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BLACK RHINOCEROS IMMOBILIZATION UTILIZING A NEW TRANQUILLIZING AGENT

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SUMMARY

Eleven black rhinoceroses were successfully immobilized, ten o fthem in the Arusha Chini area of Tanzania and one, a penned animal, near Nairobi. Of the total number, two were immobilized with Etorphine hydrochloride (M. 99) and acetylpromazine; six with a combination of Etorphine, acetylpromazine and a new tranquillizer, Azaperone; and three with Etorphine and Azaperone. In addition, one attempt at immobilization with a relatively new analgesic, Fentanyl, was not satisfactory at the dosage used, the animal being immobilized later with Etorphine and included in the eleven rhino described. Injection was accomplished on the ten Tanzania animals with Cap-Chur equipment from a helicopter, and on the penned animal with a hand syringe. Specimens and data were collected from the immobilized rhino. They were then loaded into crates, given an antidote (nalorphine hydrobromide) intramuscularly, and then trucked to points of release or to holding pens. Immobilization data, weights, sexes, relative ages, rectal temperatures, respiratory rates and pulse rates are tabulated.

INTRODUCTION

The Tanzania Game Department wished to translocate a small population of black rhinoceroses (*Diceros bicornis* L.) from near Arusha Chini because the animals had come into conflict with agricultural interests and because their habitat was being degraded and their survival was consequently in doubt. Conventional roping methods of capture proved impracticable because of the conditions; it was therefore decided to use drug immobilization.

Rhinoceroses have been immobilized with nicotine alkaloids (Palmer, pers.comm., 1964) and with Sernylan (Carter, 1965), but considerable progress has been made since the advent of the neuroleptic-analgesic mixtures, most of which in more recent times have contained the potent thebaine derivative, Etorphine hydrochloride (Reckitt and Son). The description and pharmacology of Etorphine (M. 99) have been reported by Blane *et al.* (1967), and its use in immobilizing African wild ungulates has been reported by Harthoorn and Bligh (1965), King and Carter (1965), Harthoorn (1966), and Pienaar *et al.* (1966).

Various drugs have been used in the immobilization mixtures, but these usually included acetylpromazine or a similar phenothiazine, and sometimes the parasympatholytic agent hyoscine, with Etorphine or other morphine-like compounds as the analgesic. Pienaar (1968) suggested that the extrapyramidal effects of the phenothiazine derivatives and the toxic effects of hyoscine caused reactions which terminated in death or necessitated special methods of resuscitation in certain species of wildlife. Therefore, it was felt desirable to keep the amount of acetylpromazine as a component of our dosage at a minimum, delete hyoscine entirely, and try the addition or substitution of a new neuroleptic, Azaperone.

Azaperone (R–1929, Janssen Pharmaceutica), as described by the Janssen Research Laboratory, induces only a small body-temperature variation, does not cause local tissue reaction after intramuscular injection, and can be prepared easily in concentrated solutions. The butyrophenones, of which Azaperone is a member, are potent inhibitors of learned reflexes, are potent anti-emetic agents with the capacity of antagonizing the emetic activity of the morphine-like analgesics, display potentiating and synergistic effects on the action of most anaesthetic drugs, antagonize the respiratory depressant effect of morphine-like compounds, and are anti-shock agents.

Janssen Pharmaceutica reported that Fentanyl (R-4263 Citrate) is a prototype of a recently-discovered new group of 4 acyl-anilino-piperidines and is a typical morphine-

like analgesic. Its action is similar to that of morphine in most pharmacological experiments, and most of its effects are neutralized by nalorphine hydrobromide. According to Janssen Pharmaceutica it is up to 1,000 times more potent than pethidine, being the shortest-acting analgesic known, and reaches peak intensity much more rapidly than longer-acting analgesics. However, it is only about one-tenth as active as Etorphine. Pienaar (1968) reported very favourably on the use of Fentanyl, particularly in animals such as members of the Tragelaphine and Hippotragine groups, where Etorphine was much less effective and even caused mortality in certain cases. It is not known if Fentanyl has ever been used on black rhinoceroses; at this time no published data are available, but it was thought to be feasible to try it on rhinoceroses.

METHODS AND MATERIALS

Etorphine was used in a concentration of 4 mg/ml, acetylpromazine in a solution of 10 mg/ml, and Azaperone and Fentanyl in 100 mg/ml solutions. Etorphine was used in combination with acetylpromazine and with Azaperone, singly and together. Fentanyl was used with Azaperone.

The rhinoceroses, when located in the heavy bush, were shot with Cap-Chur equipment from Hughes 300 and Bell 47G-3Bl helicopters, using 3–5 cm^3 syringes. Shots were made at ranges of *c.* 10 m, and both the CO_2-powered and the powder Cap-Chur rifles proved very satisfactory. The CO_2 pistol, however, apparently had insufficient velocity to penetrate the hide, or the angle of incidence was less than 90° to the surface, and was unsuitable on three attempts. Injection sites were generally in the hindquarters, hips or loins. Reinforced or heavy needles were a necessity, but the barbs were closely trimmed.

Two-way radios provided contact between the helicopter and the ground crew, which consisted of approximately eight men in a Volvo Laplander, a Toyota and two lorries. The helicopter kept the injected rhinoceros in sight until it went down, and directed the ground crew to its location.

Upon reaching the immobilized rhinoceros its legs were secured with rope, after which the syringe was removed and the injection site treated with Mylipen. Padding was put under the animal's head to protect the lower eye, a cloth covering was put over the upper eye to shield it from the sun, rectal temperatures were recorded, ticks were collected, body measurements were recorded, the premolars were examined to determine relative age, and blood samples were obtained from the ear veins. Swabs were taken from lesions for agar culture at Kabete Veterinary Laboratory. Sulphathiazole ointment was applied to sores, lesions and abrasions; 3.5 g of Berenil were injected against trypanosomiasis; and 20 ml of Streptomycin and 30 ml of Streptopen were injected into each animal. Animals to be translocated and released were eartagged.

The rhinoceroses were then loaded into a lorry for later transfer to a crate, or loaded directly into a crate on the lorry, by means of a cable running over the front of the truck bed to a winch on another vehicle, and facilitated by three heavy roller ramps from the tailgate of the truck to the ground. The antidote, nalorphine hydrobromide, was administered intramuscularly into the soft tissue around the anus after the rhinoceros was in the crate.

RESULTS

A total time of 44 h was utilized with the helicopters during two capture trips (October, 1968 and February, 1969), which included 9 h of helicopter travel-time from Nairobi to the site and return. Seven rhinoceroses were immobilized on the first trip and three on the second. While the helicopter was the most practical method of capture under the circumstances, considerable time was expended in searching the extensive stands of dense bush and trees for rhinoceroses.

Two animals were immobilized with Etorphine and acetylpromazine in combination (nos. 1 and 4, Table 1), each receiving 2.0 mg Etorphine and 25.0 mg acetylpromazine; or 2.44 µg/kg of Etorphine for no. 1, and 1.76 µg/kg for no. 4. The time from injection to the first sign of ataxia was 5–7 min, the time from injection to apparent immobilization from 10–20 min, and the time from injection to going down 15–25 min.

Five rhinoceroses received dosages of Etorphine in combination with both acetylpromazine and Azaperone. One other, no. 3 in Table 1, received this in effect; it was first injected with 20.0 mg of Fentanyl plus 10.0 mg acetylpromazine and 300.0 mg Azaperone, but after approximately half an

TABLE 1

Drug immobilization data on 11 black rhinoceroses in East Africa

	Sex	Weight (kg) A-actual E-estimated	Doses of drugs in mg (and μg/kg) Analgesic Etorphine	Analgesic Fentanyl	Neuroleptic Acetyl-promazine	Neuroleptic Azaperone	Antidote Nalorphine	Route	Elapsed time (min) from injection to: Ataxia	Immob.	Down	Antidote	Up
1.	Female	818 E	2.0 (2.44)		25.0 (30.56)		200.0 (244.50)	IM	7	10	15	118	126
2.	Male	1185 A	2.0 (1.69)		20.0 (16.87)	250.0 (210.97)	200.0 (168.78)	IM	5	21	25	258	270
3.	Male	1085 A		20.0[1] (18.43)	10.0 (9.27)	300.0 (276.50)			7				
			2.0[2] (1.84)		20.0 (18.43)		300.0 (276.50)	IM		5	7	63	81
4.	Male	1196 A	2.0 (1.76)		25.0 (21.74)		300.0 (250.84)	IM	5	20	25	170	177
5.	Male	955 E	2.0 (2.09)		25.0 (26.18)	200.0 (209.53)			8	13	18	Drowned in lake	
6.	Male	1033 A	2.0 (1.93)		25.0 (24.20)	200.0 (193.61)	300.0 (290.42)	IM	7	—	42	74	77
7.	Male	700 E	2.0 (2.86)		25.0 (35.71)	200.0 (285.71)	250.0 (357.14)	IM	5	—	12	66	79
8.	Female	400 E	1.0 (2.50)		20.0 (25.00)	200.0 (250.00)	200.0 (250.00)	IM	7	10	12	46	55
9.	Male	600 E	2.0 (3.33)			350.0 (583.33)	200.0 (333.33)	IM	7	—	13	60	65
10.	Male	750 E	2.5 (3.33)			400.0 (533.33)	250.0 (333.33)	IM	4	7	9	51	63
11.	Female	820 E	2.25 (2.74)			400.0 (487.80)	180.0 (219.51)	IM	5	6	10	65	77

[1]First syringe, little effect other than slight ataxia after 28 min.
[2]Second syringe.

hour displayed little more than slight ataxia, so was subsequently given 2.0 mg Etorphine and 20.0 mg acetylpromazine which immobilized it rapidly. Other than this exception four of the five each received 2.0 mg Etorphine, 20.0–25.0 mg acetylpromazine, and 200.0–250.0 mg Azaperone. The remaining rhinoceros, number 8 in Table 1, an immature penned female, received 1.0 mg Etorphine, 20.0 mg acetylpromazine, and 200.0 mg Azaperone. These dosages resulted in a range of 5–8 min from the time of injection to the first indications of ataxia, 10–21 min to immobilization, and 12–42 min to going down. The effective amount in µg/kg of each component of the mixture is listed in Table 1 in parenthesis under the total dosage.

Three animals were immobilized through the use of Etorphine and Azaperone only, with dosages of 2.0–2.5 mg Etorphine and 350.0–400.0 mg Azaperone. These rhinoceroses became ataxic 4–7 min after injection, were immobilized in 6–7 min, and went down in 9–13 min.

The µg/kg data listed in Table 1 are the most accurate in the case of nos. 2, 3, 4 and 6, since these are the only animals actually weighed. The weights of the other animals were estimated by persons with considerable experience of rhinoceroses, and it is felt that they are quite reasonable estimates. If these estimates are accepted, then the following data on micrograms of the specified drugs per kilogram of animal weight are valid:

Etorphine (11 cases): 1.69–3.33.
Fentanyl (1 case): 18.43 (insufficient).
Acetylpromazine (2 cases as the only neuroleptic): 21.74–30.56.
(6 cases with Azaperone): 16.87–35.71.
Azaperone (3 cases as the only neuroleptic): 487.80–583.33.
(6 cases with acetylpromazine): 193.61–285.71.

An unfortunate incident, which can very likely be prevented in future work, caused the loss of one rhinoceros (no. 5). The ground crew became stuck in the muddy bottom of a gulch at the time the rhinoceros became ataxic. In following the path of least resistance in his ataxic condition, the rhinoceros walked into a small lagoon on the edge of Nyumba ya Mungu Lake. Between sinking into the soft bottom-mud and becoming immobilized he drowned in the 5 min before the ground crew reached him. He was pulled out with a vehicle and given artificial respiration by jumping on his rib-cage for approximately 15 min, although the heart-beat was already inaudible.

The first four rhinoceroses caught were translocated to the Mkomazi Game Reserve, travelling a distance of 160–200 km (100–125 miles) from the capture site. Observations by game scouts during the four months subsequent to their relocation indicate that these rhinoceroses have remained in the general area of release, even though no facilities were available for acclimatization pens at the release site. The remaining animals caught at Arusha Chini were retained by the trappers and transported to holding pens approximately 160 km (100 miles) from the capture site.

The variation in the elapsed time (Table 1) from the animal going down to the injection of the antidote, 32–233 min, is directly correlated with the amount of bush that had to be cleared to get the lorries to the animals, the efficiency with which the measurements and specimens were taken, and the facility with which the animals were loaded into the crates on the lorries. The antidote used was nalorphine hydrobromide, and 180.0–300.0 mg were injected intramuscularly into the soft tissue around the anus after the animals were in the crates. The rhinoceroses gained their feet 3–18 min after injection of the antidote, with very little struggle, and remained quite calm and relatively quiet for the trip to their release site or pens.

Four of the nine Arusha Chini rhinoceroses were hauled with the head forward in the direction of travel, and five with the head to the rear of the truck. No apparent advantages or disadvantages were noted in travel comfort or behaviour of the rhinoceroses in either position. However, release was facilitated by the head-forward position, in that they backed slowly out of the crate when the door was raised, rather than charging out as soon as the door was partially opened as was the case when facing to the rear of the truck. This latter behaviour resulted in damage to the sliding doors on two occasions at Mkomazi Game Reserve.

Table 2 lists the relative ages of the immobilized animals, and such physiological data as rectal temperatures, respiration and pulse or heart rate. It should be noted that all of these animals, with the exception of no.

TABLE 2

Physiological data from 11 black rhinoceroses in East Africa

	Sex	Relative age	°C Temp—Time (°F)	Respir./ min.—Time	Pulse/min.— Time
1.	F	Old	38.6–1620 (101.5)	8–1622 7–1632 8–1645	86–1620 82–1622 80–1632 92–1645
2.	M	Mature	38.2–1054 (100.7) 38.7–1200 (101.6)	12–1050	52–1050 52–1110 68–1210 72–1435
3.	M	Mature	40.3–1330 (104.6) 39.9–1412 (103.8)	16–1335 16–1340 16–1345	96–1328 80–1350
4.	M	Mature	38.4–1255 (101.2) 38.6–1327 (101.5)	24–1458	44–1300 52–1325 68–1410 56–1438
5.	M	Mature	37.4–1215 (99.3)	Dead (drowned)	
6.	M	Young Adult	41.5–1420 (106.7)	8–1435	65–1435
7.	M	Young Adult	38.7–1015 (101.6) 38.7–1115 (101.7)	12–1015 10–1030 10–1050 16–1115	56–1017 60–1030
8.	F	Immature	37.0–0927 (99.1) 37.8–1005 (100.0) 37.0–1018 (99.1)	18–0920 13–0950 7–1001 8–1004 8–1010 12–1020	60–0930 92–0951 84–0952 64–1006 60–1014 68–1023
9.	M	Immature	40.0–1030 (104.0) 40.3–1035 (104.5) 40.2–1041 (104.4)	16–1030 12–1049 16–1100	92–1030 88–1100
10.	M	Immature	37.5–0825 (99.6) 37.4–0840 (99.4)	9–0825 12–0830 7–0840 6–0855 7–0902	54–0825 54–0830 52–0840 60–0855 60–0902
11.	F	Immature	39.2–1245 (102.7) 39.6–1310 (103.5) 39.4–1330 (103.0)	6–1245 6–1259	44–1235 60–1245 60–1255 44–1259 56–1330

8, were subjected to the excitement and stress of the chase by helicopter, and subsequent hazing or surveillance until immobilized.

The classification into the relative age categories used here is arbitrary on our part, since we lacked knowledge of the eruption and relative-wear criteria of black rhinoceros dentition. These relative ages are based largely on body size, although the dentition was examined.

Rectal temperatures varied from 37.0–41.5°C, and where recorded more than once in the same animal appear to be quite stable. Variations between individuals are assumed to be due to differences in chase activities, behaviour after injection, and time of day (ambient temperatures). The highest temperature recorded, 41.5°C, occurred in no. 6, which required the longest time to go down after being injected (42 min) and ran quite far during the hottest part of the day (1435 h) before becoming immobilized. It is interesting to note that nos. 8, 9 and 11 reveal a slight increase in temperature, then a slight decrease over relatively short periods of time while down. All of these wild-caught animals sweated quite freely during and after the stress and activity of capture. The penned rhinoceros, not being subjected to the same stresses, exhibited the lowest temperature (37.0°C). The mean rectal temperature in 11 animals was 38.9°C.

Respiratory rates ranged from 6–24 exchanges/min, with a mean for ten rhinoceroses of 12. These rates are well within, or slightly below, the so-called normals given by King and Carter (1965) of 15–30/min.

Heart rates varied between the extremes of 44 and 96 in ten black rhinoceroses; however the variations within individuals ranged from 4–32/min. The mean pulse rate for these animals was 68.2.

DISCUSSION

No literature is known which reports the use of Fentanyl or Azaperone in the immobilization of black rhinoceroses. Certain other drugs, such as phencyclidine (Sernylan), when used alone or in combination with Etorphine, have resulted in prolonged recovery periods with the subsequent danger of radial paralysis (King and Carter, 1965). Phencyclidine as reported by Carter (1965), when used alone on black rhinoceroses, required a minimum of 20 min for the animals to go down, and they were down for a period of 5–31 h, sometimes eventually dying.

It is obvious from the existing literature pertaining to Etorphine, and the results of this small sample, that the morphine-like analgesics are the most efficient immobilizing agents known to date, and tend to be generally safer because of the ability to antagonize them. Consultation with Dr. A. M. Harthoorn indicated the need for an immobilizing mixture that was safe for the rhinoceroses, yet would render them tractable or quiet for translocation and handling after the reversal of the morphine-like agent. The single trial of Fentanyl in this report is inconclusive, although it tends to support limited laboratory work performed by the author and Dr. Harthoorn on domestic livestock, which indicated that Fentanyl had less than one-tenth the potency of Etorphine. Further investigations into the use of Fentanyl should be conducted, as Pienaar (1968) found that its use with elephant in Kruger National Park was ideal in that they generally remained standing, and were practically oblivious of people. Such behaviour would have obvious advantages in the capture and movement of rhinoceroses.

In reviewing the data presented in this paper, the times required for the rhinoceroses to go down under the three mixtures are most interesting. While I realize that means may have little value in this type of application, since the average time to go down can be greatly influenced by one poor injection and the condition of the animal, I will use them with qualifications for comparison of the neuroleptic-analgesic solutions. The two animals receiving only Etorphine and acetylpromazine went down in 15–25 min, with a mean of 20 min. The six animals receiving Etorphine (including the one which also received Fentanyl) in combination with acetylpromazine and Azaperone, exhibited a wider range (7–42) with a mean of approximately 19 min. The three animals injected with Etorphine and Azaperone displayed a narrow range of 9–13 min, and a mean of 11 min. This latter group, however, also received the highest doses of Etorphine and Azaperone in µg/kg. This might indicate that 'down' times could be reduced safely with the dosages used in the latter group, but this might also occur if the drugs used in either of the two other groups were increased similarly.

There appear to be no significant differe-

nces in rectal temperatures of the rhinoceroses amongst the three groups. Notwithstanding, it is my opinion that there are advantages in the use of Azaperone as a synergistic and tranquillizing agent on account of the more favourable characteristics mentioned previously in comparison to the phenothianzines, particularly with reference to the body-temperature control mechanisms.

While it is suggested that Etorphine-acetylpromazine and/or Azaperone mixtures may in themselves be sufficient, the interest in further experiments with Fentanyl as a substitute for Etorphine is based, aside from the actual possible effectiveness, on availability and economic considerations. Recently, difficulty has been experienced in obtaining Etorphine in East Africa from the present source of supply, although formerly it was available from England. Fentanyl, on the other hand, can be obtained from Belgium, and, even if the effective dosages are 15–20 times those of Etorphine, it is less costly.

In the interests of increasing such factors as safety, efficacy and availability of various drugs and combinations in the efficient and humane capture of wild animals. I recommend that more extensive and intensive experiments be conducted along these lines in drug immobilization.

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