CHEMICAL IMMOBILIZATION OF MOOSE AT THE MOOSE RESEARCH CENTER, ALASKA (1968-1981).

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Abstract: Data from chemical immobilization of Alaskan moose (*Alces alces*) from 1968 through 1981 at the Moose Research Center was compiled and assessed. Immobilizing drugs tested during that period were succinylcholine chloride, CI 744, xylazine hydrochloride and etorphine hydrochloride. Other adjunct and reversing drugs were discussed. From 1968 to 1975 succinylcholine chloride was the routine drug used for immobilization at the Moose Research Center with 1258 moose darted and 908 immobilized. Mean induction time was 8.5 minutes and mean time immobilized was 25.7 minutes. Hyaluronidase added to succinycholine chloride decreased induction time by 33% with no increase in mortality. Mortality rate for succinylcholine chloride was 5.5% of moose immobilized, however only 72.2% of moose darted were immobilized. Etorphine hydrochloride became the routine immobilizing drug in 1975 and is used routinely. To date 138 adult moose and 98 calves and yearlings have been immobilized. Mean induction time for etorphine was 11.4 minutes, and time immobilized was dependent upon time of antagonist injection. The mortality rate using etorphine on adults was 8.7%, but nearly all moose darted went down but many required supplemental doses. The mortality rates were inflated because these figures include data from early experimental work with the drugs. Familiarization with the drugs and the conditions for their use has decreased mortality significantly. Etorphine with xylazine is the drug combination presently preferred, but it is far from the ideal drug as presently available. The conclusion is that the ideal drug or drug combination to immobilize moose has not been found.

Chemical immobilization for capture of free-ranging animals became an accepted procedure during the 1950's with development of efficient projectile systems and drugs. The history and development of chemical immobilization has been documented (Harthoorn 1965, 1975; Young 1975). Franzmann (1982) reviewed and assessed chemical immobilization of North American moose (*Alces alces*). This paper outlines our experiences with chemical immobilization of Alaskan moose (*Alces alces gigas*) from 1968 through 1981 at the Moose Research Center (MRC) on the Kenai Peninsula, Alaska. Several reports and papers have provided information from various segments of our research (Franzmann and Arneson 1974, Franzmann et al. 1974, Franzmann and Schwartz 1982), but a compilation and an assessment of our data are lacking.

STUDY AREA

The MRC is located within the Kenai National Wildlife Refuge (KNWR - Formerly the Kenai National Moose Range) on the Kenai Peninsula in southcentral Alaska. Several papers

have described the topography and vegetation of the Kenai Peninsula (Oldemeyer and Seemel 1976, Oldemeyer et al. 1977, and Sigman 1977). Research facilities at the MRC were described by Franzmann and Schwartz (1982). Figure 1 is a schematic drawing of the MRC.

METHODS

Approaching Animal

Most moose captured at the MRC were initially trapped using rectangular corral traps (LeResche and Lynch 1973) located strategically along 24 km of MRC fenceline both inside and outside the 4 enclosures (Fig. 1). The traps measure 30x5 m and when a moose was caught it was approached on foot and subsequently immobilized.

In a few instances it was necessary to utilize a helicopter to approach a moose in the enclosures when specific animals were required. All free-ranging moose outside the MRC enclosures which were not caught by perimeter traps were approached by helicopter (Bell Jet Ranger). Helicopter use was limited to immobilization with succinylcholine chloride (Anectine, Burroughs-Wellcome and Co., Research Triangle Park, NC).

Tame and semi-tame moose have been maintained at the MRC in various numbers and in most cases have been approached to immobilize with a hand-syringe.

Projectile System

The projectile system used for nearly all MRC moose immobilizations was the Cap-Chur system (Palmer Chemical

Co., Douglasville GA). The only exception was the use of hand-held syringes to inject tame or semi-tame moose. Projectile dart body size varied from 3 to 15 ml depending upon drug used and the internal charge was adjusted accordingly. The firing charge used was primarily green or low for moose in the traps and moose darted from the helicopter. Occasionally a brown or extra low charge was used in a trap.

Drugs

The principal immobilizing drugs used at the MRC were: succinylcholine chloride, which is a paralyzing drug acting at the myoneural junction; etorphine hydrochloride (M-99, Lemmon Co., Sellersville, PA) a synthetic narcotic and potent CNC analgesic; xylazine hydrochloride (Rompun, Haver-Lockhart, Shawnee, KS) a non-narcotic CNS sedative, analgesic, and muscle relaxant; and CI-744 (Parke-Davis and Co., Detroit, MI) which is a 1:1 combination of tiletamide hydrochloride (CI-634) a CNS depressant and diazepionone (CI-716) a tranquilizer.

The primary antagonist used to reverse the effects of etorphine was diprenorphine hydrochloride (M50-50, Lemmon Co., Sellersville, PA). Cyprenorphine hydrochloride (M285, American Cyanamid Co., Princeton, NJ) was the first antagonist used with etorphine but was replaced by diprenorphine.

Adjunct drugs used were: hyaluronidase (Wydase, Wyeth Laboratories, Philadelphia, PA) which is an enzyme that breaks down connective tissue at the injection site hastening absorption of the immobilizer; and xylazine which was used as a sole immobilizing drug and as an adjunct drug with etorphine. Occasionally a tranquilizer such as acepromazine

maleate (Acepromazine, Fort Dodge Laboratories, Inc., Fort Dodge, IA), or promazine hydrochloride (Sparine, Wyeth Laboratories, Inc., Philadelphia, PA) were used after immobilization for their tranquilizing effect.

Adult (36 months +) female moose from MRC had a mean weight of 339.2 kg (n=81). Non-MRC moose had a mean weight of 400.5 kg (n=66). Adult males from the MRC averaged 402.3 kg (n=21) body weight and non-MRC weighed 454.6 kg (n=5) (Franzmann et al. 1978). Yearling moose immobilized in late summer/fall ranged in weight from 200 to 275 kg. Moose calves immobilized in late summer/fall ranged in weight from 90 to 175 kg (Franzmann et al. 1978).

RESULTS AND DISCUSSION

Approaching Animal

Fenceline traps at the MRC were useful to catch and hold moose for subsequent immobilization. From 1969 to 1974, during the most intensive trapping period, 824 moose were trapped during 4322 trap nights (trap success = 0.19). Generally, moose in traps were easily approached and darted. On occasion, however, some were hyperactive and would charge or flee from the person darting making dart placement more difficult.

Moose escaping from the trap by jumping and breaking through the trap walls was more prevalent in traps on the outside of the MRC enclosure than those inside (Fig. 1) (3.5% escaped from outside traps and 1.4% from inside traps). Moose within the enclosures were free-ranging, but had more experience with the fenceline and some had been trapped repeatedly. Male moose under 3 years of age were the most excitable in a trap of all sex and age classes.

The use of a helicopter to approach moose was effective with a good pilot and in most instances the animal could be forced into an open area for darting. Occasionally moose would enter a stand of large trees and could not be forced out; in such cases they could be darted if the overstory was not too thick.

Dart placement was extremely important and the heavy muscles of the hind limb was the site of choice. This was relatively easily accomplished with moose in MRC traps. Moose darted from a helicopter could be darted in the hind limb musculature under ideal conditions. Often the top of rump and loin had to be selected and if the moose did not have a heavy subcutaneous fat layer the injection was absorbed more rapidly.

Moose immobilized with a hand held syringe were generally injected in the neck muscle dorsal to the juglar furrow.

Projectile Systems

Cap-Chur guns and darts were generally satisfactory for immobilizing moose. The advantages of the system were:

1. Simplicity of design which afforded less opportunity for mechanical failure.
2. Availability of a variety of dart sizes to accommodate various drug volumes.
3. Interchangeability of dart components with different dart body sizes.
4. Availability of supply.
5. Darts could be reused if not damaged.

No system is without fault, and the major disadvantages of the system were:

1. Errant flight of the dart.
2. Variability in projecting charge.
3. Swelling and distortion of dart body.
4. Incomplete injection - primarily with large (7 ml or greater) darts.

Other systems became available during the studies, but were not evaluated because the system being used was satisfactory, conversion would be costly, and volume of drug needed limited our choices. Blow dart systems have a great potential for darting moose in the MRC traps, but were not used for moose because the maximum volume of the darts is 3 ml. The drugs being used for moose after development of blow-darts required much larger volumes. If an effective and safe drug becomes available for moose in North America whose total dosage volume is 3 ml or less, it is believed the blow-dart system would be the projectile system of choice for moose in MRC traps.

Drugs and Immobilization

Succinylcholine chloride (SCC) used in the concentration of 10 mg/ml was the first immobilizing drug used at the MRC, and it was routinely used until 1976. Hyaluronidase (HD) was added to SCC (9 N. F. units/mg SCC) for 510 of 838 moose immobilized. Tables 1, 2, and 3 list the mean induction time and time immobilized for the various dosages of SCC and SCC/HD for adult moose inside MRC, outside MRC and free-ranging. Dosages varied from 12.5 to 25.5 mg SCC/adult moose. This variability was primarily influenced by condition of moose which is a function of season. Lower dosages were used during late winter and spring for both sexes and during the late rut (October) for bulls.

Combined sex and drug mean induction time was 8.5 minutes (n = 838) and mean time immobilized was 25.7 minutes (n = 505) (Table 4). We were unable to record all times up for moose thereby explaining the lesser sample size on time immobilized. Likewise, some of the down times for free-ranging moose were recorded when the animal was observed down. In some cases the helicopter would return late to the immobilized moose and the moose may have been down for a few unknown minutes.

The most accurate induction time data was provided by MRC immobilizations where the moose were in traps and were observed through the entire immobilization process. The mean induction time for inside MRC moose was 10.0 minutes (n = 105) for SCC and 6.5 minutes (n = 148) for SCC/HD (Table 1). Outside trapped MRC moose had a mean induction time of 10.2 minutes (m = 55) with SCC and 6.9 minutes (n = 94) with SCC/HD (Table 2)/ The combined mean induction time for all MRC trapped moose was 10.1 minutes (n = 160) with SCC and 6.7 minutes with SCC/HD.

Mean induction time was lessened with the use of HD by 3.4 minutes (33%). We reported the decrease in induction time with HD (Franzmann et al. 1974), but also reported an increase in mortality using HD. Additional data disputes this finding with 28 of 704 (4.0%) moose killed with SCC/HD and 22 of 554 (4.0%) killed with SCC (Table 5). The mortality rate was the same for both drugs.

Lowered dosage did not decrease induction time (Tables 1, 2, 3). Lowered dosages were used on animals in poor condition. The major influence on induction time was the addition of HD. Sex and location did not influence dosage other than that which could be attributed to condition of the moose.

The most disturbing data are that only 72.2% (908 of 1258) (Table 5) of moose darted where immobilized. This quickly converts to time, and when darting is done by helicopter, it converts to money. It was necessary to observe a darted moose for 20 minutes before repeating a SCC dose which meant much additional time and money. It was this characteristic of SCC along with its very narrow range of tolerance by moose which made us search for another immobilizing drug.

Experiences using CI-744 to immobilize moose were reported by Franzmann and Arneson (1974). The test was limited and results inconclusive. However, moose successfully immobilized required 2.9 to 5.3 mg CI-744/kg body weight. The drug is not presently commercially available thereby its use in moose immobilization is limited. If the drug becomes commercially available further studies on its use in moose are warranted.

Xylazine was used at the MRC as an immobilizer (Franzmann and Arneson 1974) but it has been limited to use for procedures when the animal can be closely monitored for long periods of time. Ataxia during recovery may last up to 2 hours. Immobilization was produced in moose using dosages of 2.2 mg/kg. body weight. Xylazine has been primarily used at the MRC as an adjunct drug to etorphine.

Etorphine was first used at the MRC in 1969 but not routinely until 1975. All data are from trapped MRC animals. In 1976 we began combining xylazine with etorphine to alleviate some problems experienced with etorphine alone such as; hyperthermia, muscle tonus, and incomplete immobilization. Tables 6 and 7 summarize the results with

etorphine and xylazine. In adult moose (Table 6) the mortality rate was 8.7% (12 of 138), but most occurred with dosages under 8 mg etorphine (9 of 78 - 11.5%). Adult moose receiving 8 mg or more of etorphine experienced mortality rate of 5.0% (3 of 60). The proportion of moose not immobilized was also greater for those receiving less than 8 mg etorphine (11.5% vs 1.7%). Supplemental doses required for moose receiving less than 8 mg was 23 of 78 (29.5%) but for those receiving 8 mg or more was 5 of 60 (8.3%).

The data clearly indicate that the major problems experienced with etorphine and etorphine/xylazine mixtures (supplemental doses needed, not down, mortality) were related to underdosing. It is further indicated that induction time is lessened with etorphine/ xylazine mixture when the etorphine dose is less than 10 mg. For 5 mg etorphine dose the mean induction time is lessened by 10.5 minutes, for 7 mg by 1.8 minutes, for 8 mg by 2.6 minutes, and for 9 mg by 2.8 minutes.

It is recommended that the minimum dosage for adult Alaskan moose weighing approximately 400 kg should be 10 mg etorphine (0.025 mg/kg body weight) when used alone and 8 mg etorphine/200 mg xylazine when the combination is used. Moose in extremely poor condition may require a lesser dose. There are definite indications that higher doses may be needed for moose in extremely good condition. Franzmann and Schwartz (1982) reported that doses of 12 mg etorphine and 400 mg xylazine were needed to immobilize adult Alaskan moose in excellent condition during late fall. Body weights were not available for these moose but were estimated greater than 400 kg.

The major benefit from using xylazine with etorphine appears to be lowered induction time based upon data presented. However, from our experiences we believe that moose receiving xylazine with etorphine were less stressed. This is an intangible that was not evident in the data, but rather an opinion. The use of HD with etorphine and etorphine/xylazine mixtures was not tested at the MRC; however, decreased induction times may result as was experienced with the HD and SCC mixture.

Table 7 summarizes the results of immobilizing moose calves and yearlings. Two dosages were used for calves (2 and 3 mg). Although a higher proportion of mortality (2.8%) was experienced with the 3 mg dosage, the important statistic is that with the 2 mg dosage 40% of calves had to be given supplemental doses, while only 8.3% of calves with the 3 mg dosage required supplementation. The calves were immobilized during fall and winter and weighed from 90 to 175 kg. The recommended dose for these calves is 3 mg etorphine (.017 to .033 mg/kg body weight). Mean induction time for the 3 mg dose was 9.2 minutes. Adding xylazine may lower the induction time and should be considered as an adjunct to etorphine for calves.

Data (Table 7) relative to immobilizing yearling moose (200 to 275 kg body weight) indicates that the minimum dosage of etorphine should be 5 mg (0.018 to 0.025 mg/kg body weight). An etorphine/xylazine mixture may lower induction time and minimize stress; the combination was not tested on yearlings. It is interesting to note that as the dosage of etorphine was increased from 5 to 7 mg the mean induction time decreased from 9.1 to 7 minutes.

Etorphine has been a satisfactory immobilizing agent for both moose calves and yearlings. The mortality rate has been low (3 of 82 - 3.6%), the need for supplemental doses has been minimal (7 of 82 - 8.5%), and only 2 of 82 (2.4%) calves and yearlings did not go down when properly dosed.

Etorphine and/or etorphine with xylazine appear to be effective immobilizing drugs for moose. Nevertheless, several important aspects of their use have not been presented: (1) etorphine is an extremely dangerous drug if accidentally injected or absorbed by humans; (2) etorphine is highly regulated because it is a narcotic; (3) etorphine and xylazine are not cleared for use in food animals; (4) neither drug is available in an adequately concentrated form for use in large ungulates such as moose. Etorphine is available in the United States in a concentrate of 1 mg/ml only. Xylazine is available in the United States in a concentration of 100 mg/ml. For moose requiring 12 mg etorphine/400 mg xylazine, the volume of drug is 16 ml. This means that the animal must be double darted adding to cost, hazard to operators, and to health and safety of the animal.

The conclusions reached are that etorphine and etorphine/xylazine mixture are the drugs of choice for moose at this time, but to increase efficiency, reduce hazard, reduce stress on animals and operators, reduce cost, and provide for an aesthetically acceptable immobilization technique the drugs must be made available in a more concentrated form. New drugs that become available for moose immobilization will be tested at the MRC, because the ideal drug for immobilizing moose has not yet been discovered.

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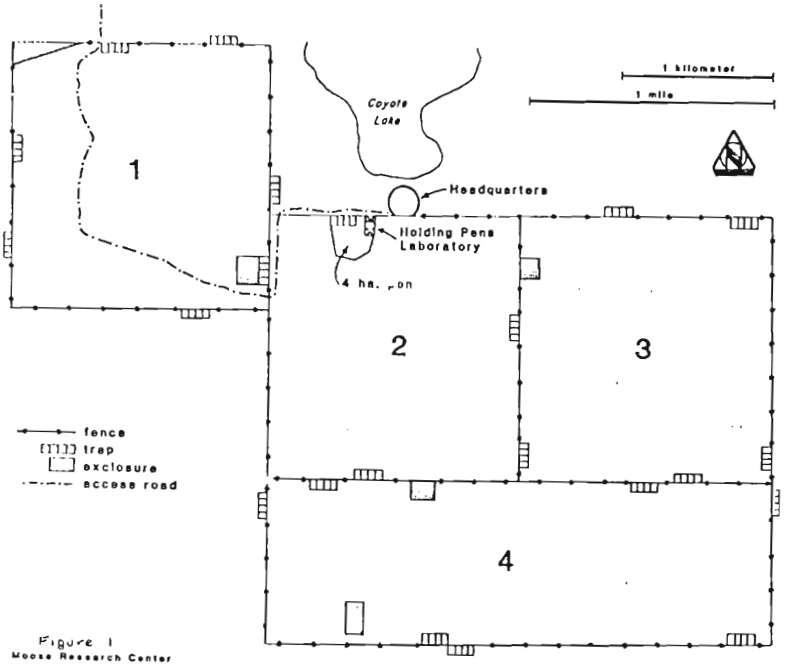

Figure 1
Moose Research Center

Table 1. Effects of succinylcholine chloride (Anectine) 1/ and hyaluronidase (Wydase) 2/ administered to trapped adult 3/ Alaskan moose within the Kenai Moose Research Center (MRC) enclosures, 1968 to 1976. (Sample size in parenthesis).

Dosage (mg of Anectine)	Mean Induction Time (min.)				Mean Time Immobilized (min.)			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
13	0	8.0(1)	0	6.0(1)	0	10.0(1)	0	14.0(1)
13.5	7.5(3)	10.6(23)	2.5(1)	8.3(13)	41.5(3)	20.4(23)	22.0(1)	34.4(12)
14	9.1(7)	8.9(9)	4.5(1)	5.2(5)	9.1(7)	18.6(9)	14.1(1)	20.0(5)
15	9.7(3)	9.0(1)	0	6.0(1)	15.7(3)	25.0(1)	0	17.0(1)
15.5	0	10.5(2)	8.0(1)	0	0	16.5(2)	27.0(1)	0
16	9.0(2)	0	6.0(1)	6.0(1)	26.0(2)	0	21.0(1)	31.0(1)
17	6.3(3)	0	21.0(1)	0	19.3(3)	0	7.5(1)	0
17.5	0	0	0	9.0(1)	0	0	0	21.0(1)
18	10.5(2)	8.4(4)	6.3(18)	7.6(17)	15.0(1)	19.8(4)	25.1(15)	26.1(14)
18.5	0	0	18.0(1)	0	0	0	39.0(1)	0
19	6.5(2)	7.2(6)	5.2(6)	6.6(28)	38.5(2)	30.3(6)	26.0(5)	30.8(23)
20	15.0(2)	12.6(5)	3.8(3)	6.4(14)	17.8(2)	22.9(4)	32.3(2)	32.8(13)
21	8.0(1)	10.7(6)	7.0(3)	6.6(15)	31.0(1)	30.0(6)	28.0(2)	28.9(14)
21.5	0	0	4.0(1)	0	0	0	44.0(1)	0
22	0	10.8(9)	11.0(1)	4.9(13)	0	27.9(9)	18.0(1)	0
23	0	11.1(13)	0	0	0	30.6(13)	0	0
24	19.0(1)	0	0	0	34.0(1)	0	0	0
Mean	9.4(26)	10.2(79)	6.4(38)	6.6(110)	21.5(25)	24.2(78)	25.6(32)	29.9(98)
Sex Combined Mean	10.0(105)		6.5(148)		23.5(103)		28.8(130)	
Sex and Drug Combined Mean	8.0(253)				26.5(233)			

1 Anectine - Burroughs Wellcome and Co., Research Triangle Park, NC.

2 Wydase -Wyeth Laboratories Inc., Philadelphia, PA - 9 NF units Wydase per mg Anectine.

3 Adult female moose mean body weight was 339.2 kg (n=81); male moose mean body weight was 402.3 kg (n=21) (Franzmann et al. 1978).

Table 2. Effects of succinylcholine chloride (Anectine) 1/ and hyaluronidase (Wydase) 2/ administered to trapped adult 3/ Alaskan moose outside the Kenai Moose Research Center (MRC) enclosures, 1968 to 1976. (Sample size in parenthesis).

Dosage (mg of Anectine)	Mean Induction Time (min.) Anectine Male	Anectine Female	Anectine w Wydase Male	Anectine w Wydase Female	Mean Time Immobilized (min.) Anectine Male	Anectine Female	Anectine w Wydase Male	Anectine w Wydase Female
12.5	0	12.0(1)	0	0	0	34.0(1)	0	0
13	0	12.8(5)	0	0	0	22.4(5)	0	0
13.5	10.0(1)	13.3(3)	0	15.0(1)	37.0(1)	12.3(3)	0	23.0(1)
14	19.0(1)	0	0	3.0(1)	25.0(1)	27.0(2)	0	14.5(2)
15.5	10.0(1)	0	0	9.0(2)	20.0(1)	0	0	14.5(2)
16	0	11.0(1)	0	0	0	14.0(1)	0	0
18	5.0(1)	6.0(4)	5.5(2)	6.5(15)	32.0(1)	21.8(3)	25.5(2)	25.8(15)
19	6.0(1)	0	5.3(3)	5.6(21)	35.0(1)	0	33.3(3)	30.0(1)
20	0	7.9(10)	6.5(2)	6.5(20)	0	34.5(9)	22.5(2)	25.6(20)
21	0	10.0(6)	5.0(2)	9.6(8)	0	29.0(2)	26.0(2)	29.0(6)
22	0	9.8(14)	6.0(1)	10.1(10)	0	24.8(13)	2.0(1)	0.9(10)
23	0	15.5(4)	0	5.1(5)	0	30.5(4)	0	35.4(5)
24	0	0	0	7.5(1)	0	0	0	17.0(1)
Mean	10.0(5)	10.2(50)	5.6(10)	7.0(84)	29.8(5)	26.6(47)	30.0(10)	26.4(81)
Sex Combined Mean	10.2(55)		6.9(94)		26.9(52)		26.8(91)	
Sex and Drug Combined Mean	8.1(149)				26.8(143)			

1 Anectine - Burroughs Wellcome and Co., Research Triangle Park NC.

2 Wydase - Wyeth Laboratories Inc., Philadelphia PA - 9 NF units Wydase per mg. Anectine.

3 Adult female moose mean body weight was 400.5 kg (n=66); male moose mean body weight was 454.6 kg (n=5) (Franzmann et al. 1978).

Table 3. Effects of succinylcholine chloride (Anectine) 1/ and hyaluronidase (Wydase) 2/ administered to free-ranging adult 3/ Alaskan moose outside the Kenai Moose Research Center (MRC) enclosures, 1968 to 1976. (Sample size in parenthesis).

Dosage (mg of Anectine)	Mean Induction Time (min.) Anectine Male	Anectine Female	Anectine w Wydase Male	Anectine w Wydase Female	Mean Time Immobilized (min.) Anectine Male	Anectine Female	Anectine w Wydase Male	Anectine w Wydase Female
20	10.6(6)	11.3(10)	9.1(28)	8.9(18)	9.0(1)	30.3(4)	19.9(10)	26.5(2)
21	7.2(14)		9.0(36)	9.2(30)	14.0(2)	36.0(2)	21.5(13)	18.3(7)
22	0	9.7(11)	8.1(15)	7.5(51)	0	17.2(4)	14.0(1)	25.8(8)
22.5	13.5(2)	5.7(3)	0	0	0	0	23.0(2)	0
23	10.8(8)	9.6(41)	6.4(7)	8.2(34)	40.0(1)	17.6(9)	0	23.6(17)
23.5	0	14.4(5)	0	0	0	20.5(4)	0	0
24	0	7.7(22)	6.0(3)	9.5(24)	0	37 (1)	21.0(2)	18.8(11)
24.5	12.0(1)	15.0(1)	0	0	30.0(1)	25.0(1)	0	0
25	8.0(1)	8.2(5)	8.4(8)	8.7(24)	0	30.8(5)	24.8(4)	24.8(12)
25.5	13.0(1)	4.0(1)	0	0	0	16.0(1)	0	0
Mean	9.4(33)	9.3(135)	8.8(87)	8.8(181)	20.3(6)	24.6(34)	21.8(32)	22.6(57)
Sex Combined Mean	9.3(168)		8.8(268)		23.2(40)		22.3(89)	
Sex and Drug Combined Mean	9.0(436)				22.6(129)			

1 Anectine - Burroughs Wellcome and Co., Research Triangle Park NC.

2 Wydase - Wyeth Laboratories Inc., Philadelphia PA - 9 NF units Wydase per mg. Anectine.

3 No body weights available, but this group estimated larger by minimum of 50 kg than moose listed in Table 2.

Table 4. Effects of succinylcholine chloride (Anectine) 1/ and hyaluronidase (Wydase) 2/ administered to Kenai Moose Research Center (MRC) inside and outside trapped and free-ranging Alaskan moose, 1968 to 1976. (Sample size in parenthesis).

Moose Group	Mean Induction Time (min.)				Mean Time Immobilized (min.)			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
Inside MRC	9.4(26)	10.2(79)	6.4(38)	6.6(110)	21.5(25)	24.2(78)	25.6(32)	29.9(98)
Outside MRC	10.0(5)	10.2(50)	5.6(10)	7.0(84)	29.8(5)	26.6(47)	30.0(10)	26.4(81)
Free-ranging	9.4(33)	9.3(135)	8.8(87)	8.8(181)	20.3(6)	24.6(34)	21.8(32)	22.6(57)
Mean	9.4(64)	9.7(264)	7.9(135)	7.8(375)	22.4(36)	25.0(159)	24.6(74)	26.9(236)
Sex Combined Mean	9.6(328)		7.8(510)		24.5(195)		26.4(310)	
Sex and Drug Combined Mean	8.5(838)				25.7(505)			

1 Anectine - Burroughs Wellcome and Co., Research Triangle Park NC.

2 Wydase - Wyeth Laboratories Inc., Philadelphia PA - 9 NF units Wydase per mg. Anectine.

Table 5. Effects of succinicholine chloride (Anectine) 1/ and hyaluronidase (Wydase) 2/ on 1285 adult Alaskan Moose, 1968 to 1976. (Sample size in parenthesis).

Moose Group	Percentage Immobilized of Moose Darted				Percentage Killed of Moose Darted			
	Anectine		Anectine w Wydase		Anectine		Anectine w Wydase	
	Male	Female	Male	Female	Male	Female	Male	Female
Inside MRC 3/	60.5 (26 of 43)	73.8 (79 of 107)	71.7 (38 of 53)	79.6 (109 of 137)	0 (0 of 43)	0 (0 of 107)	3.8 (2 of 53)	4.4 (6 of 137)
Outside MRC	45.5 (5 of 11)	69.4 (50 of 72)	83.3 (10 of 12)	79.2 (84 of 106)	0 (0 of 11)	1.4 (1 of 72)	0 (0 of 12)	2.8 (3 of 106)
Free-Ranging	75.0 (51 of 68)	73.5 (186 of 253)	64.2 (79 of 123)	70.0 (191 of 273)	7.4 (5 of 68)	6.3 (16 of 253)	2.4 (3 of 123)	5.1 (14 of 273)
Mean	67.2 (82 of 122)	72.9 (315 of 432)	67.6 (127 of 188)	74.4 (384 of 516)	4.1 (5 of 122)	3.9 (17 of 432)	2.7 (5 of 188)	4.5 (23 of 516)
Sex Combined Mean	71.7 (397 of 554)		72.6 (511 of 704)		4.0 (22 of 554)		4.0 (28 of 704)	
Sex and Drug Combined Mean	72.2 (908 of 1258)				4.0 4/ (50 of 1258)			

1 Anectine - Burroughs Wellcome and Co., Research Triangle Park NC.

2 Wydase - Wyeth Laboratories Inc., Philadelphia PA - 9 NF units Wydase per mg. Anectine.

3 MRC - Moose Research Center

4 Percentage killed of moose immobilized = 5.5% (50 of 908)

Table 6. Immobilization of adult moose at the Moose Research Center with etorphine (M-99) 1/ and etorphine with xylazine (Rompun) 2/. (Sample size in parenthesis).

Drug and Dosage	Number 3/ of Moose	Supplemental Doses	Mean Induction Time(min)	Mean Time Immobilized(min)	Recovery Time	Not Immobilized	Mortalities
M-99 4 mg Rumpun 400 mg	2	2	43 (1)			1	1
M-99 5 mg	23	12	15.8±11.9 (15)	21.6±12.4 (16)	2.4±3.6(15)	5	2
M-99 5 mg Rompun 500 mg	3	1	5.3±0.6 (3)	56.7±59.4 (3)	10.0 (1)		
M-99 6 mg	7	1	10.8±8.0 (6)	20.0±9.5(6)	6.6±6.8(5)		1
M-99 7 mg	23	5	12.0±8.5 (21)	18.7±8.7 (20)	2.5±2.6(16)	2	4
M-99 7 mg Rompun 300 mg	20	2	10.2±5.4 (14)	25.8±12.8 (8)	3.1±1.8 (8)	1	1
M-99 8 mg	12	2	12.8±9.4 (11)	35.0±44.5 (9)	4.1±3.8 (10)		
M-99 8 mg Rompun 200 mg	12		10.2±6.4 (9)	32.9±35.8 (7)	3.2±1.8 (5)		1
M-99 9 mg	6		14.8±12.5 (5)	16.3±6.6 (4)	2.0±1.4 (4)		
M-99 9 mg Rompun 100 mg	9	1	12.0±8.5 (7)				
M-99 10 mg	11	2	6.8±2.6 (10)	17.1±6.6 (8)	3.8±2.9 (5)	1	
M-99 10 mg Rompun 200 mg	4		9.2±1.0 (4)	11.5±6.2 (4)			
M-99 10 mg Rompun 300 mg	2		8.0 (1)		3.0 (1)		
M-99 12 mg Rompun 400 mg	4		8.0±1.0 (3)	16.3±1.3 (3)	9.5±0.7 (3)		1
TOTAL	138	28	11.4±9.1 (109)	23.5±18.2 (88)	3.6±3.4 (73)	10	12

1 M-99 - Lemmon Co., Sellersville, PA.

2 Rompun - Haver-Lockhart, Shawnee, KS.

3 Body weights ranged from 325 to 500 kg (estimated).

Table 7. Immobilization of moose calves and yearlings at the Moose Research Center with etorphine (M-99) 1/ (Sample size in parenthesis).

Etorphine Dosage	Number of Calves	Number of Supplemental Doses	Mean Induction Time(min)	Mean Time Immobilized(min)	Recovery Time	Not Immobilized	Mortalities
			CALVES (90-175 kg body weight)				
2 mg	10	4	10.6±7.3 (8) 2/	5.0±5.7 (8)	1.6±1.1 (7)		
3 mg	60	5	9.2±6.2 (48)	22.9±6.2 (47)	2.4±2.7 (44)	2	2
TOTAL	70	9	9.4±6.6 (56)	20.3±14.6 (55)	2.3±2.6 (51)	2	2
			YEARLINGS (200-275 kg body weight)				
3 mg	3		15±9.9 (2)	15.5±12.0 (2)	1.0 (2)	1	
4 mg	3	1	25.7±18.8 (3)	14.5±14.9 (2)	1.0 (1)		1
5 mg	14	2	9.1±9.0 (12)	17.7±10.4 (12)	1.3±0.5 (10)		
6 mg	5		8.6±3.8 (4)	25.0±8.7 (3)	1.0 (2)		1
7 mg	3		7.0±1.0 (3)	10.0±6.2 (3)	2.0 (1)		
TOTAL	28	3	11.0±8.4 (24)	14.4±10.2 (22)	1.3±0.4 (20)	1	2

1 M-99 - Lemmon Co., Sellersville, PA.