USE OF YOHIMBINE HYDROCHLORIDE TO REVERSE IMMOBILIZATION OF POLAR BEARS BY KETAMINE HYDROCHLORIDE AND XYLAZINE HYDROCHLORIDE

Authors: Ramsay, Malcolm A., Stirling, Ian, Knutsen, Lars Ø., and Broughton, Eric

Source: Journal of Wildlife Diseases, 21(4) : 396-400

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-21.4.396

Journal of Wildlife Diseases, 21(4), 1985, pp. 396–400

USE OF YOHIMBINE HYDROCHLORIDE TO REVERSE IMMOBILIZATION OF POLAR BEARS BY KETAMINE HYDROCHLORIDE AND XYLAZINE HYDROCHLORIDE

Malcolm A. Ramsay,[1] Ian Stirling,[1,2] Lars Ø. Knutsen,[3] and Eric Broughton[4]

ABSTRACT: Yohimbine hydrochloride (YH) effectively reversed the immobilizing effects of ketamine hydrochloride (KH) combined with xylazine hydrochloride (XH) in 48 wild polar bears (*Ursus maritimus*) handled in the summer. Single intravenous doses of YH ranging between 0.029 and 0.198 mg/kg resulted in a median time of 10 min (range: 1–123 min) to post-injection recovery from KH-XH immobilization. Convulsions and muscle twitching were observed in some bears after YH was administered and one death occurred. Median respiratory rate and heartbeat rate increased from 5 br/min to 12 br/min and 51 BPM to 79 BPM, respectively, soon after yohimbine was administered. The median time to recovery after KH-XH administration, including processing and handling time, was 113 min for bears administered yohimbine and 202 min for bears not administered YH. After YH-induced recovery, polar bears showed signs of reduced awareness and many remained recumbent for undetermined periods although they could coordinate movements, stand, and walk or run if disturbed. YH proved to be a useful antagonist to immobilization induced by KH-XH in a field situation.

INTRODUCTION

Ketamine hydrochloride (KH) and xylazine hydrochloride (XH) used in combination (KH-XH) safely immobilize bears (Addison and Kolenosky, 1979; Lee et al., 1981; Lynch et al., 1982; Schweinsburg et al., 1982). Although KH-XH have many positive features, there are some drawbacks; respiratory rate is depressed during immobilization and recovery is slow.

These drawbacks are especially important in the summer because polar bears are very fat at that time and running before capture often increases their body temperature. High ambient temperatures coupled with a depressed breathing rate increase the risk of hyperthermia. Consequently we tried to immobilize bears with low dosages of KH-XH, but these increased the risk of bears recovering before the work was completed and the risk of longer and more stressful inductions. This can result in harm to the researchers or the bears (Schweinsburg et al., 1982).

An antagonist for KH-XH immobilization in bears has not been reported. However, recent studies indicate yohimbine hydrochloride (YH) is a safe and effective antagonist for both KH and XH in domestic carnivores and wild ungulates (Hatch et al., 1982, 1983; Hsu, 1983, 1984; Jessup et al., 1983). During the summer of 1984 we tested YH as an antagonist to KH-XH immobilization in wild polar bears.

MATERIALS AND METHODS

Polar bears older than 1 yr were captured in northeastern Manitoba, Canada during August and September of 1983 and August of 1984. Bears in both years received remote intramuscular injections of a 1:1 mixture of KH (Ketaset, Parke, Davis and Co., Inc., Brockville, Ontario K6V 3G9, Canada) and XH (Rompun, Bayvet Division, Miles Laboratories Ltd., Missisauga, Ontario L4W 2A1, Canada) each lyophilized and reconstituted in solution at 20% w/v (Lee et al., 1981). KH-XH was administered using standard Cap-Chur powder equipment (Palmer Chemical and Equipment Co., Inc., Douglasville, Georgia 30133, USA). Darts were of 7

Received for publication 31 January 1985.

[1] Department of Zoology, University of Alberta, Edmonton, Alberta T6G 2E9, Canada.
[2] Canadian Wildlife Service, Department of the Environment, 5320 122 Street, Edmonton, Alberta T6H 3S5, Canada.
[3] Zoologisk Institutt, P.O.B. 1050, University of Oslo, Blindern, Oslo 3, Norway.
[4] National Wildlife Research Centre, Canadian Wildlife Service, Ottawa, Ontario K1A 0E7, Canada.

ml and 10 ml capacity, fitted with 4-cm barbed needles. They were fired into the shoulder/neck region where subcutaneous fat is thinnest (Øritsland, 1970) thus increasing the probability of drugs entering into highly vascularized tissue. Body weight was only visually estimated prior to injection, which resulted in variation in the dosages administered. If a bear did not show severe ataxia or lie down within 15 min after the first drug injection, then a second dose was administered. If we wished to administer more than 10 ml initially then two darts were used within 3 min. For those bears requiring more than one dart, time of KH-XH administration was assigned as the time of first drug injection.

A helicopter was used for locating and darting all bears handled in 1984 and approximately half the bears handled in 1983. In 1983, a truck was used for approaching and darting some bears near Churchill, Manitoba.

Once fully immobilized, each bear received ear tags and lip tattoos with the same unique number and an identifying symbol was dyed on the back to facilitate subsequent identification. Body length and girth measurements were obtained and body weight was estimated from axillary circumference (Stirling et al., 1977). We also collected a first pre-molar tooth for aging. A prophylactic dose of penicillin (Penlong XL, Rogar/STB Div., BTI Products Ltd., Montreal, Quebec H9J 2M5, Canada) was injected intramuscularly in the thighs and shoulders and a bland ophthalmic ointment (Anithal, Rogar/STB Div., BTI Products Ltd., Montreal, Quebec H9J 2M5, Canada) applied topically to the eyes. In addition, we covered the eyes with a soft paper blindfold to protect against corneal drying, retinal damage, and insect bites and to reduce visual stimuli. Body core temperature was determined using a standard rectal thermometer or telethermometer inserted rectally (YSI Telethermometer, Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio 45387, USA). Heart rate was monitored with a stethoscope or a telemetry pulse recorder (Exersentry, Respironics Instruments, Inc., Monroeville, Pennsylvania 15146, USA).

Yohimbine hydrochloride (YH) (Sigma Chemical Co., St. Louis, Missouri 63178, USA) was used only in 1984. It was constituted at 3% w/v in a 5% ethanol solution and sterilized by pressure filtration through a 0.22-micron filter (Millipore Ltd., Missisauga, Ontario L4V 1M5, Canada). Bacterial sterility of the filtrate was tested aerobically on tryptose agar (Difco Laboratories, Inc., Detroit, Michigan 48232, USA) at 37 C. The solution was then sealed in sterile light-proof 50-ml vials and refrigerated at 5 C until used. YH dosage ranged between 0.029 and 0.198 mg/kg body weight and was not administered until all processing and collection of data were completed. The drug was injected into the sublingual vein on all bears, except for eight in which the femoral vein was used. The delivery rate did not exceed 1 ml/min and the time of administration was set to when the YH injection was completed.

Time of first recovery was defined as when a bear could lift its head without external stimulus. We usually left after first recovery to minimize stress to the bears and potential danger to researchers. Hence, most bears were not monitored after first lifting their head. When possible, we measured heartbeat and respiratory rates immediately before and after administering YH.

Statistical differences in dosages of KH-XH received and recovery time between treatment groups were determined by the Mann-Whitney U-test at a significance level of 0.05 for a two-tailed test.

RESULTS AND DISCUSSION

We immobilized and measured recovery times for 73 polar bears in 1983 and 1984 (Table 1). Thirteen bears handled in 1983 were immobilized from a truck while 12 were immobilized from a helicopter. Approximately half the bears each year received only one KH-XH injection. There was no significant difference in the median dosage of KH-XH received by bears in either year ($U = 493.5$, $P = 0.216$) nor in the dosage received when a truck vs. helicopter was used in 1983 ($U = 59.0$, $P = 0.30$).

YH was usually administered 1.5 hr after initial KH-XH delivery (Table 1). The period prior to YH administration represented the time to achieve induction, the time to determine that a bear was safe to approach, and the time to handle and process a bear. The time taken to drug and handle each polar bear was protracted for two reasons. First, prior to having a reversal agent, we remained with the bears until we were sure they would experience no problems during recovery after we left. Secondly, during 1984 when YH was tested, we spent extra time with the im-

TABLE 1. Characteristics of polar bears (≥1 yr old) immobilized with ketamine hydrochloride (KH) and xylazine hydrochloride (XH) and observed until recovery (1983–1984).

	1983 (no YH administered)	1984 (YH administered)
Total number immobilized	25	48
Number of single injection immobilizations	13	23
Sex ratio (F/M)	1.08	0.71
Mean weight (kg) ± 1 SD	189 ± 75	249 ± 110
Range (kg)	65–344	84–524
Dosage KH-XH (mg/kg each)		
Median	11.0	10.7
Mean ± 1 SD	12.9 ± 5.4	11.3 ± 4.2
Range	4.7–30.8	4.1–24.2
Dosage YH (mg/kg)		
Median	—	0.099
Mean ± 1 SD		0.102 ± 0.035
Range		0.029–0.198
Interval (min) from KH-XH to YH administration		
Median	—	89.0
Mean ± 1 SD		94.9 ± 25.7
Time (min) to recovery after YH administration		
Median	—	10.0
Mean ± 1 SD		14.6 ± 18.8
Time to recovery (min) after initial injection of KH-XH		
Median	202	111
Mean ± 1 SD	242 ± 114	110 ± 27

mobilized bears recording physiological parameters with which to evaluate the reversal effects. Hence, recovery from KH-XH immobilization had advanced to a variable, but usually unknown, degree when YH was administered. The four earliest recovery times for bears that did not receive YH occurred before all handling data were collected and while a research crew was still with the bears. Nonetheless, the time to recovery was significantly lower for bears that received YH ($U = 103.0$, $P < 0.001$). The median time to recovery for bears that did not receive YH was nearly twice that of bears administered YH (Table 1).

The median time to recovery after YH administration was 10.0 min. Three bears took longer than 30 min and 16 bears recovered in less than 6 min. We noted no obvious correlation between measured variables and the longest or shortest recoveries.

Heart rates and respiratory rates increased after YH administration in most animals monitored (median heartbeat rate (BPM) before YH—51.0, after YH—79.0; median respiratory rate (br/min) before YH—5.0, after YH—12.0) often within 1 min of delivery. Because some bears recovered rapidly, post-YH monitoring of heart rate and occasionally respiratory rate, was difficult and maximal changes may not always have been recorded. In one-third ($n = 16$) of the cases in 1984, recovery after YH administration was accompanied by slight twitching of the extremities or the whole body. No bears in

1983, when YH was not used, showed similar muscle twitching during recovery.

One 20-mo-old female cub had strong convulsions within 4 min of yohimbine administration and which continued for more than 10 min. Her weight was 118 kg with a KH-XH dosage of 10.2 mg/kg each and YH dosage of 0.09 mg/kg. This bear was with her mother and sibling, thus we departed after its litter-mate began to recover. The next day the cub that had convulsed was dead at the site of handling. A necropsy in the field established the cause of death as acute cardiac failure following massive subendocardial hemorrhage of the left ventricle. The cause of the subendocardial hemorrhage was not determined. The female sibling weighed 130 kg and received a KH-XH dosage of 10.8 mg/kg each and YH at 0.08 mg/kg. She displayed no convulsions during recovery and on the following day appeared fully recovered.

Recovery after YH administration was occasionally dramatic, and some bears were able to stand and walk with co-ordination within 5 min. Although we were never threatened overtly by bears that had received YH, the potential to have to deal with an alert and non-sedated bear existed. Researchers planning to use YH to reverse KH-XH immobilization should ensure that personnel and equipment are removed safely before YH is administered.

YH appeared to be a useful antagonist for KH-XH immobilization in wild polar bears. Its availability, relatively low cost, and efficacy make it an attractive adjunct to KH-XH chemical immobilization. Biologists could completely process drugged bears more quickly knowing that yohimbine would rapidly reverse KH-XH immobilization. Although bears showed some sedation after recovery and many remained recumbent for undetermined periods, they could easily be stimulated to stand or walk. There was no evidence of relapse to unconsciousness.

ACKNOWLEDGMENTS

We would like to thank H. Cleator, A. Derocher, S. Miller, and I. Thorleifson for assistance during handling operations. M. Gillespie of the Manitoba Department of Natural Resources kindly allowed us to use a field research camp. Dr. D. Rainnie of the Western College of Veterinary Medicine carried out the field necropsy and subsequent histopathology on the bear that died. D. Andriashek, W. Calvert and J. Murie critically reviewed an early draft of the manuscript and offered many useful suggestions. Support was received from the Canadian National Sportsmen's Fund, the Canadian Wildlife Service, the Churchill Northern Studies Centre, the Manitoba Department of Natural Resources, the Max and Marjorie Ward Fund, the National Sciences and Engineering Research Council of Canada, the Norsk Polarinstitutt, the NWT Wildlife Service, the Polar Continental Shelf Project, and the World Wildlife Fund (Canada).

LITERATURE CITED

ADDISON, E. M., AND G. B. KOLENOSKY. 1979. Use of ketamine hydrochloride and xylazine hydrochloride to immobilize black bears (*Ursus americanus*). J. Wildl. Dis. 15: 253–258.

HATCH, R. C., N. H. BOOTH, J. D. CLARK, L. M. CRAWFORD, J. V. KITZMAN, AND B. WALLNER. 1982. Antagonism of xylazine sedation in dogs by 4-aminopyridine and yohimbine. Am. J. Vet. Res. 43: 1009–1014.

———, ———, J. V. KITZMAN, B. M. WALLNER, AND J. D. CLARK. 1983. Antagonism of ketamine anesthesia in cats by 4-aminopyridine and yohimbine. Am. J. Vet. Res. 44: 417–423.

HSU, W. H. 1983. Effect of yohimbine on xylazine-induced central nervous system depression in dogs. J. Am. Vet. Med. Assoc. 182: 698–699.

———, AND W. P. SHULAW. 1984. Effect of yohimbine on xylazine-induced immobilization in white-tailed deer. J. Am. Vet. Med. Assoc. 185: 1301–1303.

JESSUP, D. A., W. E. CLARK, P. A. GULLETT, AND K. R. JONES. 1983. Immobilization of mule deer with ketamine and xylazine, and reversal of immobilization with yohimbine. J. Am. Vet. Med. Assoc. 183: 1339–1340.

LEE, J., R. SCHWEINSBURG, F. KERNAN, AND J. HAIGH. 1981. Immobilization of polar bears (*Ursus maritimus*, Phipps) with ketamine hydrochloride and xylazine hydrochloride. J. Wildl. Dis. 17: 331–336.

LYNCH, G. M., W. HALL, B. PELCHAT, AND J. A. HANSON. 1982. Chemical immobilization of black bear with special reference to the use of ketamine-xylazine. *In* Immobilization of North

American Wildlife, L. Nielsen et al. (eds.). Wisc. Humane Soc., Milwaukee, Wisconsin, pp. 245–266.

ØRITSLAND, N. A. 1970. Temperature regulation of the polar bear (*Thalarctos maritimus*). Comp. Biochem. Physiol. 37: 225–233.

SCHWEINSBURG, R. E., L. J. LEE, AND J. C. HAIGH. 1982. Capturing and handling polar bears in the Canadian Arctic. *In* Immobilization of North American Wildlife, L. Nielsen et al. (eds.). Wisc. Humane Soc., Milwaukee, Wisconsin, pp. 267–288.

STIRLING, I., C. JONKEL, P. SMITH, R. ROBERTSON, AND D. CROSS. 1977. The ecology of the polar bear (*Ursus maritimus*) along the western coast of Hudson Bay. Can. Wildl. Serv. Occas. Paper 33: 1–64.