Isoflurane Anesthesia in Rodent Surgery

Feb 28, 2011
Cristina Weiner VMD MS
Senior Manager, Head of Surgical Services
Taconic
• **Basic Surgical Principles: Surgery in a Research Environment**

• **Adjuncts to Successful Surgery**
  - Analgesics
  - Inhalant Anesthesia
    • Methods, Mechanisms, and Considerations
    • Pre-, Intra-, and Post-Operative Assessments of Animals
    • Advantages/Disadvantages
  - Alternatives to Inhalant Anesthetics
    • Injectable
    • Local

• **Summary**
Surgery in a research environment

• Inducing a lesion

• Performed successfully to ensure that lesion induced does not negatively affect the researcher

  • Any observations a researcher notes is attributable to his/her experiment and not to complications from surgery
    – Appropriate surgical and analgesic/anesthetic technique
    – Appropriate acclimation time, healing time, materials used, etc
    – Appropriate expectations for what the surgery entails
Surgery in a research environment

- Aseptic technique
- Acclimation time
- Recovery time
  - Procedure dependent
- Appropriate materials
  - Catheters
  - Suture
  - Technique
  - Wound clips
- Appropriate clinical assessments
  - Scoring system
Adjunct

an addition; something that, when added, serves simply to augment or extend that to which it has been added
Adjuncts to Successful Surgery

Adjuncts

- Analgesia
- Anesthesia
- Pre-, Intra-, and Post-Operative Assessments
- Hypothermia
- Antibiotics
Analgesia:

Analgesia is neurological state where pain is not perceived to its full ability. Painful stimuli are still present but not perceived as pain while the patient is still conscious.
Analgesia

• Opioids
  – Buprenorphine (Buprinex)
  – Industry standard
  – Current literature
  – Preemptive analgesia
  – Used for all procedures unless justification provided
  – *controlled substances
Adjuncts to Successful Surgery

Analgesia

• NSAIDS
  • Carprofen, ketoprofen, flunixin
  • Anti-inflammatory
  • Customer approved
Anesthesia:

Anesthesia is a temporary induced state of *unconsciousness*. It is a means used to prepare a person or animal for surgery. Usually reversible.
Adjuncts to Successful Surgery

Anesthesia

- **Inhalant (gas)**
  - Specialized equipment (Vaporizer)
  - Faster on & off
  - Safer?

- **Injectable**
  - Site (IP, IM, IV, SQ)
  - Dose (mg/kg), Volume (ml)
  - Reversible

- **Local**
  - Injection or Infiltration

- **Electronarcosis**
- **Hypothermia**
- **Acupuncture**
- **Transcutaneous electric nerve stimulation**
• **Inhalant (gas) Anesthesia**
  – Specialized equipment (Vaporizer)
  – Faster on & off
  – Ease of use
  – Safer?
• **Inhalant Anesthesia**
  – Isoflurane
  – Industry standard
  – State-of-the-art Facility
• **How does gas anesthesia work?**
  - Enters the blood stream from the lungs

• **MAC: Mean Alveolar concentration**
  - Alveolar concentration of an anesthetic required to block the response to a specified painful stimulus in 50% of a group of animals.
  - The lower the MAC value, the lower the concentration required, ie the more potent the anesthetic
    - MAC isoflurane: 1.38
    - MAC ether: 3.2
    - MAC nitrous oxide: 250
Supply oxygen and anesthetic agents to the animal

- Anesthetic does not flow without oxygen
- Gases pass from the flowmeter through the vaporizer
- Vaporizer delivers an accurate concentration of anesthetic to the animal via the nosecone
- Waste anesthetic gas is scavenged
• **Inhalant Anesthesia circuits:**
  
  – Portable Anesthesia Machines

  – Wall-mounted systems
Inhalant Anesthesia

- **Induction: General**
  - Place animal within the anesthesia chamber
  - Turn on the oxygen to flow at 1-2 liters per minute
  - Turn on the isoflurane to 2-5%
  - Animals should become anesthetized within 5-10 minutes
    - Observe for loss of righting reflex
    - Once this occurs, leave animal in chamber for one additional minute prior to removing
    - Observations essential
  - Remove animals from chamber and place onto nosecone
• **Inhalant Anesthesia**

  – **Maintenance: General**
    - Animal is placed onto a nosecone
    - Obligate nasal breathers
    - Diaphragm should be appropriate size for animal
    - Animals should not respond to noxious stimuli
      - Toe pinch
    - Respiration should be regular
    - Maintain isoflurane concentration at 1-3%
Inhalant Anesthesia: Planes of Anesthesia

General

- **Stage 1:** voluntary movement; lasts until loss of consciousness, pupils dilate

- **Stage 2:** involuntary movement, CNS depression, reflexes become exaggerated, palpebral reflexes present, vocalization, salivation

- **Stage 3:** surgical anesthesia, muscles relax, loss of swallow and vomit reflex
  - Plane 1: no eyeball movement, decrease RR and depth, pupils become less dilated, eyeball rotation, palpebral reflex present, loss of jaw tone
  - Plane 2: bradycardia, hypotension, CRT slows, loss of palpebral reflex, eyeball rotation ventrally, jaw tone minimal, absent pedal reflex
  - Plane 3: deep surgical anesthesia, weak corneal reflex, centered and dilated pupil, bradycardia, hypotension, RR and depth decreases
  - Plane 4: cyanosis, loss of sphincter control, lowered HR, widely dilated pupil

- **Stage 4:** impending death
• **Inhalant Anesthesia**

  – **Recovery**

  • Animal is removed from nosecone and placed into heated recovery cage
  • Can be maintained on room air or oxygen
• **Process: General**

  - **Induction**
    - Isoflurane: 3-5%
      - chamber
  
  - **Maintenance**
    - 1-3%
      - Nosecone
      - Intubation
  
  - **Recovery**
    - Oxygen/room air
Inhalant Anesthesia

- Assessing the Animal as a surgical and anesthetic candidate
  - Pre-Operative
  - Intra-Operative
  - Post-Operative
Inhalant Anesthesia

- **Pre-Operative Assessments**
  - Haircoat clipped; aseptic preparation with betadine and alcohol
  - Day of surgery: assessed for health status
    - Rodent normative biology
      - Nocturnal animals
    - Porphyrin staining
    - Body condition
    - Lumps/bumps
    - Food intake
    - Malocclusion
    - Urine/fecal output
    - Hydration status
  - Fasting is generally not needed
Inhalant Anesthesia

- **Intra-operative monitoring**
  - What anesthetic plane?
    - Procedure dependent
    - Can modify isoflurane concentration as needed
  - Response to toe pinch
  - Reflexes
  - Pulse oximetry
    - Tells oxygen saturation in the blood
    - Pigmented animals
  - Capnograph
    - Provides concentration of blood carbon dioxide
    - Drive towards respiration
  - HR, RR
  - Arterial/Venous lines
  - Body Temperature
Intra-Operative Monitoring
Hypothermia

- Recirculating water tablet
- Draping
- Fluids
- Monitoring
- Effect on anesthetics
- Half-on, half-off during recovery
• **Post-Operative Assessments**
  – Animal Condition
    - Inflammation
    - Infection
    - Porphyrin staining
    - Body condition
    - Lumps/bumps
    - Food intake
    - Malocclusion
    - Urine/fecal output
    - Hydration status
  – Condition of the surgical model
Inhalant Anesthesia

- Advantages
- Disadvantages
Inhalant Anesthesia

- **Advantages:**
  - Rapid induction and recovery
  - Depth of anesthesia can be altered rapidly
  - Metabolism minimal
  - Safe (?)
• **Advantages, cont’d:**

  – Slightly more respiratory depression than other inhalants (halothane) but slightly less cardiovascular depression

  – Non-irritant

  – Non-explosive

  – Non-flammable

  – Almost completely eliminated in exhaled air
    • Little effect on liver microsomal enzymes and minimal interference in drug metabolism or toxicology studies
• Disadvantages
  – Operator safety
    • Scavenge systems
    • Down-draft tables
  – Cost
    • Materials needed
  – Technical skill
Alternatives to Inhalant Anesthesia

- **Injectable**
  - Subcutaneous (SQ)
    - Slower absorption
  - Intramuscular (IM)
    - May be difficult in small mammals
  - Intraperitoneal (IP)
    - More rapid uptake
    - Some compounds can be irritating
  - Intravenous (IV)
    - Often continuous infusions are needed for surgery, can be a challenge in small mammals
    - Time-consuming
Alternatives to Inhalant anesthesia

**Injectable – General Features**

- **Ketamine**
  - Advantage: immobility, ease of administration
  - Disadvantage: increased skeletal muscle tone, variable analgesia, respiratory depression, prolonged recovery

- **Xylazine**
  - Advantage: sedative, moderate analgesia, potentiate action of other drugs
  - Disadvantage: cardiovascular and respiratory depression at high doses

- **Acepromazine**
  - Advantage: sedation, potentiate action of other drugs, smooth recovery
  - Disadvantage: hypotension from peripheral vasodilation, hypothermia

- **Pentobarbital sodium**
  - Advantage: ease of administration
  - Disadvantage: severe cardiovascular and respiratory depression, poor analgesia, surgical anesthesia is reached at doses associated with respiratory failure
Alternatives to Inhalant anesthesia

**Injectable** *(Taconic does not use)* – General Features

- **Propofol**
  - Advantage: rapid induction of short period of anesthesia, smooth recovery
  - Disadvantage: insufficient analgesia for major surgery, apnea upon induction, respiratory depression

- **Tribromoethanol (Avertin)**
  - Advantage: surgical anesthesia in rodents, good skeletal muscle relaxation
  - Disadvantage: irritant to the peritoneum, not pharmaceutical grade

- **Alpha-chloralose**
  - Advantage: stable, long-lasting light anesthesia, minimal cardiovascular and respiratory depression
  - Disadvantage: not pharmaceutical grade, poor analgesic properties, prolonged recovery
Alternatives to Inhalant Anesthesia

- **Local**
  - Injection or Infiltration
  - Often used in conjunction with other drugs
Alternatives to Inhalant anesthesia

Hypothermia

- Rodent physiology
  - High surface area: body weight ratio
  - High metabolism

- Proper anesthetic depth

- Neonatal animals
Adjuncts to Successful Surgery

Antimicrobials

- No longer considered routine
- May interfere with experimental procedures
- Must be warranted by Veterinary Sciences and/or client
- Rationale based on procedure
- Delivery route:
  - Injection vs. water
• **Summary**
  – Inhalant Anesthesia offers many advantages over injectable compounds
    • Advantageous for the animal
    • Advantageous for the user
  – Technical expertise and facility support is needed
  – Taconic facilities are compatible with large-scale usage of this methodology
  – Taconic uses inhalant anesthetics routinely
• Questions?
• Taconic Vet Sciences (J. Smith)
• Academy of Surgical Research