Introduction
This paper discusses techniques for anesthesia of wild and captive North American Deer. Ruminants, in general, are difficult patients to anesthetize. Wild ruminants are particularly difficult as they are prone to a variety of stress-related complications. The first part of this paper is a general discussion of anesthesia in wild ruminants. This is followed by case discussions for each species.

Pre-Anesthetic Considerations
Several factors will influence the method of anesthesia, and the means of drug administration. If possible, the animal should be moved into an enclosure or handling facility. This allows the handler to administer drugs without remote delivery equipment or with low velocity remote delivery equipment. If animals must be captured in a large enclosure, the capture must be carefully planned to decrease chase times. Prolonged chase times can result in capture myopathy (exertional rhabdomyolysis) or hyperthermia. Prolonged chase times can also increase the risk of trauma.

Elective procedures should be planned for the cool hours of the day. Rumenal tympany can be a serious complication during anesthesia. If the procedure is elective, captive deer should be fasted for 24 hours. Ruminants are prone to hypoxemia during general anesthesia [1]. This is exacerbated by dorsal or lateral recumbency and alpha-2 agonist drugs (e.g., xylazine, medetomidine) [1]. Chronically debilitated animals and animals with severe fluid deficits or blood loss are poor anesthetic candidates and are at an increased risk of dying during a procedure.

Monitoring and Supportive Care
Hypoxemia is not uncommon during deer anesthesia [1,2]. Hypoxemia, in association with hyperthermia is particularly serious since it increases tissue oxygen demand. This will increase the risk of capture myopathy or acute mortality. Hypoxemia can be minimized in the field. Animals should be positioned in sternal recumbency and the head and neck extended to maintain a patent airway. The animal should be monitored ideally with a pulse oximeter. A multi-site sensor applied to the tongue generally provides a good signal. Normal hemoglobin saturation should be 95 - 98%, below 85% it is considered hypoxemic. If a pulse oximeter is not available the mucous membranes should be monitored for cyanosis. Severely hypoxemic animals are often tachycardic. Heart rates above 150 bpm in mature deer may be due to a stress response induced by hypoxemia, hypercarbia, pain or hypotension. Tachycardia, followed by severe bradycardia (heart rate < 30) is a warning sign that hypoxemia is very severe and heart failure is imminent.

Supplemental inspired oxygen should be considered in hypoxemic animals. Portable equipment is available to facilitate oxygen delivery (Figure 1). An ambulance type regulator (Easy Reg ® Precision Medical Inc., Northampton, PA, USA) and aluminum D-cylinder is lightweight, portable and sturdy. It can provide a 10 l/min flow for up to 30 minutes. An E-cylinder will provide this flow for an hour or more. A nasal catheter can be used in deer and bison. The catheter should be threaded as far as the medial canthus of the eye. A flow rate of 6 - 8 l/min is generally sufficient for white-tailed deer and mule deer. A flow rate of 8 - 10 l/min is required in larger deer species (Figure 1).

Figure 1. Anesthetized moose receiving supplemental nasal oxygen. Percent hemoglobin saturation is being monitored with a pulse oximeter and a nasal septum probe. - To view this image in full size go to the IVIS website at www.ivis.org . -
Heart rate and pulse quality should be monitored every 5 minutes. The auricular artery is easily palpated in deer. If the auricular artery cannot be palpated a femoral pulse can be used.

Maintenance in sternal recumbency will help to prevent the development of rumenal tympany. If rumenal tympany is a problem the animal may be rocked gently to stimulate eructation. A rumen tube will predispose to regurgitation and aspiration and must be used with care. If rumenal tympany is severe, it is advisable to finish the procedure quickly and antagonize the anesthetic agents. If alpha-2 agonists have been used, the administration of tolazoline, yohimbine, or atipamezole will stimulate rumenal activity and relieve rumenal tympany.

Rectal temperature should be monitored every 5 - 10 minutes. Deer are prone to hyperthermia [1,3], especially following a long chase. Rectal temperature greater than 40ºC are cause for concern, and attempts should be made to cool the animal, cold water sprayed on the animal or snow packed into the inguinal and axillary regions may help. Rectal temperature in excess of 41ºC is an emergency and should be treated aggressively. It is difficult to actively cool large animals and often the best option with severe hyperthermia is to antagonize the immobilizing agents and allow the animal to recover. Hyperthermia greatly increases metabolic oxygen demand. Hyperthermia, in the face of hypoxemia, is a particularly serious complication. Hyperthermic animals should receive supplemental inspired oxygen to offset hypoxemia.

**Pharmacological Considerations**

This section discusses pharmacological agents that may be used for anesthesia of deer, specific drug doses can be found in Table 1 and Table 2. It is important to note that all of these drugs are off label, there are no anesthetics approved for game farmed or wild cervid species in North America. Attention must be made to hunting seasons and appropriate marking of wild captured animals, to avoid consumption of drug residues in meat. It is often possible to perform simple procedures on calm, captive, wapiti following sedation with 1 mg/kg of xylazine IM. The addition of 1 - 2 mg/kg of ketamine IV will produce light anesthesia, and will decrease the risk of sudden arousal from the sedation (Figure 2).

![Figure 2. Wapiti sedated with xylazine hydrochloride. A blindfold has been placed to decrease visual stimuli, and the legs are hobbled to prevent injury if the animal attempts to kick. - To view this image in full size go to the IVIS website at www.ivis.org. -](image)

| Table 1. Recommended Anesthetic and Antagonist Dosages in Captive Wapiti and White-tailed Deer |
|---------------------------------------------------------------|-----------------|-----------------|
| **Wapiti** | **White-tailed deer** |
| Xylazine (mg/kg) IM | 1 | 2 - 3 |
| Xylazine (mg/kg) IM + Ketamine (mg/kg) IV | 1 (x) + 1 - 2 (k) | 2 - 3 (x) + 1 - 2 (k) |
| Xylazine + Telazol (mg/kg) IM | 1 (x) + 2 (t) | 1 - 1.5 (x) + 2 - 3 (t) |
| Carfentanil (µg/kg) + Xylazine (mg/kg) | 10 (c) + 0.1 (x) | 10 (c) + 0.2 (x) |
| Yohimbine (mg/kg) IM or dose divided half IV and half IM [2] | 0.1 - 0.2 | 0.1 - 0.2 |
| Tolazoline (mg/kg) IM or dose divided half IV and half IM [2] | 2 - 4 | 2 - 4 |
| Atipamezole (µg/kg) IM or dose divided half IV and half IM [2] | 100 | 100 - 200 |
| Naltrexone (mg/kg) IV | 1 | 1 |
A mixture of xylazine and telazol is useful for anesthesia of Wapiti, White-tailed deer, mule deer and moose. The mixture is prepared in a 1:2 ratio by adding 250 mg of 100 mg/ml xylazine to 500 mg of telazol powder. The resulting mixture contains approximately 89 mg/ml of xylazine and 178 mg/ml of telazol [1]. Antagonism of the xylazine component will hasten recovery. yohimbine, tolazoline or atipamezole can be used to antagonize xylazine in deer [4]. Carfentanil will produce reliable immobilization in deer [5,6]. Carfentanil should be combined with xylazine to produce muscle relaxation, or animals will demonstrate muscle rigidity and spontaneous movement.

**Drug Delivery**

Captive deer are ideally immobilized in a suitably designed handling system that allows the use of hand-held injections under controlled conditions. When darts are used, the times to recumbency are generally longer and immobilization is unreliable. Dose requirements may also be higher when darts are used; however, remote drug delivery may be required for anesthesia of zoo specimens or game farmed species if handling systems are inadequate. A pole syringe, which can extend reach up to 5 meters, and shields may be a good option for drug delivery to smaller deer species. A blow pipe and blow darts, such as Telinject ® darts, will facilitate drug delivery up to 10 meters. The advantage of blow darts is that they are relatively atraumatic. Blow darts are available in volumes up to 5 ml. Dart pistols propel projectiles with CO2 or compressed air. Pistols will deliver darts accurately up to 15 meters. Metal darts expel their contents using an explosive charge. This will increase tissue trauma compared to blow darts.

A dart rifle will be needed for the majority of drug immobilizations of free-ranging deer. Dart rifles are available from a variety of companies. Dart velocity is controlled by either changing the charge type or adjusting the power with a dial. These systems can propel a dart to distances > 60 meters, but to ensure accuracy and reduce tissue trauma, dart delivery should be kept to 30 meters or less. Dr. Terry Kreeger’s Handbook of Wildlife Chemical Immobilization [5] contains an excellent description of currently available remote delivery equipment.

**Complications**

The most common complications encountered during anesthesia of wild ruminants are hypoxemia, hyperthermia and rumenal tympany, which have been discussed above. Capture myopathy is a potentially serious complication that can be very difficult to treat [7]. In the acute form of capture myopathy the animals oxygen demand is far in excess of oxygen supply. Animals often present with hyperthermia, cyanosis, acidosis, tachycardia, and hypotension. The animal may die during the anesthetic or soon after [7]. If the animal survives the acute stage it may develop subacute or chronic capture myopathy. This can have a variety of manifestations including paraplegia, ruptured muscles, myoglobinuria or oliguria [7]. The treatment of acute capture myopathy is directed at symptomatic treatment for shock, correcting acid base disturbances, maintaining normothermia and oxygenation. Treatment is extremely difficult in a field situation and often unsuccessful. Animals with

### Table 2. Recommended Anesthetic and Antagonist Dosages in Wild Deer

<table>
<thead>
<tr>
<th>Species</th>
<th>Xylazine mg/kg / Ketamine mg/kg</th>
<th>Xylazine mg/kg / Telazol ® mg/kg</th>
<th>Carfentanil µg/kg / Xylazine mg/kg</th>
<th>Other combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moose</td>
<td>2 / 4</td>
<td>1.5 / 3</td>
<td>5 - 10 / 0.1</td>
<td>Medetomidine 60 µg/kg + Ketamine 1.5 mg/kg</td>
</tr>
<tr>
<td>Elk</td>
<td>2 / 4</td>
<td>1.5 / 3</td>
<td>5 - 10 / 0.1</td>
<td>Medetomidine 70 µg/kg + Ketamine 2 mg/kg</td>
</tr>
<tr>
<td>White-tailed Deer</td>
<td>2 / 6</td>
<td>2 / 4</td>
<td>10 / 0.1</td>
<td>Medetomidine 100 µg/kg + Ketamine 2 mg/kg</td>
</tr>
<tr>
<td>Mule Deer</td>
<td>2 / 6</td>
<td>2 / 4</td>
<td>10 / 0.1</td>
<td>Medetomidine 100 µg/kg + Ketamine 2 mg/kg</td>
</tr>
<tr>
<td>Woodland Caribou</td>
<td>2 / 6</td>
<td>2 / 4 (S)</td>
<td>10 / 0.2</td>
<td>Medetomidine 150-200 µg/kg + Ketamine 2 mg/kg or Etorphine 60 µg/kg + Xylazine 0.3 mg/kg</td>
</tr>
<tr>
<td>B. grounds Caribou</td>
<td>2 / 6</td>
<td>2 / 4 (S)</td>
<td>10 / 0.2</td>
<td>Medetomidine 150-200 µg/kg + Ketamine 2 mg/kg</td>
</tr>
</tbody>
</table>

S. This is a suggested dosage and a good starting place for the drug combination in this species. The combination has not been tested in this species, and the dosage has been extrapolated from experience with other drug combinations.
chronic capture myopathy generally need to be euthanized. It is best to prevent capture myopathy by keeping chase times to a minimum and avoiding prolonged physical restraint. Trauma is not uncommon during capture. White-tailed deer can be very flighty and, as such, they are prone to self trauma.

Anesthesia of Captive or Game Farmed Deer
Game farmed and other captive deer often have very different drug requirements compared to free ranging animals. The following section deals with anesthetic management of captive deer. The focus of this section is on wapiti, mule deer and white tailed deer. The first section deals with general considerations, this is followed by case discussions.

Sedation of Captive Deer
White tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) usually require 2 - 3 mg/kg body weight (BW) of xylazine IM, to produce recumbent sedation. Wapiti (*Cervus elaphus*) require approximately 1 mg/kg IM, to produce recumbent sedation [8].

Once the xylazine is administered the animal should be left alone until it assumes lateral recumbency. It is then cautiously approached and a towel is placed over its eyes to decrease stimulation; noise should be kept to a minimum. Animals may appear to be very sedated under xylazine sedation, but they can wake up quite suddenly. To decrease sudden arousal, administer 1 mg/kg BW of ketamine into the jugular vein. Administer a "top-up" of ketamine at 10 - 15 min intervals. Allow at least 10 min to elapse following the last dose of ketamine, prior to reversal of xylazine. If ketamine is administered close to xylazine reversal, rigidity and convulsive activity may be seen. A combination of xylazine at the above doses in wapiti, mule deer, and white tailed deer, plus azaperone at a dose of 0.1 mg/kg BW, IM, will produce very effective sedation. Side effects of xylazine sedation can include rumenal tympany, regurgitation, decreased thermoregulatory ability, and respiratory and cardiovascular depression. Since xylazine-induced sedation can last several hours, the effects of the xylazine should be reversed. Yohimbine is very effective in most cervids at a dose of 0.1 - 0.2 mg/kg BW. Administer 0.1 mg/kg IV and 0.1 mg/kg IM. Tolazoline is also effective, and can be used at a dose of 2 - 4 mg/kg BW. Give half IV and half IM.

Sedation plus Local Anesthesia
Various local anesthetic techniques may be used in cervids, and can be combined with sedative techniques for surgery. Techniques include antler block, paravertebral or field block for flank analgesia, local infiltration, and IV regional anesthesia. Keep in mind the size of the animal and the toxicity of the drug. To avoid toxicity, it is wise to avoid doses of lidocaine in excess of 8 mg/kg BW during infiltration, and to use less than 4 mg/kg for IV regional anesthesia. With 2% lidocaine in a 60 kg deer, this translates to no more than 24 ml with infiltration, and no more than 12 ml of lidocaine, without epinephrine, IV. To increase the volume available for administration, the lidocaine can be diluted with an equal volume of sterile water to produce a 1% solution.

Local Analgesia for Velvet Antler Removal
The simplest way to block velvet antler is to perform a ring block at the base of the antler pedicle. Lidocaine hydrochloride (without epinephrine) is administered at a dose rate of 1 ml/cm of pedicle circumference. The block will produce surgical analgesia in 1 - 2 minutes and will last approximately 90 minutes (Figure 3).

Drugs for Capture via Remote Delivery
Xylazine-telazol is a useful combination for capture of escaped animals or for IM sedation/anesthesia. The combination is more reliable than xylazine alone and can be administered at a much smaller volume than xylazine-ketamine. To mix the drug add 250 mg of 100 mg/ml xylazine HCl to 500 mg of telazol powder. The resulting solution contains approximately 89 mg/ml of xylazine and 178 mg/ml of telazol, it can be administered by IM injection and generally produces sufficient anesthesia for minor procedures in the field. The effective dose for wapiti and moose is 1 mg/kg of xylazine + 2 mg/kg of telazol. White tailed deer and mule deer require 1.5 mg/kg of xylazine + 3 mg/kg of telazol. Excited animals often require a higher dose. This combination will provide approximately 45 minutes - 1 hour of anesthesia. Anesthesia may be prolonged with IV ketamine at a dose of 1 - 2 mg/kg, Q 15 min. Once the procedure has been completed, antagonism of xylazine is
recommended with tolazoline or yohimbine at the above dosage. The major complication associated with this technique is hypoxemia.

**Injectable Anesthesia**

Short term anesthesia can be readily accomplished with combinations of xylazine and ketamine:

- **White tailed and mule deer**: Xylazine 2 mg/kg BW + Ketamine 3 - 4 mg/kg BW, together, IM.
- **Wapiti**: Xylazine 1 mg/kg BW + Ketamine 3 - 4 mg/kg, together IM. There are 2 major disadvantages with this combination.

1. The drug volume requires 2 darts.
2. Adequate time must be allowed for the animal to absorb and metabolize the ketamine, one must usually allow 30 - 45 minutes post-ketamine administration before reversing the effects of the xylazine. A better approach is to administer a sedative dose of xylazine IM: White tailed and mule deer, xylazine 2 - 3 mg/kg BW IM. Wapiti, xylazine 1 mg/kg BW IM. Once the animal becomes recumbent, administer 1 - 2 mg/kg BW of ketamine IV. This will produce approximately 15 min of anesthesia. Anesthesia may be prolonged by the administration of additional boluses of ketamine (0.5 - 1 mg/kg BW) as the depth of anesthesia decreases, usually at 10 - 15 minute intervals. Using this technique anesthesia can be prolonged for up to 30 minutes, and the effects of the xylazine may be reversed 10 minutes following the last dose of ketamine. Animals tend to maintain their airway protective reflexes, but if regurgitation does occur, the head should be lowered, and if possible the pharynx should be suctioned and the trachea intubated. The major complication is hypoxemia. This becomes more severe if anesthesia is maintained for longer than 15 minutes.

Anesthesia can also be maintained with guaifenesin infusions plus 1 - 2 mg/kg boluses of ketamine to maintain anesthesia. Extra care must be taken as these animals appear to be particularly sensitive to toxic side effects. Signs of guaifenesin toxicity include extensor rigidity or opisthotonus. If these signs are observed, discontinue administration. Anesthesia can still be maintained with ketamine.

**Inhalational Anesthesia**

Inhalational anesthesia is recommended for prolonged, or very invasive procedures. Either halothane or isoflurane can be used. A small animal circle system can be used on animals weighing up to 150 kg. Use a 3 - 6 L rebreathing bag and fresh gas flows of 10 - 20 re breathing/kg BW/min. Cervids premedicated with xylazine can usually be maintained on approximately 1% halothane or 1.3% isoflurane. Induction of adult cervids can be achieved with xylazine sedation followed by IV ketamine at a dose of 2 - 3 mg/kg BW, using the techniques described above. Fawns are usually easy to handle. Avoid xylazine in cervids < 3 months since neonates are dependent on heart rate for cardiac output and bradycardia is not well tolerated. Fawns can be induced with IV diazepam, 0.2 mg/kg BW combined with ketamine 2 - 3 mg/kg BW. Cervids must be intubated, as airway protective reflexes are absent under inhalational anesthesia. Regurgitation and aspiration can occur.

Intubation is difficult in cervids. The best technique is to maintain the animal in sternal recumbency with the head and neck extended. Use a laryngoscope with a long flat blade and stiffen the endotracheal tube with a stylet. The epiglottis is long and mobile. The flat blade of the laryngoscope should be placed on the dorsum of the epiglottis, depressing it ventrally. The opening to the glottis can then be visualized and intubation can proceed. Animals induced with xylazine and ketamine may swallow, or close the glottis opening during intubation. The depth of anesthesia may be increased with an additional dose of ketamine (1 - 2 mg/kg BW). If difficulties are still encountered, a low dose of guaifenesin will facilitate intubation.

Hypoventilation occurs especially in dorsal recumbency. Intermittent positive pressure ventilation may be required. Usually, cervids maintain a relatively high blood pressure; hypotension may be encountered if rumenal tympany is present. The respiratory and hemodynamic compromise produced by rumenal tympany can be severe. The incidence of rumenal tympany can be decreased if food is withheld for 24 - 36 hours prior to anesthesia. Water should be withheld for 12 h prior to anesthesia. Rumenal tympany may be resolved by passage of a stomach tube. If not, the anesthesia may be terminated, or emergency rumenal trocharization performed. Passive regurgitation can occur. Inflate the cuff on the endotracheal tube to ensure an adequate seal of the airway. The animal should be extubated when the swallowing reflex occurs, and the ETT should be removed with the cuff partially inflated. Animals that have had xylazine premedication should receive yohimbine, to reverse the effects of the xylazine, at a dose of 0.1 - 0.2 mg/kg BW. Divide the dose, give half IM and half IV. Postoperative analgesia can be achieved with 0.025 - 0.05 mg/kg BW of butorphanol.
Case 1. Wapiti

**Problem** - A two-year-old female wapiti has injured her distal right forelimb. There is a large laceration overlying the caudal metacarpus and possibly some damage to the flexor tendons. There was a chute facility but the animal required anesthesia to adequately examine the limb and treat the wound.

**Solution 1** - Weight was estimated, a cow of this age weighs about 150 - 250 kg. If this is a calm animal the simplest solution is to move her into the squeeze and administer either 0.75 mg/kg of xylazine IV or 1 mg/kg of xylazine IM. The cow can be released from the squeeze into a small pen. Once the cow is recumbent she can be carefully approached and blindfolded. It may be possible to examine the limb at this point, alternatively, 1 - 2 mg/kg of ketamine can be administered IV [8]. This will ensure adequate anesthesia and will prevent any sudden movement. The cow will need to be in lateral recumbency, this will increase the risk of hypoxemia and rumenal tympany. If a pulse oximeter is available it can be used to monitor hemoglobin saturation. If saturation is less than 85% supplemental inspired oxygen should be considered. It is determined that there is no tendon damage and the wound can be sutured. Prior to suturing the wound it should be infiltrated with local anesthetic. Mepivicaine or neat lidocaine can be used for the infiltration. The ketamine can be "topped up" every 15 - 20 minutes. An IV catheter placed in the jugular or the cephalic vein will facilitate administration of additional ketamine, and provides rapid access if a sudden arousal from anesthesia occurs. Once the procedure is complete the xylazine should be antagonized with either yohimbine, tolazoline or atipamezole. Top up doses of ketamine should be avoided 10 - 15 min prior to antagonism of alpha-2 agonist drugs.

**Solution 2** - If the cow was stressed, and impossible to move into the chute, xylazine-telazol would be a better choice for anesthesia. It is more reliable than xylazine alone, and is a better choice for animals that are under high sympathetic tone.

Case 2. White-Tailed Deer

**Problem** - You are asked to collect semen from a five-year-old white-tailed deer buck. The buck is held in a 10 x 10 meter pen, and it has been injured in a rutting fight. It is mid November. The buck weighs 120 kg is in hard antler, and appears to be quite worked up.

**Assessment** - There are several factors that add to the difficulty of this case. The buck is in rut and electroejaculation is a relatively potent stimulus; therefore, the deer will need to be in a deep plane of anesthesia to avoid arousal. Some form of remote drug delivery will be required in this situation.

**Solution** - A calm white-tailed deer may be sedated with 2 - 3 mg/kg of xylazine, followed by IV ketamine. There is a risk of sudden arousal on approach, and a deer in hard antler presents a significant risk to the handlers. The best choice in this situation is xylazine-telazol [2], and it would be advisable to start at the high end of the dose range. In this animal 1.5 mg/kg of xylazine + 3 mg/kg of telazol should be sufficient. The volume of this mixture will be 1.5 ml, which will easily fit in a low velocity blow dart. There are several options for drug delivery. A pole syringe and shields may be adequate for a calm deer, but is somewhat risky for handlers in this situation. A blow pipe is the best choice, as it delivers the dart at a low velocity, and dart contents are expelled at a low velocity. A dart pistol could also be used. At close range dart rifles often propel darts with excessive velocity. The dart should be placed in the gluteals, or the quadriceps. Once the dart is placed the deer should be left alone and the room darkened. This will decrease stimulation and facilitate a smooth induction. It generally takes 5 - 10 minutes for induction of anesthesia. Once the deer is recumbent it should be cautiously approached, eye lubrication should be administered and a blindfold is placed. Anesthetic depth can be increased, if needed, with 1 - 2 mg/kg of ketamine IV. A pulse oximeter will greatly facilitate monitoring. If hemoglobin saturation is < 85% supplemental inspired oxygen should be delivered via a nasal catheter at a flow rate of 5 - 10 liters/min. The flow rate can be titrated to achieve a hemoglobin saturation of 95 - 97%.

The deer will be maintained in lateral recumbency and should be closely monitored for bloat. During electroejaculation the limbs should be restrained to avoid trauma to the handlers. Once the procedure is complete the deer should be placed in sternal recumbency and either yohimbine, tolazoline or atipamezole is administered to hasten recovery.

Free-Living Deer Anesthesia

Wild deer will generally be at a greater risk for complications than captive deer. Drug requirements are higher and the risk of capture myopathy, hyperthermia or trauma is potentially higher. There are a variety of protocols for capture of deer. This section describes some of these protocols.

**Pharmacological Considerations**

Xylazine hydrochloride has been used in deer for over 30 years. There is a well recognized risk of hypoxemia. Read et al., conducted a trial to measure the effects of a xylazine / Telazol mixture [1]. All wapiti exhibited mild to marked hypoxemia (PaO2 = 43 +/- 11.8 mmHg) and showed marked improvement after 5 minutes of nasal insufflation of oxygen at 10 L/min (PaO2 = 207 +/- 60 mmHg).
Medetomidine is an extremely useful alpha-2 agonist drug for wildlife anesthesia when it is formulated at a concentration of 10 mg/ml (zalopine). Medetomidine is 20 - 40 times more potent than xylazine. However, its use alone is not generally recommended as induction times are unacceptably long. Medetomidine is generally used in combination with ketamine. The major advantage of medetomidine-ketamine is that ketamine requirements are much lower than with xylazine. This factor allows for an earlier antagonism of the combination i.e., the alpha-2 agonist can be antagonized with less risk of unmasking convulsive activity or ridgity from residual ketamine. Medetomidine should always be antagonized with atipamezole at a 3 - 5:1 ratio. Less specific alpha-2 agonist drugs (yohimbine, tolazoline) are usually not effective.

The opioids etorphine, carfentanil and fentanyl have been widely used for immobilization of several different deer species [9]. In most cases they have been combined with xylazine hydrochloride, acepromazine maleate or other sedatives in order to achieve optimum immobilization. The choice of opioid for use in deer may be governed as much by availability as by any other factor.

Thiafentanil oxalate (A3080, Wildlife Pharmaceuticals, Fort Collins, Colorado, USA) is another potent opioid anesthetic that is being evaluated for wildlife and has been used in wapiti in a limited number of studies [10]. Thiafentanil is approximately 6,000 times more potent than morphine, making it only slightly less potent than carfentanil which is rated as 8000 times more potent than morphine. Doses in wapiti as high as 100 µg/kg provided very rapid immobilization (<1 min in some cases) and numerous wapiti have been immobilized at doses near 50 µg/kg.

A variety of narcotic antagonists have been used in deer. They include nalorphine, diprenorphine (Revivon®), naloxone (Narcan), nalmefene and naltrexone (Trexonil®).

Of these products, naloxone has the shortest half-life. Narcotic recycling, or renarcotization, especially of animals immobilized with carfentanil or etorphine has been reported when naloxone is used [10]. Naltrexone is known to have a longer half-life in some species than any of the other antagonists listed (although no critical trials have been conducted in ungulates) and when adequate doses of naltrexone are used recycling is generally not a problem [11].

Long acting tranquilizers can be extremely useful in the management of wild and semi-domesticated deer. These drugs will facilitate transport of deer and will decrease stress in acutely captured deer. They have the potential to decrease the risk of trauma, and capture myopathy. Azaperone (0.2 mg/kg) can be used immediately post reversal to facilitate short translocations (6 hr or less). Clopixon acuphase (1 mg/kg) will provide up to 4 days of tranquilization [12].

Free-living Wapiti, White Tailed Deer and Mule Deer Anesthesia
The major problem with anesthesia of wild deer is that they usually have a high level of background stress. Drug dosages should be increased to override the effects of the stress hormones. In white tailed deer and mule deer xylazine-telazol®, medetomidine-ketamine or carfentanil-xylazine could be used. Xylazine-telazol® or carfentanil-xylazine are recommended in wild wapiti. Both combinations should be used at the high end of the above dosage range (Table 2). A deer in this situation would be very prone to hyperthermia and capture myopathy. Chase times should be kept to a minimum to decrease the risk of these complications.

Moose Anesthesia
Moose anesthesia is very similar to that of other cervids. A major complicating factor is their large size; mature moose weigh 400 - 700 kg. All of the same precautions apply, and particular attention must be paid to the prevention of capture myopathy and hyperthermia. There are several drug choices for anesthesia of moose (Table 2). A dose of 10 µg/kg of carfentanil plus 0.1 mg/kg of xylazine will produce reliable immobilization. The carfentanil should be antagonized with 100 mg of naltrexone/mg of carfentanil. If carfentanil is not available, or inappropriate for the situation, 1 mg/kg of xylazine plus 2 mg/kg of telazol® will also provide reliable immobilization. The xylazine can be antagonized with 0.5 - 1 mg/kg of tolazoline. A final option is 1 mg/kg of xylazine plus 4 mg/kg of ketamine. The major drawback of this technique is the volume of the drugs. If 100 mg/ml xylazine and 100 mg/ml ketamine were used, a volume of 30 ml could be required for a large moose, which is quite impractical and likely to create significant muscle damage if used from the two or three darts that would be needed.

Caribou Anesthesia
For the sake of this paper woodland caribou and barren ground caribou are considered together. Caribou can be very difficult to anesthetize, and have very high drug requirements, when compared to other species. Their speed and agility can make them a difficult target for remote delivery. Caribou appear to have much higher drug requirements than reindeer [13]. Drug
choices for caribou include medetomidine-ketamine, etorphine-xylazine or carfentanil-xylazine (Table 2). Xylazine-telazol® has been effective in captive caribou, but may not be as effective in free-ranging animals.

References


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