MOOSE POPULATION RESEARCH AND MANAGEMENT STUDIES IN YUKON

IMMOBILIZATION OF MOOSE USING COMBINATIONS OF CARFENTANIL, FENTANYL AND XYLAZINE, SOUTHWEST YUKON, 1983.

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IMMOBILIZATION OF MOOSE USING COMBINATIONS OF CARFENTANIL, FENTANYL AND XYLAZINE, SOUTHWEST YUKON 1983.

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Abstract

Sixty-three female moose were immobilized using 1 of 4 combinations of carfentanil and xylazine with and without fentanyl citrate. One to 6 mg of diprenorphine and 140 - 220 mg of naloxone were used as the primary narcotic antagonists. A combination of 2.5 mg carfentanil, 30 mg fentanyl and 40 mg xylazine resulted in the shortest induction time but no significant difference was observed between animals grouped according to the drug combination received. Moose which received fentanyl appeared to have smoother induction periods and had increased muscle relaxation during anesthesia. Mean induction time of all moose for which complete immobilization records are available (n=60) was 10.7 minutes. Moose in which the dart injection site was a large muscle mass had a significantly shorter induction time (8.1 min.) than those darted in other body sites (18.6 min.). Three mortalities occurred within 2 months of immobilization. Although no necropsies were performed, capture related etiology was suspected as induction times were prolonged. Immobilization of cows in late pregnancy did not effect prenatal calf survivorship.

Introduction

Narcotic drugs have been used extensively in North America for the immobilization of moose, of which etorphine hydrochloride (M99, Cyanamid, Montreal, Quebec) has been the most popular (Gasaway et al. 1978, Lynch 1981, Franzmann 1982). A doubling in cost in recent years and problems associated with the large volumes required to immobilize moose (Franzmann et al. 1984b) have made the use of this drug less attractive. Carfentanil (Janssen Pharmaceutica, Mississauga, Ontario) has recently been used as an effective substitute (Haigh et al. 1982, Franzmann et al. 1984b, Meuleman et al. 1984, Seal et al. 1985, Smitt and Dalton 1985). Fentanyl citrate (Janssen Pharmaceutica, Mississauga, Ontario) has also recently been successfully used to immobilize moose when administered in concentrations of 30-40 mg/ml (Haigh et al. 1977). The characteristics of anesthesia produced by carfentanil and fentanyl are similar to those of etorphine narcosis. The effects of both carfentanil and fentanyl are blocked by administration of appropriate narcotic antagonists such as naloxone hydrochloride (E.I. du Pont de Nemoirs, Maryland) and diprenorphine (M50:50; Cyanamid, Montreal, Quebec).

Cow moose were immobilized and radio-collared in the southwest Yukon during March 1983 as part of a study to determine productivity and causes and rates of mortality (Larsen et al. 1987). This paper presents observations made during the immobilization and recovery of these moose.

Methods

Sixty-three cow moose (≥ 2 yrs.) were darted from a helicopter using 3 ml Cap-chur darts with 4 cm barbed needles fired from a Palmer extra-long range rifle (Palmer Chemical and Equipment Co., Douglasville, Georgia) using low range (green wad) charges. Ten mg/ml stock solutions of carfentanil were diluted to 2 mg/ml concentrations for ease of handling and more precise measurement. Fentanyl was used in a 30 mg/ml concentration and xylazine (Rompun; Haver-Lockhart, Mississauga, Ontario) in a 100 mg/ml concentration.

Four drug combinations were used for initial injection: a) 5 moose received an initial injection of 2.5 mg carfentanil and 40 mg xylazine (Group A); b) 20 received 2.0 mg carfentanil, 30 mg fentanyl and 40 mg xylazine (Group B); 33 received 2.5 mg carfentanil, 30 mg fentanyl and 40 mg xylazine (Group C); and 2 received 2.0 mg carfentanil and 40 mg fentanyl (Group D). Three additional cows were excluded from our analysis due to incomplete records (Appendix 1). Target areas for dart injection were the heavy muscle masses of the shoulder, proximal hind legs and dorsal abaxial pelvic region. Subjects which were not recumbent or showing signs of ataxia within 12 minutes of injection were given a second doze of immobilizing drugs.

The eyes of the immobilized moose were covered to protect the cornea from trauma and drying and to prevent light damage to the retina. An incisor tooth was extracted and age determined from tooth cementum annuli (Sergeant and Pimlott 1959). Blood samples were collected from either the jugular or cephalic veins and the reproductive tract was palpated rectally for pregnancy diagnosis (Greer and Hawkins 1967). Packed cell volume was determined in the field by centrifuging blood at <8000 r.p.m. for 5 minutes. Heart rate and rhythm, rectal temperature, and respiratory rate were monitored throughout anesthesia (Appendix 1).

One hundred and forty to 220 mg of naloxone was administered as the primary narcotic antagonist. One half the moose received the entire dose of naloxone subcutaneously and the other half received 50% of the dose subcutaneously and the remainder intravenously. One to 6 mg of diprenorphine was also administered subcutaneously. Moose were observed until standing and again within 48 hours. Radio collar signals were used to locate moose daily during the calving period and to determine birth rates.

Immobilization induction time (IIT) was defined as the amount of time between injection and recumbancy. IIT of moose receiving more than one injection of immobilizing drugs was measured from the time of initial dart injection. Analysis of variance (ANOVA) was used to test for differences in IIT between drug doze groups and animals grouped according to injection sites. Paired comparison t-test was used to test for differences between mean fecundity and birth rates.

Results and Discussion

The mean IIT of all moose for which complete immobilization records were available (n=60) was 10.7 minutes. Mean IIT was significantly lower ($P<0.001$) for moose injected in preferred large muscle sites (8.1 min.) compared to moose injected in other body regions (18.6 min.) (Table 1). Forty-six moose received the first dart in preferred injection sites of which 3 required a second injection to induce immobility. Seven of the 14 moose in which the initial injection was not in a preferred site required a second drug injection. This relationship between injection site and IIT was previously reported by Haigh et al. (1982) and shows that drug absorbtion occurs more rapidly in large muscles.

No significant difference ($P>0.01$) in IIT was found for moose according to the 3 major drug combinations (groups A, B and C) (Table 1); however, a combination of 2.5 mg carfentanil, 30 mg fentanyl and 40 mg xylazine resulted in the shortest time. Induction appeared smoother in moose that received fentanyl. As well, muscle relaxation during anesthesia, although poor, was increased in comparison to moose immobilized with only carfentanil and xylazine.

The level of anesthesia using all drug combinations was adequate to collect the samples and perform the examinations required. Accurate pregnancy diagnosis was not compromised by the firm muscle tone maintained by moose under examination; however the detection of multiple fetuses was difficult in some animals. Two of the animals fell into lateral recumbency, and the rest remained in sternal recumbency and frequently the head was held erect during sampling. Immobilized moose retained laryngeal reflexes and the eyes were usually open with the pupils at least partially responsive to light. Sampling and examination elicited little or no response.

Capture related etiology was suspected in 3 cows (5%); 2 which died within 2 weeks and the third after 2 months of immobilization (Appendix 1). All 3 cows had prolonged IIT (16-28 minutes) and 1 of the cows had a respiratory rate twice the sample average (Table 2). One of the cows had the lowest packed cell volume in the sample, while the other 2 had above average levels. Body temperatures were below the critical level (40.2^{o}C) for moose (Franzmann et al. 1984a) and the cardiac rhythm and rate was similar to the sample mean in 2 of the cows. No cardiac data was collected for the third cow.

Long IIT may result in greater muscle exertion which contributes to the total period of stress to which the animal is exposed. It is the authors opinion that prolonged IIT increases the risks of complications to immobilization procedures. However, no direct relationship is apparent between vital signs during immobilization, IIT or the risk of post-anesthetic complications (Table 2.).

The moose in this study were subjectively assessed to be in good body condition based on visual and physical examinations. However, the mean packed cell volume (PCV) was lower (41.6%, SD $\pm$ 5.4) than levels reported for pregnant and non-pregnant moose (49.1% and 47.9% respectively) in good condition in Alaska (Franzmann and LeResche 1978). According to their classification system, female moose in March with a PCV of 41.6% were in fair to poor body condition.

The influence of sampling techniques on PCV, including the effects of immobilization, and the variation of PCV according to geographical location of the study group have not been determined. However, elevation of PCV in humans occurs when moving from a low to a higher altitude (Lawrence and Berlin 1951)

and although previously accepted that anxiety elevates PCV measurements, this result is now being questioned (Mathew and Wilson 1986). Excitement and exercise of the horse has been related to elevation of the PCVs (Schalm et al. 1975). Similar physiological and environmental variables may be responsible for the changes in PCV of moose regardless of body condition.

Following injection of the narcotic antagonists, recovery to a standing position took from 1 to 10 minutes (x = 3.49 min.; SD $\pm$ 1.62). Residual ataxia was observed in animals immediately after standing. Immobilization of adult cow moose in March did not effect prenatal calf survivorship. Fecundity or mean number of calves predicted to be born (124 calves/100 cows) was not significantly different (t-test, $P = 0.18$) from the number of calves observed to be born (112 calves/100 cows) (Appendix 1). Furthermore, Larsen and Gauthier (1986) reported that birth rates were not significantly different between immobilized and non-immobilized cows in the same study area.

Table 1. Immobilization induction time (IIT) of moose grouped according to drug dose and injection site.

Drug Dose[a.]	Good Injection Site (Min.) X	SD	(N)	Poor Injection Site (Min.) X	SD	(N)	All Animals (Min.) X	SD	(N)
A	13.4	3.6	(5)	-	-	-	13.4	3.6	(5)
B	8.5	4.9	(15)	18.8	5.7	(5)	11.0	6.8	(20)
C	7.2	4.1	(26)	19.9	5.8	(7)	9.9	6.9	(33)
D	-	-	-	14.0	-	(2)	14.0	-	(2)
Total	8.1	4.9	(46)	18.6	6.3	(14)	10.7	6.7	(60)

a. Drug combinations were

A = Carfentanil 2.5 mg + Xylazine 40 mg
B = Carfentanil 2.0 mg + Xylazine 40 mg + Fentanyl 30 mg
C = Carfentanil 2.5 mg + Xylazine 40 mg + Fentanyl 30 mg
D = Carfentanil 2.0 mg + Xylazine 40 mg

Table 2. Vital signs and packed cell volume (PCV) of moose grouped according to immobilization induction time (IIT).

IIT (min)	Sample Size (N)	Rectal Temperature (Mean) (C)	Heart Rate (Mean) (/min)	Respiratory Rate (Mean) (/min)	PCV (Mean) (%)
< 5	15	38.9	61.9	16.3	43.7
5 - 10	18	38.9	64.9	13.8	40.0
11 - 20	16	39.0	61.9	16.1	42.2
Over 20	5	39.7	57.7	14.4	39.4
Total Mean	54	39.0	63.0	15.6	41.6

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Appendix I. Adult cow moose immobilized in the southwest Yukon, March 1983

Sequence #	Moose ID	Carfentanil (mg)	Fentanyl citrate	Xylazine (mg)	Naloxone (mg) IV	Naloxone (mg) S.Q.	Diprenorphine (mg) S.Q.	IIT (min)	Rectal Temp (°C)	Heart rate beats/min	Respiratory rate breaths/min	P.C.V. (%)	Fecundity	Birth	Inject. Site[a]
1	113	2.0		40		140	3	7	NA	NA	NA	NA	1	1	P
2	114	2.0		40		160	3	21	40.0	56	16	32	2	1	P
3	115	2.5		40		150	3	16	NA	60	10	33	1	1	G
4	116	2.5		40		180	3	7	39.7	44	8	38	0	0	G
5	117	2.5		40		140	3	15	38.6	62	6	42	1	1	G
6	118	2.5		40		160	3	12	NA	64	18	46	0	0	G
7	119	2.5		40		160	3	17	39.8	66	14	47	1	unk.	G
8	120	2.0	30	40		160	3	8	38.5	80	6	36	1	1	G
9	121	2.0	30	40		160	3	8	38.2	62	18	38	1	unk.	G
10	122	2.0	30	40		160	3	NA	40.2	90	14	41	2	1	G
11	123	2.0	30	40		160	3	7	NA	60	20	41	1	unk.	G
12	124	2.0	30	40		160	3	10	37.6	76	20	30	1	1	G
13	125	2.0	30	40		180	1.5	12	39.6	68	7	44	1	1	G
14	126	2.0	30	40		160	3	7	38.4	104	18	38	1	1	G
15	336	2.0	30	40		160	3	7	40.2	60	6	30	2	2	G
16	128	2.0	30	40		160	3	21	39.0	63	6	44	2	1	P
17	129	2.0	30	40		160	3	2	39.1	64	22	36	1	1	G
18	130	2.0	30	40		180	1	5	38.8	74	16	42	1	2	G
19	131	2.0	30	40		220	6	16	39.0	62	32	43	1	NA	P[1]
20	132	2.0	30	40		180	3	24	39.8	63	14	43	1	unk.	G
21	133	2.0	30	40		160	3	12	NA	NA	NA	41	2	1	G
22	134	2.0	30	40		160	3	4	38.5	52	7	42	1	1	G
23	135	2.0	30	40		180	4	8	39.7	52	24	33	1	unk.	G
24	136	2.0	30	40		160	3	6	NA	60	5	40	1	1	G
25	137	2.0	30	40		160	3	7	39.3	64	10	45	2	2	G
26	140	2.0	30	40		160	3	13	38.0	68	18	33	2	unk.	P
27	141	2.0	30	40		220	4	29	NA	NA	NA	36	1	unk.	P
28	142	2.0	30	40		160	3	15	40.2	54	15	39	1	unk.	P
29	143	2.5	30	40		180	3	20	38.4	58	24	35	2	1	G
30	144	2.5	30	40		180	3	12	40.2	74	22	48	2	2	G
31	145	2.5	30	40	90	90	3	17	39.1	62	24	44	1	1	G

Appendix I (cont'd...)

Sequence #	Moose ID	Carfentanil (mg)	Fentanyl citrate	Xylazine (mg)	Naloxone (mg) IV	Naloxone (mg) S.Q.	Diprenorphine (mg) S.Q.	IIT (min)	Rectal Temp (°C)	Heart rate beats/min	Respiratory rate breaths/min	P.C.V. (%)	Fecundity	Birth	Inject. Site[a]
32	146	2.5	30	40	90	90	3	6	38.7	54	16	42	1	1	G
33	-	2.5	30	40	90	90	3	5	NA	42	24	40	NA	NA	G
34	147	2.5	30	40	90	90	3	11	38.6	52	18	46	3	1	P
35	148	2.5	30	40	90	90	3	6	38.4	56	6	41	1	1	G
36	-	2.5	30	40	90	90	3	7	NA	NA	NA	NA	NA	NA	G
37	149	2.5	30	40	90	90	3	10	38.5	66	12	44	1	2	G
38	150	2.5	30	40	90	90	3	9	37.9	62	27	44	1	2	G
39	151	2.5	30	40	90	90	3	9	39.3	78	18	41	1	1	G
40	152	2.5	30	40	90	90	3	4	38.5	60	26	47	1	2	G
41	153	2.5	30	40	90	90	3	NA	38.8	90	30	43	2	1	G
42	154	2.5	30	40	90	90	3	5	NA	54	20	NA	2	1	G
43	155	2.5	30	40	90	90	3	12	38.2	64	12	41	1	2	G
44	156	2.5	30	40	90	90	3	28	39.2	58	18	45	2	1	P
45	157	2.5	30	40	90	90	3	28	39.5	NA	NA	32	1	NA	P[2]
46	158	2.5	30	40	90	90	3	8	39.0	70	16	41	1	unk.	G
47	159	2.5	30	40	90	90	3	5	39.4	58	16	46	1	2	G
48	160	2.5	30	40	90	90	3	15	37.2	54	14	43	1	1	P
49	161	2.5	30	40	90	90	3	35	40.2	54	18	44	1	1	P[3]
50	-	2.5	30	40	90	90	3	5	NA	NA	NA	NA	NA	NA	G
51	162	2.5	30	40	90	90	3	19	39.2	54	14	42	2	1	P
52	163	2.5	30	40	90	90	3	3	37.2	56	8	49	2	1	G
53	164	2.5	30	40	90	90	3	4	37.8	52	16	45	0	0	G
54	165	2.5	30	40	90	90	3	5	38.0	52	12	45	1	1	G
55	166	2.5	30	40	90	90	3	4	38.0	72	15	44	1	1	G
56	167	2.5	30	40	90	90	3	6	38.2	69	14	48	1	1	G
57	22	2.5	30	40	90	90	3	20	39.4	69	12	49	NA	NA	P[4]
58	334	2.5	30	40	90	90	3	18	39.1	64	16	44	1	1	P
59	169	2.5	30	40	90	90	3	4	38.2	58	16	40	1	1	G
60	170	2.5	30	40	90	90	3	3	40.0	60	12	41	0	0	G
61	171	2.5	30	40	90	90	3	9	38.8	54	14	39	1	1	G

Appendix I (cont´d...)

Sequence #	Moose ID	Carfentanil (mg)	Fentanyl citrate	Xylazine (mg)	Naloxone (mg) IV	Naloxone (mg) S.Q.	Diprenorphine (mg) S.Q.	IIT (min)	Rectal Temp (°C)	Heart rate beats/min	Respiratory rate breaths/min	P.C.V. (%)	Fecundity	Birth	Inject. Site[a]
62	172	2.5	30	40	90	90	3	5	40.6	56	10	49	2	2	G
63	173	2.5	30	40	90	90	3	4	40.6	82	15	NA	1	1	G

[a]. Injection sites of initial dart were grouped as (1) **good** - shoulder, proximal hind legs and dorsal abaxial pelvic region, or (2) **poor** - all other areas.

[1] - dead 15 days after immobilization

[2] - found dead 54 days after immobilization

[3] - initial dart did not fully discharge

[4] - dead 6 days after immobilization