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CAPTURE AND TRANSLOCATION OF THE FREE-RANGING BLACK RHINOCEROS: MEDICAL AND MANAGEMENT PROBLEMS

Michael D. Kock
Peter Morkel

Approximately 65,000 black rhinoceroses (*Diceros bicornis*) inhabited Africa south of the Sahara in the early 1970s. Because of poaching and habitat loss, this number has dwindled to about 2000, a decline of over 95%. Despite a 17-year ban on the sale of rhinoceros horn, as mandated by the Convention of International Trade in Endangered Species (CITES; see Appendix), poaching has persisted and, in some areas, intensified. Of the free-ranging black rhinoceroses in Africa, 95% now reside south of the Zambezi River, with about 430 in Zimbabwe, 400 in Namibia, and 750 in South Africa.

Poaching in Zimbabwe and Namibia has led to aggressive antipoaching practices, including translocation and horn removal. In Zimbabwe and Namibia, more than 400 animals have been translocated to private ranching and wildlife estate lands since 1986.[1,2,12] Some have been recaptured for relocation after escape or for investigation and treatment of medical problems, and over 150 have been dehorned as an antipoaching measure.

The capture and translocation of black rhinoceroses in Zimbabwe has resulted in an unacceptable mortality rate of 13 to 20% since 1986. A similar mortality rate of 22% has been recorded with capture and translocation operations in Namibia. In Zimbabwe, most deaths occurred within 1 week to 12 months after capture and, although many were caused by traumatic injury (e.g., horn loss, fighting), a significant number remain unexplained.[9,11] Investigations into the effects of capture, boma confinement, and translocation[5] have begun to identify contributing factors in these unexplained mortalities. The black rhinoceros appears to be less sensitive to common capture complications that occur during or shortly after chemical immobilization, but is more vulnerable to the effects of confinement and translocation afterward.[3] Whereas overt clinical manifestations of peracute and acute capture stress and myopathy are not apparent, physiological responses occurring soon after capture indicate otherwise. The changes in these parameters suggest an increased predisposition to the effects of further stress (e.g., trauma, nutritional changes and imbalances, oxidant stressors,* infections).[3] Based on these findings, an adaptive management approach has been adopted in Zimbabwe and Namibia that attempts to reduce the high mortality rate associated with capture and translocation. Significant improvements in management may be accomplished in these three areas: capture, boma confinement, and translocation.

CAPTURE AND TRANSPORT

Regardless of the methods used, capture and transport of the black rhinoceros should be undertaken only by experienced personnel.[1] Depending on terrain, logistics, and economic factors, rhinoceroses can be darted either from the ground or from a helicopter.[2] Ground darting requires considerable coordination, the use of a fixed-wing aircraft, and bush skills. Helicopter darting is preferable if large numbers of animals are to be captured in a short period. Human and animal safety is of paramount importance.

Minimizing Stress

The first step in lessening the stress experienced by black rhinoceroses during capture is short, smooth induction of anesthesia. Work in Namibia has established the value of using high doses of etorphine HCl (M99, C-Vet), 4 to 4.5 mg, combined with azaperone (Stresnil, Janssen Animal Health), 250 to 300 mg, and hyaluronidase (Hyalase, Fisons Pharmaceuticals), 4500 U in producing rapid induction times of less than 4 minutes.[12] Research in Zimbabwe has

*Paglia, D and Miller, E. Personal communication, 1992.

In Fowler, 1993

Table 35–1. COMPARISON OF PHYSIOLOGICAL AND BLOOD PARAMETERS IN CHEMICALLY IMMOBILIZED BLACK RHINOCEROSES IN ZIMBABWE, 1988 AND 1990

Parameter	Drug Combination*				
	n	*M99/X/H*	*n*	*M99/X*	*p Value*†
Induction time	14	7.0 ± 1.2‡	22	17 ± 2.5	<0.004
Distance moved (km)	14	1.3 ± 0.33	25	2.9 ± 0.5	<0.03
Body temperature (°C)	14	37.6 ± 0.23	27	38.8 ± 0.19	<0.0006
Respiration (breaths/min)	14	7 ± 0.9	27	10 ± 0.8	<0.009
Pulse (beats/min)	14	66 ± 4.1	21	77 ± 5.2	>0.1
Cortisol (μg/dl)	14	1.67 ± 0.25	27	2.1 ± 0.13	>0.1
Glucose (mg/dl)	14	62.5 ± 6.6 (3.5)§	27	102.9 ± 6 (5.7)	<0.02
CPK (IU/liter)	14	214 ± 38	27	348 ± 32	<0.02
LDH (IU/liter)	14	738 ± 66	23	1136 ± 57	<0.0001

*M99, etorphine; X, xylazine; H, hyaluronidase.
†Significance determined using analysis of variance.
‡Mean ± SEM.
§Numbers in parentheses, mmol/liter.

supported the use of high doses of etorphine (4 mg) with xylazine (100 mg) and Hyalase (4500 U).[4,7] These combinations have reduced the induction time from 17 ± 2.5 minutes to 3.6 ± 0.5 minutes,[4] with significant reductions in stress, based on physiological and blood parameters (Tables 35–1 and 35–2).[4] High doses of etorphine are a compromise between rapid induction and the possibility of inducing serious respiratory depression. An experienced wildlife veterinarian should always be present to deal with medical emergencies.

Following immobilization, the rhinoceros should be processed as quickly as possible by following a well-organized protocol. Doxapram HCl, 20 mg/ml (Dopram Injectable, Continental Ethicals), is routinely given IV immediately after immobilization (200 mg), and nalorphine, 10 mg (Nalorphine Hydrobromide, Centaur Labs), may be given IV to improve respiration further. This is particularly important in animals experiencing rapid induction, older animals, or those in poor condition. The first 10 minutes appear to be critical with regard to respiratory complications (normal immediate postcapture respiratory rate, 12 to 15 breaths/min, drops to 4 to 7 breaths/min within minutes, may need further medical treatment if less than 4 breaths/min). Whether the rhinoceros is placed in sternal or lateral recumbency, the animal's position must be shifted every 20 minutes prior to sledding or crating. Body temperature following capture should range from 36 to 39° C (96.8 to 102.2° F). If above 41° C (105.8° F), immediately reversing the animal should be considered. Cardiovascular system status can be gauged by the capillary refill time (less than 2 seconds) and by the prominence of the ear veins. The use of pulse oximetry is recommended.

Projectile equipment used to immobilize the black rhinoceros must be robust, reliable and, for ground darting, have sufficient power to project a heavy dart up to 40 m. In Zimbabwe, a compressed air gun fitted with a red-dot point scope is used.* The advantages of this system include accuracy, minimal noise on discharge, and continuous use (10 to 20 shots) without the need for powder charges or adding air to the cylinder. In Namibia, the Palmer Cap-Chur long-range projector is recommended as standard equipment.† Other weapons used successfully in Zimbabwe include the model 171c Pneu-Dart Long Range rifle‡

*Lowndes Tranquilliser Systems, Fenney Bentley, Derbyshire, UK.
†Palmer Chemical Equipment, Atlanta, GA.
‡Pneu-Dart, Inc., Williamsport, PA.

Table 35–2. COMPARISON OF BLOOD VALUES IN CHEMICALLY IMMOBILIZED BLACK RHINOCEROSES AFTER TRANSPORT AND PRIOR TO REVERSAL OF M99, ZIMBABWE, 1988 AND 1990

Parameter	Drug Combination Used for Immobilization*				
	n	*M99/X/H*	*n*	*M99/X*	*p Value*†
Cortisol (μg/dl)	14	4.2 ± 0.4‡	26	3.5 ± 0.4	>0.05
Glucose (mg/dl)	14	128 ± 6.5 (7.12)§	27	184 ± 9.0 (10.2)§	<0.0001
CPK (IU/liter)	14	419 ± 77	27	472 ± 58	>0.05
AST (IU/liter)	14	81 ± 7	27	107 ± 5.3	<0.007
LDH (IU/liter)	14	729 ± 67	27	956 ± 48	<0.009

*M99, etorphine; X, xylazine; H, hyaluronidase.
†Significance determined using analysis of variance.
‡Mean ± SEM.
§Numbers in parentheses, mmol/liter.

Table 35–3. COMPARISON OF SELECTED BLOOD PARAMETERS INDICATIVE OF HEALTH STATUS OF BLACK RHINOCEROSES IN ZIMBABWE*

Parameter	Value			
	n	*Cool Winter Months*†	*n*	*Hot Winter Months*‡
RBC (x 10^6/μl)	84	5.26 ± 0.07§	14	4.3 ± 0.22
Hemoglobin (g/dl)	84	16.1 ± 0.2	10	13.6 ± 0.9
PCV (%)	87	43 ± 0.55	14	39.1 ± 1.8
WBC (x 10^3/μl)	85	11.5 ± 0.44	14	7.8 ± 0.5
Total protein (g/dl)	83	8.4 ± 0.07	14	6.7 ± 1.2

*Blood samples collected at capture in the cool winter months and the hot winter months.
†Browse is available, but the quality is reduced over time (May to August).
‡Leaf fall, limited browse available, poor quality (September to October).
§Standard error of the mean.

with red powder charges. Projectile darts used in any of these systems should be of a minimum standard, generally 2 to 3 ml in volume, with a minimum needle size of 46 × 5 mm and a tapered low collar or bead about 25 mm from the tip. Needles longer than 46 mm are preferable, up to a maximum of 65 mm. Closed, pointed ends with side porting holes are preferred, rather than open-ended, beveled needles. If the latter are used, the tip must be bent or the walls must be relatively thick to prevent coring.

Following chemical immobilization, rhinoceroses may be loaded directly into a crate, as in Namibia (Fig. 35–5), or placed in lateral recumbency on a wooden sled for transport, as in Zimbabwe (Fig. 35–6). In Zimbabwe, over 300 animals have been transported to holding bomas on sleds without any obvious complications,[1,7] even though in some cases transport times were longer than 3 hours. It is believed that holding animals on sleds is without hazard for 1 to 2 hours and crating is preferable, although not necessary, for longer journeys. Recommendations that rhinoceroses be kept in sternal recumbency[2] are not supported by data collected in Zimbabwe.[6] Reports have indicated alterations in rhinoceros blood gases in lateral recumbency,* although the differences were not regarded as life-threatening.

Choosing the appropriate climatic condition is important in the successful capture with minimal stress to the animals. In southern Africa, capture in May to September, in the cool winter months, with an average temperature of 20° C (68° F), is recommended. Zimbabwean rhinoceroses captured in late September to early October, the hot winter months, when the average temperature is about 30° C (86° F), score significantly poorer on body condition than at other times of the year (Fig. 35–7). Blood parameters consistently indicate compromised health compared to baseline values collected during the cooler parts of the year (Table 35–3). Only rhinoceroses in good condition should be caught, preferably in the cool of the day.

Associated Medical Problems

In some instances, medical problems necessitate the capture of black rhinoceroses and, in others, healthy animals experience medical problems as a result of capture.

*Raath K: Personal communication, 1991.

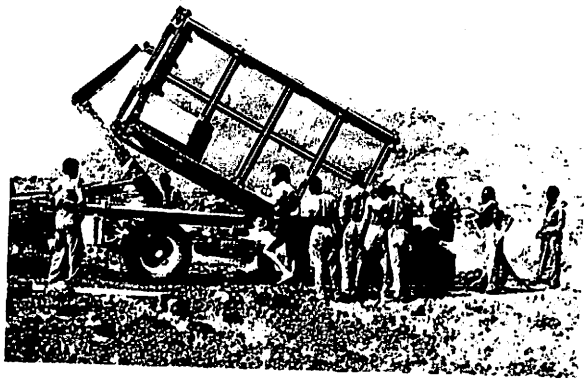

Figure 35–5. Crate system used in Namibia to load and transport recently captured black rhinoceroses.

Figure 35–6. Black rhinoceros in lateral recumbency on a sled after chemical immobilization; Zambezi Valley, Zimbabwe, 1988.

Problems Necessitating Capture

The presence of snares on limbs (Fig. 35–8) and occasionally around the chest or abdomen is an increasingly common medical problem requiring capture in Zimbabwe because of human population pressure adjacent to wildlife estate lands and private rhinoceros conservancies. Removal is simple and basic wound treatment protocols are indicated. Wounds from other causes (e.g., fencing, bullets, intraspecific fighting) may also require treatment. A common complication of healing during January to May in Zimbabwe is infestation with the Old World screwworm fly (*Chrysomyia bezziana*). This requires intensive treatment because, if left untreated, it can result in death from tissue destruction and secondary infection. Other medical reasons for capture include neoplasm removal, treatment of burn wounds from a veld fire, and lameness and loss of condition. Lameness and loss of condition were noted in an older bull that was later found to have severe osteoarthritis of the stifle joint, the cause of which was unclear.

Figure 35–7. Recently captured female black rhinoceros scoring 2 (out of 5) on a body condition scale.

Capture-Related Problems

Medical problems sometimes arise as a result of capture and translocation. The terrain inhabited by rhinoceroses is conducive to injury during capture. Rapid, smooth induction to anesthesia lessens this potential.[4] Prolonged running may lead to hyperthermia and alterations in stress parameters[7] and, if the body temperature is above 39° C (102.2° F), cooling

Figure 35–8. Presence of snare on limb requires capture of black rhinoceros in Zimbabwe.

Table 35–4. COMPARISON OF CORTISOL AND GLUCOSE VALUES OF BLACK RHINOCEROSES IN NORMAL OR STRESSED OUTCOME CATEGORIES AT CAPTURE

Parameter	Value*			
	n	*Normal*	*n*	*Stressed*
Cortisol (μg/dl)	27	1.69 ± 0.08	19	2.41 ± 0.15
Glucose (mg/dl)	28	70.2 ± 6 (3.9)†	24	128 ± 10 (7.11)

*Mean ± SEM; results determined from blood samples collected at capture (mean time from capture, 28 minutes).
†Numbers in parentheses, mmol/liter.

with water and providing shade are important. Fortunately, the black rhinoceros seems to be a robust animal, and mortalities at the time of capture are rare.[1,7]

The treatment of dart or other fresh wounds with antibiotic ointment and spray is essential soon after immobilization, because cellulitis and abscess formation have occurred in some animals. The thickness of the skin appears to prevent rupture and the subsequent drainage of abscesses, possibly leading to systemic involvement. In Zimbabwe, dart wounds are routinely injected with cloxacillin intramammary ointment (Orbenin LC, Beecham Pharmaceuticals), and all animals are given long-acting penicillin, 1 vial/250 kg (Tricillin, CAPS Veterinary).

Damage to the eyes following immobilization may occur, depending on the nature of the terrain (thick, thorn-laden bushes) and, on whether the animal is to be transported in lateral recumbency on a sled. The eyes should be examined and flushed, if needed, and ophthalmic ointment instilled (Opticlox, Norbrook Laboratories) prior to sledding or crating. A blindfold over both eyes is recommended for animals transported on sleds. Several animals at capture, notably bulls, have been blind in one eye, with chronic scarring. These animals experienced stressful recovery from anesthesia because of circling.

Stress Monitoring

The establishment of baseline biological parameters for the black rhinoceros in Zimbabwe[6] has enabled the evaluation of stress[4] and the detection of medical problems (Tables 35–3, 35–4, and 35–5). Stress parameters, including cortisol and glucose levels and other routine hematological parameters, may be accurately measured soon after capture of the rhinoceros, even in remote areas, as a result of technological advancements in laboratory equipment. These parameters are valuable in predicting problems and establishing treatment regimens.

BOMA CONFINEMENT

After chemical immobilization of black rhinoceroses in Zimbabwe, the animals are transported by sled to nearby holding bomas. It is both logistically difficult and stressful for the animals to be translocated immediately, because this might require an 18- to 24-hour trip over rough terrain. It is preferable that the animals acclimatize in holding bomas for at least 3 weeks. In Namibia, it is recommended that recently caught rhinoceroses not be transported immediately if the journey is likely to exceed 24 hours. If they are to be transported over long distances, they must be boma-trained for at least 3 to 4 weeks.

Successful boma management includes several essential strategies, because during this period the prognosis for long-term survival can be established.[4] Nutritional problems and trauma incurred during this period may severely compromise the animal's health (Tables 35–5 and 35–6). In Zimbabwe, trauma-induced horn loss is a major risk factor contributing to mortality. Of the 151 adult and weaned subadult rhinoceroses translocated to private ranches from 1988 to early 1989, 16% (24) lost front horns or suffered nasal injuries and, of the injured, 29% (7 of 24) died.[5,7]

Boma Design

Boma design and construction have evolved slowly in southern Africa over the last two decades, with significant improvements occurring in recent years. Formerly, bomas in Zimbabwe were constructed in a line of 10, each about 24 m² in area. A smaller boma was constructed for the recovery of an immobilized animal following sled transport. Boma walls and gates were constructed with mopane poles (made from a local small tree), each with a small gate leading to the transport crate.

Such bomas are now considered inadequate and were redesigned in 1990. Although the basic design

Table 35–5. SIGNIFICANT COMPARISONS OF BLOOD PARAMETERS IN BLACK RHINOCEROSES*

Parameter	Value					
	n	*At Capture*	*n*	*After Transport*	*n*	*After Confinement*
Cortisol (μg/dl)	46	1.98 ± 0.1	50	3.29 ± 0.14	26	2.05 ± 0.2
CPK (IU/liter)	52	296 ± 21	48	492 ± 34	27	2138 ± 283
LDH (IU/liter)	41	1075 ± 48	49	970 ± 41	27	1521 ± 155
AST (IU/liter)	51	81.4 ± 3.2	49	98 ± 3.9	22	162 ± 17
Glucose (mg/dl)	50	93.4 ± 6.9 (5.14)	49	176 ± 5.9 (9.7)	27	152 ± 11.2 (8.35)

*Mean ± SE; $p < 0.05$.

Table 35–6. BLOOD VALUES IN BOMA-CONFINED BLACK RHINOCEROSES*

Parameter	Period of Boma Confinement			
	n	*1–7 Days*	*n*	*8–80 Days*
CPK (IU/liter)	21	2407 ± 324	6	1200 ± 424
LDH (IU/liter)	21	1660 ± 185	6	1032 ± 149
Glucose (mg/dl)	21	165 ± 11 (9.21)†	6	96 ± 19 (5.3)
Magnesium (mg/dl)	14	1.33 ± 0.12 (0.55)	9	2.5 ± 0.23 (1.03)
Creatinine (mg/dl)	21	1.13 ± 0.06 (100)‡	6	0.83 ± 0.14 (73.3)
Potassium (mEq/liter)	21	3.51 ± 0.08	6	4.58 ± 0.15
WBC (× 10³/liter)	23	12.1 ± 0.6	7	9.6 ± 0.88
Absolute WBC Differential Counts				
Neutrophils	23	8.36 ± 0.4	7	5.7 ± 0.6
Eosinophils	3	0.11 ± 0.02	5	0.52 ± 0.07

*Comparison of mean values (± SE); $p < 0.05$.
†Numbers in parentheses, mmol/liter.
‡Units, μmol/liter.

and construction materials were retained, a further 10 bomas are now constructed parallel to the first row, 10 to 20 m apart. In addition, the size has been increased to at least 36 m², with larger water troughs and the inclusion of a cube trough. Steel swing gates replace the older wooden ones (Fig. 35–9) and walls are at least 2 m high, with all gaps covered with thatching grass. One important addition is the building of an elevated catwalk along one side to allow for easy observation, feeding, and veterinary intervention (Fig. 35–10). In these new bomas, rhinoceroses seem to acclimatize better, become less agitated, and be easier to move or introduce to another rhinoceros (i.e., cow and calf combinations). Feeding from the catwalk is easier and food intake more easily monitored.

In Namibia, bomas are designed with a minimum area of 64 m² with closely spaced poles for walls, 2.4 m in height, and poles must not be less than 100 mm top diameter (Fig. 35–9). Six bomas are built in a 3 × 3 configuration. All bomas have interleading sliding doors (1.8 m wide) and a sliding door to the outside. A single loading ramp is provided to access a central corridor between the bomas.

Medical Problems

From a management perspective, the first 3 days of confinement are the most difficult. Although temperament and acceptance of confinement vary considerably among black rhinoceroses, they may become aggressive and agitated during the first few days after capture. Some animals settle down immediately, but others (male and female) can remain aggressive for weeks.

The solitary nature and aggressive behavior of the black rhinoceros may result in fighting when animals are placed in close proximity (e.g., in adjacent bomas). Because of their tremendous strength and intensity of aggression, traumatic injuries are common.

When a cow and calf are reintroduced after cap-

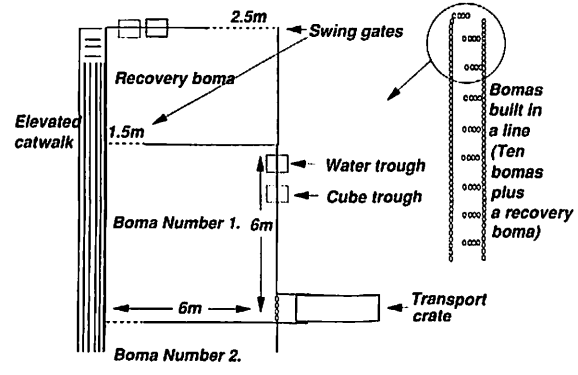

Figure 35–9. Holding bomas for black rhinoceroses captured in Zimbabwe. Note the linear design and the swing gates.

Figure 35–10. Catwalks built alongside bomas aid in the management of the black rhinoceros during boma confinement.

ture, if the cow decides to attack the calf, the calf may be seriously injured. If the calf becomes agitated it may attack its mother, traumatizing its nose. Nasal bones are not fully developed in calves and fractures occur, possibly leading to sequestrum formation or infection, which could result in meningitis.[11] Similar damage may occur if calves or subadults charge the boma walls when they perceive outside movement or noise. The construction of solid boma walls has lessened such aggressive responses to outside stimuli in Zimbabwe. Nasal bone fractures are difficult to treat, making prevention prudent.

The reintroduction of the cow and calf should proceed quietly and carefully. The use of long-acting tranquilizers is useful in lessening agitation during reintroduction. It is also recommended that the animals be kept in separate adjacent bomas for 12 to 24 hours after capture, during which time they usually begin calling to each other. The attempted reintroduction of unweaned calves is always strongly recommended, because no evidence has been found to show that quick and minimally stressful immobilization causes lactation to cease. However, if severe fighting does occur during reintroduction, it is usually wise to separate the animals. More recent work in Zimbabwe (1992) suggests that calves less than one year old may be awakened from anesthesia with the mother. Both animals settle with minimal aggression. The calf's anesthesia should be reversed 20 seconds before the mother's.

Adult rhinoceroses often lose their rostral horns after a single blow directed against the boma walls. The tip may become wedged between two boma poles when attempting to fight an animal in the adjacent boma, also resulting in horn loss a few days later. Loss of the horn leaves a hemorrhagic stump of germinal tissue that is extremely vulnerable to further trauma, possibly leading to nasal bone fracture, hemorrhage, chronic ulceration, or screwworm fly (*Chrysomyia bezziana*) myiasis. If the germinal epithelium is intact and there are no other complications, the horn regrows at a rate of 8 to 9 cm annually. In any event, loss of the horn reduces the prognosis for long-term survival.[3]

Animals with chronic nasal trauma should be confined until healing is complete and measures to reduce the chances of further trauma must be instituted. Treatment consists of aggressive flushing, cleaning, and the application of a pour-on acaricide (Flumethrin 1%, Drastic Deadline, Agricura/Bayer) or wound oil (Wound oil NF, Milborrow) and a fly repellant.

Fractures sustained during or shortly after capture may initially go unnoticed. One animal that fell over a 2-m high river bank during capture sustained a chip fracture of a carpal bone. It was not until a month later that lameness and lateral deviation of the leg were noted. Secondary infection occurred, probably related to the dart wound, and the animal died.

Fatal cardiac tamponade, the result of the rupture of a coronary artery aneurysm, occurred in one adult female rhinoceros.[8] Although she was less aggressive than expected at the time of capture, she was immobilized, transported, and reintroduced to her calf without complications. She was found dead 4 days later in sternal recumbency. This lesion has been seen before in Zimbabwean rhinoceroses and, although the cause remains unclear, it may be the result of a parasitic lesion.[8]

Diarrhea is occasionally seen during boma confinement, although the cause is unclear. It may result from changes in diet, combined with the stress of confinement. Rhinoceroses that are weaned onto alfalfa hay or cubes may suffer a transient diarrhea, but this usually subsides when the cubes are eliminated and browse is increased.

Signs of hemolytic crisis have not been observed during boma confinement, although one adult bull passed red urine 3 days after capture. However, this was likely myoglobinuria, because this animal's anesthesia and transport time was in excess of 5 hours. A hemolytic crisis was seen in a Namibian black rhinoceros the day after transport; the cause was not determined.

Skin lesions are often present at capture, often the result of migrating adult or larval filarial nematodes (*Stephanofilaria dinniki*),[10] and probably do not require treatment. On one occasion, multiple, raised, punctate, 5- to 10-mm diameter ulcerated lesions developed on the lateral chest and thorax during confinement. This animal was treated with antibiotics and the lesions resolved completely.

Table 35–7. RECOMMENDED TRANQUILIZER DOSES FOR BLACK RHINOCEROSES*

Age†	Weight Range (kg)	Recommended Drug: *Clopixol-Acuphase*	Recommended Drug: *Trilafon*
Calf	100–350	0.67–1 mg/kg (200–250 mg)‡	0.5–0.8 mg/kg (100–200 mg)
Subadult	300–500	0.67–1 mg/kg (250–300 mg)	0.6–0.8 mg/kg (200–300 mg)
Adult	500–1200	0.24–0.41 mg/kg (300–600 mg)	0.2–0.6 mg/kg (300–500 mg)

*To aid in taming and training during boma confinement and for transport.
†All animals should receive Clopixol-Acuphase. Adults might not need Trilafon, but calves and subadults should receive Trilafon.
‡Total dose range in parentheses.

Management Recommendations

Long-Acting Neuroleptics

The use of a long-acting neuroleptic (LAN) in animals is a relatively new concept.* In humans, LANs are used in the treatment of psychoses and are particularly useful in the treatment of chronic schizophrenia by reducing anxiety and hostility, decreasing motor activity, and moderating excitement. LANs have significantly aided in the successful acclimatization of black rhinoceroses during boma confinement by reducing agitation, aggression, and trauma. Zuclopenthixol acetate, 50 mg/ml, (Clopixol-Acuphase, A/S Lundbeck) produces excellent tranquilization, without affecting appetite, during the critical first 3 days of boma confinement. Combinations of Clopixol-Acuphase and perphenazine enanthate, 100 mg/ml (Trilafon, Sherag) have been used in Zimbabwe and Namibia on aggressive animals. The two are used in combination because the effects overlap, providing good tranquilization for about a week.

Clopixol-Acuphase begins to act within an hour, peaks at about 36 hours, and wears off at about 72 hours. Trilafon begins to act at about 12 hours and continues for about 7 days. It is recommended that all rhinoceroses be treated with Clopixol-Acuphase and Trilafon be used on particularly aggressive adults. Excitable adult females, subadults, and calves may also be treated with the two drugs in combination. Recommended doses are listed in Table 35–7.

Horn Tipping and Dehorning

The tipping of horns should be a standard procedure for all rhinoceroses to be translocated, although this might not be necessary for horns shorter than 20 cm. Tipping helps prevent horn loss, especially in rhinoceroses with long horns and reduces serious adverse interacations in the postrelease settling period following translocation. Approximately 33 to 50% of the front horn should be removed, using a crosscut wood or bow saw. Depending on the length of the rear horn, tipping may not be necessary. Experience suggests that the horns become sharp again in approximately 5 months.

*Ebedes H, Burroughs R: Personal communication, 1991.

In Namibia, complete dehorning has been carried out on wild populations in situ and when establishing new populations as a result of the poaching threat to the desert rhinoceros. Few large predators threaten this unique rhinoceros population, but the density is low. Following standard immobilization procedures, the front and rear horns are removed approximately 6 cm from their bases and rounded with hoof clippers and rasp. Stockholm tar is applied to the surface to prevent cracking and any infection if the germinal area is exposed. Stockholm tar is not used on females with calves, because the smell may prevent the cow from smelling the calf and complicate reintroduction. Regrowth in two animals was documented at 4 to 7 cm annually.

Nutrition

Various types of preferred fresh browse (e.g., forbs, shrubs, and trees) should be present in the boma, either on the ground or hung from the wall, before the rhinoceros arrives. Good-quality alfalfa or grass hay should be introduced on the first day, with the amount increased gradually until each animal is fed 25 kg/day by the second week. A minimum of 40 kg of edible fresh browse/animal should also be offered in the early morning and late afternoon (usually, 80 to 120 kg browse must be offered to yield 40 kg edible browse). Feed should be kept in the boma at all times. Black rhinoceroses tend to eat certain browse species well for a few days and then go off that species, so a variety must be provided. Rhinoceros or horse cubes should be introduced gradually, up to about 4 to 10 kg/animal/day, by the second week. Water containing a mineral-vitamin mix should be changed daily.

Duration of Confinement before Translocation

In Zimbabwe, until 1988, most black rhinoceroses were translocated within 1 to 7 days of capture. This practice carried with it a significant risk of morbidity and mortality.[5,7] It is now recommended that all rhinoceroses remain in boma confinement for at least 3 weeks. Biological parameters should be determined at capture and compared to baseline values,[8] and any potential health problems should be investigated.

At capture, each rhinoceros should be scored on body condition (1, emaciated; 2, poor; 3, fair; 4, good; 5, excellent). Animals that score 4 or 5 can be translocated after 3 weeks' confinement. Those scoring 3 should be evaluated. Blood parameters should be within minimum standards (RBC, ≥4 × 10⁶/μl; Hb, ≥14 g/dl, PCV, ≥35%; total protein, ≥7 g/dl). If at least three of these parameters are not acceptable, translocation should be delayed until improvement occurs. Rhinoceroses with body scores of 1 or 2 should not be translocated (see Fig. 35–8). Nutrition should be re-evaluated and medical treatment instituted, if necessary.

TRANSLOCATION

More than 350 black rhinoceroses have been translocated in Zimbabwe since 1986, 171 to private land and the remainder to wildlife estate land on ex-situ breeding programs in the United States and Australia. A few of the early animals were free-released on arrival at their destinations, but most were placed in bomas prior to release. The practice of free release is not recommended because the animals often move a long distance away immediately, making it impossible to monitor them in the new environment. In addition, medical problems resulting from transport may go unnoticed.

Black rhinoceroses in Namibia are either translocated immediately after capture (if the journey is relatively short) and held in bomas at the release site, or they are tamed and trained in bomas at the capture site prior to translocation.

Loading and Transport

During acclimatization in the holding bomas, rhinoceroses ideally should be gradually introduced to transport crates. This is achieved by placing alfalfa and cubes inside the crates and allowing the animals to move into and out of the crates at will. A small dose of etorphine (0.25 to 0.5 mg for subadults and adults) should be administered before loading a rhinoceros into a crate for transport. After administration of the etorphine, either by projectile dart or with a pole syringe, the animal should be left to rest quietly for 10 to 20 minutes. Some animals may then be guided into crates without ropes, but others need encouragement. A rope should be placed over the front horn and lower jaw and gentle, forceful traction exerted to guide the animal into the crate. All crates should be positioned on the truck so that the animals face backward, thereby preventing injury from sudden stops.

A dose of Clopixol-Acuphase should be given to all rhinoceroses, either early on the day of transport or after crating (see Table 35–7). The dose of etorphine used for crating can be reduced in tranquilized animals. Animals that become agitated and aggressive in their crate prior to transport should be moved into the shade to avoid hyperthermia. Using water to cool such animals is not recommended, because crate floors may become slippery. Prior treatment with etorphine and/or Clopixol-Acuphase prevents agitation in most animals and ensures a tranquil state during transport.

Boma Management at Release Site

Boma design at the translocation site should conform to minimum standards (see earlier). Attention to nutrition must continue at the translocation site. Initial maintenance on alfalfa and cubes is preferable, with local browse introduced gradually, especially if it differs from that in the capture area. Weaning animals off alfalfa and cubes and onto browse should be done over a 2-week period. They should consume about 40 kg of browse daily at the time of release (2 to 3 weeks after transport). At this time, the animals should score a 3, 4, or 5 on body condition.

Release and Associated Medical Problems

All rhinoceroses in boma confinement at a single location should be released during the night and into early morning. Rhinoceroses have been successfully released at hourly intervals in Zimbabwe, but the recommendation is to release single animals (or cow and calf combinations) at 24-hour intervals. Increasing the interval (by several days) between individual releases may augment territorial behavior and increase the likelihood of fighting. Introduction of other animals months to years later, especially bulls, often results in territorial battles in which the newly introduced animals may be killed.

Mortalities in black rhinoceroses are common following translocation, either in the translocation boma or after release. Death can result from interspecific fighting and trauma, horn loss, screwworm fly infestation, or parasitism. Some animals have become mired in mud during the rainy season. Unfortunately, in many cases, the causes were not determined. Because browse is often in short supply at the time of translocation, nutritional deficiency is sometimes suspected.

Of the animals that have been necropsied, many have had hemosiderosis,* possibly suggesting hemolytic episodes.* The significance of blood parasites (*Theileria, Trypanosoma* sp.) is unclear, but may be relevant. Exposure to *Leptospira* serovars occurs in free-ranging black rhinoceroses from the Zambezi valley, but the significance is equivocal.

Preventive Measures and Long-Term Survival

Factors relevant to long-term survival may only be determined with improved monitoring of translocated animals. The location and health status of each animal should be logged at regular intervals, preferably on a daily or weekly basis. Data should be gathered on all animals that give birth, and necropsy should be promptly conducted on any animal that dies.

*Jessup D: Personal communication, 1991.

Telemetry equipment would be invaluable in such monitoring. Other postrelease monitoring aids include marking all animals with a white paint, using ear tags and notches, notching a nail for tracking purposes, placing a transponder in the forehead, 10 cm in front of the left ear, and using either a horn telemetry implant or a neck collar.

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CHEMICAL IMMOBILIZATION OF WILD EQUIDS

Henning Wiesner

Wild equids frequently require sedation for simple procedures, such as moving from one enclosure to another or loading into crates or vehicles for transport. Wild equids may appear to be docile, but caution should be exercised to avoid human injury.

SEDATION

Oral Sedation

Aggressive stallions may be calmed for routine moving or transport with acepromazine (Vetranquil 1%, Albrecht) 1.5 mg/kg PO, as granules. The granules are mixed with moist food and readily consumed by the animal. The effect begins within 15 to 20 minutes. The animal does not lie down spontaneously because of the physiological reflexes that maintain an upright position. This sedation is not sufficient for the physical restraint of adult equids, but juveniles may be easily caught. Ketamine may be also administered, 0.5 mg to 1 mg/kg IV, to immobilize an animal for minor surgery or wound treatment.

Parenteral Sedation

The following drugs may be administered by IM injection: romifidine (Sedavet, Boehringer), 0.06 mg/kg, medetomidine (Farmos Group Ltd.), 0.08 mg/kg, or detomidine[1] (Dormitor, Farmos Group Ltd.) 0.08 mg/kg. Effects begin within 5 to 7 minutes and last 60 to 90 minutes, with the following side effects: ataxia, perspiration, bradycardia hypertension (up to 200 mm Hg), and relaxation of the eyelids, ears, lower lip, and penis.

For transport, routine movement, settling in of wild equids, and prophylactic treatment of capture myopathy, a long-acting neuroleptic (LAN) such as perphenazine enanthate (Trilafon LA, Sherag; Decentan, Merck), 0.6 to 0.8 mg/kg IM, can be successfully used in zebras. An LAN should always be combined with a short-acting neuroleptic such as acepromazine or xylazine to enhance and modulate the effects of the two drugs. An LAN may be effective for up to 72 hours.[2]

IMMOBILIZATION

Hoof trimming and minor or major surgery of wild equids always requires immobilization. For the last two decades, the major drug used for the immobilization of wild equids has been etorphine hydrochloride. In Europe it is combined with acepromazine and marketed as Immobilon (C-Vet). In North America it was marketed as M99 (Lemmon). Etorphine is

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