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IMMOBILIZATION OF POLAR *(Thalarctos maritimus)* AND BROWN *(Ursus arctos)* BEARS USING ETORPHINE AND XYLAZINE

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Introduction

The polar bear and the brown bear are exceedingly strong and ferocious animals, so that capture and handling of them is fraught with many dangers, both for the human attendant and for the bears themselves. When these bears are kept in captivity, many occasions arise when veterinary attention is called for, and, therefore, an adequate means of restraint is required. When anesthesia was first considered for use in bears, either volatile anesthetics, e.g., ether (administered in an ether chamber) or intravenous anesthetics, e.g., chloral hydrate, morphine, and halothane (administered with the bear in a squeeze cage) were used.[5] Both of these methods required the use of physical restraint, which caused the animal considerable stress and also increased the risk of injury to the bear.

The administration of narcotics and other drugs from afar, by a projectile syringe or dart, lessens the necessity of physical capture.[12] Only those narcotics effective in small doses are satisfactory because of the limited capacity of the darts.

Phencyclidine, a disassociative anesthetic, was the first drug that could be used in a dart for the immobilization of bears. Used alone, its side effects of excitement and tonic/clonic muscle spasms were marked, but these were reduced by the simultaneous use of a variety of tranquilizers.[6,18,24] Succinylcholine chloride, a depolarizing muscle relaxant, was used as a "knock-down" agent for capturing bears, but it has no narcotic nor analgesic properties. It has been shown that phencyclidine and etorphine are safer to use in the bear.[8,14] As phencyclidine has been taken off the market as a result of its abuse by drug addicts ("angel dust"), etorphine is now the primary drug that can be administered by a single dart to effect immobilization. Other drugs, such as xylazine (8-10 mg/kg),[3,15,17,19] ketamine (10-12 mg/kg),[9,13] and droperidol plus fentanyl (as Innovar-Vet® + 1 ml/18 kg)[9] are also effective in bears. However, the effective dose constitutes such a large volume of fluid that it is prohibitive for use in a dart, although 2.0 mg of ketamine has been administered in two darts to a bear for immobilization before maintenance on halothane oxygen anesthesia.[16]

Etorphine induces analgesia and catatonia. The dose-related side effects are excitement, tachycardia, raised blood pressure, opisthotonus, mydriasis, hyperpyrexia, respiratory depression, cough center depression, inhibition of gastrointestinal motility, and antidiuresis.[1,11] Etorphine is unique in that it is safer to give the maximum dosage rather than the minimum effective dosage, as underdosing results in marked hyperexcitability and hyperventilation leading to a possible fatal alkalosis. Bears have been found to be one of the more sensitive species to the effects of etorphine, with the dosage per kilogram being relatively low. It has been used in polar bears at dosages of 2-3 mg/animal,[7] 0.5 mg/45 kg body weight[20,22] or 6-8 μ/kg.[2] For brown bears, 8-10 μ/kg has been suggested.[2]

Various tranquilizers have been administered simultaneously with etorphine to reduce the excitement effects.[22] Etorphine is now sold in some parts of the world already mixed with a phenothiazine tranquilizer under the trade names of "Large Animal Immobilon® " and "Small Animal Immobilon® ." Some workers have found that the addition of acepromazine to etorphine results in too much residual

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sedation.[2]

This report discusses the results of five years experience in the use of Large Animal Immobilon® in Tierpark Hellabrunn, primarily in the polar bear but also in the brown bear.

Materials and Methods

The agents used in the immobilization of the bears were:

1) Immobilon® - (Large Animal) - Reckitt and Colman. One ml contains 2.45 mg etrophine (as hydrochloride) and 10 mg acepromazine maleate, a neurolept-analgesic, 2) Revivon® - Reckitt and Colman. One ml contains 3 mg diprenorphine (as hydrochloride) (with methylene blue 0.001% and chlorocresch 0.1%), a reversal agent, direct antagonist to etorphine), 3) Rompun® - Bayer. One ml contains 100 mg xylazine, a tranquilizer and analgesic agent, and 4) Kinetin® - Schering. One ampule contains 150 IU hyaluronidase as a dry substance. Used to increase the uptake into the blood of the active agents from the muscle.

One ampule of kinetin was added to the immobilizing agent, either Immobilon or Immobilon plus Rompun, which was then administered to the animal intramuscularly using the Telinject blowpipe and dart system (Telinject G.m.b.H.).[23]

The bears were either put singly into their small sleeping cages and darted from the outside through the bars, using the 1.0 m blowpipe, or were darted in the main enclosure, using the 2.0 m blowpipe (maximum range 15 m). Darts of 2 ml volume were used in all cases. The bear, in particularly the polar bear, is endowed with a thick layer of subcutaneous fat, which may be up to 7.5 cm thick in some areas of the body. Therefore, the darts were aimed at the neck and shoulder musculature, where the fat is thinnest, to assure that the injection was intramuscular and not intrafat.

After darting, the animal was left undisturbed until fully immobilized, since continual close assessment of the animal could precipitate unwanted excitement and aggression. Such reactions either effectively increased the dose of Immobilin required, or induced tachycardia and rapid respiration predisposing to the development of hyperventilation, thus leading to severe alkalosis and possibly death.[1]

The depth of anesthesia was initially ascertained by gently stimulating the pinna of the ear, with a stick (such as a broom handle), to elicit the ear twitch reflex. This reflex is used as the head is the last part of the body affected by the immobilization. Once the ear twitch reflex was suppressed it was deemed safe to enter the enclosure and attend to the animal.

The depth of anesthesia was considered to be

a) *Unsatisfactory* - if the animal could actively move its limbs and even stand up, when its ear pinna was stimulated or if the animal was approached.

b) *Satisfactory* - if the ear twitch reflex had gone, but stimulaton elicited physical reactions, such as limb flexion. This level of anesthesia was considered to be adequate for transferring the bear from one place to another or for procedures which are not very painful (such as the taking of blood samples).

c) *Light* - if the ear twitch reflex was present and feeble movements could be elicited on stimulation.

d) *Operation Deep (op. deep)* - if reaction to painful stimuli was also suppressed.

e) *Too Deep* - if there were signs of respiratory embarrassment.

If during the handling of the animal the level of narcosis was not considered to be deep enough, a further dose of Immobilon was injected intramuscularly, with up to a quarter of the initial dose being given.

When the handling of the animal was finished, all equipment and auxiliary personnel were removed from the bear's cage or enclosure and a computed dose of Revivon was given (double the dose of Immobilon) intramuscularly, plus 1 ml

subcutaneously to prevent the danger of narcosis recurring later due to the enterohepatic recirculation of the etorphine. The vein of choice was the tongue vein, as this was always readily available, whereas the femoral vein, which is also suggested, was far more difficult to use. As the tongue vein is very thin walled, it is better not to draw back on the syringe, as this will cause the vein to collapse. Any bleeding after the needle was removed, was stemmed by the application of firm pressure. If the vein could not be used, the Revivon was given intramuscularly into the tongue muscles. Once the Rivivon was administered, prompt exit from cage was required as the speed of recovery is very fast.

Animals showing any signs of hangover, e.g., drowsiness, during the following 24 hours post-immobilization, were given more Revivon intramuscularly by dart (0.5-1.0 ml).

Results

Fifty bears were immobilized in the five year period from 1975 to 1980 (Tables I and II), thirty-three with Immobilon alone and seventeen with Immobilon plus Rompun. No fatalities due to the immobilization occurred.

The side effects seen were:

a) Muscular spasms caused by etorphine, when Immobilon was used alone.

b) Three of the bears suffered drowsiness following reversal of the immobilization [Table No. I(10), I(14), and II(1)] extending to the next day in one of the bears [No. I(10)].

c) One polar bear [Table No. I(25)] experienced epileptiform convulsions while under the effects of the Immobilon but it recovered uneventfully on administration of Revivon. Perhaps convulsions were related to a head injury sustained 14 days previously.

The average induction time was about thirteen minutes for Immobilon alone, and fifteen minutes for Immobilon plus Rompun. It is possible that the induction times of over

TABLE I.

Results of the Immobilization of the Polar Bear

No.	Age (yrs)	Sex	Weight (kg)	Dose		Induction Time (min)	Level of Narcosis	Second Dose			Indication for Immobilization	Side Effects
				"Immobilon" Etorphine (mg)	"Rompun" Xylazine (mg)			Etorphine (mg)	Time After Initial Dose (min)	Level of Narcosis		
1.	Adult	0.1	-	2.25	-	-	Satisfactory	-	-	-	Transfer	Muscular spasms
2.	18	0.1	299	2.7	-	10	Op. deep	-	-	-	Transfer and tooth removal.	Muscular spasms
3.	Adult	0.1	-	2.925	-	-	Satisfactory	-	-	-	Transfer	Muscular spasms
4.	Adult	0.1	-	3.375	-	-	Satisfactory	-	-	-	Transfer	Muscular spasms
5.	17	1.0	400+	5.4	-	-	Op. deep to deep	-	-	-	Cleaning of Pool.	Muscular spasms
6.	>20	0.1	300+	2.25	-	10	Op. deep	-	-	-	Cleaning of pool.	Muscular spasms
7.	Adult	0.1	-	2.25	-	-	Satisfactory	-	-	-	Cleaning of enclosure.	Muscular spasms

No.	Age (yrs)	Sex	Dose			Induction Time (min)	Level of Narcosis	Second Dose			Indication for Immobilization	Side Effects
			Weight (kg)	"Immobilon" Etorphine (mg)	"Rompun" Xylazine (mg)			Etorphine (mg)	Time After Initial Dose (min)	Level of Narcosis		
8.	Adult	0.1	400+	2.25	-	10	Op. deep	-	-	-	Cleaning of enclosure.	Muscular spasms
9.	18	1.0	500+	2.925	-	-	Satisfactory	-	-	-	Skin samples taken.	Muscular spasms
10.	18	1.0	500+	2.7	-	20	Satisfactory	0.675	45	Satisfactory	Wound repair. Head radiography.	Muscular spasms Hangover occurred next day for a few hours.
11.	18	1.0	500+	2.7	-	15	Op. deep	-	-	-	Wound treatment.	Muscular spasms
12.	18	1.0	500+	2.7	-	10	Op. deep	-	-	-	Repair of artery and bite wound.	Muscular spasms
13.	18	1.0	500+	3.375	-	25	Light to satisfactory	- -	- -	- -	Animal pulled out stitches and started massive arterial bleeding again. Wound repair.	Muscular spasms
14.	>20	0.1	350+	2.25	-	20	Light	-	-	-	Transfer	Muscular spasms Hangover
15.	Adult	0.1	-	2.25	-	-	Satisfactory	-	-	-	Transfer	Muscular spasms
16.	Adult	0.1	400+	4.5	-	-	Satisfactory	-	-	-	Treatment of abscess in hindpaw.	Muscular spasms
17.	Adult	0.1	400+	2.25	-	-	Satisfactory	-	-	-	-	Muscular spasms
18.	Adult	0.1	400+	3.375	-	20	Satisfactory	-	-	-	Treatment of hindlimb lameness.	Muscular spasms
19.	Old	0.1	400+	2.925	-	10	Satisfactory	-	-	-	Wound treatment.	Muscular spasms
20.	Old	0.1	400+	2.25	-	15	Satisfactory	-	-	-	Wound treatment.	Muscular spasms
21.	Old	0.1	400+	2.7	-	10	Satisfactory	-	-	-	Wound treatment.	Muscular spasms
22.	19	1.0	600+	2.7	-	7	Satisfactory	-	-	-	Transfer (sold)	Muscular spasms
23.	>20	0.1	350+	2.25	-	10	Satisfactory	-	-	-	Transfer	Muscular spasms
24.	1½	0.1	-	1.575	-	20	Satisfactory	-	-	-	Wound repair. Trauma to head.	Did not stand up after Rivivon, possibly due to shock from the head trauma. Muscular spasms

			Dose					Second Dose				
No.	Age (yrs)	Sex	Weight (kg)	"Immobilon" Etorphine (mg)	"Rompun" Xylazine (mg)	Induction Time (min)	Level of Narcosis	Etorphine (mg)	Time After Initial Dose (min)	Level of Narcosis	Indication for Immobilization	Side Effects
25.	1½	0.1	-	2.25	-	-	Satisfactory	-	-	-	Wound treatment.	Epileptic form convulsions.
26.	1½	0.1	-	1.35	-	10	Unsatisfactory	0.225	20	Satisfactory	Wound treatment.	Muscular spasms
27.	>20	0.1	400	2.925	10	20	Satisfactory	-	-	-	Transfer	-
28.	½	1.0	-	2.25	5	-	Satisfactory	-	-	-	Treatment of inflammation of tongue and mouth due to fish bone.	-
29.	½	1.0	-	2.25	10	-	Satisfactory	-	-	-	-	-
30.	Adult	0.1	400+	2.25	-	-	Unsatisfactory	0.45	20	Satisfactory	Interdigital abscess. Very painful.	Muscular spasms
31.	Adult	0.1	400+	2.25	10	-	Satisfactory	-	-	-	Transfer (sold)	-
32.	Adult	1.0	400+	2.7	5	8	Op. deep	-	-	-	Transfer	-
33.	Adult	0.1	400+	2.7	10	8	Op. deep	-	-	-	Transfer	-
34.	Juve.	1.0	100	0.675	2	20	Light	0.1125	-	Satisfactory	Castration	-
35.	-	0.1	-	0.9	2	20	Light	0.787	-	Satisfactory	-	-
36.	½	1.0	-	2.25	10	-	Satisfactory	0.675	-	Satisfactory	Diagnostic examination Transfer (sold)	-
37.	-	0.1	-	1.575	-	-	Satisfactory	-	-	-	Diagnostic examination	Muscular spasms
38.	4	0.1	-	3.375	5	-	Satisfactory	-	-	-	Wound treatment.	-
39.	12	0.1	550+	3.375	5	-	Unsatisfactory	0.9	-	Unsatisfactory	Treatment of inflammation. Inspection of mouth.	- -
40.	12	0.1	550+	4.05	5	30	Unsatisfactory	2.025	35	Satisfactory	Inspection of mouth.	-
41.	>25	0.1	500+	3.6	10	-	Op. deep	-	-	-	-	-
42.	>25	0.1	500+	3.15	10	-	Satisfactory	-	-	-	Wound treatment.	-
43.	Adult	0.1	400+	1.35	5	20	Unsatisfactory	-	-	-	Skin samples. Not able to take them.	-
44.	Adult	0.1	400+	2.925	10	12	Satisfactory	-	-	-	Skin samples for histology.	-

TABLE II.

Results of the Immobilization of the Brown Bear

No.	Age (yrs)	Sex	Dose				Induction Time (min)	Level of Narcosis	Second Dose			Indication for Immobilization	Side Effects
			Weight (kg)	"Immobilon" Etorphine (mg)	"Rompun" Xylazine (mg)				Etorphine (mg)	Time After Initial Dose (min)	Level of Narcosis		
1.	Adult	0.1	111	2.25	20		-	Satisfactory	-	-	-	Transfer	Hangover due to excess xylazine. Had to give 0.5 ml Revivon intramuscularly in the evening.
2.	Adult	0.1	75	1.125	-		6-8	Satisfactory	-	-	-	Transfer	Muscular spasms
3.	Adult	1.0	78.5	0.9	-		6-8	Satisfactory	-	-	-	Transfer	Muscular spasms
4.	Adult	0.1	59.5	0.9	-		6-8	Satisfactory	-	-	-	Transfer	Muscular spasms
5.	Juve.	0.1	37.5	0.5625	-		6-8	Satisfactory	-	-	-	Transfer	Muscular spasms
6.	Adult	0.1	112	2.7	-		6-8	Op. deep	-	-	-	Transfer	Muscular spasms

twenty minutes were a result of either an intrafat injection or an insufficient dosage.

During anesthesia, respiration was slow and deep 0.5-4.0 breaths/minute, with no evidence of cyanosis. After Revivon was administered, the respiratory rate quickened and the bears stood up within 1-5 minutes after intravascular injection or 5-10 minutes after intramuscular injection.

Discussion

The effects of various dosages of etorphine were variable as a result of

i) Intrafat injection rather than intramuscular injection.

ii) The mental state of the bear before immobilization—angry and fractious animals required higher dosages, or local anesthesia may be employed in conjunction with the immobilization.

Since acepromazine alone was not strong enough to reduce muscular spasms in the bear [Table No. I(1-27), I(30), II(2-6)], xylazine was added to the dart to boost the tranquilizing effect of acepromazine (Table No. I(27-29), I(31-36), I(38-44), II(1)]. When field work was first started, xylazine was found to prolong recovery time [Table No. II(1)], but this was found to be dose-related, since when lower doses of xylazine were used this effect was not seen. The addition of xylazine did not effectively reduce the dosage for etorphine, nor the induction time.

The safety of etorphine has been emphasized in the case of one polar bear [Table No. I(12) and I(13)], with immobilizations being carried out in the morning and early evening of the same day. The bear was originally injured in a fight. It was then immobilized in the morning and the wound was cleaned and sutured. The bear recovered from the immobilization uneventfully, but in the afternoon it tore out the sutures, reopening the wound and setting off arterial bleeding. The bear was found lying in a pool of blood, but was sufficiently aware to require re-immobilization before the wound could be

repaired. It is interesting to note that for this second immobilization an extra 0.675 mg of etorphine was required to obtain a satisfactory depth of narcosis. Even after the large blood loss, the bear recovered uneventfully from the second immobilization. The safety of etorphine for these two species is also indicated by the zero mortality rate.

The fact that the bears appeared to be oblivious to the darting greatly mitigated physiological stress reactions prior to immobilization, as opposed to methods relying on initial physical restraint.

The advantage of Immobilon followed by Rivivon is that the immobilization time can be kept as short as possible, the time being dictated by the time required for the handling procedures. The shorter the period of immobilization/anesthesia, the less likely the development of adverse side effects.

Conclusion

The average effective dosage for etorphine, when the Immobilon® plus Rompun® mixture was used is:

Polar Bears	7.312 μg/kg with maximum of 7.95 μg/kg body weight,
Brown Bears	16.82 μg/kg body weight.

The dosage of xylazine/animal was considered to be adequate if 10 mg was given for an animal of 300 kg or heavier and 5 mg for an animal below 300 kg.

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HDROCEPHALUS, EPENDYMITIS, AND ENCEPHALITIS IN AN ASIAN BLACK BEAR *(Selenarctos tibetanus)*

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Summary

Hydrocephalus, ependymitis and encephalitis occurred in a 7-week-old black bear cub resulting in gross distension of the calvarium, divergent strabismus, weakness, inanition, and incoordination. The diagnosis was made by physical and neurologic examinations, electroencephalography, and double contrast ventriculography. Confirmation was made by gross and microscopic examination of the brain and spinal cord. Cause and effect relationships between an earlier respiratory infection and the CNS lesions could not be made.

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Case Report

A female Asian black bear was born to clinically normal parents in a zoological park. The cub was depressed and unable to suckle at birth and subsequently was bottle fed. Physical examination at this time was unremarkable. At approximately four weeks of age, a respiratory infection was diagnosed and treated with chloramphenicol palmitate 7 mg/kg of body weight, administered orally every eight hours. The animal responded to therapy but did not attain vigor or normal ambulation. During this time the animal's cranium enlarged disproportionately to body size.

Physical examination at seven weeks of age revealed a grossly enlarged cranium with no palpable bone dorsal to the