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IMMOBILIZATION OF POLAR BEARS *(Ursus maritimus,* PHIPPS) WITH KETAMINE HYDROCHLORIDE AND XYLAZINE HYDROCHLORIDE

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Abstract: Free ranging polar bears *(Ursus maritimus)* were immobilized using a concentrated solution of 200 mg ketamine HCl and 200 mg xylazine HCl per ml. A mean dosage of 6.8 mg (n=21) of each drug/kg body weight was successful in immobilizing polar bears older than one year and 2.8 mg (n=6) of each drug/kg body weight was effective for cubs of the year (COY). Mean induction time for bears other than COY was 13.2 min. Mean induction time for COY was 2 min. Bears were tractable for a minimum of 30 min. Male and female polar bears responded similarly to the drugs. Immobilization was characterized by slow deep breathing, relaxed muscles, no excess salivation and no convulsions. The combination of ketamine HCl and xylazine HCl appears to be a useful alternative to drugs previously used for immobilizing polar bears.

INTRODUCTION

The use of chemical restraints in handling wild animals is now common practice.[9] In Canada, relatively large numbers of polar bears are immobilized annually in research programs. Until recently phencyclidine HCl[3] in combination with promazine HCl[4] have been the most commonly used drugs. However, several problems are associated with the use of phencyclidine HCl. The major problem is one of availability due to the drug's abuse potential. In addition, phencyclidine HCl frequently causes convulsions and respiratory difficulties in bears. Consequently, we tested ketamine HCl[5] in combination with xylazine HCl[6] as an alternative.

The action and use of these drugs in a wide variety of species have been described by several authors.[1,6,7,9,16] This paper reports the results obtained using a ketamine HCl-xylazine HCl combination to immobilize free ranging polar bears in the High Arctic.

MATERIALS AND METHODS

This study was conducted in conjunction with a Northwest Territories Wildlife Service polar bear mark-recapture project in Lancaster Sound. During the months of April and May, 1980, 45 polar bears were located and immobilized from a helicopter as described by Lentfer.[10] The immobilizing agent used was a drug combination of

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[3] Sernylan®, Bio-centic Laboratories Inc., St. Joseph, Missouri.

[4] Sparine®, Wyeth Ltd., Downsview, Ontario.

[5] Crystalline, Parke, Davis and Co., Brockville, Ontario.

[6] Rompun®, Haver-Lockhart, Bayvet Division, Cutter Laboratories Inc., Mississauga, Ontario.

ketamine HCl 20% w/v and xylazine HCl 20% w/v, i.e., 200 mg aa[7]/ml.

To prepare this solution the formula and procedure used is: ketamine HCl, 20 g; xylazine HCl, 20 g; lactic acid 85%[8] q.s. pH 5.5; and SDH_2O q.s. add 100 ml. Dissolve 20 g xylazine HCl in 50 ml sterile distilled water. Add 4 to 6 drops of lactic acid 85%. Dissolve 20 g of ketamine HCl in above solution. Heat gently to 50 C. Add sufficient sterile distilled water to obtain 100 ml final volume. (NOTE: At this concentration, solution approaches saturation, hence more concentrated solutions may begin to crystalize in a few hours.) Sterilize solution into 50 ml sterile bottles using 0.22 μm bacterial filter.[9]

Darts[10] were used to deliver the drugs at a dosage of 5.5 mg aa/kg body weight. Needles of 4.5 cm were used for adult bears while 3 cm needles were used for smaller bears. Cubs of the year (COY) were injected with a hand held syringe. Most injections were intramuscular into the hindquarters although dart injections occasionally occurred elsewhere. If little or no effect was evident in 15 to 20 min following the initial injection, a second dose was administered. Mean heart rates, respiratory rates, rectal temperatures, induction times, and dosages were based only on those bears which were immobilized with one injection.

'Time to first effect' was defined as the time period from injection to the first drug induced sign (for example, stumbling or staggering).

'Induction time' was the period from injection to the time that the bear became tractable, i.e., when it had lost muscle control of head and legs and could be handled safely. Statistical differences in induction times and dosages between COY and other bears were determined by the Mann-Whitney U-Test at a significance level of 0.05 for a one-tailed test. Differences between sexes were determined by a two-tailed T-test at a significance of 0.05. Recovery times were not recorded because of time constraints.

Once polar bears were immobilized they were marked with individually numbered ear tags. Bears were also tattooed on both sides of the upper lip with a corresponding number. Data recorded for each bear included weight, sex, total length, thoracic girth and physical condition. The first premolar was pulled for age determination. All bears were painted with a number for subsequent identification from the air.

RESULTS AND DISCUSSION

The shelf life of the concentrated solution used in this study is unknown, but no crystalization occurred after 9 months in any unused vial of drug. However, once a vial had been opened and was in use for several days, some crystalization eventually occurred. This was probably caused by introducing crystals from the syringe used to load the darts. The possibility of crystals forming could be reduced if a new syringe was used for each dart or if the drug was dispensed from bottles of smaller volume. However, we found that the drug would go back into solution easily if it was warmed by being carried close to the body.

A total of 45 polar bears was successfully immobilized using the ketamine HCl-xylazine HCl combination. Twenty-seven bears became tractable with one injection (Table 1), twelve animals required a second dose and six received three or more injections. Of the 12 animals requiring a second injection,

[7] aa, from the Latin 'ana' meaning of 'each' (drug).

[8] Fisher-Certified Reagent, Fisher Scientific Co., Fair Lawn, New Jersey.

[9] Millex® - GS, Millipore Ltd., Mississauga, Ontario.

[10] Cap-chur® Palmer Chemical Co., Douglasville, Georgia.

TABLE 1. Observations on single intramuscular administrations of ketamine HCl and xylazine HCl to polar bears.

	BEARS 1 YR.			SAMPLE	CUBS OF THE YEAR			SAMPLE
	MEAN	SD	RANGE	SIZE	MEAN	SD	RANGE	SIZE
Induction Dosage (*mg aa/kg)	6.8	1.5	3.3-10.6	21	2.8	1.3	1.6- 5.0	6
Time to First Effect (min.)	4.6	2.6	1.0-10.0	17	1.6	0.9	1.0- 3.0	5
Induction Time (min.)	13.2	7.2	4.0-30.0	21	2.0	1.3	1.0- 4.0	6
Respiration Rate (bpm)	10.1	3.2	5.0-17.0	17	11.3	2.1	9.0- 13.0	3
Heart Rate (bpm)	62.3	14.3	36.0-90.0	17	78.7	20.6	63.0-102.0	3
Rectal Temperature (°C)	38.7	1.1	36.4-40.2	17	38.1	1.5	36.4- 39.0	3

*Dosage refers to both ketamine HCl and xylazine HCl in a 20% w/v solution; i.e. 6.8 mg aa/kg indicates 6.8 mg/kg ketamine HCl and 6.8 mg/kg xylazine HCl.

five received the initial injection in a poor location, four were given small injections by hand and three showed little or no effect after the initial injection. Unsuccessful initial injections can be explained partially by individual variation in response to the drug. However, effective dose is often a function of dart placement and it is probable that some injections occurred in fatty tissue, bone, or between the fascia of muscle groups. Supplemental doses delivered by dart were normally one half of the original dose while hand injections were 100 to 300 mg aa.

Effective dosages for bears other than COY ranged from 3.3 to 10.6 mg aa/kg with a mean of 6.8 mg aa/kg (n=21) (Table 1). This was within the range of dosages found effective for black[1] and grizzly bears.[1,3,9] The effective dosage for COY ranged from 1.6 to 5.0 mg aa/kg with a mean of 2.8 mg aa/kg (n=6). Mean induction time for COY was 2.0 min (n=6) while other bears took an average of 13.2 min to become tractable. There was a significant difference both in the effective dosage and the induction time between COY and other bears. A similar difference in induction times for younger animals was reported for black bears.[1] Dosages and induction times did not differ significantly between sexes ($P > 0.5$, n 21).

The average induction time of 13.2 min is longer than reported for other species.[1,2,8,9] The longer induction time associated with ketamine HCl and xylazine HCl in polar bears could be a function of 1) lower species sensitivity, 2) insufficient dosage or 3) needle length. Haigh,[8] suggested that the longer induction time experienced with black and grizzly bears in the fall was associated with needles of insufficient length to penetrate the fat layer and inject intramuscularly.

After darting, bears continued moving away from the helicopter. Bears other than COY began to show effects of the

drug in an average of 4.6 min (n=17). The most common signs were stumbling and staggering. Several bears showed a slow deliberate walk, while some stood still for several minutes. The sequence of drug effect was similar to that observed in black bears,[1] with the hind quarters affected first and subsequent loss of coordination moving forward. Prior to becoming tractable, bears often lay with their heads up, but were not approachable.

Underdosed bears were characterized by persistent slow walking with some staggering. These bears often stumbled or fell repeatedly but would recover quickly and resume walking. A drugged bear's ability to focus on movement and react to loud, sharp sounds were normally reliable indications of incomplete sedation. At this stage, most bears became tractable if left undisturbed for a short time.

Once bears were tractable, they appeared to be deeply asleep. There was no evidence of tetanus or convulsions which are common when ketamine HCl is used alone.[3,15] Eyes remained open in 60% of the bears and nystagmus was present prior to complete sedation in all bears we could observe. Urination did not occur in contrast to black bear where it occurred frequently.[1]

Heart rates, respiratory rates and rectal temperatures were measured an average of 24 min (n=21, SD=8.5) after the initial injection. Heart rates for nonmedicated sleeping polar bears range from 40-65 beats/min.[5,12] In this study, immobilized bears other than COY exhibited heart rates from 36-90 beats/min with a mean of 62.3 beats/min (n=17).

Similar frequencies were observed in black bears[1] drugged with ketamine HCl and xylazine HCl. Ketamine HCl is known to be a cardiac stimulant but the bradycardia associated with xylazine HCl[11] appears to reduce the stimulant effect.

Respiratory frequencies for COY averaged 11.3 min (n=3), while that of older bears ranged from 5-14 with a mean of 10.1 min (n=17). Best[4] observed respiratory rates of 10-20/min in moderately active bears, while strenuous activity resulted in panting. Of 45 bears in this study, only one was observed to pant during the tractable period. This bear also had the highest observed heart rate (108 beats/min) and rectal temperature (41.5 C). Values of these measurements were not included in the overall means. Some bears were undoubtedly overheated from running as rectal temperatures ranged from 36.5 to 40.2 C with a mean of 38.7 C (n=17). This is in contrast of 36.9 C for bears at rest.[1] Some bears may have passed the "panting threshold" but were unable to pant due to the influence of the drugs, as both ketamine and xylazine cause varying degrees of respiratory depression.[14,12]

Time limitations precluded recording length of tractable periods; however, all 45 bears were tractable for at least 30 min and several for 60 min or longer. Seventeen of the bears were resighted on different occasions and showed no ill effects. No deaths were observed. Ketamine HCl has a relatively wide therapeutic safety margin and Addison and Kolenosky,[1] encountered only one fatality during 355 trials with black bears.

CONCLUSIONS

A major limitation in immobilization of large animals has been the lack of commercially available agents of sufficient concentration to allow small volume "dart gun" administration of appropriate dosages. We were able to

[11] Rompun® Product Insert. Chemagro Animal Health Dept. Baychem, Co., Kansas City, Ma.

[12] Ketasex® Product Insert. Rogar/STB. London, Ontario.

formulate a concentrated solution using the crystalline salts of ketamine HCl and xylazine HCl at 20% w/v of each drug. In this study immobilization of adult bears was successful at a mean dosage of 6.8 mg aa/kg, although Andriashek (Pers. Comm.) reports requiring higher dosages while working under summer conditions. Considering the wide safety margin and lack of undesirable side effects, the combination of ketamine HCl and xylazine HCl appears to be a useful alternative to phencylidine HCl for immobilization of polar bears.

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