Isoflurane Anesthesia in Rodent Surgery

Taconic

Smart Solutions To Improve Human Health

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Taconic

Outline

- **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

Adjuncts to Successful Surgery



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

Adjuncts to Successful Surgery

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.

Adjuncts to Successful Surgery

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

Adjuncts to Successful Surgery



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**

Adjuncts to Successful Surgery: Methods, Mechanisms, and Considerations

- **Inhalant (gas) Anesthesia**
  - Specialized equipment (Vaporizer)
  - Faster on & off
  - Ease of use
  - Safer?

Adjuncts to Successful Surgery: Methods, Mechanisms, and Considerations

- **Inhalant Anesthesia**
  - Isoflurane
  - Industry standard
  - State-of-the-art Facility

Adjuncts to Successful Surgery: Methods, Mechanisms, and Considerations

- **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

Adjuncts to Successful Surgery: Methods, Mechanisms, and Considerations

- **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

http://www.paragonmed.com/images/anes/M1200.jpg

Shown with Universal Control Arm
http://www.mipcompany.com/images/anesthesia_systems/pam_w_arm.jpg

Adjuncts to Successful Surgery: Methods, Mechanisms, and Considerations

- **Inhalant Anesthesia circuits:**
  - Portable Anesthesia Machines
  - Wall-mounted systems

Adjuncts to Successful Surgery: Methods, Mechanisms, and Considerations

- **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

Adjuncts to Successful Surgery: Methods, Mechanisms, and Considerations

- **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**

Adjuncts to Successful Surgery: Methods, Mechanisms, and Considerations

- **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

Inhalant Anesthesia

Intra-Operative Monitoring
Hypothermia

- **Recirculating water tablet**
- **Draping**
- **Fluids**
- **Monitoring**
- **Effect on anesthetics**
- **Half-on, half-off during recovery**

Inhalant Anesthesia

- **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 (?)

Inhalant Anesthesia

- **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

Inhalants—Isoflurane

- **Disadvantages**
  - Operator safety
    - Scavenge systems
    - Down-draft tables
  - Cost
    - Materials needed
  - Technical skill

Adjuncts to Successful Surgery

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

Adjuncts to Successful Surgery

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

Adjuncts to Successful Surgery

Alternatives to Inhalant Anesthesia

- **Local**
  - Injection or Infiltration
  - Often used in conjunction with other drugs

Adjuncts to Successful Surgery

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?**

References

- **Flecknell, P. Laboratory Animal Anesthesia: A Practical Introduction for Research Workers and Technicians. Academic Press, 1996.**
- **Taconic Vet Sciences (J. Smith)**
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