**ANESTHESIA AND ANALGESIA IN FARM ANIMALS**

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**OUTLINE**

- Introduction
- Sedation/anesthesia considerations & concerns
  - Bovine, Small ruminants, swine … south camelids?
  - Sedative and anesthetic drugs
  - Sedation/Anesthetic protocols

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**INTRODUCTION**

- Dairy bovine & Beef cattle
- Small ruminants
- Swine
- South America Camelids

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**BOVINE**

- Dairy Cows
  - Used to being handled
  - Mild physical restraint + local or regional anesthesia for standing sedation
  - Light sedation
    - Usually lower doses of sedatives/anesthetics
  - General anesthesia
    - Endotracheal intubation is recommended
  - Recovery usually is smooth

- Beef Cattle
  - Infrequently handled
  - Require more physical restraint
  - Heavy sedation
    - Larger doses of sedatives/anesthetics
  - General anesthesia
    - Endotracheal intubation is recommended
  - Recovery can go rough sometimes depending on animal’s disposition

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**SMALL RUMINANTS**

- Sheep and goats
  - Easier to handle (most of the times)
  - Most common procedures can be done with mild physical restraint and local anesthesia (e.g. c-section) in lateral recumbency
  - Light sedation/analgia and mild physical restraint provides means to do a lot in this species e.g.
    - U-catheter placement
    - Detailed examination of urogenital tract

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**CONSIDERATIONS FOR ANESTHESIA IN RUMINANTS**

- Fasting
  - Adult cattle: 48 hours for food and 12 to 18 hours for water before procedure
  - Small ruminants: no longer than 24 hours for food and 12 for water
  - Benefits of fasting long enough
    - Decrease incidence of regurgitation and aspiration pneumonia
    - Decrease the ruminal contents mass compression on the respiratory and cardiovascular functions
    - Avoid excessive fasting (change in ruminal flora and ketosis)
  - Young ruminants: not usually fasted (hypoglycemia)
Ruminal tympany and regurgitation → aspiration pneumonia

Always risk of bloating and regurgitation of ruminal contents

Runen → up to 600 L

Bloating and loss of esophageal sphincter tone → regurgitation

Ruminal tympany → ruminoreticular motility and eructation are reduced or absent

Contributes to the depression of the cardiovascular and respiratory systems

Saliva production

Volume of saliva up to 16 and 160 L/day (sheep and cattle)

Under anesthesia still the same volume being produced

Obstruction of unprotected airway

Avoid anticholinergics

Airway protection

Endotracheal intubation = ideal

No practical under field conditions

Details to be considered for the anesthetized animals

Lateral recumbency → elevate proximal portion of the neck and tilt head downward to facilitate drainage of liquid contents from the oral cavity

Airway protection

Endotracheal intubation → poses some challenges

Narrow and long oral cavity, rostro-dorsal angle of the laryngeal entrance

Good/great anesthesia induction

Light inductions may trigger regurgitation

Muscle relaxation vs placement of mouth gag vs use of stomach tube as a guide for the endotracheal tube

Respiratory protection

Animals are SENSITIVE to the anesthetic-induced alterations in the respiratory system

Unique features: smaller Vt and higher respiratory rate

Respiratory and Cardiovascular Systems

Changes in the Vt and RR has SIGNIFICANT impact on respiratory function

Hypercapnia and hypoxemia common in spontaneously breathing ruminants under anesthesia or heavy sedation

Much often and in greater magnitude in non-fasted animals

Oxygen supplementation and assisted ventilation

O2 flow of 15 L/min in adults

Demand valve (equine demand valve, JD Medical Dist. Co

E-tank for emergency (lasts only 40 minutes at this flow)

Small ruminants: assist ventilation with an ambu bag

Musculoskeletal System

Myopathy and peripheral neuropathy → large animals

Hypotension, pressure on dependent muscles, poor positioning, noncompliant surfaces, and prolong periods of recumbency

Under field conditions: soft and grassy location or well bedded stall
**CHEMICAL RESTRAINT OF RUMINANTS**

- Extra-label drug use
  - Most of the sedatives and anesthetics in cattle
- Withdraw periods for commonly used drugs for animals used for milk and meat production
  - Recommendations by Food Animal Drug Residue Avoidance & Databank (FARAD)

**COMMONLY USED DRUGS — CHEMICAL RESTRAINT**

- Alpha2-agonists
  - Xylazine
  - Dexmedetomidine
  - Romifidine
  - Detomidine
- Provide analgesia
- Sedation outlast analgesia
- Reversals
  - Tolazoline: 0.2 – 2 mg/kg (½ IM and ½ IV)
  - Yohimbine (0.1 – 0.2 IV) variable efficacy
  - Atipamezole (0.12 – 0.22 mg/kg) IM

- IM or IV xylazine at 0.015-0.025 mg/kg produces standing sedation
  - Analgesic effects are minimal
  - Extremely anxious cattle require higher doses (e.g. 0.05 mg/kg)
  - Increasing the dose to 0.1-0.2 m/kg causes recumbency

**COMMONLY USED DRUGS — CHEMICAL RESTRAINT**

- Benzodiazepines
  - Midazolam, Diazepam, and Zolazepam (combo with Tiletamine = Telazol)
- Sedation and muscle relaxation
- When used alone in healthy animals may cause paradoxical excitation
- Minimal effects in the cardiovascular and respiratory functions
- Great sedation for calves, small ruminants, sick patients as sole drug
- Not recommended for standing sedation in cattle
  - Ataxia and recumbency
**Phenothiazines → Acepromazine**
- Delayed onset of action (15 to 20 minutes)
- Duration of action: 4 to 6 hours
- Minimal respiratory effects but may cause cardiovascular depression: hypotension (high doses and hypovolemic patients)
- No analgesic effects
- Sedative effects are less than xylazine
  - So, best used in combo with other drugs to achieve good sedation

**Opioids**
- Receptors are located in the peripheral and central nerve systems
- Very important components of the pain pathway
- Excitatory effects and behavioral changes may happen with butorphanol in ruminants
  - High doses and sole drug for sedation
  - Minimal analgesic effects
  - However, potentiates sedative and analgesic effects of other drugs
- Morphine is more efficacious analgesic for painful procedures
  - Anecdotal reports of excitement in cattle
  - For standing sedation: cattle receiving morphine seem to be more alert than those receiving butorphanol
  - Buprenorphine provides good analgesia for up to 6 hours given IM

**Ketamine Stun – standing sedation**
- IM low-dose combination of butorphanol, xylazine, and ketamine
  - Butorphanol → 0.02 – 0.1 mg/kg
  - Xylazine → 0.02 – 0.0275 mg/kg
  - Ketamine → 0.05 – 0.1 mg/kg
  - Similar combo using 5-10-20 ratio (5mg butorphanol, 10 mg xylazine, and 20 mg ketamine) IM → standing sedation in tame cows and Brahman cows for cesarean section
  - Duration: 30-40 minutes
  - If more is required: ½ of ketamine + ½ butorphanol or ¼ xylazine

**Medetomidine alone: sedation at 0.005 mg/kg IV**
- Increasing the dose to 0.03 mg/kg IM

**K-Stun – sedation for recumbency**
- IM combination of butorphanol, xylazine, and ketamine
  - Butorphanol → 0.05 – 0.1 mg/kg
  - Xylazine → 0.02 – 0.05 mg/kg
  - Ketamine → 0.3 – 0.5 mg/kg
  - Chemical restraint for 15 minutes
  - Along with casting rope and local or regional block allows performance of fracture stabilization, castration, and preputial resection/amputation in bulls
  - Animals appear to be alert but are not bothered by surroundings and remain quiet
**STANDING CHEMICAL RESTRAINT OF ADULT CATTLE**

- Medetomidine alone: 0.03 mg/kg IM → lateral recumbency for 60 to 70 minutes in calves
- Delivering via tranquilizing gun at 0.04 mg/kg IM → complete immobilization in capturing free-ranging cattle
- Immobilization of free-ranging cattle (e.g. Limousin, Scottish highland cattle, African bison) for non-painful procedures
  - Xylazine: 0.3-0.5 mg/kg IM
  - Ketamine: 0.7-1 mg/kg IM
  - Telazol: 0.7-1 mg/kg IM
- IM medetomidine (0.06 mg/kg) and Telazol (1.2 mg/kg) produce immobilization and analgesia for minor procedures for up to 60 minutes

**IV combination of xylazine (0.2 mg/kg) and diazepam (0.1 mg/kg) gives short-term chemical restraint with recumbency in cows**
- Duration: up to 30 minutes
- Animals usually stand up 60 minutes after drug-combo administration
- Lowering xylazine dose and increasing diazepam dose → procedures that do not require intense analgesia.
- Duration up to 30 minutes
- Sedation for recumbency in calves
  - Older than 2 weeks: IV xylazine (0.05 mg/kg) and diazepam (0.2 mg/kg)
  - Newborns (up to 1 week): diazepam (0.3 mg/kg IV) and butorphanol (0.1 mg/kg IV)

**INDUCING RECUMBENCY AND GENERAL ANESTHESIA**

- Recumbency cons
  - Fasting, regurgitation, respiratory depression
  - Compliant surfaces, positioning, and duration of recumbency
  - Placement of an IV catheter
- Likely to become recumbent when sedated
- Unusual to perform procedures in a standing small ruminant
- Same anesthetic concerns as cattle
- Options of sedatives to use
  - Benzodiazepines: midazolam IM and diazepam IV
  - Good sedation for sick goat/sheep
  - Not that reliable on anxious animal
  - Opioids
    - Butorphanol: potentiates sedation 0.05 – 0.1 mg/kg IV; 0.2 mg/kg IM
    - Buprenorphine: good analgesia 0.01 mg/kg IV, IM
    - Morphine: great analgesia 0.05 – 0.1 mg/kg IV, IM

**CHEMICAL RESTRAINT FOR SMALL RUMINANTS**

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**Table 1**

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<th>IM</th>
<th>Duration of Effect</th>
<th>Sedation or Analgesia</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xylazine</td>
<td>0.3-0.5 mg/kg</td>
<td>60-70 minutes</td>
<td>Immobilization</td>
<td>in calves</td>
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<tbody>
<tr>
<td>Midazolam</td>
<td>0.05-0.1 mg/kg</td>
<td>30 minutes</td>
<td>Immobilization</td>
<td>in ruminants</td>
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<tr>
<td>Diazepam</td>
<td>0.2 mg/kg</td>
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<td>Butorphanol</td>
<td>0.05-0.1 mg/kg</td>
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</tr>
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Chemical Restraint for Small Ruminants

- **Options of sedatives to use**
  - Alpha-2-agonists: reliable sedation
  - Ketamine: must be combined with a muscle relaxant
  - Telazol: good sedation/anesthesia

- **Xylazine specifics**
  - Sheep: pulmonary effects
    - Pulmonary Intravascular Macrophages (PIMs)
      - Release of prostaglandins and vasoactive substances, alveolar edema, increase in the transpulmonary pressure, decrease in pulmonary compliance, pulmonary congestion
      - Severe hypoxemia
    - Healthy vs sick patients

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  - Healthy vs sick patients

- **Goats are more sensitive to the sedative effects than sheep and camelids**
  - Goat's dose: 0.05 – 0.1 mg/kg IV
  - Sheep's dose: 0.1 – 0.4 mg/kg IV
  - Camelids
    - Llamas: 0.2 – 0.4 mg/kg IV, IM
    - Alpacas: 0.4 – 0.6 mg/kg IV, IM

Camelids chemical restraint
- Xylazine (0.025-0.03 mg/kg IV or 0.4 – 0.6 mg/kg IM combine with Ketamine (1.1 mg/kg IV or 3 – 5 mg/kg IM) → recumbency for 30 minutes
  - Better analgesia than xylazine alone
  - Adding butorphanol (0.05 – 0.1 mg/kg IV, IM) or morphine (0.05 – 0.1 mg/kg IV, IM) → minor surgical procedures (e.g. wound debridement and cleaning)
  - Add local/regional anesthetic block → more painful procedures (e.g. castration w/ intratesticular block)

- **Benzodiazepines and opioids**
  - Benzodiazepines (0.1 – 0.2 mg/kg IV; 0.2 – 0.4 mg/kg IM): SEDATION
  - Butorphanol (0.02 mg/kg IV) and xylazine (0.01-0.02 mg/kg): deep sedation and recumbency for 60 minutes in goats
  - Xylazine (0.2 mg/kg) and ketamine (3 mg/kg): deep sedation for 30 min. but not surgical anesthesia
  - Young or sick/debilitated: diazepam (0.1 – 0.3 mg/kg IV) or midazolam (0.2 mg/kg IM)
  - For non-painful procedures only (e.g. radiographs and U/S)

- **Under field conditions, most drug regimes are based on ketamine**
  - Ketamine Stun
    - IV combo: xylazine (0.22-0.33 mg/kg), butorphanol (0.08-0.11 mg/kg), and ketamine (0.22-0.33 mg/kg) → reliable recumbency and analgesia up to 25 minutes
    - IM combo: xyalzine (0.22-0.55 mg/kg), butorphanol (0.1-0.2 mg/kg), and ketamine (0.2-0.5 mg/kg IV)
    - Sedation up to 30 – 45 minutes
    - Repeating ½ ketamine IV and butorphanol extend sedation for more 10 minutes

- **Llama lullaby**
  - 1 ml (100mg) of butorphanol and 1 ml (100 mg) of xylazine in 10 ml (1000 mg) of ketamine
  - 1ml/45 kg (99 lb) → standing sedation in camelids
  - However, they tend to go on sternal recumbency

General Anesthesia of Small Ruminants

- **Observations**
  - Animals appear to be stunned but alert, oblivious to surroundings and procedures
  - Procedures been performed with this heavy sedation/anesthesia: castration, biopsy, septic joint flushing, casting of fractured limbs, and flank laparotomy (c-section or correction of uterine torsion)

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Combination of drug regimes

- Ketamine (5 – 10 mg/kg) and xylazine (0.05 – 0.1mg/kg) IM
- Surgical anesthesia lasts 20 to 30 minutes depending on the ketamine’s dose
- Dehorn or disbudding of kids (add local block: ring block of the cornual nerve)
- Animals usually standing within 45 minutes after drugs administration

Tracheal intubation for goats and sheep

- Intubation can be challenging
- Have long ET tubes and long laryngoscope
- Small and narrow larynx entrance and usual cavity
- Mouth does not open widely
- Excessive salivation occurs with light anesthetic attempts of tracheal intubation
- Position animal on sternal recumbency and neck and head
- Clean oral cavity if necessary
- Keep the proximal portion of the neck elevated and the head and mouth downward for drainage of any regurgitated contents

Obstructive urolithiasis

- Sedation for general examination
- Exteriorization of the penis
- Diazepam IV 0.2 – 0.5 mg/kg
- Avoid xylazine or any other alpha2-agonists
- General anesthesia for surgery
- Blood work – plasma potassium
- Elevated K+ causes cardiac arrhythmia
- Tall T wave, smaller or no P wave

C-section

- Inverted L block
- Lidocaine therapeutic dose: 4 - 6 mg/kg
- Dilute to ½ concentration
- Add bicarbonate solution for painless injection
- Bicarbonate (1 part to 4 parts of lidocaine)

Analgesia

- Don’t forget NSAIDs
- Banamine (1-2 mg/kg) or Meloxicam (0.5-2 mg/kg IV, PO)
- Gabapentin
- Cattle: 10 - 20 mg/kg PO twice/day
- Small Ruminants ?
**SWINE**

- Especially challenging for immobilization
  - Very prone to musculoskeletal injuries
  - Come in all sizes

- Sedation/Anesthesia considerations
  - They do not accept manual restraint
  - No part of its body is easily grasped for restraint
  - They bite and they scrape
  - They scream LOUD, very LOUD!
  - They stress .... Severe stress .... They die 🐖
  - Poor eyesight but excellent sense of smell
  - They can be very young (6 weeks) or very old (15 years)
  - Intelligent creatures!!

**CONSIDERATIONS FOR ANESTHESIA IN SWINE**

- Anesthesia challenge
  - Few superficial veins (dorsolateral surface of their ears)
  - Injection is restricted to be intramuscular (long needles 3 cm in length)
  - Injection in the fatty tissue: delay drug absorption into the bloodstream and delivery to the CNS
  - Site of injection: behind the ears

- Light sedation for examination
  - Midazolam intranasal
    - 0.2 – 0.5 mg/kg
  - Use a catheter (22G) to splash in the nasal cavity
  - Give 10 – 15 min for full effect
  - You can always add sedation by giving xylazine (0.5 mg/kg) IM
  - Local block (castration)

- Xylazine (2 mg/kg IM)- pigs are the most resistant species to it
  - Dexmedetomidine (5 -10 mcg/kg IM): sedation for examination - 30 min
  - Alpha-2 agonist + butorphanol (0.2 mg/kg IM): sedation for mild painful procedure – 30 minutes
  - Alpha-2 agonist + ketamine (7 - 10 mg/kg IM): deep sedation – 30 minutes
  - Midazolam + Ketamine + opioid (butorphanol or hydromorphone 0.1 mg/kg IM): mild sedation – 20 minutes
  - Analgesia outlast sedation :) 
  - Great sedation for very young pigs
**Chemical Restraint for Swine**

- Xylazine (1-2 mg/kg IM) + Telazol (2 mg/kg IM)
- Deep sedation lasting 40 minutes

Other drugs that can be given alone for short and mild sedation (15 minutes)

- Acepromazine (0.05 – 0.5 mg/kg IM) maximum 10 mg
- Midazolam (0.4 mg/kg IM)
- Detomidine (0.05 mg/kg IM)
- Azaperone (2 – 4 mg/kg IM) – produces 20–30 minutes sedation
  - FDA approved to be used in pigs
  - Used to control aggression when mixing commercial pigs
  - Reports of excitement when given IV
  - In large boars should not exceed 1 mg/kg (priapism)

**TKX – sedation and immobilization**

- Telazol (500 mg), ketamine 2.5 mL (250 mg), and xyalzine 2.5 mL (250 mg)
- Commercial pigs: 1.25 mL/35-75 kg (77-165 lb) IM
- Potbellied pigs: 0.007/0.012 – 0.013/0.018 mL/kg IM for 30 – 40 minutes

**Combination of sedatives with ketamine/telazol followed by isoflurane face mask produces general anesthesia**

**General Anesthesia for Swine**

**Reversals**

- **Opioids** ➔ Naloxone 0.02 mg/kg IV
- **Benzodiazepines** ➔ Flumazenil 0.02 – 0.0 mg/kg IV

**Alpha2-agonists**

- Tolazoline ½ IM and ½ IV or all IM
- Atipamezole IM

**Considerations for Tracheal Intubation**

- Mouth does not open widely
- Use a long laryngoscope blade (4 – 8 cm)
- Achieve good muscle relaxation for better opening of the mouth
- Pigs have elongated soft palate
- Epiglottis trapped behind elongated soft palate (like a brachycephalic small making more difficult to visualize)
- Presence of the pharyngeal diverticulum

**Tracheal Intubation is Recommended for GA in pigs!**

**Use a soft stylet if necessary**

- Soft stylets can cause injury to tracheal and peribronchial tissues
- Tension pneumothorax can be the consequence

**Always be gentle in twisting the ET and trying to feed it down the trachea**

- Traumatic intubation that injures the laryngeal mucosa has serious consequences
- Hematoma
- Generalized edema
- Difficult to breath, obstruction, and death

**Extubation happens when the animal is completely awake, in sternal recumbency, and almost chewing the tube**
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Drugs and doses for chemical restraint for cattle

Farm Animal Anesthesia, Wiley Blackwell – Huichu Lin