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IMMOBILIZATION OF OCELOTS AND BOBCATS WITH KETAMINE HYDROCHLORIDE AND XYLAZINE HYDROCHLORIDE

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ABSTRACT: We immobilized 10 ocelots (*Felis pardalis*), and 21 bobcats (*F. rufus*) in south Texas (USA) during March to November 1991 with a mixture of ketamine hydrochloride (KH) and xylazine hydrochloride (XH); two ocelots were immobilized twice. Species were immobilized with (mean ± SE) 14.7 ± 1.6 mg KH/kg body mass for ocelots, 13.3 ± 1.8 mg KH/kg for bobcats, and 1.1 ± 0.1 mg XH/kg and 1.2 ± 0.1 mg XH/kg for ocelots and bobcats, respectively. Immobilization times in bobcats were longer ($P = 0.08$) than in ocelots. Adult female ocelots (18.5 ± 2.6 mg/kg) needed larger ($P < 0.05$) doses of KH than adult males (12.0 ± 1.7 mg/kg). Bobcats were immobilized during summer with lower initial (8.6 ± 0.9 mg/kg, $P < 0.001$) and total (10.1 ± 1.3 mg/kg, $P = 0.02$) doses of KH than bobcats immobilized in winter (14.5 ± 1.0 mg/kg, and 18.5 ± 3.8 mg/kg, respectively); summer immobilization times (44.3 ± 3.8 min) were also shorter ($P = 0.03$) than during winter (59.1 ± 5.2 min). Bobcats immobilized during summer had lower ($P < 0.01$) initial rectal temperatures (39.4 ± 0.2 C) than bobcats trapped in winter (41.1 ± 0.4 C). Overall, we observed no effects of KH-XH dose on body temperature.

Key words: Bobcat, *Felis rufus*, *Felis pardalis*, immobilization, ketamine, ocelot, xylazine.

INTRODUCTION

Ketamine hydrochloride (KH) has several advantages that justify its widespread use in wildlife immobilization. The most significant are that it is effective on a large spectrum of species (Beck, 1976), it can be given intramuscularly, and it has a large margin of safety (Ramsden et al., 1976). However, when used alone, KH may present problems such as body rigidity due to muscular contraction, excess salivation, convulsions, vomiting, and hyperthermia (Wright, 1982). Some side effects may be counteracted by combining KH with muscle relaxants such as acepromazine maleate (AM), or xylazine hydrochloride (XH) (Amend et al., 1972). Problems with AM use are discussed by Sedgwick (1979) and Muir and Hubbel (1989). Xylazine hydrochloride is a muscle relaxant with sedative and analgesic properties, and may equilibrate some of the negative effects of KH (Paddleford, 1988). Xylazine hydrochloride should be administered in low doses to avoid severe respiratory depression and vomiting (Muir and Hubbell, 1989) or effects on blood characteristics (Seal et al., 1987). Additionally, XH effects may be antagonized with yohimbine (Seal and Kreeger, 1987).

The use of KH-XH combinations to induce anesthesia in wild carnivores has increased recently (Seal and Kreeger, 1987). In felids, KH-XH first was used for domestic cats in the 1970's (Amend et al., 1972), and later applied to wild felids, such as the endangered Iberian lynx (*Felis pardina*) (Beltrán, 1988). Free-ranging ocelots (*Felis pardalis*) have been immobilized with KH alone (Konecny, 1989), KH-AM (Tewes, 1986), KH-chlorpromazine (Emmons, 1988), and KH-XH (Crawshaw and Quigley, 1989). Bobcats (*Felis rufus*) also have been immobilized with a variety of products (McCord and Cardoza, 1982), including KH-XH (Fuller et al., 1985). Yet, little detailed information is available on dosages and effects of KH-XH in immobilizing free-ranging medium-sized felids. Our objectives were to determine effective doses of KH and XH for field immobilization of bobcats and ocelots, to determine interspecific as well as intraspecific differences in doses, and to determine the effects of the KH-XH combination on body temperature.

MATERIAL AND METHODS

Field work was conducted from March to November 1991 in the Rio Grande Plains of south Texas (USA). Study sites included several private ranches in Willacy (26°28′N, 97°38′W), Kenedy (26°57′N, 97°40′W), Jim Wells (27°46′N, 98°06′W), Zavala (28°51′N, 99°46′W), and Kinney (29°20′N, 100°25′W) Counties; bobcats were trapped also in the Rio Grande National Wildlife Refuge (managed by the U.S. Fish and Wildlife Service), and Las Palomas Wildlife Management Area (Texas Parks and Wildlife Department), both located in Cameron County (26°07′N, 97°31′W). Study sites were in the Tamaulipan Biotic Province (Blair, 1950); the climate is subtropical and semiarid (Thornthwaite, 1947). The two dominant seasons are winter (October to February), and summer (March to September) (Laack, 1991); average daily mean temperatures for winter and summer are 18 C, and 26.4 C, respectively (Soil Conservation Service, 1982).

Bobcat and ocelots were captured in single-door, 108 × 55 × 40-cm wire box-traps (Tomahawk Trap Co., Tomahawk, Wisconsin, USA). A bait compartment containing a live chicken was attached to the rear of the trap (Tewes, 1986). Traps were placed in shaded areas to reduce the risk of hyperthermia for captured animals. Traps were checked early in the morning, and testing of captured animals usually was completed before noon. Trapped animals were immobilized by intramuscular (IM) administration of a mixture (approximately 10:1 by weight) of KH (100 mg/ml, Ketaset, Aveco Co., Inc., Fort Dodge, Iowa, USA) and XH (20 mg/ml, Anased, Lloyd Laboratories, Shenandoah, Iowa), into the hindquarters with a pole syringe (Tewes, 1986). Drug doses were based on estimated body weight.

We defined induction time as the interval from KH-XH injection to motionlessness and lack of responsiveness; immobilization time was the time from induction until the animal began to feel tactile stimuli and could not be handled safely. Animals were continuously observed to record both induction time and immobilization time.

Following induction, individuals were weighed, measured, ear-tagged, had a blood sample taken, and had their sex and age class determined; body mass, tooth wear, and physical characteristics were used as criteria to distinguish juveniles from adults (McCord and Cardoza, 1982). During immobilization, rectal temperature was recorded with a digital thermometer at 15-min intervals. The animals' eyes were covered with protective bandages to minimize disturbance. All work was carried out under field conditions, mostly in shaded areas. We allowed immobilized animals to recover inside the trap, covered with a mat in a shaded area, and released them several hours later when recovery was apparently complete.

Differing effects of drug dosages on the two species were assessed by one-way analysis of variance (ANOVA) using the procedure GLM of the SAS package (SAS Institute Inc., 1988). The effects of sex in ocelots and seasonal effects in bobcats were evaluated by a one-way ANOVA. Small sample size for female bobcats precluded analysis of bobcat data including sex by two-way ANOVA. A two-way ANOVA (species, sex, species-sex interaction) was performed on summer data. A repeated measures ANOVA was used to test for the effect of KH-XH on body temperature of immobilized animals (Cody and Smith, 1987). Two adult male ocelots were immobilized twice within 25 days and 30 days, respectively; these immobilizations were analyzed as independent data (Seal et al., 1987).

RESULTS

Ocelots (five adult males, four adult females, one juvenile male) and bobcats (16 adult males, five adult females) did not differ ($P > 0.05$) in mean (±SE) values of body mass (9.2 ± 0.5 kg, and 9.6 ± 0.4 kg, respectively), drug doses (KH: 14.1 ± 1.6 mg/kg, and 13.3 ± 1.8 mg/kg; XH: 1.1 ± 0.1 mg/kg, and 1.2 ± 0.1 mg/kg, respectively), and induction time (11.2 ± 1.8 min, and 9.1 ± 1.1 min, respectively). Nevertheless, mean immobilization time of bobcats (50.0 ± 3.3 min) was longer ($P = 0.08$) than for ocelots (40.3 ± 2.8 min). Based on summer data analysis with both species pooled, there was larger ($F = 12.8$, $P = 0.001$) body mass, and lower XH doses (mg/kg, $P = 0.04$), and induction times ($P = 0.02$) in males than in females; in summer, bobcats received lower ($P = 0.04$) total KH doses than ocelots, although significant ($P = 0.05$) species-sex interaction was observed due to lower KH doses of two female bobcats (7.4 ± 0.1 mg/kg), and higher doses of female ocelots (Table 1).

Bobcats were immobilized using higher doses of KH in winter (initial, $P < 0.001$, and total, $P = 0.02$); immobilization time

TABLE 1. Mean (±SE) values of immobilization characteristics of ocelots and bobcats in south Texas during 1991 with a mixture of ketamine hydrochloride and xylazine hydrochloride.

	Number of samples	Ketamine (mg/kg)		Xylazine (mg/kg)	Induction time (min)	Immobilization time (min)	Initial rectal temperature	Hour of evaluation (Central time, USA)
		Initial	Total	Total				
Ocelot (April to June)								
Male	8	9.9 ± 1.5	12.0 ± 1.7	1.0 ± 0.1	9.4 ± 1.9	38.4 ± 2.7	40.0 ± 0.7	0945 ± 36
Female	4	12.1 ± 1.6	18.5 ± 2.6	1.3 ± 0.0	14.2 ± 3.4	44.6 ± 7.4	40.1 ± 0.0	0902 ± 69
F-value		NS[a]	4.7[b]	NS	NS	NS	NS	NS
Bobcat								
March to September	13	8.6 ± 0.9	10.1 ± 1.3	1.2 ± 0.1	9.4 ± 1.6	44.3 ± 3.8	39.4 ± 0.2	1020 ± 20
October to November	8	14.5 ± 1.0	18.5 ± 3.8	1.3 ± 0.1	8.5 ± 1.3	59.1 ± 5.2	41.1 ± 0.4	1112 ± 36
F-value		17.9[d]	6.1[b]	NS	NS	4.8[b]	13.6[c]	NS

[a] NS, no significant difference.
[b] $P \leq 0.05$.
[c] $P \leq 0.01$.
[d] $P \leq 0.001$.

and initial body temperatures also were higher ($P < 0.05$) in winter (Table 1). Female and male ocelots received similar initial doses of KH-XH, but we required higher ($P = 0.05$) total doses of KH for females than for male to obtain similar immobilization times (Table 1). Six ocelots (three males and three females) and five bobcats (three males in summer, one male and one female in winter) received a second dose of KH (6.2 ± 0.5 mg/kg in ocelots, and 7.4 ± 0.9 mg/kg in bobcats) to achieve complete immobilization before handling. These second doses of KH were administered at 16.5 ± 0.5 min (ocelots) and 21.4 ± 3.67 min (bobcats) after the first KH-XH injection. In ocelots, initial doses of KH were 10.8 ± 2.0 mg/kg for individuals successfully immobilized with one single dose, and 9.9 ± 1.3 mg/kg for those that required a second dose of KH; in bobcats, mean ± SE values were 10.5 ± 0.8 mg/kg and 11.9 ± 2.9 mg/kg for first and second doses of KH, respectively. A significant correlation ($r = 0.88$, $P < 0.001$, $n = 11$) was found between initial and second doses of KH for ocelots and bobcats combined.

No species effects of the drugs on body temperature either at the beginning of immobilization (Table 1) or throughout the processing were observed (ocelot mean temperature at handling: 39.7 ± 0.3 C, range: 37.9 to 42.1 C, bobcat mean temperature at handling: 40.1 ± 0.3 C, range: 36.5 to 42.7 C). However, ocelots which required second doses of KH had higher ($P < 0.01$) initial rectal temperatures (42.0 ± 0.1) than those successfully immobilized with one single dose (39.1 ± 0.4); in bobcats, no significant differences were found in initial rectal temperature between those requiring one or two doses. Nevertheless, bobcats immobilized during winter had higher ($P = 0.003$) initial rectal temperatures than those immobilized during summer. Overall, ocelots were handled earlier ($P \leq 0.05$) in the day than bobcats (0930 hr ± 34 min, and 1041 hr ± 18 min, respectively). However, no significant relationship between hour of handling and body temperature was found.

DISCUSSION

Ocelots were immobilized with a lower mean total dose of KH (14.1 ± 1.6 mg/kg) than the values (range from 19.6 mg/kg to 28 mg/kg) reported by Laack (1991) and Ludlow and Sunquist (1987). Laack (1991) and Tewes (1986) used KH in a 9:1 combination with AM. Crawshaw and Quigley (1989) immobilized three female ocelots (one subadult and two adults) with a dose of 3.3 mg/kg of KH and 0.3 mg/kg XH; however, they did not report induction time or additional doses. Mean induction time observed in this study (11.2 ± 1.7 min) was higher than the mean of 4.5 min and range of 1.5 to 15 min reported by Tewes (1986) and closer to the 9 min reported by Laack (1991) for adult ocelots.

In our study, two of four female ocelots appeared to be pregnant when immobilized, based on external palpation, and a third exhibited a characteristic decrease in home-range size, typical for pregnant females (Laack, 1991) soon after capture. Pregnancy may have been a factor in the observed difference with males; both XH and KH are transferred across the placenta in 5 to 10 min, and reach fetal levels at 70% of those found in the mother (Muir and Hubbell, 1989). Sex differences in response to drugs have been reported, among other species, for lynxes (*Felis lynx*) immobilized with phencyclidine hydrochloride (Berrie, 1972). Alternatively, responses of some ocelots to capture-related stress, as measured by initial rectal temperature, would explain the higher doses of KH required to immobilize some individuals.

Fuller et al. (1985) used a dose of 11 mg/kg KH and 1.5 mg/kg XH to immobilize bobcats. These values correspond with the mean values found in our study, especially for bobcats in summer. Lower doses of KH may be used if the dose of XH is increased. Beltrán (1988) used 3.75

mg/kg of a 1:1 mixture of KH:XH to immobilize Iberian lynxes, which are similar in size to bobcats and ocelots; however, Iberian lynxes were kept in a conditioned, quiet room for some time before immobilization was attempted.

Because bobcats in winter were immobilized later in the morning than bobcats in summer, they were likely longer in the trap before immobilization was performed. Higher rectal temperatures at the beginning of immobilization for bobcats in winter may be evidence for a higher level of stress or excitability, when compared with bobcats in summer. Pigozzi (1987) reported that hyperthermia may have caused the death of a crested porcupine (*Hystrix cristata*) (10.2 to 11.1 kg average body mass) immobilized at 1300 hr in summer with KH (10.7 to 11.2 mg/kg), and XH (20 mg/individual) as preanesthetic. Also, excited animals usually require higher drug doses (Addison and Kolenosky, 1979).

In conclusion, our results support the use of KH-XH as a safe immobilization agent for free-ranging medium-sized felids. A mixture of KH (10–15 mg/kg) and XH (1 mg/kg) is an effective dose to safely immobilize box-trapped felids for radio-tagging, blood-sampling, and other basic procedures under field conditions. If high ambient temperatures are expected, we recommend conducting the immobilization early in the morning, which also may help to decrease level of excitability caused by trapping in some individuals.

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