IMMOBILIZATION OF FREE-RANGING AFRICAN WILD DOGS (*LYCAON PICTUS*) USING A KETAMINE/XYLAZINE/ATROPINE COMBINATION

Steven A. Osofsky, D.V.M., John W. McNutt, Ph.D., and Karen J. Hirsch, D.V.M.

Abstract: Five free-ranging adult African wild dogs (*Lycaon pictus*), 24–31 kg, were darted with 35–50 mg ketamine, 60 mg xylazine, and 1.25 mg atropine. Four of five immobilizations had no dart failures, with times to sternal recumbency between 9 and 13 min. Immobilized dogs exhibited complete skeletal muscle relaxation, and none exhibited any signs of arousal during physical examination or sampling. Continuous monitoring of pulse rate and percent oxygen saturation of hemoglobin (SpO$_2$) trends, in addition to other anesthesia monitoring procedures, indicated no adverse physiologic responses unique to this drug combination. All dogs exhibited relatively stable SpO$_2$ profiles for the duration of monitoring, with a mean (±SD) SpO$_2$ of 89% ± 4.9%. Yohimbine administration (2.5 mg i.v., 2.5 mg i.m. or s.c.) 30–37 min after darting provided effective reversal, with times to standing after yohimbine ranging from 2.0 to 10.2 min. All dogs appeared behaviorally normal and returned to their packs after the procedures.

Key words: Wild dog, *Lycaon pictus*, ketamine hydrochloride, xylazine hydrochloride, yohimbine hydrochloride, pulse oximetry, free-ranging.

INTRODUCTION

The African wild dog (*Lycaon pictus*) is one of the most endangered canids.[5] A collaborative effort between the private Botswana Wild Dog Project and the Government of Botswana's Wildlife Veterinary Unit was established to develop a wild dog immobilization protocol for research and management purposes. Factors considered in selecting a drug protocol included efficacy, animal and human safety, existence of an antagonist, availability, and cost.

Chemical immobilization of wild canids has recently been reviewed.[14] Drug protocols used for immobilization of the wild dog[27] include phencyclidine hydrochloride,[3,19] phencyclidine with promazine,[22,23] ketamine hydrochloride,[3] ketamine with acepromazine (Citino, pers. comm.), ketamine with a fentanyl/droperidol combination,[29] tiletamine with zolazepam,[1,4,7,28] medetomidine or medetomidine and ketamine

with or without atipamezole antagonism,[26,30] ketamine and xylazine with or without RX 821002A antagonism,[6,12,20,26] and fentanyl and xylazine with naloxone/yohimbine antagonism.[21] Free-ranging wild dogs have also been successfully captured without drugs, using (for example) a helicopter-assisted boma technique.[4]

The cardiopulmonary effects of ketamine, xylazine, and atropine in domestic dogs are well documented.[2,13] This combination of drugs, when applied in the dosages reported here, fit the drug selection criteria and was used to immobilize five adult free-ranging wild dogs.

CASE REPORT

Five adult wild dogs (one female, four males), estimated to weigh 24–31 kg, were immobilized in and around Moremi Game Reserve in northern Botswana (19°7–32′S, 23°24–46′E) in November 1993. Environmental temperatures varied from 30°C to 36°C. All dogs were members of packs that were habituated to humans. Packs (*n* = 4) ranged from 6 to 22 individuals and were approachable within 5–15 m in a four-wheel-drive vehicle. Body weights were estimated based on previous known weights

From the Botswana Department of Wildlife and National Parks, P.O. Box 131, Gaborone, Botswana, Africa (Osofsky, Hirsch); and the Division of Environmental Studies, University of California, Davis, California 95616, USA (McNutt). Present address (Osofsky, Hirsch): USAID Biodiversity Program, % 121 Courthouse Road SW, Vienna, Virginia 22180, USA.

of individual dogs and assessment of body condition at capture.

An air gun or blowpipe (Telinject S.A., Randburg 2125, Republic of South Africa) was used to project 2- or 3-ml darts, with 1.5- × 20-mm needles (Telinject U.S.A., Saugus, California 91350, USA). All dogs except one received a single i.m. dart; dog no. 4 required multiple darts because of partial injections/bounces.

All dogs were immobilized with a combination of ketamine hydrochloride (Vetalar, 100 mg/ml, Aveco Co., Fort Dodge, Iowa 50501, USA), xylazine hydrochloride (Rompun, 100 mg/ml, Mobay Corp., Shawnee, Kansas 66201, USA), and atropine sulfate (Centaur Labs, 10 mg/ml, Johannesburg 2000, Republic of South Africa). Xylazine was antagonized with yohimbine hydrochloride (Yobine, 2 mg/ml, Lloyd Laboratories, Shenandoah, Iowa 51601, USA). For the four dogs immobilized with a single dart, ketamine dosage ranged from 1.4 to 1.9 mg/kg, xylazine from 1.9 to 2.4 mg/kg, and atropine from 0.04 to 0.05 mg/kg. For all dogs, yohimbine dosage ranged from 0.16 to 0.21 mg/kg. Time to sternal recumbency was defined as the time from darting to sternal recumbency and immobility, and ranged from 9 to 13 min for the four dogs immobilized with a single dart.

A sterile ophthalmic ointment (Lacrilube, Allergan Pharmaceuticals, Doornfontein 2094, Johannesburg, Republic of South Africa) was applied to the eyes of each dog prior to blindfolding. Monitoring of anesthesia began as soon as possible and included rectal temperature, heart and respiratory rates, palpation of femoral pulse quality and regularity, and continuous recording of pulse rate and oxygen saturation using a pulse oximeter (Nellcor N-20P, Nellcor, Hayward, California 94545, USA). Human disposable SpO_2 (percent oxygen saturation of hemoglobin) sensors (Oxisensor D -25, Nellcor) were attached to wooden clothespins, the mouths of which were modified to fit on the distal tongue or upper lip. The electrocardiogram (ECG) of dog no. 3 was recorded (Silogic EC-60, Silogic Design, Stewartstown, Pennsylvania 17363, USA).

No dogs exhibited signs of arousal during physical examination and sampling. Clinical pathology results confirmed normal health. All dogs exhibited excellent skeletal muscle relaxation, pink oral mucous membranes, and normal capillary refill times. The mean ($\pm$SD) rectal temperature at initial handling, excluding dog no. 4, was 38.7 $\pm$ 0.6°C. Hyperthermia (41.9°C) was seen in dog no. 4 because of a prolonged capture process related to dart failures. The mean respiratory rate at initial handling was 15 $\pm$ 3.3 breaths/min. Heart rates were variable, with two dogs initially bradycardic. Using the pulse oximeter, the mean minimum pulse rate was 85 $\pm$ 30 beats/min and the mean maximum pulse rate was 113 $\pm$ 15 beats/min. The mean pulse rate for the five dogs was 105 $\pm$ 15 beats/min. Dog no. 3 exhibited a normal sinus rhythm on ECG.

All five dogs exhibited relatively stable SpO_2 profiles for the duration of monitoring. Minimum and maximum values differed by 6–11 percentage points for individual dogs. The mean minimum SpO_2 was 84% $\pm$ 3.9% and the mean maximum was 93% $\pm$ 5.1%. The mean SpO_2 for the five dogs was 89% $\pm$ 4.9% (range of means, 84–94%).

For anesthesia reversal, four dogs received 2.5 mg yohimbine i.v. and 2.5 mg yohimbine i.m., and one dog received half the yohimbine s.c. instead of i.m.. Yohimbine was administered 30–37 min after darting (after the final dart for dog no. 4). Time to standing was defined as the time from administration of yohimbine to the time when the dog was standing on all four feet; this time ranged from 2.0 to 10.2 min. The mean total elapsed time from darting to standing, excluding dog no. 4, was 40.1 $\pm$ 4.3 min. All dogs were observed and/or checked intermittently as long as possible after recovery. With occasional mild ataxia from residual ketamine quickly disappearing when the dogs first started to walk, all

dogs returned to their packs and appeared behaviorally normal after completion of the procedures.

DISCUSSION

These dogs were relatively well habituated to humans, which most likely made the immobilization process smoother and may account for success with the relatively low ketamine doses used compared to typical wild canid protocols.[14] Wild canid immobilizations relying on ketamine or phencyclidine have commonly been characterized by rough inductions, insufficient muscle relaxation, paddling movements of the legs, excessive salivation, convulsions, rough recoveries, and prolonged recovery times.[14,28,29] Other wild canid protocols have used consistently higher ketamine doses than those used in the present study.[14] The mean ketamine:xylazine ratio used in this study was 0.73:1, compared with ratios of 5:1 or higher reported previously for other species.[16] In one study on captive wild dogs, a similarly low ketamine:xylazine ratio was used,[26] but the actual mg/kg dosages of both drugs were markedly higher than those reported here. The mean ketamine dosage in the present study was lower than ketamine dosages used in combination with medetomidine in wild dogs[26,30] or other captive carnivores.[10] Alpha$_2$ agonists may reduce ketamine dosage requirements by their effects on the central nervous system as well as through enhanced cyclohexamine bioavailability related to reduced hepatic blood flow, depressed metabolic function, and decreased urinary excretion.[12]

When higher dosages of ketamine are used with xylazine, a period of at least 45 min prior to yohimbine administration has been recommended to facilitate biotransformation of ketamine to inactive metabolites to avoid a rough recovery.[14] Decreasing the amount of ketamine relative to xylazine has been shown to reduce the overall recovery time after yohimbine administration.[15]

Bradyarrhythmias have been associated with several injectable sedation/immobilization protocols in nondomestic canids, including ketamine–xylazine combinations.[15,17,18,26,30] Atropine sulfate has been used to offset xylazine-associated[16] or medetomidine-associated[8] bradycardia in nondomestic canids. The beneficial effect of anticholinergics with alpha$_2$ agonists is dose, time, route, and species related, and an increase in heart rate does not preclude the possibility of cardiac arrhythmias.[25] In free-ranging situations, premedication is not practical.

Hemoglobin oxygen saturation measurement using pulse oximetry accurately estimates the arterial oxygen saturation of hemoglobin (Sao$_2$) in domestic dogs.[9,24] All dogs in this study breathed atmospheric air, under the influence of drugs known to cause cardiorespiratory depression.[2,13] In domestic dogs, an i.v. protocol using a similar atropine dosage, lower xylazine dosage (1.1 mg/kg), and significantly higher ketamine dosage (11 mg/kg) resulted in significant hypoxemia for 25 min of the anesthetic episode, which was attributed to the ketamine.[13]

The mean yohimbine dosage used in this study was 0.19 mg/kg, with a mean i.v. bolus of approximately 0.10 mg/kg. Intravenous dosages >0.15 mg/kg resulted in extreme tachycardia in gray wolves.[15] In captive wild dogs anesthetized with a ketamine–xylazine combination, 0.31 ± 0.02 mg/kg of yohimbine given i.m. led to significantly longer times to first arousal compared with i.v. dosages of 0.11 ± 0.01 mg/kg.[26] Whether used as a sole agent or with ketamine, xylazine immobilization of wild mammals without the use of a reversal agent has been characterized by long recovery times.[11]

Since completion of this initial study, 15 additional wild dogs in Botswana have been immobilized without incident using the combination described: 35–50 mg ketamine, 60 mg xylazine, and 1.25 mg atropine. Administration of 5 mg of yohimbine (2.5 mg i.v. and 2.5 mg i.m. or s.c.) provided effective reversal. Continuous monitoring

of SpO$_2$ and pulse rate trends prior to anesthetic reversal, in addition to other anesthesia monitoring procedures, indicated no adverse physiologic responses unique to this drug combination. The time to recumbency and time to standing after yohimbine administration found in this study are deemed safe for this free-range setting. This anesthesia protocol appears to be effective, safe, reversible, and inexpensive.

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