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CHEMICAL IMMOBILIZATION AND BLOOD ANALYSIS OF FERAL HORSES (*EQUUS CABALLUS*)

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ABSTRACT: Combinations of etorphine hydrochloride and xylazine hydrochloride in different dosages were tested for their efficacy as immobilizing agents on 16 recently captured feral mares in corrals. The results of these trials led to the utilization of a standard combination of 5.5 mg of etorphine hydrochloride, 150 mg of xylazine hydrochloride, and 3 mg of atropine sulfate in a 7-ml dart syringe for field capture. This combination was used, administered by dart gun from helicopters, to capture 87 free-ranging feral horses from about 80 bands. Five mares died at the time of capture and the remains of three other mares were found near the site of capture 4 mo later. Blood samples collected from each animal and analyzed for hematologic variables, concentrations of urea, and glucose yielded values comparable to domestic "hot-blooded horses." Serum cortisol concentrations (4.7 ± 0.4 μg/dl) were comparable to values from undisturbed captive animals. Approximately 48 min of helicopter time were required per horse captured. The cost per animal captured was $159 for helicopter time and $66.70 for drugs and darts.

INTRODUCTION

Free-ranging feral horses are captured commonly using helicopters to herd them into traps. This process results in capture of horses of mixed sexes and ages. Bands are disrupted and mixed, which makes it difficult to select single individuals from each band. A census project, requiring the placement of radio collars on mares from up to 100 different bands, would have required the capture by roundup of approximately 730 horses to selectively place the 100 collars. The cost and time required for this procedure prompted the present study involving the exploration of the feasibility of selective capture using drugs and helicopters. Samples of blood and physical data were collected also to allow evaluation of the condition of the animals in relation to data from captive feral and domestic horses.

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MATERIALS AND METHODS

The corral studies were conducted in the Palomino Valley Wild Horse and Burro Placement Center, Sparks, Nevada during December 1981 and February 1982. A total of 16 mares placed singly in a 30 × 30-m corral were darted using a Palmer Cap-Chur® gun (Palmer Chemical Co., Douglasville, Georgia 30134, USA) with a 7-ml dart containing the selected drugs. NCR-3 needles with barbs were used to ensure retention of the dart and full delivery of the drugs. Low power (green wad) charges were used in the dart gun in the corrals and in the field.

The drugs used were etorphine hydrochloride, 1 mg/ml (M99®, Lemmon Company, Rockville, Maryland 20850, USA), xylazine hydrochloride, 100 mg/ml (Rompun®, Haver-Lockhart, Bayvet Division, Cutter Laboratories Inc., Shawnee, Kansas 66201, USA), and atropine sulfate, 15 mg/ml (Med-Tech, Inc., Elwood, Kansas 66024, USA). The drugs were mixed in a single syringe. Atropine sulfate was included in the mixture to prevent the secondary atrioventricular block induced by xylazine hydrochloride (Muir et al., 1979). Reversal was accomplished with intravenous diprenorphine, 2 mg/ml (M50/50®, Lemmon Laboratories). All animals were given intramuscularly 1.5 million units of long-acting penicillin.

The free-ranging feral horses were captured in the Pah Rah Mustang Area and Pine Nut Mountains Wild Horse Herd Management Area in western Nevada during February 1982. Ambient temperatures ranged from −3 to +4 C. Animals were located and darted from three Bell helicopters, a 4763B-2, a 4763B-1 and a Saloy turbo. A band was located and an animal

thought to be a mare was selected and darted. The animal was observed from the air until signs of drug effects became evident. When the animal went down and stayed down for about 1 min, the helicopter was landed nearby and processing begun. Mares captured in the field were fitted with a radio collar, length and girth measured, respiration and heart rate counted, rectal temperature taken, and a blood sample collected for chemistry and hematology (Seal et al., 1977, 1978; Seal and Mech, 1983). The teeth were photographed and the age estimated. Antidote (diprenorphine) was administered and the animal observed until on its feet. Records were kept of induction time (min from darting until the animal went down and stayed down), total time down, and time for recovery after antidote administration. Statistics in the text are means and standard errors. Statistical comparisons were by 1-way ANOVA.

RESULTS

Corral

Dosages of etorphine hydrochloride from 4 to 6 mg in combination with 100 to 200 mg of xylazine hydrochloride were tested on 16 mares ranging in estimated age from 2 to 15 yr. Induction time for 13 animals was 10.5 ± 1.0, range 7.2 to 15.5 min. The induction time decreased with increase of either etorphine hydrochloride or xylazine hydrochloride. One animal was struck in the base of the tail and went down in less than 1 min, presumably because the drug was injected intravenously. Two mares darted with 4 mg etorphine hydrochloride and 200 mg xylazine hydrochloride did not respond.

The animals were startled by the injection but usually settled down and walked or jogged for several min. After 3–6 min, there was a subtle change in gait and some stumbling. After 6–7 min the response was reminiscent of the Straub-Herman effect with a stiff gait and rapid shortened paces. They banged into the sides of the corral and stumbled to their knees before going down. Once down, the front legs were in extensor rigidity and the rear legs exhibited a paddling motion.

Immobilized animals were hypertonic and had tremors and leg movements with the 100-mg doses of xylazine hydrochloride. Higher doses of xylazine hydrochloride reduced the excitement phase that became evident 6–7 min after administration of the drugs and produced better relaxation in the immobilized animal. All animals exhibited a tachycardia with heart rates greater than 120 per min. Respiration rates were near normal at 13.6 ± 1.3, range 5 to 20 min. Body temperatures were 40.2 ± 0.3, range 38.7 to 42.3 C, compared to the normal of 38 C for domestic horses.

Recovery after intravenous administration of diprenorphine, was 57.7 ± 4.3, range 30 to 95 sec. Recovery in one horse was delayed as a result of probable intramuscular injection. The sequence of recovery was an acceleration of respiration at about 30 sec, righting at about 50 sec, and rising to feet at 65 sec. The animals were on their feet, moving, and able to return to their group in another corral within a few min.

Field captures

A standard drug dosage of 5.5 mg etorphine hydrochloride, 150 mg xylazine hydrochloride, and 3 mg atropine sulfate in 7-ml darts was used for all captures. Bands were spotted from the helicopter and approached closely enough to allow selection of an individual judged to be a female. This horse was then pursued to allow a shot at the left side at ranges of 8 to 30 m. Darts were usually placed in the rump area. Darts placed at angles off 90 degrees frequently bounced; they were never effective and another dart had to be delivered to the animal. Pursuit of an animal for more than 10 min prior to placing a shot was avoided to minimize exertion and overheating. We noted that when the horses became stiff-gaited 6–7 min after darting they separated from their band and could no longer be herded with the helicopter.

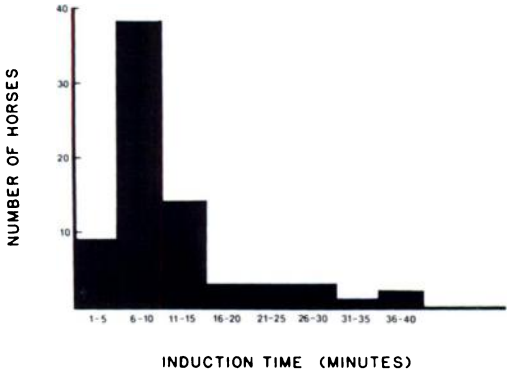

FIGURE 1. Distribution of induction times for 75 horses immobilized with 5.5 mg etorphine hydrochloride and 150 mg xylazine hydrochloride.

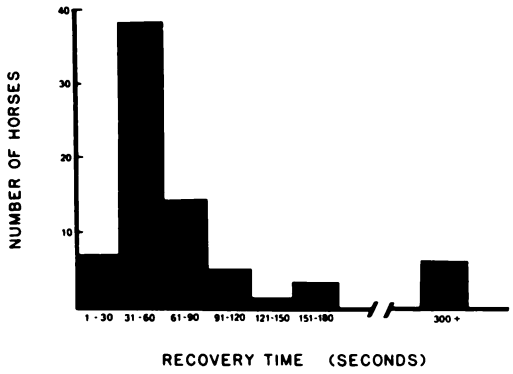

FIGURE 2. Distribution of recovery times for 72 horses given 11 mg of diprenorphine for reversal of etorphine hydrochloride anesthesia.

A total of 87 horses was captured in 69.2 hr of helicopter time distributed over 13 flights and 6 days. Flight time per horse captured ranged from 32.4 to 61.5 min for 13 flights. The captures included 11 stallions, 70 mares that were collared, five mares that died or were euthanized, and one mare that was released without a collar. The immediate deaths (6% of the total) included two animals with broken legs that were euthanized, one animal that unexpectedly and abruptly died while being processed, one animal that was darted three times in 2 days unintentionally (she had been released without a collar) and died shortly after the third darting, and an animal that died several hr after processing. When relocated 4 mo later, the remains of three other mares were found near their sites of capture. All of the other radioed animals were located alive at this time.

A total of 138 darts were fired for a mean of 1.59 darts per animal captured. There were 15 misses and 26 bounces; 10 animals required two darts for immobilization. Some of these double doses and half the failures may have been the result of drugs freezing in the darts, since we were flying with a door removed from the helicopter and drugs were freezing in our drug kits. Only about half of the darts that hit and initially stuck were recovered when the animal went down. The remainder were lost during the animal's movements. The mean helicopter flight time required per horse captured was 47.7 min. Since helicopter time cost $200 per hour, the average cost of flying time was $159 per animal captured.

Horses captured ranged in estimated age from 2 to 13+ yr (median = 8 yr). No effort was made to classify to year the animals 13 yr and older. The mean induction time of 11.6 min (Table 1, Fig. 1) was closely comparable to the time observed in the corral with similar drug dosages. The median time was 9.5 min, 2.1 min shorter than the mean time because six animals went down more than 25 min af-

TABLE 1. Biological data on 75 free-ranging feral mares captured by darting from helicopters in Nevada.

Variable (units)	Mean	SE	*n*
Group size	6.8	0.4	75
Induction (min)	11.6	0.8	75
Down (min)	30.7	1.4	66
Recovery (sec)	65.7	3.8	65
Temperature (C)	40.3	0.1	66
Respiration (per min)	19.1	0.9	70
Body Length (cm)	148	1.4	51
Girth (cm)	163	1.6	42

TABLE 2. Hematology, cortisol, glucose, and serum urea values for 50 feral mares captured with drugs in Nevada, February 1982.

Variable (units)	n	Mean	SE	Range
Hemoglobin (g/dl)	50	17.7	0.21	15.2–22.0
Red cells ($10^6/\mu l$)	48	9.3	0.14	7.1–10.9
Hematocrit (vol%)	48	47.5	0.55	40–56
MCV (fl)	48	50.7	0.60	40–60
MCHC (g/dl)	50	37.6	0.34	33–50
White cells ($10^3/\mu l$)	49	6.9	0.25	4.2–10.9
Cortisol (μg/dl)	46	4.7	0.41	1–12
Glucose (mg/dl)	50	132	4.6	64–198
Serum urea N (mg/dl)	39	17.7	0.55	12.3–25.3

ter drugging. The mean recovery time was 65.7 ± 3.8 sec (Fig. 2) when seven outliers with times greater than 300 sec were removed from the calculations. These delayed responses, 509 ± 85 sec, resulted from intramuscular rather than intravenous injections with a slower drug absorption. Comparison of morning and afternoon data for induction and recovery times indicated no time-of-day effect.

Rectal temperatures ranged from 38.0 to 42.3 with a mean of 40.3 ± 0.1 C. Body temperatures of animals drugged in the morning (39.9 C) were lower than the afternoon (40.7 C) ($F = 12.6$, df = 1 and 85, $P < 0.001$). These high body temperatures, with 25% greater than 41.1 C, considering the low ambient temperatures, suggest that capture by this method in warmer weather might present problems. The mean respiration rate of 19 per min is near normal. All animals exhibited a tachycardia with heart rates greater than 120 per min. Tremors and leg movements were minimal and did not interfere with the processing.

Blood data for free-ranging mares

Analysis of the blood data (Table 2) for time-of-day or induction time effects yielded no significant differences for hematologic values, chemical values or cortisol concentrations. Animals judged to be lactating had lower hemoglobin (17.2 vs. 18.0 g/dl, $F = 4.23$, df = 1 and 48, $P < 0.05$), fewer red blood cells (8.93 vs. 9.81 × $10^6/\mu l$, $F = 13.5$, $P < 0.001$), lower hematocrit (46.2 vs. 48.6 vol%, $F = 5.49$, $P < 0.025$), and smaller red blood cells (46.2 vs. 48.6 fl, $F = 6.12$, $P < 0.02$). Cortisol (4.7 ± 0.4 μg/dl) and glucose (132 ± 4.7 mg/dl) concentrations were the same in lactating and dry mares.

DISCUSSION

There are few reports on the use of chemical immobilization for capture of free-ranging feral horses in North America. Donkeys were captured in Death Valley with etorphine hydrochloride (Blake et al., 1981), but details of immobilization procedures were not presented. A report to the Bureau of Land Management (Moore, 1979) described the use of etorphine hydrochloride in combination with tranquilizers to capture 34 horses. There were eight mortalities. No drug dosage or physiological data were included. Borchard (1980) described the use of succinylcholine chloride and helicopters to capture 23 stallions and one mare in Idaho. There were nine deaths. High death rates have been common with use of succinylcholine chloride for immobilization in horses and other wild species (Tavernor, 1960; Jones, 1972). Berger et al. (1983) used succinylcholine chloride to capture 23 feral horses with ground stalking techniques and lost three animals. The down time (mean 12 min) was too brief to allow the multiple procedures needed for this study and 1,950 person-hours were required for the captures.

Borchard tested etorphine hydrochloride in six animals in corral trials and rejected its use because of tremors in the animals after immobilization and expense of the drugs. Etorphine hydrochloride in combination with various tranquilizers is commonly used for the immobilization of equids in zoos (Jones, 1972; Seal et al., 1978; Wright, 1982) and in the wild (Har-

thoorn, 1976). Etorphine hydrochloride, in combination with acepromazine, has been used in thousands of domestic horses particularly in the United Kingdom (Dobbs and Ling, 1972; Jenkins et al., 1972; Evans, 1974). Tranquilizers are used in combination with etorphine hydrochloride to reduce the intensity and duration of the excitement phase during immobilization and to provide better relaxation in the anesthetized animal. Acepromazine and xylazine hydrochloride are most commonly used for this purpose in equids (Kerr et al., 1972; Hillidge and Lees, 1977; Muir et al., 1979). Fatalities have been recorded for xylazine hydrochloride and etorphine hydrochloride in horses, but the prevalence appears to be less than 0.1% (Hillidge and Lees, 1977; Fuentes, 1978). We found that the induction time and relaxation effects of xylazine hydrochloride were dependent upon dose. It would be useful to do further corral studies to develop a combination of dosages that would further reduce the induction time. This could reduce helicopter time and losses of animals in difficult terrain.

The calculated material and helicopter time costs for capture of the animals could be reduced by perhaps 30% with experience. An experienced crew could capture and process eight to 10 animals in a working day. The method appears to be of particular value for selective capture of animals from individual bands on site.

The hematologic values were similar to those for "hot-blooded" horses such as Thoroughbreds and Arabians (Schalm et al., 1975). The cortisol values are in the same range as has been reported for captive feral horses with indwelling catheters (5.6 ± 1.51 μg/dl) or in samples collected by the heading/heeling technique (5.0 ± 2.20 μg/dl) (Kirkpatrick et al., 1979). These values for cortisol are about 40% less than those found in samples from animals immobilized with succinylcholine chloride (Borchard, 1980). The apparently normal serum cortisol values suggest that this technique was less "stressful" than the use of succinylcholine chloride. We repeatedly observed that the mares rejoined their band shortly after recovery.

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