CARFENTANIL AND XYLAZINE FOR IMMOBILIZATION OF MOOSE (ALCES ALCES) ON ISLE ROYALE

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CARFENTANIL AND XYLAZINE FOR IMMOBILIZATION OF MOOSE (ALCES ALCES) ON ISLE ROYALE

U. S. Seal,1 S. M. Schmitt,2 and R. O. Peterson3

ABSTRACT: Twenty-one moose were captured on Isle Royale between 28 May and 2 June 1984 at licks on the western end of the island. The animals were darted, at ranges of 10 to 35 m, with 3-cc dart syringes containing 3 or 4 mg of carfentanil and 100 or 175 mg of xylazine. Three animals were drugged with carfentanil alone. Immobilization time ranged from 2.5 to 6 min. There was no excitement phase evident in 18 of the animals and they rarely moved more than 30 m after darting. Reversal was begun at 30 to 90 min after darting using naloxone and diprenorphine given intramuscularly (i.m.) and intravenously (i.v.). Recovery time varied from 10 min to 3 hr with the longer times occurring at the higher doses of immobilizing drugs. Two animals died within 30 hr, one as the result of aspiration of rumen contents and the other was unable to get on its feet and was euthanized. Analysis of blood samples from the 18 moose immobilized with the drug combination yielded hemoglobin values of 13.1 ± 0.3 g/dl, hematocrit: 37.6 ± 0.7%, red blood cells: 5.46 ± 0.1 million/µl, leucocytes: 6.1 ± 0.4 thousand/µl, and serum urea nitrogen: 29.3 ± 1.6 mg/dl. Our experience indicated that quiet, undisturbed moose can be immobilized with 3 mg carfentanil and 100 mg or less of xylazine.

INTRODUCTION

Carfentanil is a powerful opioid agent of the fentanyl family whose use has been reported for the immobilization of 19 species of ungulates in South Africa (De Vos, 1978), for 61 elk (Cervus elaphus) and three moose in Utah (Meuleman et al., 1984), and for polar bear (Ursus maritimus) (Haigh et al., 1983). This report presents our experience with the use of carfentanil alone and in combination with xylazine for the capture of 21 free-ranging moose on Isle Royale National Park, located in northwestern Lake Superior.

MATERIALS AND METHODS

The carfentanil (Janssen Pharmaceutical, New Brunswick, New Jersey 08903, USA) was supplied in ampules containing 10 mg which was diluted to 3 mg/ml to provide a convenient concentration to use in 3 cc Palmer-type Cap-Chur darts. Xylazine, 100 mg/ml (Rompun, Bayvet, Shawnee, Kansas 66201, USA) and diazepam, 5 mg/ml (Valium, Hoffmann-La Roche Inc., Nutley, New Jersey 07110, USA) were used as tranquilizers and muscle relaxants. Benzathine penicillin, 300,000 units/ml (Flo-cillin, Bristol Laboratories, Syracuse, New York 13201, USA) was used as an antibiotic and doxapram hydrochloride, 20 mg/ml (Dopram, A. H. Robbins Co., Richmond, Virginia 23220, USA) was used as a respiratory stimulant. Diprenorphine, 2 mg/ml (M 50/50, Lemmon Company, Sellersville, Pennsylvania 18960, USA) and naloxone, 20 mg/ml, (Dupont Pharmaceuticals, Garden City, New Jersey 11530, USA) were used as antagonists. Naloxone hydrochloride, 0.4 mg/ml (Narcan, Endo Laboratories, Manati, Puerto Rico 00701, USA) was carried as an antagonist to carfentanil for use in case of accidental human injection (Parker and Haigh, 1982).

The drugs were delivered in darts using a Palmer long range Cap-Chur gun (green charges) to free-ranging animals as they came into a lick. The shooters sat quietly at an edge of the lick without effort at concealment. The animals entered the lick area from different approaches at distances of 20 to 100 m. They usually moved to within 30 m of the shooter without concern for his presence. When darted the animals usually acted startled, looked around, moved a few meters, and frequently resumed feeding. After 60–90 sec about half of the animals moved out of the lick onto solid ground and remained quietly until they fell. Three animals moved away at a trot into the woods after being darted. Two were located within 30 m of
TABLE 1. Response of moose to two doses of carfentanil and xylazine.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Dose 1*</th>
<th>Dose 2*</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>6</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>5.3†</td>
<td>14.4†</td>
<td>6.8</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>38.8</td>
<td>0.1</td>
<td>38.5</td>
</tr>
<tr>
<td>Respiration (/min)</td>
<td>16.7</td>
<td>2.8</td>
<td>21.2</td>
</tr>
<tr>
<td>Heart rate (/min)</td>
<td>46.2</td>
<td>8.5</td>
<td>51.6</td>
</tr>
<tr>
<td>Down time (min)</td>
<td>4.2</td>
<td>0.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Up time (min)</td>
<td>95.4</td>
<td>30.5</td>
<td>38.9</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>13.2</td>
<td>0.2</td>
<td>13.0</td>
</tr>
<tr>
<td>RBC (10^6/µl)</td>
<td>5.62</td>
<td>0.14</td>
<td>5.39</td>
</tr>
<tr>
<td>Hematocrit (%)</td>
<td>37.5</td>
<td>0.6</td>
<td>37.6</td>
</tr>
<tr>
<td>WBC (10^6/µl)</td>
<td>5.1</td>
<td>0.5</td>
<td>6.6</td>
</tr>
<tr>
<td>Urea N (mg/dl)</td>
<td>27.0</td>
<td>2.0</td>
<td>30.5</td>
</tr>
</tbody>
</table>

* Dose 1 was 4 mg carfentanil and 175 mg xylazine.
† Dose 2 was 3 mg carfentanil and 100 mg xylazine: Data on three animals immobilized with carfentanil alone are given in the text.
‡ All values are mean and standard error of the mean.

The lick, but one moose, which had received the high dose, moved about 200 m into a swamp and required 90 min to locate. It was found in a dorsal recumbent position. Occasionally, about 90 sec after darting, we forced an animal to move from the lick onto the shore. Several animals went down in the shallow water, but it was possible to prop their heads and complete our procedures. After reversal they were hazed onto the shore.

All animals were given 6 to 9 million units of long-acting penicillin intramuscularly prior to reversal. The movement and location of all animals with radio-collars were checked at least twice daily to monitor the course of recovery and possible difficulties. Respiration and heart rate were counted shortly after the animal was immobilized and a rectal temperature taken. Serial temperatures taken on some of the animals indicated that the initial temperature was the highest. None of the animals showed evidence of significant hypo- or hyperthermia. Ambient temperature ranged from 0 to 18 °C.

Ages were estimated from inspection of incisor wear. The collected animals ranged in age from 1 to 15+ yr.

Blood samples for hematology, serum chemistries, and serology were collected from the jugular vein shortly after the animals were immobilized. The samples were cooled and serum separated within 36 hr. The hematology samples, collected into EDTA, were analyzed 3 to 7 days after collection (Seal et al., 1983). This delay precluded doing differential white counts, but did not affect routine hematology assays. The samples did not have detectable clots. Statistical analyses included one- and two-way ANOVA and Pearson correlation coefficients.

RESULTS AND DISCUSSION

Immobilization

The first six animals were darted with a mixture of 4 mg carfentanil and 175 mg of xylazine (Table 1, Dose 1). The next 12 animals were darted with a mixture of 3 mg carfentanil and 100 mg xylazine (Table 1, Dose 2). The last three animals were darted with 3 mg carfentanil only. The mean immobilization time for all three doses was 4.1 min. All animals darted were immobilized and located. Mean body temperature was 38.6 °C shortly after immobilization and was stable during the handling period. Respiratory rates ranged from 12 to 32 per min in 20 animals with one yearling male dropping to six per min at 15 min post darting. This animal responded to 80 mg of doxapram i.v. with an increase in respiratory rate to 15 per min.

The three animals immobilized with carfentanil alone were hypertonic and had obvious muscle fasciculations. In two cases they had body temperatures of 39.4-40.0 °C reflecting the increased muscular activity. This hypertonicity was managed by...
i.v. injection of 10 mg of diazepam, but could be a problem in animals which were excited and active prior to immobilization and in warmer ambient temperatures.

Reversal and recovery were prolonged in the six animals immobilized with the high drug dose. The animals were given various combinations of naloxone (50 to 80 mg) and diprenorphine (4 to 8 mg) both intramuscularly and intravenously to initiate reversal. The moose held their heads up within 3 or 4 min, but took from 25 to 150 min to get on their feet. The animals were stimulated vigorously in an effort to assist arousal and were closely observed until they moved away. The 12 moose captured with the lower drug doses were on their feet within 10 to 45 min after administration of the antagonists. The three moose darted with 3 mg carfentanil alone were on their feet within 4 to 10 min after administration of either 6 mg of diprenorphine (2 animals) or 80 mg of naloxone. These results suggest that the prolonged depression with the drug combination was primarily a function of the xylazine used and that the dosage of this part of the mixture may need to be further reduced for immobilization of quiet moose which have not been chased.

Blood data

The hematological values were the same for the two groups of moose captured with the combination of carfentanil and xylazine (Table 1) and are very similar to data reported for etorphine-drugged or shot moose (Le Resche et al., 1974) in Alaska and Minnesota. The three animals captured with carfentanil alone, compared to the animals captured with the drug combination, had significantly higher values of hemoglobin (16.2 ± 0.2 g/dl, P < 0.01), red blood cells (6.90 ± 0.2 10^6/ml, P < 0.01), and hematocrit (45.3 ± 0.3%, P < 0.01) with no overlap of any values between the groups. These differences suggest that xylazine may be producing splenic relaxation and sequestration of red cells whereas carfentanil alone may be causing splenic contraction. The white blood cell counts were the same for all groups. Serum urea nitrogen values were the same for the three drug dosage groups (Table 1), indicating no measurable effect of the xylazine on urea in the 10–15 min interval between darting and collection of the blood sample (Mautz et al., 1980). The urea nitrogen levels are two- to four-fold higher than the fall and winter levels that have been reported for other moose, but are similar to those reported for June through August for Alaskan moose (Le Resche et al., 1974). Correlations between the physiological and blood data, from the 18 moose that received the drug combinations, indicated a significant negative correlation of body temperature and hematology values (hemoglobin r = −0.68, P < 0.005; hematocrit r = −0.72, P < 0.002; red blood cells r = −0.53, P < 0.04).

Morbidity and mortality

Regurgitation, difficulty in drug reversal, prolonged depression during reversal, possible drug “recycling,” and abnormal behavior for several days were the primary problems encountered. All animals showed increased salivation which was heaviest in the animals immobilized with carfentanil alone. Regurgitation occurred in all of the animals immobilized with the higher dose and in half of the animals immobilized with the lower dose of the carfentanil and xylazine.

Several moose that were captured with the high dose returned to the lick later in the day after release and paced for several hours without feeding or drinking. Two animals returned the next 2 days and paced back and forth across the lick for 60–90 min in the area where they were darted, ignoring the presence of several observers. This behavior was reduced in frequency and intensity in the animals given the lower drug dosage. This behavior is suggestive of carfentanil “recycling” as was noted for polar bears and black
bear cubs (*Ursus americanus*) (Haigh et al., 1983).

Necropsy of the two animals that died shortly after capture indicated that the first animal, a female, had aspirated rumen contents. A male was euthanized 30 hr after capture because he was unable to rise despite repeated efforts, administration of additional antagonists, and efforts at assistance. At necropsy, the male was found to be in overall poor body condition, to have very little body fat, and the remaining fat was yellow. Femur marrow fat content was 9% by ether extraction and 19% by dry weight. Fat reserves indicated that the animal was in poor condition. There were no rumen contents in the bronchi or lungs. There were no signs indicative of capture myopathy (Lewis et al., 1977).

Mortality-sensing radio-collars signalled the deaths of two other animals 11 and 16 days after capture and release. They probably died less than 1 wk post capture. The remains of the first were found head first in a 1 m hole. The other moose had been consumed by wolves so that a cause of death could not be established. Both had been captured with the low dose combination and did not have any unusual physiological or blood findings. The possibilities include foreign body pneumonia, narcotic recycling, predation, post capture myopathy, or a combination thereof. Other reports of moose captured with drugs have indicated about 10% losses of animals shortly after capture (Franzmann and Arneson, 1974; Lynch, 1981) but prolonged followup using radiotelemetry has been infrequent so that delayed mortality data are not usually available.

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**LITERATURE CITED**


