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EXPERIENCE WITH DRUGS FOR CAPTURE AND RESTRAINT OF WILDEBEEST, IMPALA, ELAND AND HARTEBEEST IN KENYA[1]

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Abstract: Two hundred and sixteen wildebeest (*Connochaetes taurinus*), 111 impala (*Aepyceros melampus*), 39 eland (*Taurotragus oryx*) and 9 hartebeest (*Alcelaphus buselaphus cokii*) were drug-immobilized for capture or for handling in captivity. Drugs used for capture were combinations of xylazine, etorphine and acepromazine, or xylazine and fentanyl, with or without the addition of azaperone. For restraint in captivity, xylazine alone proved to be satisfactory in most instances. Drugs were injected with projectile syringes. Recommendation on dosage are given.

INTRODUCTION

Wildebeest (*Connochaetes taurinus*), impala (*Aepyceros melampus*), eland (*Taurotragus oryx*) and hartebeest (*Alcelaphus buselaphus cokii*) were required for studies of their role in the epizootiology of certain diseases of livestock in Kenya. Because of limited personnel and resources it was necessary to develop methods for drug-immobilization of these animals to facilitate capture in the field and subsequent restraint for collection of specimens and experimental infection studies. The purpose of this paper is to describe the methods used and to make recommendations on the drugs, dosages and techniques found most practical. Projectile syringes were used, delivered by short range CO_2 and long range powder projectors.[4] Syringes capable of holding 1-10 ml of fluid were used, the size chosen according to the volume of drugs required in each case. Barbed needles were used, to ensure retention of the syringe until injection was complete, and to facilitate retrieval of the syringes. Small skin wounds caused by withdrawing the barbed needles were treated with topical antiseptics. Low therapeutic doses of procaine penicillin and dihydrostreptomycin sulfate were injected intramuscularly after capture to guard against wound infection.

Methods of Approach for Capture

Three methods were employed:

(1) Cautious approach of the subject by motor vehicle and projection of the syringe from the vehicle. This was used for undisturbed impala, and territorial male wildebeest and hartebeest.

(2) Herding a group of animals with a motor vehicle toward a shooter in hiding. This method was used for eland, impala and hartebeest in areas where trees or brush afforded hiding places.

(3) Chasing the subject at high speed and projecting the syringe from a motor vehicle. This was used for wildebeest in areas where the terrain was sufficiently open and smooth. A helicopter was used on occasion from which to "dart" eland in rocky or partly wooded areas.

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[4] Cap Chur equipment manufactured by Palmer Chemical Co., Douglasville, Georgia, USA.

Drugs Used for Capture

For the capture of wildebeest, the following drug combinations were used (the amounts indicated are dose ranges; body weights were estimated):

(1) A combination of xylazine (X),[5] etorphine (E) and acepromazine (A)[6] in doses of 0.1-0.5 mg X, 12-18 μg E and 50-75 μg A per kg body weight.

(2) Fentanyl citrate (F)[7] and azaperone (Az)[7] in amounts of 0.10-0.12 mg F and 0.5-0.6 mg Az per kg.

(3) A combination of xylazine, fentanyl and azaperone as 0.1 mg X, 0.15-0.20 mg F, and 0.5 mg Az per kg for adult animals; and 0.2 mg X, 0.4 mg F, and 1 mg Az per kg for 2-5 week old calves.

(4) A combination of xylazine and fentanyl citrate in amounts of 0.5 mg X and 0.5 mg F per kg for 2-5 week old wildebeest calves.

For capture of impala a combination of xylazine, etorphine and acepromazine was used in amounts of 0.75-1.2 mg X, 24-40 μg E and 100-160 μg A per kg.

For capture of eland the EA combination was used in doses of 16-64 μg E and 66-264 μg A; also the XEA combination as 0.4 mg X, 13-16 μg E, and 53-66 μg A per kg.

To capture hartebeest, a combination of xylazine, etorphine and acepromazine was used in doses of 0.26-0.32 mg X, 16 μg E and 66 μg A per kg.

After capture and confinement, the effects of etorphine and fentanyl were reversed with diprenorphine and nalorphine, respectively, using 3.0 mg of diprenorphine for each 2.45 mg of etorphine, and 25 mg nalorphine for each 10 mg fentanyl used. These antagonist drugs were given intravenously, except as otherwise stated under Results. To reduce risks of respiratory distress, tympany, or regurgitation, the antagonist drugs were always given as early as possible, and in all cases, within 30 min after capture.

Drugs Used for Restraint of Captive Animals

In most cases, xylazine alone was used for restraint of captive animals. For wildebeest, doses of 0.3-0.5 mg per kg body weight were employed; for impala 0.6-1.5 mg, for eland 0.4-1.0 mg and for hartebeest 0.5 mg/kg.

In some cases, for restraint the same XEA drug combination was used as for capture, but at lower dosage levels: wildebeest, 0.3-0.5 mg X, 0.8 μg E and 35 μg A/kg; impala, 0.7-1.2 mg X, 6-12 μg E and 25-50 μg A/kg; hartebeest, 0.5 mg X, 8 μg E and 33 μg A/kg. For restraint of large captive eland, the same doses of the XEA mixture as used for capture, were used.

Xylazine, azaperone and fentanyl were sometimes used in restraint of captive wildebeest, in doses of 0.1 mg X, 0.5 mg Az and 0.15-0.2 mg F/kg.

RESULTS

Equipment

In general, the drugs were effectively delivered by the projectile syringes. Two problems, however, were encountered. First, the rubber plungers in the syringes lost shape and resilience after repeated use, so that eventually they were not properly moved by the explosive charge for injection. Replacement of old plungers was the remedy. Second, the aluminum syringe barrels tended to bulge, so that they would no longer fit the projector barrels. One reason for this was too much thread in the ends of the syringe barrels, so that when the nose and tail

[5] Rompun 2%. Bayer A.G., 509 Leverkusen, Bayerwerke, West Germany.

[6] Large Animal Immobilon, containing 2.45 mg etorphine hydrochloride and 10 mg acepromazine maleate per ml, manufactured by Reckitt and Colman Ltd., Hull, England.

[7] Janssen Pharmaceutica. Azaperone was dissolved in an aqueous solution of tartaric acid: 1 g azaperone + 0.5 g tartaric acid in a few ml water dissolved by heating and diluted to 0.1 mg azaperone/ml. Storage must be in a dark bottle or in the dark. Fentanyl citrate, 1.57 g equivalent to 1.0 g fentanyl base was dissolved in 100 ml water to make a 10 mg/ml solution.

pieces were fully screwed in, there remained bands of unused thread, which thinned and weakened the syringe barrels. When this problem was brought to the attention of the manufacturer, the faulty syringe barrels were replaced.

Only the "low speed" .22 blank cartridges supplied for propulsion in the long range syringe projector could be used safely on the thin-skinned impala and the wildebeest calves. This limited the maximum effective range to about 40 m. The "medium speed" blank cartridges could safely be used on older wildebeest, eland and hartebeest, thus increasing the maximum delivery distance to approximately 55 m. The "high speed" blank cartridges were judged too powerful for use on the species we captured, at risk of deep body penetration.

Methods of Approach

The various methods of approach to the animals were selected to adapt to the habitat and the behaviour of the species. Only territorial males of hartebeest and wildebeest would allow approach to about 50 m, to be darted from a stationary vehicle. Only occasionally, with particularly tame animals, could impala be approached closely enough to be captured in this manner.

The shooting from ambush method was suitable in most impala and eland habitat and some hartebeest habitat but usually not practicable in the more open habitat of wildebeest. Impala were successfully herded toward a shooter hiding in a tree, while eland were more difficult to herd and often moved away from an operator in hiding.

Chasing at high speed and projecting the syringe from a motor vehicle was an effective method when wildebeest were found on smooth, open ground. Eland also could be taken by this method, but a helicopter was useful in rock or partly wooded terrain. The disadvantages of using a helicopter are the high cost and the difficulty of coordinating movements with the ground transport necessary for the captured animals.

Drugs for Capture

The first animals we attempted to capture were eland. Although (in our opinion) high doses of etorphine and acepromazine were given, the darted animals did not become immobilized and could not be approached and caught. With injection of etorphine and acepromazine alone, eland developed the head-held-high and high-stepping gait characteristic of animals under the influence of etorphine. Although vision and awareness appeared to be somewhat reduced, they continued to trot away when approached and could not be caught. Addition of xylazine to the etorphine-acepromazine mixture resulted in animals slowing and stopping, usually within 3 to 5 min after being darted, and then rapidly becoming ataxic and finally collapsing after an interval of 5-15 min. One cow eland died after immobilization with XEA when an additional injection of xylazine was given to keep her recumbent. No other losses of eland occurred.

Addition of xylazine to the etorphine-acepromazine combination, and also later to fentanyl with azaperone, did not interfere with remobilization of animals when etorphine and fentanyl were reversed by injection of the antagonists, diprenorphine and nalorphine. It appeared, however, that most animals which regained their feet after XEA or XFAz were more calm than they would have been if xylazine had not been added to the capture drug mixture. This was an advantage when animals were being confined immediately after capture, yet the depressant effects of xylazine were usually not so pronounced as to put the animals at a serious disadvantage to predators, in cases where they were released at once after diprenorphine or nalorphine was injected.

In hartebeest, the XEA combination was very effective. No difficulties were encountered.

In capture of wildebeest, the XEA drug combination was the most effective used. Although the recovery time was not as short as when fentanyl was used and reversed with nalorphine, the difference was insignificant. Fentanyl and azaperone

without xylazine was unsatisfactory in adult wildebeest. Too often the "capture interval", the time between injection and capture, was long (approaching 30 min) or the darted animals did not allow capture. Addition of xylazine greatly shortened the capture interval and thus improved efficiency. When using fentanyl to capture wildebeest calves, it was found that azaperone could be entirely replaced by xylazine in a 1:1 ratio with fentanyl, with improved capture efficiency. The xylazine-fentanyl mixture, without azaperone, was not used on mature wildebeest, but this could be a suitable capture drug combination. In general, there were few death losses experienced in capture of wildebeest. Those few which occurred were related to too long vehicle chases before injection (more than 3 min at maximum running speed seems to be damaging to the animal) or too long delay (approaching 30 min) from the time of capture until the antagonist drug was given. During long immobilization the recumbent animals developed tympany. This tendency was minimized by propping the animals in sternal recumbency and holding the head higher than the body.

The XEA drug combination was found to be effective for capture of impala. A few animals died during immobilization with XEA during the early stages of the work but with experience the losses were minimized. Mortality was attributed to the following:

(1) Greatly reduced drug tolerance after a period of drought when animals were in poor physical condition. Reducing the XEA dose by one-half was an effective remedy.

(2) Sudden excitement and injury in adult females after intravenous diprenorphine. This was minimized by injecting the usual dose of diprenorphine intramuscularly, so that absorption and reversal of etorphine was more gradual; or in some case an additional injection of up to 0.5 mg/kg xylazine was given at the same time that diprenorphine was injected.

(4) Loss of occasional animals after darting in dense vegetation.

Based on our experience, the recommended drugs and dosages for capture of wildebeest, impala, eland and hartebeest are listed in Table 1.

Doses were based on the following estimated average body weights:

Adult wildebeest	—	200 kg
Calf wildebeest	—	20 kg
Adult impala	—	40 kg
Subadult impala	—	25 kg
Adult eland	—	300 kg
Subadult eland	—	150 kg
Adult hartebeest	—	150 kg

Drugs for Restraint

Xylazine alone, in doses of 0.6 to 1.5 mg/kg body weight, proved to be an effective sedative for restraint of captive subadult impala. Similarly, 0.3-0.5 mg/kg was effective in adult wildebeest and subadult eland, and 0.5 mg xylazine/kg was an effective adjunct for restraint of mature hartebeest. Responses varied from sedation only, permitting adequate manual restraint with the animal standing or held down in recumbency, to complete prostration with loss of consciousness and pronounced analgesia, permitting easy collection of specimens, ear tagging, etc., operations normally slightly painful.

For optimum effect with xylazine, it was found that animals must be rather closely confined and allowed to remain undisturbed for about 15 min after injection. If allowed free movement, as in a large paddock, animals tended to keep moving and their activity seemed to interfere with sedation. For some of the most excitable animals, for example adult female impala and eland, even high doses of xylazine did not have the desired effect. For these animals, xylazine was combined with etorphine and acepromazine, as for capture. For confined impala, a dose of about half that required for capture was usually enough to put the animals down (i.e., 0.5 mg X, 9 μg E, 37 μg A) but for larger eland, the same dose as for capture was used (0.4 mg X, 16 μg E, 66 μg A). The XEA combination was found to be dangerous in

TABLE 1. Recommended drugs and doses for the capture of wildebeest, impala, eland and hartebeest.

Species	Sex	Age*	Number of Animals	Drugs**	Doses**	Average Interval Injection—Capture (min)	Average Interval Recovery after Antidote (min)
Wildebeest	M, F	A	35	XEA	0.2X 14E 60A	7	2.5
Wildebeest	F	A	3	FAz	not recommended		
Wildebeest	F	A	17	XFAz	0.1X 0.2F 0.5Az	12	1
Wildebeest	M, F	C	8	XFAz	0.2X 0.4F 1.0Az	6	1
Wildebeest	M, F	C	13	XF	0.5 X 0.5F	5	1
Impala	F	A	24	XEA	1.0X 32E 130A	5	3
Impala	M, F	SA	17	XEA	1.0X 32E 130A	5	4
Eland	F	A	7	XEA	0.4X 16E 63A	15	2
Eland	M, F	SA	2	EA	not recommended		
Hartebeest	M, F	A	4	XEA	0.3X 16E 66A	6	2

*Ages: A=Adult; SA=Subadult; C=Calf

**Drugs and Doses: X=xylazine, mg/kg body weight; E=etorphine, μg/kg; A=acepromazine, μg/kg; F=fentanyl, mg/kg; Az=azaperone, mg/kg

TABLE 2. Recommended drugs and doses for restraint of captive wild ruminants.

Species	Sex	Age*	Number of Animals	Drugs**	Doses**	Average Interval Injection—Restraint (min)	Average Interval Recovery after Antidote (min)
Wildebeest	M, F	A	21	XEA	0.2X 8E 3.5A	6	2
Wildebeest	M, F	A	6	XFAz	0.1X 0.2F 0.5Az	11	1
Wildebeest	M, F	A	113	X	0.4X	12	no antidote
Impala	F	A	15	XEA	0.5X 9E 37A	8	3-13***
Impala	M, F	SA	3	XEA	not recommended for restraint		
Impala	F	A	18	X	1.5X	13	no antidote
Impala	F	SA	10	X	1.5X	8	no antidote
Impala	M	SA	24	X	1.0X	9	no antidote
Eland	F	A	11	XEA	0.4X 16E 66A	7	2.5
Eland	M	SA	1	X	0.4X	no data	no antidote
Eland	F	A	4	X	not recommended for restraint of adult females		
Hartebeest	M	A	2	XEA	0.3X 16E 66A	5	2
Hartebeest	M	A	2	X	0.5X	12	no antidote
Hartebeest	F	A	1	X	0.5X	12	no antidote

*A=adult; SA=subadult; C=calf

**Drugs and Doses: X=xylazine, mg/kg body weight; E=etorphine, μg/kg; A=acepromazine, μg/kg; F=fentanyl, mg/kg; Az=azaperone, mg/kg

***Some impala were given the antidote, diprenorphine, intramuscularly.

impala that had suffered loss of condition during the early period of adjusting to captivity. For example, a dose of 10 mg X, 32 μg E and 130 μg A which was safe and effective for capture was a dangerous overdose for the same animals after a few days in captivity. Likewise for wildebeest, the capture dose of 0.2 mg X, 14 μg E, and 60 μg A was reduced to 0.2 mg X, 8μg E and 35 μg A for captive animals. Etorphine seemed to be the most dangerous drug in the XEA mixture and was thought responsible for the regurgitation which sometimes occurred during immobilization. When restrained with XEA, injection of diprenorphine allowed animals to regain their feet within 2 to 3 min but the residual effects of xylazine kept the animals somewhat calmer after handling than they would have been otherwise.

The xylazine, fentanyl, azaperone mixture was used on occasion for restraint of wildebeest, at the same doses as used for capture.

Drugs and doses which were found effective for restraint of captive wildebeest, impala, eland and hartebeest are listed in Table 2.

DISCUSSION

It is important to weigh the costs of equipment and drugs for chemical immobilization of game animals against the costs of the additional time and manpower necessary to capture, confine and tame without the use of drugs. Use of drugs is avoided by many professional trappers who collect animals for zoos. Although a detailed study of costs was not made, it is considered that the methods used were not excessively costly and have the added advantage of providing animals in a more tractable condition initially permitting collection of specimens and experimental manipulations. Use of drugs for capture also may permit more rapid taming of captured animals; perhaps amnesia erases the traumatic capture experience.

No serious trauma to tissues was observed as a result of the explosive charges in the Cap Chur projectile syringes.[4] Harthoorn[4] has implied that the explosive charges may be damaging to animals smaller than zebra.

The selection of drugs for capture and restraint was governed partly by their availability and partly by personal experience and the advice of others. A combination of etorphine and acepromazine was first used, as these drugs were available locally.[6] When it became apparent that greater sedative effects were needed to allow capture of the highly nervous antelopes, experiments were made with addition of xylazine. Xylazine and etorphine had been used successfully by others on the same species and also on deer. Xylazine was added to the etorphine-acepromazine as a matter of convenience, rather than trying to obtain etorphine in pure form. The XEA mixture proved satisfactory, although it is possible that omitting the acepromazine would have been safer, since all three drugs are respiratory depressants.

Fentanyl was used as a substitute for etorphine at a time when etorphine was temporarily unavailable. Again it was found that adding xylazine, with or without azaperone, provided an effective combination for capture or restraint. Fentanyl and xylazine seemed to be ideally safe and effective for capture of wildebeest calves, where there was difficulty in accurately estimating weights of the rapidly growing animals.

In general, experience in capture and handling these rather excitable wild ruminants indicated that xylazine alone was sufficient for handling most animals in captivity. Exceptions are adult impala and eland, in which xylazine did not appear to have sufficiently profound effect. The comparative high safety of xylazine makes it the drug of choice to use whenever a more potent immobilizing effect is not required.

It has been the experience of several workers that xylazine alone has not been found suitable for capture of free-ranging wild ungulates because excitement and ability to run freely interfered with its tranquilizing and muscle relaxing effects. Animals dart-injected with xylazine may

not be recovered if they are lost in dense vegetation.

For capture, the XEA combination proved to be effective, reliable and safe, except in animals in poor physical condition. Fentanyl was a useful substitute for etorphine but being somewhat less potent, it was also less efficient as an immobilizing agent.

Harthoorn[2,3] recommended the use of xylazine with etorphine as an immobilizing mixture for wildlife, because xylazine does not disrupt the heat regulating mechanisms as do some of the phenothiazine tranquilizers which have been used with etorphine. Although acepromazine is a phenothiazine-based drug, hyperthermia was not a recognized hazard with use of the XEA mixture. On the contrary, the rectal temperature decreased with both XEA and wtih xylazine alone during immobilization of confined impala and eland.[1]

Jones[5] observed dyspnea, excessive salivation, and violent struggling with etorphine and acepromazine but when acepromazine was replaced by xylazine there was less excitement and less tendency to hyperthermia.

Presnell *et al.*[7] used etorphine and xylazine with good results in white-tailed deer (*Odocoileus virginianus*) whereas others have observed excitement and failures in capture of deer with etorphine alone.

Recently, Young and Whyte[8] have recommended xylazine with etorphine for immobilization of mature eland (400-600 mg X + 4-6 mg E). Our dosage of etorphine was similar, but less (120 mg) xylazine was used, plus 20 mg acepromazine. The same authors[8] used xylazine alone for sedation of eland (0.6 mg/kg), impala (3.26 mg/kg) and wildebeest (1.3-2.6 mg/kg). We used lower doses: 0.4 mg/kg for eland, 1.5 mg/kg for impala and 0.4 mg/kg for wildebeest. Their average dose for wildebeest is about 5 times the dose that we found to be effective.

Pienaar[6] reported the successful use of xylazine alone for capture of free-ranging impala. It was our opinion, working in brushy habitat, that xylazine by itself would not have a sufficiently powerful depressant effect if the animals were allowed unlimited flight. Perhaps our doses of xylazine were unnecessarily low. Pienaar[6] used 2-5 mg/kg for capture of impala; our doses were 1.5 mg/kg for restraint of confined animals.

Harthoorn[3] also recommended higher doses of xylazine for sedation, up to 8 mg/kg, although 40 mg/kg was given to a sable without damage.

Pienaar[6] compared the usefulness of etorphine and fentanyl, with either xylazine or azaperone, for capture of eland. Fentanyl was preferred if it was intended to keep the animal on its feet but etorphine allowed more complete immobilization. Acepromazine was "not recommended" but reasons were not given.

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