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IMMOBILIZATION OF POLAR BEARS (*URSUS MARITIMUS*) WITH TELAZOL® IN THE CANADIAN ARCTIC

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ABSTRACT: In 1986, 213 polar bears (*Ursus maritimus*) were immobilized with Telazol® on the sea ice of the eastern Beaufort Sea during April and May, and 106 along the western coast of Hudson Bay near Churchill, Manitoba (Canada) in September. No animals died from handling. The efficacy of this drug at different seasons and the physiological responses of the immobilized bears were compared. A single injection of 8 to 9 mg of Telazol per kg of body weight gave a rapid full immobilization with satisfactory analgesia, and faster recovery than other drugs for which there is no antagonist. The reactions of the bears could be reliably and easily interpreted from a safe distance before the animal was approached. There was a wide range of tolerance to high dosages and bears appeared able to thermoregulate while immobilized. The mortality rate due to handling was lower than with any other drug used to date.

Key words: *Ursus maritimus*, Telazol, chemical immobilization, polar bears, seasonal variation, thermoregulation, field study.

INTRODUCTION

Many drugs have been used for immobilization of polar bears (*Ursus maritimus*) for population studies since the late 1960's: succinycholine chloride (Anectine®), the morphine derivatives etorphine hydrochloride (HCl) (M99®) and carfentanil (Carfentanil®) and their respective antagonists M5050®, and naloxone (Narcan®) and diprenorphine, phencyclidine HCl (Sernylan®), and a 1:1 combination by weight of ketamine HCl and xylazine HCl (Rompun®) and the antagonist yohimbine HCl (Schweinsburg et al., 1982; Ramsay et al., 1985). Although adequate to facilitate tagging and the collection of measurements and some specimens, these drugs or drug combinations exhibited one or more problems in terms of safety to the bears or the biologists (Stewart et al., 1980; Stirling et al., 1985).

Preliminary testing of the cataleptoid anesthetic Telazol (a 1:1 mixture by weight of the dissociative anesthetic tiletamine HCl and the tranquilizer zolazepam HCl) on a wide range of mammals has been promising (Gray et al., 1974; Boever et al., 1977; Schobert, 1987), especially for bears (Boever et al., 1977; Stewart et al., 1980; Haigh et al., 1985; Stirling et al., 1985).

In this study, we present and compare the results from immobilization of 319 polar bears with Telazol in two markedly different geographical, ecological, and physiological circumstances. Polar bears south of Churchill, Manitoba spend the late summer and early autumn on land because the ice in Hudson Bay melts completely by that time and does not refreeze until about early November (Stirling et al., 1977). They are unable to feed on seals during this period, but are in excellent condition and survive by metabolizing their subcutaneous fat (Lunn and Stirling, 1985). Although not in dens, they are in a physiological state similar to that of hibernating black bears (Nelson et al., 1983). In contrast, polar bears captured on the sea ice in the eastern Beaufort Sea in April and May are much leaner (having just survived the winter), they are feeding on seals, and adults are breeding.

MATERIALS AND METHODS

Telazol (Reading Laboratoires, Z.A.C. 17, Rue des marronniers, 94240 L'Hay-les-Roses, France) was received in powdered form and hydrated to a 20% solution (200 mg/ml). Injections were delivered in 5, 7 and 10 ml needle-barbed darts, using Cap-chur equipment (Palmer Chemical Co., Douglasville, Georgia 30133, USA) fired

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from a helicopter (Lentfer, 1968; Larsen, 1971). The weight of the bear was estimated from the air by an experienced observer and a dart was loaded with an appropriate amount of drug. Needle length ranged from 1.5 to 6 cm depending on the size and estimated fatness of the bear. Whenever possible, darts were placed perpendicular to the body surface in the lower neck, upper shoulder or upper mid-back. The subcutaneous fat is thinnest in these areas facilitating injection into well vascularized muscle masses (Øritsland, 1970). On small animals, which are harder to hit accurately, or visibly lean animals, darts were often placed on the rump to minimize the chance of injury. All cubs-of-the-year (COY's) were injected on the ground using a hand-syringe during the spring or a jab-pole during the autumn. All yearlings received darts fired from a helicopter.

We recorded the time the first dart hit the bear, the time to first ataxia, sternal recumbency, full immobilization [what Gray et al. (1974) term surgical anesthesia and Haigh et al. (1985) term sternal recumbency], and first recovery. We defined sternal recumbency as when a bear was lying down but was still capable of head movement. Full immobilization was reached when there was no head movement in response to prodding. In this analysis, first recovery was defined as unstimulated head movement. When possible, rectal temperature, respiration rate in breaths (br)/min and heart rate in beats (bt)/min were measured from one to three times for each bear at 20-min intervals, beginning as soon as practical after full immobilization. The first measurements were taken at variable times after the bear was first immobilized and some measurements were missed because of differences in the time that drugged bears could be approached, or because time-consuming precautions were taken when more than one bear (family groups or male-female breeding pairs) was drugged at the same time. Because of this, the sample sizes vary between categories in the tables.

Handling and tagging of bears required 45 min to 2 hr, depending on how many animals were immobilized at the same time. Bears were left to recover undisturbed when they were breathing well and had given no indication of possible problems. Approximately 50% of the locations were revisited and all those bears had recovered and departed.

Polar bears on land along the western coast of Hudson Bay near Churchill, Manitoba, Canada (57°00′ to 58°50′N, 92°40′ to 94°00′W) were captured between 14 and 30 September 1986, when ambient temperatures ranged between −2 and 15 C ($\bar{x}$ = 5 C, SD = 4). Bears on the sea ice in the eastern Beaufort Sea (70°00′ to 75°00′N, 120°00′ to 141°00′W) were caught between 14 April and 16 May 1986, when air temperatures ranged between −27 and −2 C ($\bar{x}$ = −14 C, SD = 5).

Standardized tagging and weighing procedures were conducted on immobilized bears (Stirling et al., 1977, 1980). Weights derived from axillary girth measurements were used in all calculations of dosage except for COY's in the Beaufort Sea which were weighed by a spring scale. Fatness was recorded on a subjective scale that ranged from 1 to 5, where 1 was emaciated, 3 was average, and 5 was obese.

Bears were not kept immobilized for extended periods of time. In Table 2, the amount of drug used to calculate dosage includes hand injections required to fully immobilize the bears, but not small additional injections given to briefly extend immobilization so processing could be completed. The amount of drug contained in darts that bounced off the bear (<2%), misfired or missed was not included.

Data were analyzed separately for the two study areas and seasons, and for bears requiring one injection versus those requiring multiple injections. Data from COY's and yearlings were each analyzed separately from those of older bears.

Data were analyzed using nonparametric statistics because of the non-normal distribution of some of the data sets. Using the two-tailed Mann-Whitney *U*-test (Sokal and Rohlf, 1981) we determined statistical differences between weights, dosages and induction times for bears given single and multiple injections, and between physiological measurements for bears given single injections in the Beaufort Sea and Churchill. We used the two-tailed Kruskal-Wallis and Multiple Comparison tests (Conover, 1980) for comparisons of dosages, induction times and physiological measurements of cubs in the Beaufort Sea and Churchill. Using a one-tailed Wilcoxon Signed Ranks Test (Conover, 1980) we compared physiological measurements of bears given single injections with those given multiple injections. The most frequently used dosages in the Beaufort Sea and Churchill were separated into 0.5 mg/kg intervals. Using the intervals, we compared the frequency distribution of dosages of the Beaufort Sea and Churchill data sets using a *G*-test (Sokal and Rohlf, 1981).

RESULTS

Dosage rates, induction and recovery times

Two hundred thirteen polar bears were immobilized during the spring on the sea

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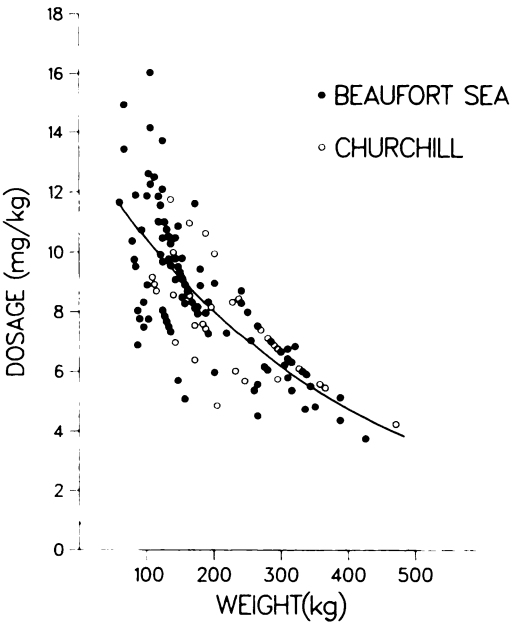


FIGURE 1. Dosage rate (mg/kg) for bears given a single injection of Telazol. $y = 13.55e^{-0.002607x}$, ($r = 0.81$, $P < 0.01$).

ice of the eastern Beaufort Sea and 106 on land in the early autumn near Churchill. None of the bears died as a result of handling. A mean dosage of 8.9 mg Telazol per kilogram of body weight (SD = 2.4) was required to immobilize bears >1 yr with a single dart during the spring compared to a mean of 7.9 mg/kg (SD = 1.9) during the autumn (Table 1). Although the mean dosages were statistically different, the frequency distributions of dosages used in the Beaufort Sea and Churchill were equivalent ($G = 8.9$, df = 11, $P > 0.05$). Separate curve-fitting of weight and dosage data for the Beaufort Sea and Churchill resulted in no significant differences in the slopes ($F = 0.0036$, df = 1, 171, $P > 0.05$), therefore the data were pooled for comparisons. The relationship between dosage and body weight for the Beaufort Sea and Churchill is summarized in Figure 1, and is described by the equation $y = 13.55e^{-0.002607x}$ ($r = 0.81$, $P < 0.01$).

There were no significant differences in the times to first ataxia, sternal recumbency, full immobilization or first recovery in bears that were immobilized with a single injection in the Beaufort Sea during the spring compared to times at Churchill during the autumn (Table 1).

TABLE 1. Characteristics of polar bears >1-yr-old immobilized with a single injection of Telazol in the Beaufort Sea and Churchill areas in 1986.

	Beaufort Sea, spring 1986	Churchill, fall 1986	Mann-Whitney U-test statistic
Total number immobilized	125	50	
Sex ratio (female/male)	1.08	1.08	
Weight (kg)	177 (82)[a] 60–426[b]	217 (86) 93–471	2,124*
Fat index	2.2 (0.6) 1–4	2.9 (0.7) 2–5	1,596*
Dosage (mg/kg)	8.9 (2.4) 3.8–16.0	7.9 (1.9) 4.2–11.8	3,810*
Time (min) to first ataxia after injection	2.6 (1.8) 0–9 85[c]	2.5 (1.3) 1–7 46	1,848
Time (min) to sternal recombency after injection	4.3 (2.8) 0–14 47	4.6 (2.3) 2–10 22	448
Time (min) to full immobilization after injection	4.7 (2.5) 1–14 89	5.3 (2.1) 2–10 30	1,036
Time (min) to recovery after injection	46.3 (21.7) 15–107 50	54.5 (39.3) 19–140 15	369

[a] Mean (SD).
[b] Range.
[c] n.
* $P < 0.05$.

Polar bears that required two or more darts for immobilization received an average of about 11 mg/kg in both study areas, or 40% more than animals immobilized with a single injection (Tables 1, 2). The mean time interval between consecutive injections fired from a helicopter was 14 min (SD = 6) in both the Beaufort Sea and Churchill study areas. The mean time intervals between injections fired from a helicopter and subsequent hand injections from the ground were 22 min (SD =

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TABLE 2. Characteristics of polar bears >1-yr-old immobilized with more than one injection of Telazol in the Beaufort Sea and Churchill areas in 1986.

	Beaufort Sea, spring 1986	Churchill, fall 1986	Mann-Whitney *U*-test statistic
Total number immobilized	55	38	
Sex ratio (female/male)	1.04	0.41	
Weight (kg)	188 (89)[a] 62–418[b]	258 (95) 124–403	628*
Fat index	2.7 (0.6) 1–4	3.2 (0.5) 2–4	624*
Dosage (mg/kg)	10.9 (3.6) 4.7–21.4	11.1 (3.6) 6.5–22.0	1,028
Time (min) to first recovery from initial injection	65.8 (26.3) 10–125 30[c]	63.1 (35.9) 29–151 9	162

[a] Mean (SD).
[b] Range
[c] *n*.
* $P < 0.05$.

7) in the Beaufort Sea, and 21 min (SD = 5) at Churchill. Time to first ataxia or sternal recumbency could not be compared because of small sample sizes. However, time to first recovery after receiving the initial injection averaged 65 min, or 30% longer than for bears given a single injection (Tables 1, 2).

There were no significant differences between dosages given to COY's or dosages given to yearlings in the Beaufort Sea and Churchill (Kruskal-Wallis $Z = 2.04$, $P > 0.05$, and $Z = 0.66$, $P > 0.05$) (Table 3). There were no significant differences between COY's and yearlings during the spring and COY's during the autumn in the time required for full immobilization or time to first recovery ($H = 5.01$, $P > 0.05$; $H = 5.78$, $P > 0.05$). There were no significant differences in time to full immobilization and time to first recovery between yearlings, and bears >1-yr-old in the Beaufort Sea ($U = 352$, $P > 0.05$; $U = 232$, $P > 0.05$, respectively). The sample sizes of time to full immobilization and recovery for yearlings from Churchill were too small to include in these comparisons.

Recovery from Telazol in both the Beaufort Sea and Churchill was gradual and predictable. Tongue movement and licking were the first signs of recovery, followed by movement of the head from side to side, head lifting, and eventually the bear would raise itself on its forelegs. When head movement occurred, the bear was aware of its surroundings and followed our movements with its eyes.

Physiological responses

Within the samples of bears that received single injections in the Beaufort Sea and Churchill, there were no significant differences in rectal temperature, respiration, or heart rate between the 20-min time intervals ($P > 0.05$). Therefore, these data were pooled for comparisons (Table 4).

Polar bears immobilized with a single injection of Telazol in the Beaufort Sea in the spring had significantly higher body temperatures, respiration rates, and heart rates than did their counterparts south of Churchill in the autumn (Table 4). The mean body temperature of bears given a single injection in the Beaufort Sea was 38.9 C (SD = 1.0) and 20 bears had temperatures ≥40.0 C. In comparison, the mean body temperature recorded for bears given a single injection at Churchill during the autumn was 39.4 C (SD = 1.0) and only one bear reached a maximum of 39.4 C.

There were significant changes in rectal temperatures and respiration rates between 20-min time intervals for bears given multiple injections in the Beaufort Sea (Table 5; $H = 19.6$, $P < 0.01$; $H = 11.3$, $P < 0.01$). In Churchill, there also were significant changes in respiration and heart rates between 20-min time intervals for bears given multiple injections (Table 5; $H = 11.5$, $P < 0.01$; $H = 7.8$, $P < 0.05$). Because of these changes, the data could not be pooled for comparisons.

Although not statistically comparable,

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TABLE 3. Characteristics of cub-of-the-year (COY) and yearling polar bears immobilized with one injection of Telazol in the Beaufort Sea and Churchill areas in 1986.

	Beaufort Sea, spring 1986		Churchill, fall 1986	
	COY	Yearling	COY	Yearling
Total number immobilized	18	15	13	5
Sex ratio (female/male)	1.00	0.50	0.63	1.50
Weight (kg)	12 (2)[a]	61 (15)	47 (8)	106 (46)
	10–15[b]	42–93	35–60	77–188
Fat index	2.0 (0.6)	1.9 (0.4)	2.9 (0.3)	3.0
	1–3	1–2	2–3	3–3
Dosage (mg/kg)	5.7 (1.6)	10.4 (2.4)	7.6 (1.7)	8.9 (2.3)
	3.3–7.6	7.1–14.3	4.2–10.3	4.8–10.4
Time (min) to first ataxia after injection		3.4 (2.2)	1.0	3.5 (2.1)
	—	2–7	1–1	2–5
		5[c]	2	2
Time (min) to full immobilization after injection	2.0 (0.4)	4.0 (3.0)	2.8 (1.4)	6.0 (5.2)
	1–3	1–10	2–6	3–12
	12	11	9	3
Time (min) to recovery after injection	29.7 (8.4)	44.6 (12.7)	36.7 (21.5)	54.0
	14–40	30–62	18–81	
	12	9	7	1

[a] Mean (SD).
[b] Range.
[c] *n*.

mean rectal temperatures, respiration rates, and heart rates were similar for bears given single and multiple injections within each study area. Bears immobilized with single or multiple injections near Churchill had lower rectal temperatures, respiration rates, and heart rates than bears in the Beaufort Sea (Tables 4, 5). Nine bears given more than one injection had body temperatures ≥40.0 C in the Beaufort Sea. The maximum rectal temperature recorded for bears that received multiple injections at Churchill was 39.5 C ($\bar{x}$ = 37.4, SD = 1.0).

Bears given multiple injections took longer to return to normal body temperatures in the Beaufort Sea during the spring than at Churchill. Rectal temperatures of bears in the Beaufort Sea given multiple injections were significantly higher than those given a single injection until >80 min ($\bar{x}$ = 38.3, SD = 0.8) after the initial dosage (T = 101.5, $P > 0.05$) and until 41

TABLE 4. Physiological measurements taken from polar bears >1-yr-old immobilized with single injections of Telazol.

	Beaufort Sea			Churchill			
	$\bar{x}$	(SD) Range	*n*	$\bar{x}$	(SD) Range	*n*	Mann-Whitney *U*-test statistic
Rectal temp. (C)	38.9	(1.0) 35.2–41.8	243	36.9	(1.0) 34.8–39.4	61	13,429*
Breaths/min	19	(13) 3–80	245	11	(8) 3–44	61	10,816*
Heart beats/min	124	(18) 76–172	218	106	(17) 68–144	57	9,426*

* $P < 0.01$.

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TABLE 5. Changes in physiological measurements with time of bears immobilized with more than one injection of Telazol.

Time from initial Telazol injection (min)	Beaufort Sea			Churchill		
	$\bar{x}$	(SD) Range	n	$\bar{x}$	(SD) Range	n
Rectal temperature (C)						
0–20	39.4	(0.8) 38.4–40.5	6	38.9	(0.8) 38.3–39.4	2
21–40	39.1	(0.7) 37.8–40.7	39	37.6	(0.9) 35.9–39.2	17
41–60	39.1	(0.7) 37.8–40.3	36	37.4	(1.1) 35.6–39.5	17
61–80	38.5	(0.9) 36.8–40.1	27	37.1	(0.6) 35.8–37.8	8
>80	38.3	(0.8) 37.0–39.5	16	36.7	(0.7) 36.0–37.4	3
Total	38.9	(0.8) 36.8–40.7	124	37.4	(1.0) 35.6–39.5	47
Breaths/min						
0–20	27	(9) 16–44	7	16	(—) —	1
21–40	28	(18) 7–82	43	22	(10) 10–48	16
41–60	18	(9) 7–44	37	13	(5) 6–24	19
61–80	17	(9) 6–32	26	14	(5) 8–22	8
>80	18	(11) 3–46	15	11	(8) 4–20	3
Total	22	(14) 3–82	128	16	(8) 4–48	47
Heart beats/min						
0–20	126	(5) 120–132	5	120	(—) —	1
21–40	129	(15) 98–160	37	117	(12) 98–142	16
41–60	121	(23) 64–164	33	110	(14) 80–136	18
61–80	120	(23) 72–180	21	101	(8) 88–112	7
>80	118	(18) 72–144	14	90	(10) 80–100	3
Total	123	(20) 64–180	110	110	(14) 80–142	45

to 60 min ($\bar{x}$ = 37.4, SD = 1.1) after the initial injection at Churchill (T = 48, $P >$ 0.05). After these periods, there were no significant differences.

In both the Beaufort Sea and Churchill, breathing rates and respiration rates of bears given multiple injections were significantly higher than bears given single injections until 41 to 60 min after initial injection (Beaufort: $\bar{x}$ = 18 br/min, SD = 9, T = 422, $P >$ 0.05; $\bar{x}$ = 121 bt/min, SD = 23, T = 317.5, $P >$ 0.05; Churchill: $\bar{x}$ = 13 br/min, SD = 5, T = 66, $P >$ 0.05; $\bar{x}$ = 110 bt/min, SD = 14, T = 51.5, $P >$

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TABLE 6. Physiological measurements taken from polar bear cubs (COY) given single injections of Telazol.

	Beaufort Sea						Churchill					
	COY			Yearling			COY			Yearling		
	$\bar{x}$	(SD) Range	n	$\bar{x}$	(SD) Range	n	$\bar{x}$	(SD) Range	n	$\bar{x}$	(SD) Range	n
Rectal temp. (C)	38.0	(0.9) 36.8–40.0	25	38.5	(0.7) 36.5–39.4	26	37.2	(0.9) 35.7–38.7	14	37.1	(1.1) 35.7–38.7	5
Breaths/ min	28	(9) 15–42	21	20	(15) 8–76	25	18	(7) 10–32	11	14	(5) 9–22	5
Heart beats/ min	144	(20) 120–188	14	125	(12) 96–142	20	127	(10) 114–144	9	119	(16) 102–140	4

0.05). There was no significant difference in rectal temperature between COY's immobilized in the Beaufort Sea and Churchill (Table 6, Kruskal-Wallis $Z = 1.89$, $P > 0.05$), but yearlings in the Beaufort Sea had significantly higher rectal temperatures than did those at Churchill (Kruskal-Wallis $Z = 2.82$, $P < 0.05$). There were no significant differences in respiration or heart rates between COY's or yearlings in the Beaufort Sea and Churchill (Table 6, Kruskal-Wallis $Z = 2.54$, $P > 0.05$; $Z = 1.08$, $P > 0.05$, respectively).

Miscellaneous observations

Three bears in the Beaufort Sea and one bear at Churchill given single injections experienced light body tremors that continued for several minutes. The maximum dosage given to these bears was 11.9 mg/kg. Two bears in the Beaufort Sea defecated approximately 35 min after single injections were administered. One bear that received a dosage of 12.3 mg/kg by multiple injections in the Beaufort Sea vomited 18 min after the initial injection. This bear's maximum body temperature was 39.4 C. It was feeding on a seal when first sighted, minutes before capture. In these bears there was no apparent relationship between dosage or body temperature and the occurrence of these behaviors. None of the bears had convulsions or required artificial respiration.

Responses to heavy dosages

As a result of overestimating the weights of polar bears from the air, seven bears received single injection dosages of Telazol ranging from 11 to 16 mg/kg. Eleven bears received multiple injections of 15 to 22 mg/kg. All these bears recovered normally without detectable detrimental effects.

DISCUSSION

The mean dosage required to immobilize polar bears with a single injection in the Beaufort Sea during the spring and at Churchill during the autumn were statistically different, although the frequency distributions of dosages were equivalent (Table 1). These values are so close they do not influence the estimation of dosages for bears in the field. The mean dosage used at Churchill in the autumn was almost identical to that reported by Stirling et al. (1985) for polar bears in the Churchill area during the summer (8.06 mg/kg, SD = 2.96). All these values are >50% higher than the dosage of 5.3 mg/kg (SD = 1.2) reported by Haigh et al. (1985). However, their mean dosage, which is near the lower end of the range given in Table 1, did not provide sufficient analgesia for ear-tagging or lip-tattooing. While these lower dosages are adequate to immobilize polar bears, dosages of 8 to 8.5 mg/kg are usually necessary to achieve full immobilization with satisfactory analgesia after a single injection.

Single injection dosages were higher for smaller polar bears in both the Churchill and Beaufort Sea areas (Fig. 1). In part, this probably occurs because the metabolic rate of juvenile mammals, including carnivores, is approximately double that of

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adults (Brody, 1945; Innes et al., 1986). The placement of the dart also has a significant effect on the efficacy of an injection (Lee et al., 1981). A dart that penetrates perpendicularly into the muscle is more effective than one which enters at an angle or lodges in fat, bone or cartilage. In our experience, the most effective areas in which to place darts are the base of the neck, upper shoulder and upper mid-back because the muscle is highly vascularized (Øritsland, 1970) and there is a minimum of subcutaneous fat to penetrate. Small bears are fast and agile, and more difficult to dart accurately from a helicopter.

Parke Davis (1982) recommends using large enough initial dosages of Telazol to ensure complete immobilization with a single injection. This is because tiletamine HCl and zolazepam HCl are metabolized at different rates and it is difficult to gauge the amount of drug required for supplemental injections. Dogs and cats (Parke Davis, 1982), and apparently polar bears, have a high tolerance for heavier dosages than required for full anesthesia. Consequently, we tended to use slightly higher amounts of Telazol in darts prepared for subadult bears in order to maximize the probability of immobilization on one dart and to avoid the stress of further chasing them to place a second dart.

In contrast, maximum dosages given to large bears were limited by the amount that could be put in a 10 ml dart. This limitation was offset by the fact that large polar bears are relatively slow-moving targets on which it is easy to place a dart accurately, thereby ensuring the maximum effect of the drug injected.

Several bears received dosages two to three times greater than the mean. In some cases this happened because their weights were overestimated from the air. Others were not immobilized by the first dart, probably because poor dart placement resulted in delayed absorption of the drug. There were no indications that these heavy dosages had any detrimental effect. None of the bears had convulsions such as are common with Sernylan or required artificial respiration which is a regular occurrence when polar bears are heavily drugged with either Sernylan or a combination of ketamine HCl and Rompun.

The times to first ataxia, sternal recumbency and first recovery of polar bears immobilized with a single injection were the same in both the Beaufort Sea during spring and Churchill during autumn (Table 1). The same was true for multiple injections. However, there were unexpected differences in the physiological responses of the bears immobilized in different seasons (Table 4).

The mean rectal temperatures of bears we immobilized during the autumn at Churchill in 1986 were similar to those reported from the same area and season by Haigh et al. (1985), and close to the mean body temperature of 37.1 C, SD = 0.2 for a resting polar bear (Hurst et al., 1982). Rectal temperatures of bears immobilized in the Beaufort Sea during the spring were similar to those reported from Churchill during the summer (Stirling et al., 1985), but both of these were significantly higher than for bears immobilized near Churchill in the autumn (Tables 4, 5). Like rectal temperatures, respiration and heart rates of polar bears immobilized in the Beaufort Sea during the spring and at Churchill during the summer were higher than at Churchill in the autumn. Mean breathing rates for both the spring and autumn were similar to the rate of 10 to 20 br/min for a moderately active bear (Best et al., 1981). Mean heart rates for bears in the Beaufort Sea in the spring and Churchill in the autumn were notably higher than the 33 bt/min reported for non-drugged sleeping bears, and were comparable to the 148 bt/min of exercising bears (Øritsland et al., 1977).

It is not surprising that polar bears immobilized in Hudson Bay during summer have high body temperatures after being chased with a helicopter. The air temperatures are hot for polar bears (15 to 25 C) and they have maximum deposits of subcutaneous fat during this period, a combination which contributes to overheating.

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However, it is less clear why polar bears in the Beaufort Sea have similarly high body temperatures in the spring when they have the least amount of subcutaneous fat in their annual cycle, and the mean air temperature is −14 C. This response was clear in yearling bears, subadults and adults.

Polar bears on the coast of western Hudson Bay during the open water season survive by remaining relatively inactive and by metabolizing their stored subcutaneous fat. Ramsay (1986) showed that the ratio of urea to creatinine in the blood of polar bears declined significantly between the summer and the autumn, by which time it was similar to that of hibernating black bears (Nelson et al., 1983). Possibly, bears in this slowed physiological condition are less susceptible to overheating caused by the stress of being captured and handled. In contrast, bears that have just left the sea ice (where they could hunt seals) at breakup in summer are probably in a physiological condition similar to that of actively hunting polar bears in the Beaufort Sea in the spring. This may explain why the body temperatures of these two groups of bears, captured under such different environmental conditions, were similar to each other but significantly different from those of animals captured at Churchill during the autumn.

Polar bears may be able to thermoregulate while immobilized with Telazol. Polar bears that became overheated as a result of being chased by a helicopter and immobilized with Telazol often had higher than normal body temperatures, occasionally ≥40 C. These bears also had accelerated heart and breathing rates which functioned to dissipate heat, then slowed down as body temperature returned to normal (Table 5). In contrast, overheated polar bears immobilized with ketamine HCl and Rompun have depressed heart and respiration rates. After yohimbine is administered to counteract the Rompun, the heart and respiration rates increase quickly and body temperature returns to normal (Ramsay et al., 1985).

None of the 319 polar bears drugged during this study died as a result of being handled. From 1983 to the present, biologists associated with the Canadian Wildlife Service Polar Bear Project (5320 122 Street, Edmonton, Alberta, Canada T6H 3S5) have immobilized 1,306 polar bears with Telazol. Of these, the only known mortality was an adult female that lay at the edge of a lake with her nose in the water and drowned before she could be reached. This mortality rate of 0.08% contrasts markedly with an average mortality of 1.3% (40/3,176) with other drugs. In comparison, the frequency of handling deaths with Sernylan and Sparine® (promazine HCl) was 1.1% (19/1,729), 1.4% (20/1,418) with ketamine HCl and Rompun, and 3.4% (1/29) with other miscellaneous drugs.

We conclude that Telazol is an excellent drug for the immobilization of polar bears. It acts rapidly and recovery is faster than with other drugs for which there is no antagonist. The reactions of the bears can be reliably and easily interpreted from a safe distance before the animal is approached. There is a wide tolerance to heavy dosages, and bears are able to thermoregulate while immobilized. The mortality rate due to handling is lower than with any other drug used to date on these animals.

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