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UNIVERSITY OF MINNESOTA

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ST. PAUL, MINNESOTA
UNITED STATES OF MINNESOTA

Field Anesthesia For Dairy Cattle

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For a variety of reasons, surgical procedures in cattle are usually performed under combinations of physical restraint, sedation and local anesthesia. These techniques work well in calm, easy to handle animals; are more cost-effective than general anesthesia; and are easily performed "in the field". Standing techniques avoid the complications of general anesthesia and recumbency common to large ruminants. However, there are situations and procedures which necessitate general anesthesia. Furthermore, although many veterinarians avoid anesthetizing cattle, general anesthesia offers advantages to both the patient and the clinician, including superior operating conditions, improved anesthetic quality, and a safer working environment.

The purpose of this paper is to review the anesthetic considerations unique to ruminants; discuss the properties of some commonly available anesthetic agents; and introduce some ideas for using these agents "in the field". Many of the anesthetic and adjunctive drugs discussed here (and elsewhere in the veterinary literature) have not been FDA approved for use in cattle in the USA. Many of these agents are secreted in milk (chloral hydrate, acepromazine, xylazine, diazepam and barbiturates) and it is the responsibility of the veterinarian administering the agent to advise owners of recommended withdrawal times. Information concerning withdrawal times can be obtained by contacting the Food Animal Residue Avoidance Bank at ph: 1-904-392-4085.

ANESTHETIC CONSIDERATIONS IN DAIRY CATTLE

1. Anesthetic concerns: body size, drug sensitivities.
2. Concerns unique to ruminants: salivation, regurgitation and bloat
3. Problems of recumbency: hypoxia, neuropathies and myopathies

1. Anesthetic concerns: body size, drug sensitivities.

When anesthetizing dairy cattle, the practitioner may be faced with managing animals weighing anywhere in the range of a 40 kg calf to a 1200 kg bull. The size of the patient determines the type of anesthetic equipment used, and depending on the extent of anesthetic management undertaken, this may mean investment in a large range of equipment. Obviously, size also influences "handlability": it is easy to move and position an anesthetized calf, it is not so easy to maneuver a recumbent adult bull! Field anesthesia of large, adult cattle requires careful planning and may necessitate "extra hands".

As is well known, ruminants are more sensitive than monogastrics to the effects of certain drugs, particularly xylazine, and overdosage can occur if care is not taken.

The risk of overdose is particularly high when dealing with patients at the extremes of the normal size range (especially large bulls), and care should be taken to accurately assess weight. If in doubt give a very small dose; you can always give more! Toxicity can also result from overdose with local anesthetic agents. Signs of toxicity include excitement, lateral recumbency, generalized tonic-clonic seizures and opisthotonus, which may progress to respiratory and cardiac arrest.

2. Concerns unique to ruminants: salivation, regurgitation and bloat.

Ruminants salivate copiously and continue to do so even when deeply anesthetized. Cattle saliva is rich in bicarbonate, phosphate and other ions, and plays an important role in the maintenance of normal rumen conditions necessary for the growth of bacteria and protozoa. Long term saliva loss may result in a metabolic acidosis but this is unlikely to happen during routine anesthesia. However, some authors have suggested collecting the saliva and returning it to the rumen via a stomach tube once the animal has recovered. Treatment with antisialagogues (eg. atropine) is of little value in cattle as these agents tend to make saliva more viscid and do not significantly decrease its production. Airway obstruction by large quantities of saliva is not uncommon in recumbent cattle. Furthermore, because of its low surface tension, saliva tends to froth, compounding the problem of airway obstruction.

Regurgitation and subsequent aspiration of ruminal contents is always a potential hazard of heavily sedated or anesthetized ruminants. Regurgitation can occur during both light and deep anesthesia and is probably due to two different mechanisms. During light planes of anesthesia, ingesta can pass up the esophagus into the pharynx as a result of an active but uncontrolled reflex mechanism. Regurgitation during deep levels of anesthesia is a passive process, governed by increases in intraruminal pressure unopposed by poor esophageal and esopharyngeal sphincter tone. Because of the sedative or anesthetic-induced depression of protective airway reflexes, aspiration of ruminal contents can easily occur.

Once an ox is placed in lateral or dorsal recumbency, the esophageal opening becomes submerged in ruminal contents, preventing normal eructation and allowing gas to accumulate. The degree of bloat is dependent on the amount of fermentation of the ingesta and on the length of time the gas is allowed to accumulate. Gross distension of the rumen may result in regurgitation and will significantly impair ventilatory function.

Salivation, regurgitation and bloat can be minimized by careful preparation of the patient and careful attention to detail during the anesthetic period. Adult cattle should be starved for 36-48 hours and withheld from water for at least 12 hours (preferably 24 hr) prior to induction of general anesthesia. Any animal so heavily sedated or anesthetized that it can not maintain sternal recumbency, must be intubated, preferably with a cuffed endotracheal tube. When possible, place cattle in a head-down, rumen-down position (ie. left lateral recumbency), and position the

head so that the larynx is higher than the nose, facilitating drainage of saliva and ruminal contents from the mouth. Despite these precautions bloat may still occur necessitating passage of a stomach tube or trocharization. Cattle should remain intubated until they are able to maintain sternal recumbency, and show evidence of return of good laryngeal control.

3. Problems of recumbency: hypoxia, neuropathies and myopathies.

Significant hypoxemia has been measured in awake cattle restrained in both lateral and dorsal recumbency. This is exacerbated by heavy sedation or general anesthesia, due to drug-induced depression of central respiratory centers and the development of ventilation/perfusion mismatching in the lungs. Very large animals, very ill animals, pregnant cows, and those patients with respiratory disease benefit from assisted or controlled ventilation with 100% oxygen.

As with any large recumbent animal, anesthetized cattle can develop nerve and muscle injury. The radial and facial nerves are particularly susceptible to damage and attention should be paid to ensuring proper padding of vulnerable areas, removal of halters, and proper positioning of the limbs (ie. pulling the bottom forelimb as far forward as possible and supporting the up limbs so that they lie parallel to the ground when the animal is in lateral recumbency). The risk of myopathy is best minimized by preventing hypotension, correctly padding and positioning the patient, and minimizing down time.

ANESTHETIC AGENTS FOR USE IN CATTLE

1. Alpha-2 Agonists

Xylazine Dose: 0.02 - 0.10 mg/kg IV 0.05 - 0.20 mg/kg IM

- produces reliable, although rousable, dose-dependent sedation.
- produces excellent muscle relaxation and good visceral analgesia.
- sedation normally lasts 30 - 45 mins but full recovery may take several hours.
- doses sufficient to produce recumbency cause depression of the cough reflex and loss of the swallow reflex.
- side effects include significant respiratory depression (decreased PaO₂ and increased PaCO₂), bradycardia, decreased cardiac output, bradyarrhythmias, decreased gut and uterine blood flow, and increased uterine contractility (resulting in abortion). Other effects include depressed gastrointestinal motility (ileus and bloat), impaired temperature regulation, hyperglycemia and the production of an osmotic diuresis (caution with urethral obstruction).
- can be used for restraint, as a premedicant prior to general anesthesia, or as part of a balanced anesthetic technique.
- avoid in the very young, the very old and the very sick.
- can be administered epidurally (dose: 0.05 mg/kg diluted in 5 - 10 ml saline).

- reversible: yohimbine (dose: 0.125 mg/kg slow IV)
atipamezole (dose: 0.025 - 0.05 mg/kg IV or IM).

Detomidine Dose: 0.01 - 0.06 mg/kg IV 0.03 - 0.12 mg/kg IM

- potent alpha-2 adrenoceptor agonist.
- doses required are similar to or greater than those for horses making this a relatively expensive drug for cattle.
- dose-dependent duration of effect; recovery may be very prolonged.
- side effects are similar to those of xylazine.
- reversible - see xylazine.

2. Phenothiazines

Acepromazine Dose: 0.01 - 0.03 mg/kg IV 0.04 - 0.10 mg/kg IM

- produces calming and tranquilization.
- will not produce reliable sedation, especially in difficult to handle animals.
- slow onset of action, 20 - 45 minutes, even after IV administration.
- long duration of action, usually 4 - 6 hr but may last much longer.
- can produce significant hypotension and may contribute to prolonged anesthetic recoveries.
- not reversible.
- poor analgesia.
- avoid in the very young, the very old, and the very sick.

3. Benzodiazepines

Diazepam Dose: 0.02 - 0.50 mg/kg IV

- too expensive to use in adult cattle at the high end of the dose range, but very effective in calves.
- results in excellent muscle relaxation and mild sedation but poor analgesia.
- can be used very effectively as part of a balanced anesthetic protocol.
- irritating and poorly absorbed if given IM.
- reversible: flumazenil (expensive drug, doses not established in cattle).

4. Anticholinergics

Not routinely used in cattle because these drugs do little to control salivation, tend to make salivary secretions more viscid, and have only short durations of action. Furthermore, these agents tend to decrease gastrointestinal motility and may predispose to the development of ileus or bloat.

Atropine (Dose: 0.02 mg/kg IV) can be given if necessary to correct drug or vagal induced bradycardia.

5. Opioids

Perhaps because of their stoic, docile nature, ruminants have often been treated as “poor relations” when it comes to pain management. Given alone, opioids will cause excitement in cattle. However, when used in combination with sedative/tranquilizers, or as part of a balanced anesthetic technique, opioids can improve the quality of restraint, and greatly benefit the patient by providing analgesia.

Butorphanol Dose: 0.05 - 0.10 mg/kg IV

- a relatively “easy to use” opioid because it is not controlled.
- relatively expensive.
- has little effect on gut function at recommended doses.

6. **Guaifenesin** (glyceryl guaiacolate, GG) Dose: 55 - 110 mg/kg IV

- centrally acting muscle relaxant, provides some sedation but no analgesia.
- acts on internuncial neurons of the spinal cord, does not affect diaphragmatic function.
- commonly used as part of anesthetic induction regimen, in combination with thiobarbiturates or ketamine - potentiates action of these agents.
- can also be used to provide casting/restraint for non painful procedures.
- minimal effects on respiratory and cardiovascular systems when used at recommended doses.
- extremely irritant, MUST be given IV via a catheter. Perivascular injection will lead to necrosis and sloughing.
- use 5% solution in cattle, concentrations greater than this may cause hemolysis.

7. **Chloral hydrate** Dose: 80 - 100 mg/kg IV

- sedative-hypnotic producing dose-dependent sedation/narcosis
- anesthetic doses produce deep sleep which lasts for several hours and may prolong recovery.
- can be given orally or via stomach tube in dilute solutions (1 as to 20 in water).
- slow onset of effect after IV administration.
- anesthetic doses can produce marked respiratory and cardiovascular depression - potentiates vagal activity resulting in bradycardia, AV block, or sinus arrest.
- usually administered as a 6 - 7% solution. Extremely irritant, MUST be given via an IV catheter. Perivascular injection will lead to necrosis and sloughing.
- probably superseded by GG and/or xylazine.

8. Barbiturates

Pentobarbital Dose: 15 - 30 mg/kg IV given slowly over 4 minutes to effect.

- duration of action is 20 - 30 mins, full recovery may take 3 hours or more.
- can result in profound respiratory and cardiovascular depression.
- do NOT give to calves less than 4 weeks of age (has produced narcosis lasting longer than 48 hr).
- may result in rough recoveries.
- a poor choice for use in cattle, although can be used successfully in sheep.

Thiopental Dose: 5 - 11 mg/kg IV given to effect (use low end after premedication)

- ultrashort thiobarbiturate, useful for procedures of very short duration or for allowing endotracheal intubation prior to inhalational anesthesia.
- produces unconsciousness and excellent muscle relaxation but poor analgesia.
- produces satisfactory anesthesia of 10 - 15 mins. Quality and length of anesthesia improved by premedication and/or the addition of GG.
- recoveries are usually smooth.
- can produce significant dose-dependent respiratory and cardiovascular depression.
- AVOID in the very young, use with caution in sick or hypovolemic patients.
- MUST be given IV via a catheter.
- generally used in concentrations of 5 - 10%, these concentrations are extremely irritant and will cause sloughing and necrosis if given perivascularly.
- low margin of safety, cumulative, avoid "top-ups".

Thiamylal Dose: 4 - 9 mg/kg IV to effect

- as for thiopental.

Methohexital Dose: 3 - 6 mg/kg IV to effect

- ultra-ultra short-acting oxybarbiturate.
- rarely used in cattle but will produce satisfactory anesthesia of 5 - 7 min duration.
- recoveries may be rough.

9. Dissociatives

Ketamine Dose: 2 - 4 mg/kg IV

- when used alone causes muscle rigidity and opisthotonus.
- questionable/poor analgesia.
- when given with appropriate sedation/tranquilization, produces excellent anesthesia of 20 - 25 mins duration.
- wide margin of safety, very reliable.
- smooth recoveries with the animal standing approx. 45 mins after induction.
- side effects include tachycardia, apneustic ventilation and hypertension.
- partial maintenance of pharyngeal tone and swallowing - NOT protective, but can sometimes make oral intubation difficult.

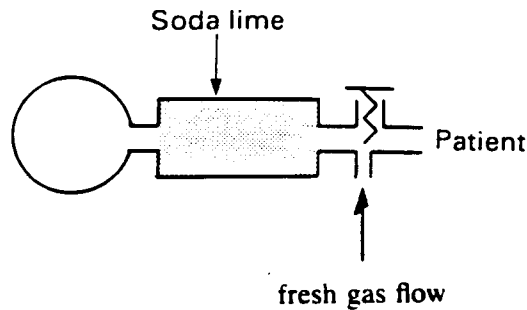
10. Other Injectable Anesthetic Agents.

Other injectable anesthetic agents such as propofol and tiletamine/zolazepam (Telazol[®]) have been used to produce anesthesia in cattle and calves under research conditions. Although effective, their actions are very similar to many of the agents already discussed, and as they offer few if any advantages, the expense of these drugs does not justify their routine use in clinical practice.

ANESTHETIC TECHNIQUES AND EQUIPMENT

Equipment Needed For Anesthesia "In the Field"

- **IV catheters:** 14 gauge, 5" over-the-needle catheters work well and are definitely worth the expense. In adult cattle it is best to desensitize the skin over the jugular vein with a small bleb of local anesthetic, then make a small stab incision through the skin with a scalpel prior to catheter placement. Catheters can be flushed with heparinized saline, capped, and sutured, glued, or bandaged into position.
- **delivery sets of some type:** Most drugs can be given directly via the catheter, or via an extension set and three-way stop cock.
- **endotracheal intubation equipment:** mouth gag suitable for adult cattle; gauze (to hold calves' mouths open); endotracheal tubes (should be cuffed); stylets (to aid intubation); laryngoscope (to aid calf intubation).
Endotracheal tube sizes:
 - (i) calves - generally require 9 - 14 mm ID tubes; may also be intubated nasally with 7 - 9 mm ID nasotracheal tubes.
 - (ii) adult cattle - generally require "horse" tubes in the range of 22 - 30 mm ID
- **ventilatory support equipment:** ambu-bags work well in calves; adult cattle are best supported with mechanical ventilation (obviously impractical in the field!). Demand valves work well and are relatively inexpensive - while delivery of 100% oxygen is preferable, a demand valve connected to a tank of compressed air will support ventilation satisfactorily.
- **padding and support:** large pads or mats are ideal but difficult to transport. Tire inner tubes positioned under the face, shoulder and hip can be effective. Upper limbs can easily be supported on hay bales while in lateral recumbency, and are also useful for supporting animals in sternal recumbency during recovery.
- **anesthetic circuits for delivery of inhalational anesthesia:** most are not suitable for use in the field, however the simple "To and Fro" circuit can be adapted for use in both calves and adult cattle. Will obviously require transportation of oxygen source, flow meter, vaporizer etc.



In this system, a cannister full of sodalime is interposed between the patient and the rebreathing bag, with the fresh gas flow entering the circuit adjacent to the pop off valve and as close to the patient as possible. This system is simple, portable and efficient but has several drawbacks. The cannister can be bulky and heavy (especially the size needed for large animals); the system tends to develop leaks; and the patient is placed immediately adjacent to the sodalime cannister where heat production and inhalation of irritant dust can be a problem. In young calves, 0.5 kg capacity cannisters, lain horizontally, work well. Adult cattle require a vertically positioned cannister (to ensure proper gas flow) with a soda lime capacity of about 5 kg, and with 5 cm ID connections to the expiratory mount and rebreathing bag. 1.5 - 3.0 litre rebreathing bags are sufficient for calves; adults require a 15 - 20 litre bag. Appropriate fresh gas flow rates are similar to those used in a circle system, with large animals initially requiring high flows (8 - 10 L/min) and maintenance flows of 4 - 5 L/min.

Endotracheal Intubation

Because of their narrow dental arcades, small oral cavities, large tongues, and inability to widely open the jaws, cattle can be "intubation challenges". Furthermore, deluges of saliva, sharp teeth edges, and the risk of regurgitation make the task even more difficult. Every effort should be made to keep cattle in a sternal, "head-up" position, until intubation has been achieved. In any case, anesthetized adult cattle **MUST NOT** be rolled or repositioned until they have been intubated. The ruminant larynx is relatively small, "fat" and fleshy, and is very sensitive to trauma. Be gentle and ensure the patient is at a reasonable level of anesthesia prior to attempting intubation- laryngeal manipulation during very light planes of anesthesia will stimulate active vomiting (not good!).

(i) Calves

Young calves are best intubated in sternal recumbency using a long bladed laryngoscope and a firm stylet to "stiffen" the endotracheal tube. Place the laryngoscope in the commisure of the mouth, extend the head and neck, and use strips of gauze (rather than someone's fingers) to hold open the mouth - this will permit the best visualization of the laryngeal area.

(ii) Adult Cattle

Large cattle are best intubated using an oral palpation technique. Intubate blindly by passing one hand into the mouth, palpating the larynx, gently spreading the arytenoid cartilages, and using the free hand to pass the tube. It can be a tight fit!

(iii) "Inbetweeners"

Young heifers can be very difficult to intubate: they are often too big to allow good visualization with a laryngoscope, and yet too small to allow passage of your arm and a tube! These animals can often be successfully intubated by passing a much smaller tube (eg. stomach tube) into the trachea and using this as a guide over which to thread the ET tube.

Position animals in sternal recumbency for recovery and do NOT extubate until the patient can chew and swallow.

Monitoring

While it is not practical to transport bulky, expensive monitoring equipment to the field, much information about anesthetic depth and patient well-being can be gained by simple observation.

- pulses should be strong and regular, 70 - 120 bpm in calves, 50 - 80 bpm in cattle.
- mucous membrane color should be pink, with a CRT of <2 seconds.
- respiratory rate is often elevated especially in adults (20 -30 bpm), for the reasons already outlined. Consider assisting ventilation with a demand valve.
- eye reflexes: eye reflexes are preserved under ketamine, so that the eye appears quite active. Thiopental results in greater depression of eye reflexes, with the eye rotating ventrally, then assuming a central position with a very constricted pupil. This is similar to the signs seen under halothane anesthesia: ventral rotation indicating very light anesthesia, and the central position with constricted pupil indicating surgical anesthesia sufficient for nearly all procedures. A centrally positioned eye with a dilated pupil indicates excessive depth.
- regular swallowing movements indicate that the animal is too light.

INJECTABLE ANESTHESIA FOR CATTLE some ideas...

The Problem...

There are many advantages associated with the use of injectable anesthetic agents. These agents are simple to administer, and equipment costs are usually minimal. Most importantly, at any time, the exact amount of drug given to the patient can be known with certainty. When combined with a simple knowledge of the drug's actions and effects this enables us to make fairly accurate predictions about the outcome of a given dose. Unfortunately, the "ideal" injectable agent does not exist, and presently available injectables have several disadvantages associated with their use. Many injectables have a low therapeutic index: they are "easily given and easily fatal". Consequently, even normal doses of these drugs may result in significant respiratory and cardiovascular depression. Repeated doses are usually cumulative

and prolonged recoveries are common consequences of "top-ups". Most importantly, most injectable anesthetic agents are notoriously poor analgesics. Because of this, painful procedures often require the administration of high doses and maintenance of a relatively deep plane of anesthesia, which is usually accompanied by significant respiratory and cardiovascular depression.

A Viable Solution...

The concept of "balanced anesthesia" originated in the early 1920's, when human anesthesiologists first combined premedication, regional analgesia, and general anesthesia to obtain sleep, muscle relaxation and analgesia (the three requirements of anesthesia) via a "balance" of anesthetic agents and techniques. This simple idea is used extensively in veterinary practice. By carefully combining selected drugs and techniques - particularly local anesthetic techniques, we can greatly improve the quality of anesthesia delivered to our patients.

- choose combinations of drugs that produce sleep, muscle relaxation and analgesia.
eg. xylazine/GG/ketamine or xylazine/GG/thiopental. A small dose of diazepam (10 - 20 mg IV) may be added to the above combinations to further improve muscle relaxation.

Most injectable combinations used in cattle provide little if any analgesia. When undisturbed the patient appears adequately anesthetized, but lightens (often abruptly), when something painful is done, necessitating potentially dangerous "top-ups".

- try including an injectable analgesic - like butorphanol, in injectable anesthetic regimens. Combinations of xylazine (0.02 mg/kg), diazepam (0.05 - 0.10 mg/kg) and butorphanol (0.05 mg/kg) all given IV have worked well for sedation in calves and goats, and have been combined with local regional blocks to permit simple procedures like dehorning.
- include local blocks as part of the overall general anesthetic technique. If possible, place the block prior to inducing the patient to take best advantage of the available "down-time". Regional blocks, specific nerve blocks, line blocks and intravenous regional anesthesia can all be used to advantage.

*****Remember that in all cases, sedated or anesthetized animals must be carefully monitored, until they are able to resume normal activities.**