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USE OF KETAMINE HYDROCHLORIDE AND XYLAZINE HYDROCHLORIDE TO IMMOBILIZE BLACK BEARS (*Ursus americanus*)[□]

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Abstract: Ketamine hydrochloride (KH) and xylazine hydrochloride (XH) used in combination (KH-XH) were effective immobilants for captive and wild black bears (*Ursus americanus*). Single intramuscular injections of 1.5-17.1 mg of KH per kg body weight combined in an approximate ratio of 2:1 with 0.9-10.0 mg of XH per kg body weight immobilized bears for 1.5-197 min. Dosages most frequently used were 4.5-9 mg KH/kg with 2-4.5 mg XH/kg. Supplemental administrations maintained tractability for up to 31 h. Immobilization was characterized by smooth induction, relaxed muscles, occasional groaning and vomition, no eye closure, no defecation, and a smooth recovery phase of variable length. Male and female bears responded similarly to KH-XH. Induction times for small bears (≤ 25 kg) were shorter than for larger bears.

INTRODUCTION

Various tranquilizers or anesthetics have been preadministered or combined with ketamine hydrochloride to minimize muscle rigidity or convulsions observed when ketamine hydrochloride is used alone as an immobilant or anesthetic.^{2,8,11,13,14} Xylazine hydrochloride has been preadministered to cats¹ and goats¹⁰ before injection of ketamine hydrochloride. The present paper reports on ketamine hydrochloride and xylazine hydrochloride used in combination to immobilize black bears (*Ursus americanus*) of central Ontario during parasitologic and life history studies.

MATERIALS AND METHODS

Seventy-two female and 100 male black bears ranging in age from five months to 15 years and in weight from 3.6 to 209 kg were immobilized. One

hundred and forty-eight bears were free-ranging, captive only when restrained in Aldrich leg snares overnight prior to immobilization. Free-ranging bears were immobilized on 311 occasions from May to September, 1975-1977 and 13 females were immobilized a total of 15 times when in dens during March and early April.

Twenty-four bears were either raised in captivity or were wild and caged for periods from one week to two years prior to the trials described. Caged bears were fed within 4 h of administration of drug on eight occasions. Food was withheld for a minimum of 12 h prior to the 44 trials with caged bears for which quantitative data are presented.

Dosages of ketamine hydrochloride[□] (KH) and xylazine hydrochloride[□] (XH) most frequently used were 4.5-9 mg KH/kg body weight and 2-4.5 mg XH/kg body weight combined (KH-XH) prior to

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[□] Ketaset (100 mg/ml): Rogar/STB, Division of BTI Products Inc., London, Ontario, Canada.

[□] Rompun (100 mg/ml): Haver-Lockhart Laboratories, Division of Bayvet Corporation, Mississauga, Ontario, Canada.

administration in an approximate ratio of 2:1. Attempts to establish minimum and maximum induction dosages resulted in a much wider range of dosages being administered.

Initial delivery to most caged bears was with a CO₂ charged pistol[‡] and 5-10 ml capacity darts. Additional drug to caged bears and all drug to free-ranging bears was injected with 16-22 gauge, 2.5-3.8 cm needles. Syringes were hand-held or attached to poke sticks. The injection site was intramuscular (IM), high on the hindquarters or less frequently in the shoulder of large males.

Time to recumbency with caged bears was defined as the period from administration of drug until they laid down. Induction time was the period from administration of the drug to tractability. Caged bears were considered tractable when they had lost all muscle control of the head, neck and legs and did not show external ear reflex in response to sharp auditory stimuli. Free-ranging bears were considered tractable when recumbent and sufficiently sedate that ears could be grasped and legs tied. Muscular activity was usually restricted to partial control of the neck and head. Recovery time was recorded only in trials with caged bears and was the period from first evidence of renewed muscle control to time of voluntary assumption of a standing position.

Immobilized free-ranging bears were weighed, measured and ear-tagged. Selected adults were fitted with radio transmitter collars. In addition, blood was removed from a femoral vessel for bacteriologic and virologic studies and a premolar tooth extracted for aging purposes. Captive bears were weighed, blood samples extracted from sublingual and femoral vessels, and engorged blood-sucking insects collected from them for parasitologic studies. Heart rates, respiratory rates, and rectal temperatures were recorded when possible.

The level of excitement of free-ranging bears prior to immobilization was categorized as low, moderate, or high.

RESULTS AND DISCUSSION

Amend *et al.*¹ and Kumar *et al.*¹⁰ when immobilizing cats and goats, respectively, with KH-XH, used dosages of KH comparable to those administered to bears but generally used much smaller dosages of XH than administered in the present study.

Successful induction dosages with bears varied from 1.5-17.1 mg KH/kg body weight combined with 0.9-10.0 mg XH/kg body weight (Table 1). The ratio of KH to XH although usually 2:1 did vary from 1:1 to 4:1.

Initial dosages of 3-7 mg KH/kg and 1.5-4 mg XH/kg produced a tractable state in 80% of 208 trials. Additional injections induced a tractable state in bears when the initial injection was unsuccessful. Unsuccessful initial dosages may be explained by individual variation among bears in response to the drugs, the variable physiological state of a specific bear when immobilized on separate occasions and unintended administration of drugs to fat rather than muscle tissue.

Supplemental dosages of KH-XH maintained bears in a tractable state for 3-31 h when administered at the rate of approximately 2-3 mg KH/kg/h and 1.5-3 mg XH/kg/h. Kumar *et al.*¹⁰ used comparable amounts of KH combined with smaller amounts of XH (0.045-0.12 mg/kg) to prolong anesthesia in goats.

One caged bear was immobilized 18 times during 105 days, and another bear 36 times in 567 days. No increased tolerance to drugs was apparent and upon necropsy one week following final immobilization with KH-XH, no lesions associated with KH-XH were observed. Eleven other bears were immobilized on more than five occasions without

[‡] Cap Chur equipment, Palmer Chemical and Equipment Co., Inc., Douglasville, Georgia, USA.

TABLE 1. Clinical observations on single IM administrations of KH^a, XH^b to black bears.

Bears in sample	Induction Dosages mg/kg		Time (min) from administration				Recovery time ^d (min)
	KH	XH	to first noticeable effect	to initial recumbency	Induction time (min)	Time tractable ^c (min)	
Caged males	8.7 ^e (2.6-16.7, 4.71) 9	4.9 (2.2-10.0, 2.69) 9	2.2 (1.5-3.2, 0.87) 3	3.8 (3.0-4.2, 0.54) 4	5.8 (3.0-12.0, 2.59) 9	68 (37-151, 36.64) 8	24 (0.47, 14.86) 8
females	6.8 (3.3-13.2, 2.56) 17	3.5 (1.9-5.7, 1.03) 17	1.7 (1.0-3.0, 0.83) 5	3.1 (2.0-5.0, 0.91) 13	6.3 (2.0-13.0, 2.97) 17	96 (25-197, 58.81) 15	19.3 (3.0-40, 11.72) 7
Free-ranging males	4.7 (1.5-16.7, 1.87) 142	2.5 (0.9-8.3, 1.04) 142	— — —	— — —	4.8 (1.0-30, 4.34) 137	30 (1.5-60, 21.15) 12	— — —
females	5.1 (2.1-17.1, 1.97) 103	2.8 (1.1-9.2, 1.17) 103	— — —	— — —	4.7 (1.0-20, 2.83) 101	— — —	— — —

^aKetamine hydrochloride.^bXylazine hydrochloride.^cCaged bears tractable when completely immobilized; free-ranging bears tractable once manageable.^dTime from initial return of muscle control to standing position.^eMean: range and standard deviation (in parentheses): sample size.

noticeable increased tolerance to the drugs. Bree *et al.*³ reported a possible increasing tolerance of monkeys to recurrent immobilization with KH but did not observe any lesions directly associated with KH.

Male and female bears did not differ significantly ($P > 0.2$) in their reaction to KH-XH as measured by time from administration to first noticeable effect, time to recumbency, induction time, time tractable and recovery time (Table 1). Beck² reported that male and female cats responded similarly to immobilization with KH.

Death of a denning adult female was the only fatality in 355 trials. The dosage given (5.6 mg KH/kg + 2.8 mg XH/kg) was not abnormal but the bear was considered to be in poor physical condition. Detailed necropsy was not possible and cause of death not established.

Induction Phase

A tractable state was achieved within six min in 69% and 85% of caged and free-ranging bears respectively. Longer induction times for caged bears (Table 1) may be explained by differences in the definition of tractability. In goats, single injections of similar quantities of KH combined with 0.045-0.12 mg XH/kg produced maximal skeletal relaxation in 15-20 min.¹⁰

The sequence of drug effect was consistent with observations when black bears were immobilized with KH.⁷ Within 1-3 min, hind legs relaxed causing bears to stagger and many to sit. With subsequent loss of coordination of forelegs, the head gradually drooped or bobbed. Bears usually assumed sternal recumbency before lateral recumbency. Finally, muscles of the neck and head completely relaxed. The last observable movement before the tractable phase was an external ear reflex in response to sharp sounds. Eyes remained open. Bears occasionally groaned late in the induction phase. Four of eight bears vomited when fed within 4 h of drug

administration but vomition was not observed when food was withheld for at least 12 h prior to immobilization.

Induction times between bears administered low dosages (KH: 1.5-2.8 mg/kg; XH: 0.9-1.7 mg/kg) and high dosages (KH: 6.1-16.7 mg/kg; XH: 3.0-8.3 mg/kg) did not differ significantly ($P > 0.2$). Level of excitement had no apparent effect on induction time. Small bears (≤ 25 kg) were tractable in less time ($\bar{X} = 3.2$ min, $n = 71$) than larger bears ($\bar{X} = 5.5$ min, $n = 163$) given comparable dosages ($P < 0.001$). Amongst non-denning females, induction times for those lactating were longer ($\bar{X} = 8.3$ min, $n = 5$) than for other females ($\bar{X} = 5.0$ min, $n = 24$) of similar weight and given comparable dosages ($P < 0.05$).

Tractable Phase

Only 5% of caged bears were tractable for less than 30 min and 57% remained tractable for more than 60 min when administered single induction dosages. Free-ranging bears which were given smaller induction dosages than caged bears (Table 1) were tractable for 1.5-60 min. The bear tractable for only 1.5 min was a cub administered one of the smallest dosages (1.8 mg KH/kg + 1.8 mg XH/kg) successful in inducing a tractable state (Table 1). The next shortest tractable phase was 12 min observed in two bears also given exceptionally small successful induction dosages (1.5 and 2.4 mg KH/kg + 1.5 and 1.2 mg XH/kg respectively) compared to those most frequently used (Table 1).

Caged bears often were highly excited prior to administration of drug. Decrease in heart rate from early ($\bar{X} = 62$, $n = 17$) to late ($\bar{X} = 41$, $n = 16$) tractable phase may indicate a return to normal heart rate. The respiratory rate varied from 5-34 breaths/min with one notable exception of 84 breaths/min. Respiration generally was regular and stable or decreased. Heart and respiratory rates late in tractable phase were relatively stable and similar to levels in bears held tractable

for 30 h while immobilized with alpha-chloralose (Addison, unpubl.).

Rectal temperatures varied from 36.5 to 41.0 C ($\bar{X}$ = 38.3 C, n = 17). Urination occurred in all trials whereas defecation was not observed. Lip and eye quivering and groaning were rare during a deep tractable state. Bears could not retract an extended tongue when immobilized with KH-XH. This is in marked contrast to frequent flicking of the tongue or licking of the lips associated with KH in cats,⁴ raccoons⁵ and bears.⁷ Muscle rigidity and/or convulsions commonly associated with KH in cats,^{2,4,6} dogs,⁸

humans^{9,12} and black bear (Addison, unpubl.) occurred in only 6 of 355 trials in which bears were administered KH-XH.

Recovery Phase

Return of coordination was gradual, occurring in reverse order to which it was lost during induction. In only one trial did the recovery phase last less than 3 min and it was less than 10 min in only 3 of 20 trials in which there was no visual, auditory or tactile stimulation of the bears. When disturbed, bears responded by assuming a standing position much earlier than when undisturbed.

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