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Bison (Artiodactyla: Bovidae) (1-Aug-2001)

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Summary
Bison can be very challenging to anesthetize. Physically restrained bison can be anesthetized with IV xylazine-ketamine or xylazine-guaifenasin-ketamine. Diazepam-ketamine can be useful in healthy bison calves, and diazepam-butorphanol may be useful in depressed calves. Three combinations are useful for the immobilization of free ranging bison. Carfentanil 4 - 8 µg/kg + xylazine 0.05 - 0.1 mg/kg is a particularly useful combination in large free-ranging animals. Xylazine 0.75 - 1.5 mg/kg + 1.5 - 3 mg/kg is a useful combination for game farmed or smaller free-ranging bison, and medetomidine 60 µg/kg + telazol 1.2 mg/kg is useful for game farmed or free-ranging bison. Volatile anesthesia can be performed with isoflurane, following induction with a suitable agent, and intubation. Bison are particularly prone to hypoxemia, bloat regurgitation, and aspiration. Supplemental inspired oxygen is recommended. Animals should be positioned in sternal recumbency, when possible, and animals should be fasted for 24 - 48 hours, when possible, prior to anesthesia. Tolazoline or atipamezole should be used to antagonize xylazine as yohimbine is not effective in bovids.

Introduction
Two subspecies of bison can be found in North America. The plains bison (*Bison bison bison*) is most commonly encountered in free-ranging and captive herds. The wood bison (*Bison bison athabascae*) is confined to a few free-ranging herds in northern Canada, and some captive animals (Fig. 1).

Figure 1. Wood bison are slightly larger than plains bison. Both subspecies have similar dose requirements and are prone to the same complications. - To view this image in full size go to the IVIS website at www.ivis.org . -

Response to anesthesia is similar in both subspecies and this discussion applies equally to both.
Bison may require anesthesia for a variety of reasons: obstetrical procedures, capture of escaped animals and traumatic injury are all common complaints, which are often emergency procedures. Free-ranging or park-based animals may also immobilization for a variety of research studies.
Bison can be extremely difficult to anesthetize. Major complications of anesthesia can include: bloat, regurgitation, and hypoxemia [1]. Bison are also predisposed to the development of capture myopathy, which can occur during or after anesthesia.

Pre-Anesthetic Concerns
Pre-operative fasting is not always possible in free-ranging or park-based bison. Like cattle, anesthesia of an animal with a full rumen pack can result in bloat or regurgitation. Xylazine or general anesthesia with volatile agents will lead to decreased rumen motility, bloat and regurgitation. These can be fatal complications and tend to be more severe in large, mature animals. Ruminants are prone to hypoxemia during general anesthesia. Positioning in dorsal or lateral recumbency will exacerbate hypoxemia. Alpha-2 agonist drugs such as xylazine or medetomidine will also exacerbate hypoxemia [1]. Bison become stressed very quickly. Stressed animals tend to over-ride the sedative effects of alpha-2 agonist drugs necessitating the use of relatively high dosages of these agents to produce recumbency [1]. Stressed animals are prone to capture myopathy [6], the acute form of which is a shock-like syndrome that can result in death within hours. The sub-acute form often results in muscle damage, myoglobinuria, and potentially kidney failure. The chronic form is characterized by severe muscle fibrosis, chronic progressive renal failure, and the possibility of muscle rupture to already weakened tissues. Rupture of the gastrocnemius muscles is a common manifestation of exertional myopathy in bison. It can occur acutely or may manifest in

the chronic form. It is extremely important to keep chase times to a minimum, and try to avoid excitement prior to induction. Hyperthermia can be a further complication. Hyperthermia increases metabolic oxygen demand and increases the risk of capture myopathy. If immobilization is anticipated, it should be planned for the cool hours of the day. Field immobilizations should probably not be conducted when ambient temperatures exceed 23°C.
Trauma during induction of anesthesia is not uncommon. It is particularly important to control the rest of the herd during induction as other members of the herd may traumatize the drugged animal. In particular attendant bulls may misread gait and behavior patterns during the induction phase and attempt to mount ataxic females.

Monitoring and Supportive Care
Hypoxemia can be severe during anesthesia. Hypoxemia, in the face of hyperthermia, is a particularly serious situation, as hyperthermia increases tissue oxygen demand. This can increase the risk of capture myopathy or result in acute mortality. Hypoxemia can be prevented or treated in the field. Animals should be positioned in sternal recumbency (Fig. 2).

Figure 2. Bison are prone to hypoxemia and rumenal tympany. They should be maintained in sternal recumbency, whenever possible, to decrease the severity of these complications. - To view this image in full size go to the IVIS website at www.ivis.org . -

The head and neck should be extended to maintain a patent airway. The animal should be monitored for hypoxemia, 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% 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 in bison may result from a stress response due to hypoxemia, hypercarbia, pain or hypotension. Tachycardia, followed by severe bradycardia (HR<30) is often a warning sign that hypoxemia is very severe and the heart may fail. Supplemental inspired oxygen should be considered in hypoxemic animals. Portable equipment is available to facilitate oxygen delivery (Fig. 3).

Figure 3. Administration of supplemental oxygen to a grizzly bear. The delivery equipment is lightweight, portable, and readily available from most ambulance supply companies. The oxygen is delivered via a nasal canula, and the flow rate is titrated to achieve a percent hemoglobin saturation of 95 - 98%. - To view this image in full size go to the IVIS website at www.ivis.org . -

An ambulance type regulator (Easy Reg® Precision Medical, Inc. 300 Held Drive, Northampton, PA 18067) and aluminum D-cylinder is light weight, 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 is a simple method to provide supplemental inspired oxygen. The catheter should be threaded as far as the medial canthus of the eye. A flow rate of 10 - 15 l/min is required in bison.
Heart rate and pulse quality should be monitored every 5 minutes. The auricular pulse is difficult to palpate in bison. The facial artery or the femoral artery may be used. Bison anesthetized with xylazine-telazol or medetomidine-telazol have an average heart rate of approximately 60 beats/min. Bison anesthetized with carfentanil-xylazine have a slightly higher heart rate. An average heart rate of 75 beats/min. has been reported with carfentanil-xylazine.
Maintenance in sternal recumbeny 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 can be used, but may predispose to regurgitation and aspiration. Generally, 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, or atipamezole will stimulate rumenal activity and relieve rumenal tympany.
Rectal temperature should be monitored every 5 - 10 minutes. Bison are prone to hyperthermia, especially following a long chase. Rectal temperature greater than 40°C 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 41°C 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.

Sedation and Anesthesia of Captive Bison

Bison restrained in a head gate and squeezed can often be sedated with intravenous xylazine. The tail vein can be used for the injection of small volumes. Xylazine can be used as the sole agent at a dose of 0.1 - 0.2 mg/kg IV for standing sedation. Sedation may be enhanced by the addition of 0.05 mg/kg of acepromazine or 0.05 mg/kg of butorphanol administered IV. All three drugs may also be combined to produce deep sedation, and possibly recumbency. If short-term general anesthesia is desired, 0.2 - 0.5 mg/kg of xylazine can be administered IV, via the tail vein, to produce recumbency. This is followed by 2 mg/kg of ketamine, via the jugular vein. If the jugular vein is used, the head must be adequately restrained to avoid injury to handlers.

Anesthesia may be prolonged with 1 - 2 ml/kg/ hour of 5% guaifenasin and additional 1 mg/kg boluses of ketamine given to effect. Use guaifenasin cautiously as we have observed guaifenasin toxicity in two bison, at what appeared to be a relatively low dose. It would be premature to say these animals are overly sensitive to the drug, but it should be used cautiously until more information is available.

Xylazine should be antagonized at the end of the procedure. If IV ketamine has been used, the antagonist should not be administered for 10 - 15 minutes to avoid undesirable effects of the ketamine, such as rigidity or convulsive activity.

Bison calves can be anesthetized with IV ketamine 2 - 4 mg/kg plus diazepam 0.2 mg/kg. This combination will give 5 - 10 minutes of light anesthesia. In depressed calves diazepam 0.2 mg/kg + 0.1 mg/kg of butorphanol can be used IV for sedation. If the calf is difficult to work with, 0.1 - 0.2 mg/kg of xylazine + 0.1 mg/kg of butorphanol can be administered IM prior to induction with ketamine-valium.

Immobilization of free-ranging bison

Immobilization of free-ranging bison requires the use of a remote delivery system, which in turn necessitates the use of potent agents that can be delivered in relatively small volumes.<

Succinylcholine - this is a depolarizing muscle relaxant that has been used for immobilization of bison. In theory, the dose is titrated to produce a locomotor paralysis, yet maintain activity in the respiratory muscles. In practice, respiratory depression is common, and muscle relaxation without anesthesia is extremely stressful and inhumane. Mortality is high with this drug and may be the result of respiratory depression or capture myopathy.

Xylazine - xylazine has been used as the sole agent for immobilization of bison. Dosages as high as 2 mg/kg have been used, but are often ineffective. Animals may appear to be sedate but will flee when approached. Bison immobilized with xylazine as the sole agent often succumb to bloat or acute capture myopathy.

Xylazine-ketamine - this can be a viable option for immobilization of bison. A dose of 0.5 - 1 mg/kg xylazine may be combined with up to 4 mg/kg of ketamine. The major drawback of this combination is that it must be delivered in a large volume if commercial preparations are used. A large bull may require 5 - 10 ml of xylazine + 40 ml of ketamine. Another drawback of this combination is that premature antagonism of the xylazine can result in rigidity and convulsions from the ketamine.

There are more viable options for bison immobilization:

Carfentanil-xylazine - this combination has been used for capture of free-ranging wood and plains bison [2,5]. Carfentanil is administered at a dose of 4 - 8 μg/kg, this is combined with xylazine, at a dose of 0.05 - 0.1 mg/kg. Bison, like other ungulates, will demonstrate increased activity and excitement during induction. If the recumbent animal demonstrates head and/or limb movement when approached, an additional 0.05 - 0.1 mg/kg of xylazine may be administered IV to improve muscle relaxation. Following the procedure, carfentanil should be antagonized with naltrexone at a ratio of at least 100 mg naltrexone to 1 mg of carfentanil. Naltrexone has been shown to be the drug of choice for antagonism of carfentanil in bison. Antagonism of carfentanil, with naloxone, has resulted in a high incidence of mortality from re-narcotization. Naltrexone has a long half-life and the incidence of re-narcotization is very low [2]. Complications of immobilization can include: hypoxemia, hypoventilation, regurgitation, and hyperthermia. Re-narcotization is not usually a problem if naltrexone is used to antagonize carfentanil. The major advantage of this combination is that it can be administered in very small volumes and will produce reliable immobilization. It is a particularly attractive combination for wild animals as decreased volume requirements will improve the accuracy of dart placement and decrease tissue trauma.

Xylazine-Telazol - we have been using a dose range of 0.75 - 1.5 mg/kg of xylazine , combined with 1.5 - 3 mg/kg of telazol. The low end of the dose is often effective in calm animals. The high end of the dose range may be required in fractious or wild animals. The drug is mixed by adding 250 mg of 100 mg/ml xylazine to 500 mg of powdered telazol. The resulting mixture has a volume of approximately 2.8 ml and contains approximately 90 mg/ml of xylazine and 180 mg/ml of telazol. A 400 kg cow could therefore require a dose volume of up to 7 ml, which can decrease dart accuracy and increase tissue trauma. Large volume requirements decrease the utility of this mixture for wild animals, but it is still very useful in captive or game farmed animals.

The mixture will produce approximately 1 hour of anesthesia, and will provide adequate analgesia for minor procedures. The

major complications that can be encountered with this combination are hypoxemia, bloat, and hyperthermia. Xylazine should be antagonized following the procedure. Since the telazol dose is relatively low, recoveries are generally smooth. Rougher recoveries may be noted if a high dose of telazol was used for induction. Tolazoline or atipamezole should be used to antagonize xylazine in bovids [4]. Tolazoline can be administered at a dose of 2 - 3 mg/kg. This dose may be split between IV and IM administration. Yohimbine will not effectively antagonize xylazine-induced sedation in bovids [4] and should not be used as the reversal agent.

Medetomidine-Telazol - the immobilization characteristics of this combination are similar to those of xylazine-telazol [1]. The major advantage of medetomidine-telazol is that it can be administered at approximately half the volume of xylazine-telazol. This quality greatly increases its utility in free-ranging animals. Another major advantage is that a lower dose of telazol is required and arousal from sedation is significantly faster than recovery following antagonism of the xylazine in the xylazine-telazol mixture. The major disadvantage is the lack of availability of commercial, concentrated medetomidine (10 mg/ml) which makes this combination difficult to obtain.

We have used this combination at a dosage of 60 µg/kg medetomidine + 1.2 mg/kg telazol to induce immobilization in captive and free ranging bison. Medetomidine can be antagonized with 180 µg/kg of atipamezole [3]. Caution should be observed following antagonism of the medetomidine as arousal from anesthesia can be very rapid, and IV administration of atipamezole should be avoided unless the condition of the animal is seriously compromised. Complications are similar to those of described for xylazine-telazol [1].

Volatile Anesthesia

Volatile anesthesia may be used for prolonged procedures. Isoflurane is preferable to halothane as less arrhythmia will be encountered in stressed animals. Induction can be achieved with IV xylazine-ketamine or xylazine-guaifenasin-ketamine in restrained animals, or IM xylazine-telazol in unrestrained animals. Intubation is similar to cattle and should be performed manually. It is very important to fast animals for 24 - 48 hours prior to general anesthesia as bovids are particularly prone to bloat and regurgitation during volatile anesthesia. Animals under 150 kg can be anesthetized with a machine for small animals. Animals over 150 kg require a large animal circuit.

Conclusions

In calm animals, when IV access can be obtained, xylazine-ketamine is a good choice to provide light anesthesia. If remote delivery is required, xylazine-telazol is a good choice, in game farm situations, as it is economical, relatively safe to handle and reliable. The major drawback of xylazine-telazol is that it must be delivered at a relatively high volume. This makes it less attractive for remote delivery to free-ranging wild bison, as small volumes will facilitate dart placement at greater distances. The drug combinations of choice for wild bison are carfentanil-xylazine or medetomidine-telazol. Both of these combinations are potent enough that they can be delivered in small volumes.

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