAM (REAR VIEW)
"Critical Patient Anesthesia"

**Philosophy**

*Death is a late sign of poor perfusion. Patients are not fine one minute and dead the next.*

*Hypoxemia, hypoventilation, hypotension, hypovolemia, and hypothermia are early indicators of anesthetic complication and poor tissue perfusion. Complication should be anticipated with all anesthetic drugs. Poor tissue perfusion is the primary concern.*

*Significant advancements have occurred in pharmacology and technology. However, patient monitoring and support of vital organ function is the most important action one can take to minimize anesthetic risk and assure favorable outcome.*

**What is a good anesthetic Drug?**

*A complete anesthetic provides unconsciousness, analgesia, and muscle relaxation. The ideal anesthetic, though it does not exist, requires no biodegradation, does not depress the ANS, is effective at a minimal dose, does not enhance pre-existing disease or complication, allows rapid recovery, is completely reversible, adverse effects easily compensated for, etc.*

**Definitions:**

*Anesthesia: Not the study of protocol: An impending terminal episode
  Avoidance of a pharmacologic misadventure

  The ONLY correct way to evaluate and anesthetic drug. Tells you how to care for patient.

*Post-hoc hypothesis: "The last thing you did killed the patient."

*Time: A continuous measurable quantity in which events occur in apparently irreversible order: an opportune moment. You can not hide from the effects of time.

*Critical Patient: "Important" One you cannot afford to lose. Less tolerant to error.

Clinical anesthesia can be divided into three areas:

Three goals
Ten fundamentals
Six steps

The Three Goals:
1. Accurately predict complications.
2. Promptly recognize complications.
3. Correct complications

The Ten Fundamentals of "Patient Oriented Anesthesia"

1. Evaluate the medical history, physical examination, and laboratory data.
2. Patient's physiological statuses should be stabilized before induction of anesthesia.
3. Minimize anesthesia anesthetic time "plan" (surgical clip and prep before anesthesia
4. Careful selection and correct dosage of anesthetic drugs-based on health status, species, breed, and pre-existing complication.
5. Maintain a patient airway, monitor and support ventilation-supplement oxygen

10/2/94 minimal dose-minimal risk
7. Monitor & support body temperature - prevent heat loss - external sources of heat
8. Continue monitoring and support of systems until recovery is complete.
9. Analgesics / tranquilizers to minimize pain and discomfort, & excitement during anesthetic recovery.
10. Prepare for the expected and unexpected - have adequate trained personnel.

The Six Steps:

1 Evaluation of health status: "to judge carefully"
   • Anesthetic drug selection is based health status

2 Equipment/Supplies: personnel "planning causes success"
   • proper equipment type and size
     • leaks, soda lime, etc.
   • monitoring equipment
     • catheter
     • endotracheal tube size

3 Premedication: "should be considered in all patients"
   • Calms the patient, reduces stress, and improves handling
   • Decreases dose of induction & maintenance drugs
   • Improves induction and recovery quality
   • May provide analgesia & prevent undesirable vagal effects

4 Induction: "to facilitate intubation"
   • Induction methods should provide a smooth and calm transition to unconsciousness.

5 Maintenance: "to keep living"
   • Injectable anesthetics are not recommended for maintenance. Repeated doses accumulate causing increased cardiopulmonary depression; recovery becomes increasingly dependent upon metabolism. Monitoring and support are the essential tasks during maintenance.

6 Recovery: "to restore to a normal state"
   • Support should continue until the patient completely recovers.

Patient EVALUATION
Signalment: species, breed, age and sex may prompt special considerations.
History: disease or past anesthetic complication - concurrent medication
Physical examination: critical to outcome. Emphasis on cardiovascular, respiratory, hepatic, renal and CNS.
Laboratory data: PCV, TP, hepatic, renal, acid-base, electrolytes, blood gases, clotting.

EQUIPMENT - SUPPLIES
Check list:
Endotracheal tubes
Catheters
Lubricant
Laryngoscope
Styliets
Machine
Breathing systems
Monitoring equipment
Drug comments are selected and are not to be considered inclusive.

Drugs for PREMEDICATION

Proper premedication or omission is important for optimal outcome. When discussing premedication assume goals, steps, and fundamentals in place. Drug selection based on patient evaluation.
ANTICHOLINERGICS: only when needed - be objective

ATROPINE (0.5 mg/ml)
- (0.02 mg/lb,) IV • IM • SQ - 60 - 90 minutes duration
- Prevents vagal induced, bradycardia, heart block, excessive salivation
- Central effects, sedation
- Do not use if tachycardia is present • dog>140 • cat>200
- May increase myocardial oxygen consumption
- Indicated with narcotics, xylazine, before muscle relaxants reversal, for bradycardia or bradyarrhythmias

GLYCOPYRROLATE [Robinul-V] (0.2 mg/ml)
- (0.005 mg/lb,) IV • IM • SQ - 2 to 4 hrs.
- Prevents vagal effect: bradycardia or block, salivation
- Does not cross blood brain barrier - no sedation - lack of central effect - no for CPR
- Longer duration; fewer side effects than atropine

CALMING OR DCSE REDUCING AGENTS

ACEPROMAZINE
- Dilute to 1 mg/ml solution for small animals
- (0.025 - 0.05 mg/lb,) IV • IM • SQ (3 mg ceiling dose) Effective/reliable
- Avoid in cardiovascular compromise • decreases vascular resistance
- May protect against arrhythmias, good antiemetic
- May prolong recovery in functional liver disease
- Lowers seizure threshold, avoid if organophosphate present
- Tachycardia possible with hypotension
- If complications occur: ADMINISTER FLUIDS

XYLAZINE [Rompun] (20 mg/ml)
- SHOULD BE PRECEDE BY ANTICHOLINERGIC
- (0.1-0.25 mg/lb,) IV • IM • SQ (5 mg ceiling dose)
- Alpha-2 agonist, lower sympathetic tone
- Avoid in cardiovascular compromise • Cardiac output is always reduced
- Decreases myocardial contractility, produces bradycardia and heart block
- Sensitizes myocardium to catecholamine induced arrhythmias / HAL
- Limit use to healthy, aggressive patients or seizure patients
- Antagonist • Yohimine (0.1 mg/kg, IV slowly to effect)

DIAZEPAM [Valium] (5 mg/ml)
- (0.1-0.5 mg/lb,) IM
- Avoid rapid IV injection; hypotension & "it burns"
- Anxiolytic; amnesic; muscle relaxant; anticonvulsant
- Useful in CNS and cardiac patients
- Little sedative effect in healthy; may cause profound depression in compromised
- Avoid mixing in same syringe with other agents
- Do not use in aggressive patients
- Prolonged effects in hepatic dysfunction
- Propylene glycol base may cause arrhythmias
- Flumazenil [Mazicon, Hoffman LaRoche] is benzodiazepine antagonist (0.05 mg/lb,) IV

MIDAZOLAM [Versed] (1 mg/ml)
- (0.1-0.2 mg/lb,) IV
- Water soluble
• More potent, more rapid onset, and shorter duration compared to diazepam
• Excellent choice in critical patient

Opiates & Opioids

Common Characteristics of (narcotics)
Opiate: drugs derived from opium. Opioid: all exogenous substances, natural and synthetic that bind to opioid receptors and produce some agonist effects. Includes opioid agonists, opioid agonist-antagonists, and opioid antagonists.

• May Be Reversed
• Generally sparing to cardiovascular system
• Depresses respiration, assisted ventilation may be necessary
• Potential for CNS excitement & panting
• Repeated or large doses may produce bradycardia (anticholinergic)
• Useful when post-op pain is anticipated

NALOXONE [Narcan]
• Pure narcotic antagonist
• (0.001 - 0.01 mg/lb.) IM • slowly IV to effect
• Dilute 0.4 mg/ml in 10 ml sterile H2O

OXYMORPHONE [Numorphan] (1.5 mg/ml) 10-15 X morphone
• (0.025-0.1 mg/lb.) IM • SQ • IV (max. 3 mg)
• Reliable 2 to 4 hrs. duration

BUTORPHANOL [Torguesic] (10 mg/ml) 2-5 X morphine
• dilute to 1 mg/ml
• (0.1-0.2 mg/lb.) IM • IV
• Decreases cough reflex

BUPRENORPHINE [Buprenex] 3-5 X morphone
• (0.05-0.1 mg/lb.) IM
• 4-12 hrs. may cause excitement use with sedative

INNOVAR-VET (0.4 mg fentanyl + 20 mg droperidol) 50-100 X morphine
• (1 ml/20 lb.) IM or (1 ml/40 lb.) IV
• Complications usually result of excessive droperidol
• Droperidol has effects similar to "Ace"

---

ACEPROMAZINE & OXYMORPHONE

Premed and chemical restraining combination
Glycopyrrolate (0.005 mg/lb.) + (Acepromazine 0.05 mg/lb.) (max. 3 mg); IM
Wait 10 minutes.
Then administer Oxymorphone (0.025-0.1 mg/lb.) IM • SQ • IV (max. 3 mg) IM.

---

XYLAZINE & BUTORPHANOL

Glycopyrrolate (0.005 mg/lb.) + (xylazine 0.125 mg/lb.) (max. 5 mg); IM
Wait 10 minutes.
Then administer (0.1-0.2 mg/lb.) butorphanol IM • IV

10/2/94
minimal dose - minimal risk

tyner
ACEPHROMAZINE & BUTORPHANOL
Glycopyrrolate (0.005 mg/lb. + Acepromazine 0.05 mg/lb.) (max. 3 mg): IM
Wait 10 minutes
Then administer (0.1-0.42 mg/lb. butorphanol) IM = IV

Drugs for INDUCTION & Limited duration injectable anesthesia

ULTRA-SHORT ACTING BARBITURATES

TIAMYLAL 2-5% [Bio-tal/Surital] THIOPENTAL 2-5% [Pentothal]

- Similar characteristics
- 2-5 mg/lb. slowly IV "to effect"
- Small doses considered safe (redistribution)
- Minimize dose in compromised patients
- High incidence of arrhythmias and apnea - (pre-oxygenate)
- Dilute concentrations for small or debilitated patients
- Support of ventilation usually prevents arrest
- Hepatic and renal perfusion are decreased, further delaying metabolism
- Cardiopulmonary depression
  - Fluids make it better
- Smooth transition to inhalation agents

KETAMINE (10 C mg/ml)

- Do not use without calming agent
- 2 to 15 mg/lb. IM
- Poor analgesia
- Inspiratory apnea - hypoxia and hypercapnia may result
- May increase heart rate - blood pressure - myocardial oxygen demand
- Considered to maintain cardiac output and B.P. better than barbiturates
- May increase intracranial and ocular pressure
- Avoid in renal, hepatic, cardiac arrhythmia, ocular surgery and epileptics
- Transition to inhalation anesthesia may be rough

Useful induction agent

Valium 0.125 mg/lb. “plus” 2.5 mg/lb. ketamine slowly IV
or
Equal volumes
Valium (5 mg/ml) and Ketamine (100 mg/ml) administer 1 ml/20 lb.

TELAZOL (Zolazepam 50 mg. + Tiletamine 50 mg./ml)

- 1-3 mg/lb. IV or IM = rapid onset
- Excitement may occur at high doses
- Inspiratory apnea leading to hypoxia and hypercapnia at higher doses
- Cat: Tiletamine metabolized first
- Dog: Zolazepam metabolized first; use premed or post-surgical sedation
- Very effective in exotics and aggressive patients
- Short procedures
  - Analgesia is superior to ketamine

Useful combinations in healthy patients:

Glycopyrrolate 0.005 mg/lb. + 0.125 mg/lb. xylazine IM or SQ
wait 15 minutes
administer 3 mg/lb. Telazol IM.

10/2/94

minimal dose - minimal risk

tyner
Acepromazine 0.025 to 0.05 mg/lb. IM or SQ
wait 15 minutes,
administer 3 mg/lb. Telazol IM.

PROPOFOL (Emulsion)

- 1-3 mg/lb. IV "to effect" concentration 10 mg/ml
- Highly lipid soluble, does produce hypos
- Advantage over barbiturate is rapid recovery, with only slight drowsiness
- Not recommended for pregnant or nursing mothers or cesarean in humans
- Support cardiovascular and pulmonary function
- Does not store well, sterility is critical
- Overrated

INHALATION INDUCTION

SHOULD HAVE "SCAVENGING SYSTEM"
- Mask or box inductions limited to the depressed or very calm
- Not appropriate to mask induce healthy patients - STRESS

Drugs used for MAINTENANCE "To keep living"
Monitoring is the key to maintenance - tells you what the patient needs.

INHALATIONS AGENTS

Advantages:
- Depth of anesthesia is easily and rapidly controlled.
- Delivery of inhalation agents in oxygen
- Placement of an endotracheal tube
- Dependence on metabolism for recovery is less
- Prepared for arrest A. Airway B. Breathe C. Circulation

Disadvantages:
- High concentrations may produce arrhythmia HAL > METH > ISO
- Cardiopulmonary depression and hypotension are dose dependent
- Sensitize the myocardium to catecholamine induced arrhythmias
- Waste gas exposure

1 MAC light anesthesia - 1.5 MAC moderate surgical anesthesia 2 MAC deep anesthesia

HALOTHANE (Fluothane)
Flow 2 L/min, MAC dog = 0.87 cat = 1.19
- Moderate induction and recovery rate • B/G 2.36
- Hepatotoxic • Arrhythmogenic • 20% metabolized • thymol preservative

METHOXYFLURANE (Metofane)
Flow 2 L/min, MAC dog = 0.29 cat = 0.23
- Prolonged induction and recovery rate • high B/G 13
- Less arrhythmogenic than
- Renal toxicity - Fluoride ion • 50% metabolized • butylated hydroxytoluene preservative
- Avoid concurrent use with tetracyclines or aminoglycoside
- Not a sick dog drug! • Not reversed by doxapram

10/2/94 minimal dose - minimal risk
ISOFLURANE (Aerane)
Flow 1L/min. MAC dog - 1.3 cat - 1.63
- Indications: When rapid recovery is important; "high risk patient" • B/G I.41
- Greatest margin of safety of all currently used gas anesthetics
- Impaired hepatic function • Renal failure
- Traumatic myocarditis (HBC) • Cardiac arrhythmias
- Trauma • Cesarean section
- Obese • Geriatrics
- Known sensitivities to other agents

NEUROMUSCULAR BLOCKING AGENT: non depolarizing
Indications: High risk patients & highly technical procedures.

Advantages:
1. Patients require less depressant anesthetic
2. Facilitation of rapid intubation
3. Non depolarizing types can be antagonized
4. Provide optimal surgical conditions
5. Produce minimal cardiovascular effects
6. Induce minimal CNS depression

Disadvantages:
1. Provides no analgesia; must monitor for adequate analgesia
2. Requires assisted ventilation - 20 cm H2O - 8-10 bpm

Non depolarizing - pancuronium - atracurium
- no fasculation, competitively blocks neuromuscular receptor
- readily applied in veterinary medicine

Pancuronium (Pavulon®) - 0.02 mg/lb. IV
Administer after patient is stable and positioned.
- onset is 3-5 minutes
- duration ~ 40 minutes
- renal excretion is the primary elimination pathway, some hepatic metabolism
- increase heart rate, mean arterial blood pressure, and cardiac output

Reversal: may required 5 to 45 min.
Administer Atropine before reversal
Neostigmine-0.02 mg/lb. IV slowly to effect.
Observe heart rate- do not repeat more than three times - hypothermia delay recovery
The drug is an anti- acetylcholinesterase, it allows build up of acetylcholine, and promotes resumption of function at the myoneural junction. However, monitoring for bradycardia and adequate respiration must continue.

Atracurium (Tracurium®) - 0.02 mg/lb. IV
- onset is 3-5 minutes
- duration ~25 minutes
- spontaneously degrades
- essentially void of cardiovascular effects and cumulative effects
Selected Precautions

Phenothiazine: hypotension
Xylazine: bradycardia/block potent
Thiobarbiturates: hyperventilation, hypotension, arrhythmias
Halothane: arrhythmias, hypotension, and hepatic effects
Methoxyflurane: renal effects of toxic metabolites, and prolonged recovery
Ketamine: increase myocardial oxygen demand, arrhythmias
Diazepam: avoid in liver disease
Isoflurane: no specific contraindication

Useful Equations and Values:
- Tidal volume: 5 to 10 ml/lb.
- Bag size: 5 times tidal volume
- Fluids: 5 - 10 ml/lb./hour up to 40 ml/lb. maximum
- Gas flow for semi-closed circle system: 5-10/ml/lb./min. 1-3 L/min.
- Gas flow for non-rebreathing system: 1.5 - 2.0 X min. vent. [M.V. x RR] must stay above 25 and TP above 3.5
- Blood volume is equal to 40 ml/lb. body weight, the perfusate is important!
- Carbon dioxide absorber: 1-2 tidal volume, change every 4 to 6 hours.

100 mg soda lime will remove 10-15 liters of CO2

Amount of donor blood needed = \( \frac{\text{Desired PCV} - \text{actual PCV}}{\text{PCV anticoagulated donor blood}} \) x Recipient blood volume

**VIGILANCE**

Monitoring: More than counting the heart rate and respiratory rate!
Monitor multiple systems for trends.
First rule of monitoring: Anesthetic depth and patient condition are dose dependent. As anesthetic dose increases, depth is enhanced and health worsens.
Recall the Three Goals: anticipate - recognize - correct

<table>
<thead>
<tr>
<th>CNS Function</th>
</tr>
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<tbody>
<tr>
<td>All anesthetics cause CNS depression!</td>
</tr>
<tr>
<td>Anesthetic depth is determined primarily by monitoring skeletal muscle tone and selected reflexes.</td>
</tr>
<tr>
<td>Jaw tone - eye reflexes - nystagmus - palpebral - corneal.</td>
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<tr>
<td>Direct response to surgical stimulation is most reliable method of determining depth.</td>
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**Adequate depth**: Surgeon can achieve goals. 
**Inadequate depth**: It is indicated by movement or inability of surgeon to achieve goals. 
**Excessive depth**: Vital function is deteriorating; surgeon can cut, patient too deep! 
If unsure assume too deep!

**Hypothermia** - ability to thermoregulate lost - body temperature (below 98 F) common after 30 min. 
Signs include: cyanosis - arrhythmias - cool extremities - decreased respiratory rate - shivering. 
Shivering during recovery may be harmful. Glucose - oxygen - energy loss 
Potentiates depression - Prolongs recovery - increases stress 
Prevent heat loss - pads - external heat - warm fluids (vasodilation) - warm inspired air 
Temperature should be check every 15 to 30 minutes

The real reason to monitor during anesthesia is tissue perfusion. Anesthetics depress autonomic function and may impair tissue perfusion.
Respiratory Function

Minute ventilation - not respiratory rate. Rates vary and do not reflect gas exchange or CNS depression. Quality of ventilation
Hypventilation - CO₂ above 40 mm Hg - cyanosis - (5 gm of reduced HB) anemic - no cyanosis - arrhythmias - increased respiratory rate common
Hypoxemia - O₂ below 60 mm Hg - poor mm color - arrhythmias - weak pulse
Dyspnea - decreased lung compliance - squeeze bag 20 cm H₂O

Cardiovascular Function

HR change is only an indication of anesthetic effects on cardiac function. Means little alone. Decrease in cardiac output further decreases cardiac output.
Preload - contractility - afterload - HR - synergy - are the components of cardiac output and are indications of tissue perfusion.
Auscultation - loudness strength of contraction indication of output
Pulse Quality - blood moving
Mucous membrane color - oxygenation
Hypotension - MAP below 60 mm Hg - poor pulse - slow CRT - cool extremities - arrhythmias - increased HR
Hypovolemia - Dehydration: elevated FCV - TP - skin turgor - dryness of mucus membrane - slow CRT - tachycardia - poor pulse - hypothermia
Bradycardia - toc deep - increased vagal tone - hypertension - increased intracranial psi - hyperkalemia
Tachycardia - anesthetic induced hypotension - hypovolemia - hypoventilation - pain
Arrhythmias - auscultation/pulse - EKG rate/rhythm - PVC/S - myocardial hypoxia - hypercarbia - myocardia trauma
Shock
Arrest
Asystole

Monitoring equipment:

Limited by knowledge of user and ability to heed early warning and take action.

1. Technician
2. Thermometer
3. Stethoscope
4. ECG
5. Respiratory/airway monitor/end tidal CO₂
6. Pulse Oximetry
7. Blood pressure - invasive/non-invasive
8. Arterial blood gases
9. Cardiac output
10. etc.,
Information Fact Sheet for Using Halothane or Isoflurane

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As a veterinarian frequently administering general anesthetics to animals, you have all of the skills necessary to safely administer highly volatile anesthetic gases. Whether you primarily use injectable anesthetics or Methoxyflurane the anesthesia principles are identical to those used with Isoflurane or Halothane. The skills include patient evaluation, selection of anesthetic drugs and dosage, and patient monitoring.

Pre-anesthetic evaluation should include a complete medical history and physical examination. Laboratory tests such as a PCV/TP and BUN (Asostick) provide good baseline information for all prospective anesthesia patients. Assessment of hydration, oxygen carrying capacity (anemia) and renal function help to direct fluid and oxygen support. Additional laboratory or diagnostic tests can be selected based on the results of these procedures.

Selection of the technique for anesthesia is based on many factors, the following four are the most important. First, the health of the animal should be considered. Old, sick, weak animals require carefully designed protocols to ensure optimal survival. Secondly, the procedure will dictate the anesthetic technique most appropriate for the animal. Thirdly, drug selection should be based on the effects desired by the veterinarian. Issues such as slow recoveries, same day discharges, or sedation to decrease fear and apprehension and improve control of the animal will direct the choice of both drug and dosage. Additionally, premeds will decrease the dosage of induction and maintenance anesthetics, many of which have lower margins of safety than the sedatives. Lastly, the animal’s temperament and breed may provide insight into the type of pre-anesthetic medications needed as well as the way the animal will recover from anesthesia. Anesthetic techniques can be effectively designed to produce smooth, calm comfortable inductions and recoveries from even severely painful surgical procedures and do not change when using Isoflurane or Halothane.

Good surgeons and clinicians monitor their anesthetized patient. Anesthetized animals must be monitored for three reasons. Most importantly, we must assure adequate blood flow is maintained for tissue perfusion. Secondly, ventilation must be monitored to assure that oxygen is continuously provided to the blood and carbon dioxide produced in the tissues is removed. Thirdly, we monitor to assess the depth of anesthesia so that we can judge effectiveness of the anesthetics, determine if additional drugs are necessary and to anticipate when the animals will wake up.
Guidelines for converting from Methoxyflurane to either Isoflurane of Halothane

Methoxyflurane (MOF) is more soluble in blood than either Isoflurane (ISO) or Halothane (HAL). Because of the differences in the solubility, ISO and HAL equilibrate much faster than MOF. Clinically, we see that animals reach a surgical plane of anesthesia and can be lightened or deepened faster with these less soluble agents. When first using ISO and HAL, change the delivered concentration frequently (i.e. every 2-4 minutes) in order to become familiar with the increased ability to change anesthetic depth and more importantly to avoid getting the animal too deep. Once familiar with ISO and HAL, frequently changing the vaporizer setting will not be necessary.

Equilibration of the patient to MOF takes a long time (high solubility in the animal). Additionally, it is associated with good analgesia at sub-anesthetic dosages and the maximum concentration that can be delivered is 3%. The combination of these factors made it difficult to overdose the animal in the time required to perform routine neutering or spaying procedures. Low volatility and high solubility also made inexpensive non-precision vaporizers safe for MOF.

Precision vaporizers are recommended for ISO and HAL because of the combined effects of low solubility (fast equilibration) and high vaporization which can produce inspired concentrations in excess of 30%. The precision vaporizer limits the chances for overdosage.

Another important property to understand when switching to a different inhalant anesthetic is the effective concentration necessary to produce anesthesia. For the gas anesthetics. The best available measure of brain anesthetic concentration is the concentration in the alveolus. Thus the minimal alveolar concentration (MAC) for a inhalant anesthetic which produces anesthesia in half of the animals is used as an indicator of potency. Drugs that require higher concentrations are less potent. MAC is the same as an effective dose for 50% (ED50) of the animals. Clinically, we approximate the concentration necessary for keeping all of the animals anesthetized by multiplying the MAC by 1.5. Expected vaporizer concentrations for maintenance of anesthesia with ISO is calculated as follows: MAC for dog = 1.34% times 1.5 equals 2.0%. For most dogs vaporizer setting of 1.75 – 2.25% will be necessary once they are in a surgical anesthetic plane. For HAL the calculations are: MAC for dog = .87% times 1.5 equals 1.3%. Vaporizer settings of 1.3 to 1.8 are frequently necessary for maintenance with HAL.
Recommended technique following induction with an IV anesthetic:

I. If the animal is relaxed, has minimal palpebral reflexes, a strong regular pulse and +/ - respirations:
   a. Set vaporizer at the following with an oxygen flow of at least 2.5 liters per minute:
      
      ISO  2.5%
      HAL  2.0%

      Maintain high oxygen flows until the anesthetic machine has filled with the anesthetic/oxygen mixture. This will take approximately 3-5 minutes. Decrease the oxygen flow rate to 1 lpm for the maintenance portion of anesthesia.
   b. Monitor vital signs and assist breathing as needed (4bpm) to assure O2 delivery, CO2 removal and Anesthetic gas delivery.
   c. If the Animal becomes more relaxed, palpebral reflexes diminish or the animal is non-responsive to minor pain...
      DECREASE the vaporizer setting to:
      
      ISO  2%
      HAL  1.5% (this usually occurs within 3-5 minutes)
   d. Increase or decrease vaporizer settings by 0.25% to 0.5% as needed based on the animal's response to surgical stimulation.

   *Remember that increasing the oxygen flow will shorten the time until the animal inhales the new concentration of anesthetic gas.

II. If the animal is fully relaxed, no palpebral reflexes are present and breathing is minimal or absent, or if the animal has weak pulses...
   a. Intubate and connect the animal to the anesthetic machine, supply only oxygen at 1 lpm. Attach monitors (pulse oximeters, ECG, capnograph, blood pressure) and ventilate until slight muscle tone and palpebral reflexes return.
   b. Once the animal is showing signs of awakening turn vaporizer to the following settings:
      
      ISO  2.5%
      HAL  2.0%

   c. Continue as in (I.b) above.

III. If the animal is moving, has strong muscle tone, and/or active palpebral reflexes:
   a. Administer more induction drugs

   Or

   b. Set vaporizer for ISO  3.0 - 4.0%
      
      HAL  2.5 - 4.0%  Assist ventilation as needed and monitor.

   c. Decrease the Vaporizer setting as soon as the animal shows signs of deepening anesthesia.
   d. Continue as in (I.b) above.

*** Adjustments in the oxygen flow is helpful in order to change the concentration of anesthetic gases in the machine. When using anesthetic machines with precision out-of-circle vaporizers, increasing the flow of oxygen will also deliver anesthetic gases to the patient's breathing circuit. The time required to fill the breathing circuit will be equal to the volume of the circuit divided by the flowrate. Some rebreathing circle apparatuses could have a volume of 6-10 liters depending on the size of the CO2 absorber and the rebreathing bag. Thus flowrates of 2.5 lpm will exchange the system in 2.5 - 4 min. Because gases mix three exchanges are needed to fully change the circuit's contents.