# THE USE OF HALOPERIDOL AS A LONG-ACTING NEUROLEPTIC IN GAME CAPTURE OPERATIONS*

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ABSTRACT: Hofmeyr J.M. The use of haloperidol as a long-acting neuroleptic in game capture operations. *Journal of the South African Veterinary Association* (1981) 52 No. 4 273-282 (En) Etosha Ecological Institute, P.O. Okaukuejo 9000, South West Africa/Namibia.

Haloperidol (R1625, Serenace) a potent, long-acting butyrophenone neuroleptic, was shown to be very effective in game capture operations for the neuroleptization of several species of African wild herbivores, especially the medium and small antelopes. With a rapid onset of action following intravenous injection and a duration of action of 10-12 h in the majority of cases, haloperidol produced profound psychomotor effects and remarkable tractability in red hartebeest, blesbok, springbok, duiker, steenbok and dik dik. Haloperidol suppressed the alarm reaction and facilitated the large-scale handling and translocation of captured animals. It also produced favourable sedation in Hartmann's zebra, Burchell's zebra, tsessebe and Black-faced impala. Extrapyramidal effects were observed in some species.

Key words: antelopes, Equidae, game capture, haloperidol, Serenace, transportation, tranquillizer, wild animals.

## INTRODUCTION

One of the major problems in the capture and transport of wild herbivores is animal losses caused by an alarm reaction which results in stress, exertion, hyperthermia and injuries. Moreover, in aggressive species and amongst male animals of many species, fighting is a major drawback during translocation operations. In view of these problems, there has long been a need for a suitable long-acting neuroleptic that would effectively suppress the alarm reaction, reduce the effects of psychological, somatic and heat stress and facilitate the handling and transport of captured wild herbivores.

Haloperidol (R1625, Haldol, Halopidol, Serenace***) is a potent and specific neuroleptic drug or major tranquillizer which was developed by Janssen Pharmaceutica, Beerse, Belgium[13] [14]. It belongs to the butyrophenone group of compounds, and the chemical designation and empirical formula for haloperidol are, respectively 4'-fluoro-4-[4-hydroxy-4 (4-chloro-phenyl)-piperidino]-butyrophenone and $C_{21}$ $H_{23}$ $Cl$ $FNO_2$[14]. The butyrophenones also include such well-known neuroleptics as fluanisone (Janssen Pharmaceutica, Beerse, Belgium), azaperone (Stresnil, Janssen Pharmaceutica, Beerse Belgium) and droperidol (Inapsine, Janssen Pharmaceutica, Beerse, Belgium)[21]. Of these drugs, haloperidol has the longest action.

Janssen[13] [14] gives a comprehensive description of the mode of action and pharmacology of haloperidol and other potent neuroleptics and states that these drugs are powerful and effective central nervous system dopamine blocking agents which have a high affinity for the membranes surrounding the synaptic cleft of dopaminergic neurones in the midbrain. At lowest effective doses, the nigrostriatum, or A9-system is specifically depressed. At significantly higher doses these drugs exert a blocking effect on the noradrenergic A10-group of neurones, i.e. on the median forebrain bundle system for self-stimulation. The autonomic noradrenergic system in the mid-brain and the rest of the sympathetic system are only significantly interfered with at much higher doses[14]. Janssen[14] put forward the hypothesis that the true antipsychotic activity of neuroleptic drugs is associated with their inhibitory effects on the dopaminergic nigrostriatum system of the midbrain and that the psychomotor sedative effects are associated with their inhibitory effects on the noradrenergic median forebrain bundle system.

In contrast, the low potency so-called sedative neuroleptic drugs such as promazine, are active only at much higher dose levels and are relatively aspecific in their neuroleptic action. Their first effect is to block noradrenergic neurotransmission in the midbrain, including the autonomic sympathetic centre. They are also active as peripheral alpha-adrenolytic compounds at low dosage levels, while the dopaminergic neurones in the midbrain are interfered with at very high doses only[14].

It is therefore not surprising that in man haloperidol is extensively used in psychiatry and is the drug of choice in the emergency treatment of psychomotor agitation, irrespective of its origin[15]. Crane, according to Thomas[23], states that in man, the most important side effects of haloperidol are extrapyramidal symptoms and dystonia, closely followed by restlessness, including akathisia.

According to Pienaar[21] the butyrophenones are not active hypotensive and hypothermic substances and consequently have little effect on the heat regulatory mechanism, blood pressure or heart rhythm of animals. In contrast these side effects are pronounced for some of the commonly used phenothiazine derivatives. Gerle[6] reports that although mild arterial hypotension is regularly seen in haloperidol treatment, it is considered insignificant and that the drug is remarkably well tolerated in patients with grave heart complaints. He concludes that haloperidol has a remarkably low toxicity and possesses powerful neuroleptic properties.

Reports on the use of haloperidol in wild animals are limited to a few studies only. Pienaar[21] found it to be a useful drug for acclimatising newly captured impala (*Aepyceros melampus melampus*) lambs to their holding pens. Hofmeyr et al.[12] found that springbok (*Antidorcas marsupialis*) are one of the more excitable ungulates and are easily alarmed during capture operations. They report on the successful tranquillization of this species with haloperidol at dosage rates of approx-

imately 0,25 mg/kg. Tranquillized springbok were exceptionally calm and tractable and showed marked catalepsy when they were placed in the back of an enclosed truck. In addition, they were not alarmed when clinical examinations were performed and blood samples taken. Therapeutic effects were maintained for 10-12 h. Extrapyramidal effects were absent even when springbok received as much as 30 mg haloperidol. However, restlessness, possibly due to over-dosage was occasionally observed. Because Hofmeyr et al.[12] only gave dosage rates, the recommended dosages for the different age groups and sexes in springbok are given in Table 1.

During the same study, Gericke et al.[5] investigated the effects of haloperidol on various blood parameters in captured springbok. They found that although the animals were considerably over-exerted as a result of the capture operation, clinical observations and blood chemistry studies showed that haloperidol was effective in reducing the effects of stress and suppressing the alarm reaction. This resulted in a marked reduction in capture mortalities[12].

Dr D.G.A. Meltzer of the Department of Physiology, Pharmacology and Toxicology, Faculty of Veterinary Science, University of Pretoria (personal communication), used haloperidol for the transportation of bontebok (*Damaliscus dorcas dorcas*). He found that initial doses of 10 mg haloperidol for ewes and 15 mg for rams appeared to be too high following immobilization with etorphine hydrochloride (M99, Reckitt & Colman, Hull, England) and that the animals were only calm when the transport vehicle was stationary. Consequently Meltzer suggests a combination of 5 mg haloperidol and 5 mg xylazine (Rompun, Bayer, Leverkusen, Germany).

Mr P. Norton, Department of Nature and Environmental Conservation, Cape Province, (personal communication), reported suitable psychomotor sedation in a single klipspringer (*Oreotragus oreotragus*) injected with 4,0 mg (0,3 mg/kg) haloperidol.

Because of its long-acting properties which maintain therapeutic levels for 8-12 h, haloperidol was evaluated in several other species of wild ungulates, including eland (*Taurotragus oryx*), kudus (*Tragelaphus strepsiceros*), gemsbok (*Oryx gazella*), roan antelope (*Hippotragus equinus*), sable antelope (*Hippotragus niger*), Burchell's zebra (*Equus burchelli*), Hartmann's zebra (*Equus zebra hartmannae*), red hartebeest (*Alcelaphus buselaphus caama*), blesbok (*Damaliscus dorcas phillipsi*), tsessebe (*Damaliscus lunatus lunatus*), Black-faced impala (*Aepyceros melampus petersi*), reedbuck (*Redunca arundinum*), common duiker (*Sylvicapra grimmia*), steenbok (*Raphicerus campestris*), and Kirk's dik dik (*Madoqua kirki*).

## GENERAL PROCEDURE

Pharmaceutical solutions of haloperidol at concentrations of 10 mg/ml, 20 mg/ml and 40 mg/ml were used (see addendum). The animals under consideration were captured in South West Africa/Namibia during the period 1972-1980. Dosages and routes of administration, drug action and duration of therapeutic effects were noted. In several cases, clinical observations on rectal temperature, cardiac rate and respiration rate were monitored. Wherever possible the mass of a sample of animals was determined in order to ascertain the

dosage rate, otherwise it was calculated from body mass obtained from other sources (Tables 1 & 2).

Eland, kudus, gemsbok, plains zebra, mountain zebra and hartebeest were captured with the boma method described by Oelofse[19] and Pienaar[22]. These animals were loaded via a ramp into communal crates on trucks. Animals were injected with haloperidol by darting them either in the holding pen or following immobilization. The holding bomas were about 25-40 m long and not wider than 20 m to accommodate the darting of animals using a pneumatic projector (Palmer Chemical & Equipment Co. Inc, Palmer Village, Georgia, USA), which has a range up to 15-20 m. The darting was done through appropriate slits made in the hessian or plastic lining, care being taken to prevent human shadows from falling against the lining and frightening the game. Zebra were usually injected while moving up the loading ramp.

The drop net technique[10][22] was used to capture sable antelope, red hartebeest, tsessebe, blesbok, reedbuck, duiker and steenbok. Black-faced impala were either lured into a capture boma or caught in drop nets. Roan antelope were lured into a boma and then immobilized before haloperidol was administered. Dik dik were caught with a netting method. Netted animals were injected intramuscularly or, preferably, intravenously with haloperidol, using disposable syringes fitted with 22 or 25 gauge needles. The veins of the ear pinna were considered the most suitable sites for injection. Animals which were darted from a helicopter or in a holding pen with etorphine hydrochloride (M99) and azaperone were injected with haloperidol before the administration of the narcotic antidote. Because haloperidol precipitates when mixed with etorphine or fentanyl (Janssen Pharmaceutica, Beerse, Belgium), it could not be incorporated in the narcotic-neuroleptic mixture.

In the majority of cases, animals were transported in communal crates and were observed to determine the effects of haloperidol during transport and release as well as the duration of therapeutic effects. Observations also included the reactions of animals to humans and other animals. In the case of red hartebeest, blesbok, Black-faced impala, duiker and steenbok, attendants usually travelled with the animals which were kept under constant surveillance in transit.

## INDIVIDUAL ANIMAL SPECIES: PROCEDURE, RESULTS AND DISCUSSION

Although obvious species differences exist, the neuroleptic effects of haloperidol were to a considerable degree influenced by the capture and transport methods used for each species, while other extraneous factors and variables also played a role. It is, therefore, necessary to give a brief description of the procedure used for each species, followed by the results obtained and a discussion where necessary.

### Burchell's zebra and Hartmann's zebra

When captured with the boma method, both species invariably commenced biting and kicking one another in the holding pen. Furthermore, considerable fighting and restlessness were displayed by untranquillized zebra transported in communal crates. This led to mortalities and injuries caused by exertion, particularly amongst foals.

Owing to the traumatic effect of dart needles on zebra, and frequent haemorrhage from the dart wound, the injection of haloperidol by remote means was not successful in these species. More consistent results were obtained when adult zebra were injected intramuscularly with haloperidol using an automatic syringe and floating needle, as they walked onto the ramp during loading. Twelve Burchell's zebra and 11 Hartmann's zebra which each received 100 mg haloperidol in this manner, at dosage rates of approximately 0,30 mg/kg and approximately 0,35 mg/kg respectively, were much calmer than controls or zebra darted with haloperidol. Soporific and cataleptic effects were evident in several of the Hartmann's zebra. Although the drug took effect within 10 min, it was necessary for the transporting vehicle to remain stationary for at least 15 min for haloperidol to exert its desired effect.

In a comparative study and following the same procedure, similar sedative effects were observed when 7 adult Burchell's zebra were each injected with 25 mg propionyl-promazine (Combelen, Bayer, Leverkusen, Germany). However, Combelen produced preputial prolapse in stallions. Duration of sedation was not determined with either drug, although haloperidol should have a longer action.

Recommended haloperidol doses for free-ranging Burchell's and Hartmann's zebra are given in Table 1. Following preliminary investigations, the indications are that captive zebras, particularly stressed animals, require significantly lower haloperidol doses.

Red hartebeest

A total of 355 hartebeest were captured, 292 with the

Table 1: RECOMMENDED HALOPERIDOL DOSAGES FOR FREE RANGING BURCHELL'S ZEBRA, HARTMANN'S ZEBRA, BLESBOK, TSESSEBE, BLACK-FACED IMPALA, SPRINGBOK, DUIKER AND STEENBOK

| SPECIES | EXERCISE | AGE AND SEX | RECOMMENDED DOSAGES | | *BODY MASS (kg) | | | DRUG EFFECTS AND DURATION |
|---------|----------|-------------|---------------------|--|-----------------|--|--|---------------------------|
| | | | Total dose (mg) | Dosage rate (mg/kg) | Range | x̄ | n | |
| Burchell's zebra+ | Automatic syringe and floating needle on ramp | Adult | 100 | ± 0,3 | 290-371 | 334 | 23 | Calm but not tractable |
| Hartmann's zebra+ | ditto above | Adult | 80-100 | 0,28-0,35 | — | · 287 | 45 | Calm but not tractable. Soporific effects at 100 mg |
| Blesbok | Intravenous injection in nets | Adult M<br>Adult F<br>Young | 15 up to 20<br>10<br>5-7,5 | ± 0,21 up to 0,28<br>± 0,14<br>0,11-0,16 | 65-78<br>70<br>45-47 | 72<br>—<br>46 | 11<br>1<br>2 | Good, tractability lasting 12-14 h. Occasional aggression |
| Tsessebe+ | Intravenous injection in drop nets | Adult M<br>Adult F<br>Young | 40-45<br>40-45<br>20 | 0,25-0,30<br>0,25-0,30<br>± 0,25 . | 148<br>148 ·<br>81 | —<br>—<br>· — | 1<br>1<br>1 | Good psychomotor effects and tractability, lasts > 6 h |
| Black-faced impala++ | Intravenous injection in drop nets and boma | Adult M<br>Adult F<br>Subadult<br>Young 8 mths<br>Young 6 mths | 7,0-7,5 (10-12)<br>5,0-6,0<br>5,0-5,5<br>3,5-4,0<br>2,5-3,0 | ± 0,10<br>0,88-0,10<br>0,09-0,10<br>0,09-0,10<br>0,09-0,11 | —<br>—<br>—<br>—<br>— | ·73,1<br>60,0<br>51,8<br>38,0<br>· 26,3 | 7<br>9<br>6<br>7<br>9 | Good psychomotor effects and tractability ± 7 h. Extrapyramidal effects |
| Springbok+++ | Boma and drop nets | Adult M very large<br>Adult M large<br>Adult F<br>Subadult<br>Young | 10-15<br>7,5-10<br>7,5<br>5,0-7,5<br>2,0-5,0 | 0,2-0,3 x̄ 0,25 | 45-55<br>· 35-45<br>25-35<br>. 25-35<br>15-25 | · 47<br>40<br>30<br>?<br>19 | —<br>—<br>—<br>—<br>— | Excellent effect and tractability. 10-12 h |
| Duiker (Semi-tame) | Intravenous injections in drop nets | Adults | 7,5 . | ± 0,45 | ·15-18 | 16,5 | 2 | Excellent effect and tractability > 12 h |
| Steenbok+ (Semi-tame) | Intravenous Injection in drop nets | Adults | 5,0 | ± 0,48 | — | 10,5 | 5 | Excellent effect and tractability > 12 h |

+ Optimum doses need confirmation.
++ Recommended dosage rate = 0,1 mg/kg. May be increased to 0,16 mg/kg, especially in troublesome rams, but antiparkinson's drugs advocated to counteract extrapyramidal symptoms.
+++ Kalahari springbok which are generally considered to be larger than springbok found elsewhere in southern Africa.

*REFERENCES
Burchell's zebra – from personal routine immobilization data.
Mountain zebra – Joubert[17].
Blesbok and duiker – P. Brand, Chief Professional Officer, Department of Agriculture and Nature Conservation, SWA/Namibia, personal communication.
Impala, blesbok and tsessebe – Sample of haloperidol tranquillized game.
Steenbok – Hofmeyr & Skinner[9].
Springbok – H.G. Luchtenstein, Lochkolk, Keetmanshoop, SWA/Namibia, personal communication.

boma method and 63 in drop nets. Eleven animals died (3,8% of boma captured hartebeest) as a result of injuries sustained in the boma. Bulls were also responsible for inflicting stab wounds in the inguinal region of other animals.

A total of 281 boma captured hartebeest were tranquillized with haloperidol soon after capture. Physical restraint was avoided by darting the hartebeest in the holding/darting pen with haloperidol at doses given in Table 1. Palmer darts fitted with NC2 barbed needles were generally fired into the gluteal or thigh muscles of the buttock (Fig. 1). Groups of up to 20 animals were handled at a time. Adults were always darted first to reduce injuries inflicted by their horns. Before they were herded into the crates via a ramp, they were left undisturbed for 20-30 min for the drug to take adequate effect. The disposition of the animals before and especially after darting was most important. The most desirable effects were achieved when the animals were alarmed as little as possible before and after darting.

Although the hartebeest were unapproachable in the darting pen, they showed remarkable tractability and cataleptic immobility inside the crates (Table 2). They were easy to handle and attendants were able to move amongst the animals without causing alarm (Fig. 2). Darts were removed, animals examined, stab wounds treated and a long-acting antibiotic (Penimycin, Panvet) administered. Animals were sexed, aged and sorted without the need for physical restraint. Polythene piping was pushed over the horns of adults and secured with Pattex contact adhesive. Only occasionally did bulls engage in combat. Effective psychomotor sedation and tractability were maintained for 9-12 h and

sometimes up to 15 h. Cataleptic immobility was maintained for several hours. While under the influence of haloperidol animals were able to urinate and defaecate normally. Upon arrival at their destinations the majority of hartebeest were still affected and were often reluctant to leave the crate.

The 63 hartebeest captured in drop nets were suitably tranquillized within 5-10 min of the intravenous injection of haloperidol. This facilitated removal from the nets and loading. No losses were sustained among netted hartebeest. Although the recommended doses (Table 2) are somewhat lower than for boma captured hartebeest, the results were more favourable and consistent, presumably due to a shorter alarm reaction and the rapid effects which followed the intravenous injection of haloperidol.

The majority of boma captured and netted hartebeest were transported directly to their final destinations soon after capture. It was safe and advisable for attendants to travel with the animals. However, 86 hartebeest were transported to holding pens where they stood in quarantine for a month with the result that 8 animals died of fighting and exposure to cold. No obvious macroscopic lesions of capture myopathy were found during all the post mortems conducted.

After quarantine, the hartebeest were again darted with haloperidol. In this instance, dosage rates were considerably lower and accuracy was more critical in captive than in free ranging hartebeest (Table 2). Side effects such as hypertonia and allotrophagia, which were only occasionally seen in captured free ranging hartebeest, were commonly observed in captive animals. In one case, abnormal feeding behaviour and the inges-

Table 2: HALOPERIDOL THERAPY IN RED HARTEBEEST

| Exercise | Age, Class and Sex | Recommended Dosages | | *Body Mass (kg) | | | Effects |
| | | Total Dose (mg) | Dosage Rate (mg/kg) | Range | $\bar{x}$ | n | |
|---|---|---|---|---|---|---|---|
| Boma captured hartebeest | Adult bulls | 20-25 up to 30 | 0,13-0,16 up to 0,2 | | | | Excellent psychomotor sedation, tractibility and catalepsy inside crates. Severe alarm reaction before neuroleptization produced. inconsistent results |
| | Adult cows | 15 | 0,09-0,13 $\bar{x}$ 0,1 | | | | |
| | Young 8-11 months | 7,5 | 0,8-0,1 | | | | |
| Netted hartebeest | Adult bulls | 15-20 | $\bar{x}$ 0,1 | 145-160 | 152 | 3 | Excellent psychomotor effects, tractability and catalepsy. Consistent results |
| | Adult cows | 12,5 | $\bar{x}$ 0,85 | 118-170 | 146 | 7 | |
| | Young 8-11 months | 7,5 | 0,8-0,1 | 77-100 | 88 | 7 | |
| Captive hartebeest | Adult bulls | 12,5 | 0,7-0,8 | | | | Favourable psychomotor effects, tractability and catalepsy, but dosages more critical; dystonia and allotrophagia more common |
| | Adult cows | 10 | $\bar{x}$ 0,7 | | | | |
| | Young 8-11 months | 5 | $\bar{x}$ 0,6 | | | | |

*Body mass determined in netted hartebeest tranquillized with haloperidol.

tion of a piece of wire resulted in death due to traumatic reticulo-pericarditis, peritonitis and necrotic foci in the liver.



Fig. 1: Red hartebeest darted with haloperidol. To avoid the accidental redarting of animals, they were all darted on the right side



Fig. 2: Fully tractable red hartebeest under the influence of haloperidol in a transport vehicle

Observations were also conducted when maintenance therapy was given to 4 free ranging netted hartebeest. Three animals were observed for 26 h and one animal for 75 h. Optimum effects were evident in the first 12 h, although suitable sedation and tractability were obtained when maintenance doses, injected at 11-12 h intervals, were equivalent to or 20 % more than the initial doses. Some restlessness was noted, when maintenance doses were 40-47 % lower than initial doses. An 88 kg yearling which was observed for 75 h, was still tractable 36 h after the last injection of 7,5 mg (0,085 mg/kg) haloperidol given at Hour 36. This may be the result of the prolonged elimination half-life of haloperidol[2], which had a "taming" effect on the animal. Extrapyramidal effects were absent, but may present problems during maintenance therapy.

In conclusion, the best neuroleptic effects and overall results were undoubtedly obtained in netted hartebeest transported directly to their destinations. Haloperidol had a significant anxiolytic effect and proved to be a most useful and valuable neuroleptic to control exertion and psychological stress during handling and transport.

These favourable effects are well illustrated by a cow that gave normal birth when she was transported with several other animals. No harm came to the calf inside the crate and at the destination it was off-loaded with the rest of the group.

In another instance, a large calf that had been gored by a bull, remained completely calm and tractable under haloperidol therapy while the reticulum, abdominal muscles and skin were sutured without local anaesthetic. The calf made a full recovery. There is some support from the literature that haloperidol possesses analgesic properties. Using the writhing test and hot plate method, Christensen et al.[1] demonstrated analgesic activity of haloperidol in mice, but at dosages affecting spontaneous activity and motor coordination, the analgesic effect may be unspecific. For instance, in the tail withdrawal test in rats, which is a much more sensitive measure for analgesic properties, haloperidol was found to be virtually inactive[16]. Therefore in the event of surgery, the additional use of a local anaesthetic is considered necessary.

### Blesbok

Of 92 blesbok captured, 9 were caught in a boma, 5 were darted from a helicopter and the balance were netted. Haloperidol was administered intravenously at recommended dosage rates which are given in Table 1. Some aggressive rams received as much as 20 mg (0,28 mg/kg) haloperidol. Neuroleptic effects were evident within 5 min and effective psychomotor sedation was maintained for 12 h (in certain cases for up to 14 h). Dosage rates were somewhat higher than for hartebeest. Although the effects were similar to those seen in hartebeest, some rams showed aggression towards attendants in the crates. Rams also fought occasionally. The use of protective piping over the horns of rams in particular, was therefore necessary to safeguard both animals and attendants from injury. Side effects of an extrapyramidal nature were rare and transient. While under sedation, micturition and defaecation occurred and several animals ruminated.

The majority of blesbok were transported directly to their final destinations, remaining completely tranquil in transit. A few animals were kept in holding pens before they were distributed to farmers 3-10 d later. There were 2 deaths in the drop nets and 2 in the holding pens, but farmers had no losses either during transport or after the animals were released.

Clinical observations made every hour for 8 hours on 9 blesbok captured in a boma, handled and tranquillized with haloperidol, showed a notable decrease in cardiac rate, respiration rate and rectal temperature after one hour, followed by almost constant values for the following 7 hours (Fig. 3, 4 & 5).

### Tsessebe

Ten tsessebe captured in drop nets were injected with haloperidol intravenously at dosage rates that ranged from 0,14-0,40 mg/kg. Favourable psychomotor sedation was obtained within 5 min at dosage rates of 0,24-0,40 mg/kg, which are considerably higher dosage rates than for hartebeest and blesbok. Neuroleptic effects were maintained throughout a 6 h observation period. Although some tsessebe were not completely tractable even at high dosage rates, it was possible to

travel with a group of 5 animals and conduct clinical observations over a period of 5 h. In general the animals were calm, but transient agitation was evident when they were transported on exceedingly bumpy roads. The use of polythene piping over the horns was necessary.
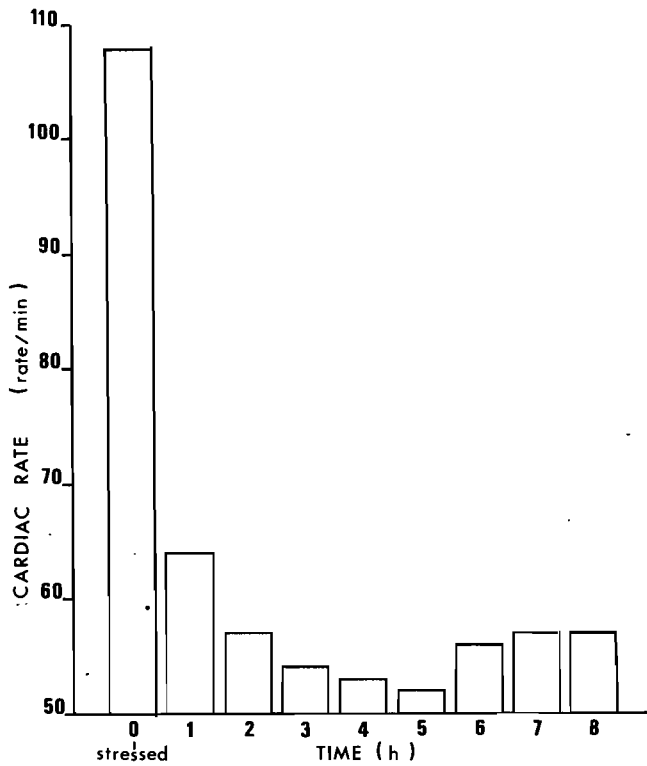


Fig. 3: The effect of capture and haloperidol therapy on the cardiac rate of blesbok (n = 9)
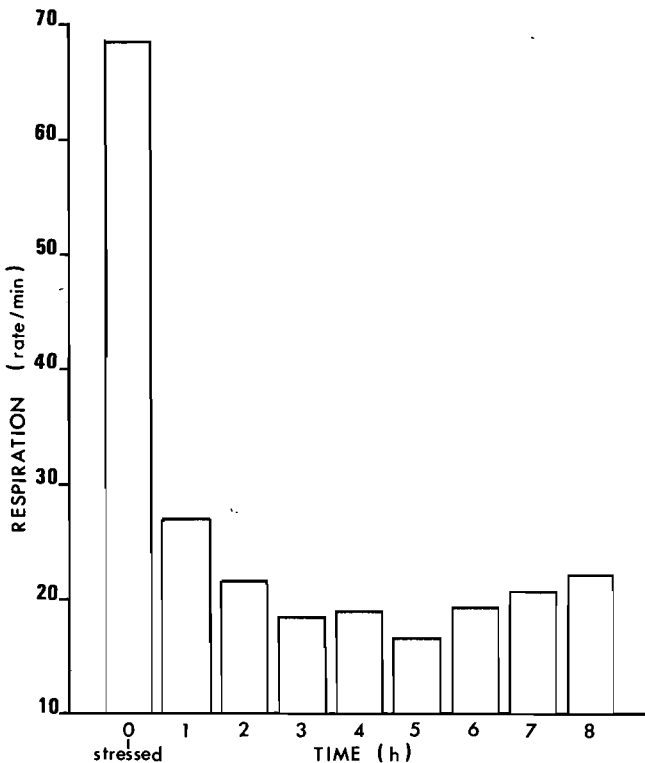


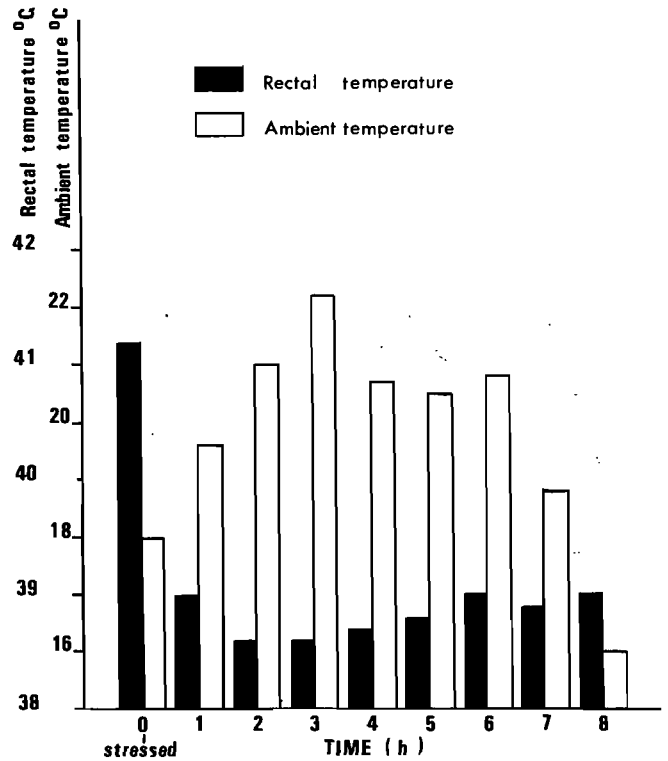Fig. 4: The effect of capture and haloperidol therapy on the respiration rate of blesbok (n = 9)



Fig. 5: The effect of capture and haloperidol therapy on body temperature of blesbok (n = 9)

There were no side effects or losses, and haloperidol successfully suppressed the alarm reaction. These results are promising in view of the fact that tsessebe are susceptible to capture myopathy and that mortalities of 64% have been reported when tsessebe were immobilized from a helicopter[24].

It should be mentioned that tsessebe can be extremely pugnacious when confined to small pens. It is therefore advisable to place bulls in individual pens, and cows and calves in a large enclosure. Recommended doses (Table 1) are 40-45 mg (0,25-0,30 mg/kg) haloperidol for adults and 20 mg (approximately 0,25 mg/kg) for large calves of approximately 80 kg mass.

## Black-faced impala

Of a total of 234 Black-faced impala captured, 70 were lured into a boma and 164 were caught in drop nets. All the impala were injected intravenously with haloperidol. A favourable neuroleptic response was observed within 5-10 min, although full tranquillization sometimes developed after 20-30 min. The use of blindfolds facilitated the handling of animals until the drug had a desirable effect and the impala were inside the crates.

Dosages are more critical and extrapyramidal symptoms, which ranged from allotrophagia in mild cases to hypertonia, torticollis and excitement in severe cases, were more frequently observed in this than in other species. Although there may be an individual predisposition, extrapyramidal effects appeared to be precipitated and enhanced by exertion, hyperthermia and excessive noise caused by the rattling of the crate during transportation. The margin, therefore, between an effective dose and one resulting in side effects is much narrower in impala and in this species haloperidol also tends to produce mild soporific effects (Fig. 6).

Fig. 6: Attendance of haloperidol tranquillized Black-faced impala during transport. Note the mild soporific effect



Fig. 7: Fully tractable duiker under haloperidol therapy

At the recommended optimum dosage rate of 0,10 mg/kg (Table 1) the animals were suitably tractable inside the crates (Fig. 6) and effective sedation lasted for approximately 7 h. At a dosage rate of 0,16 mg/kg, therapeutic levels were maintained for at least 12 h, probably longer. Extrapyramidal symptoms were controlled by the injection of 5 mg biperiden (Akineton, Knoll A G Ludwigschafen, Germany) an antiparkinson's drug. However, its effect was of rather short duration and side effects sometimes recurred. A longer acting and potent antiparkinson's drug such as dexetimide (R16470, Tremblex, Janssen Pharmaceutica, Beerse, Belgium) which has a duration of action of 48-72 h, is therefore suggested[4][25]. Although 5-10 mg xylazine controlled extrapyramidal symptoms, a pronounced soporific effect developed.

Impala are rather susceptible to injuries and exertion when caught in nets and losses as high as 10 % were encountered. They were also prone to injuries when handled in a capture boma or in pens. The injection therefore of haloperidol, without causing injuries, is still a problem which needs to be overcome.

## Duiker and steenbok

Thirty-four semi-tame common or grey duiker captured in drop nets, showed remarkable tractability and psychomotor sedation, following the intravenous injection of 7,5 mg (approximately 0,45 mg/kg) haloperidol. Similar results were obtained in 2 steenbok which received 5 mg (approximately 0,48 mg/kg) haloperidol intravenously (Table 1).

The effect was rapid and animals could be removed from the nets and loaded after 5 min. Once released in the truck they were exceptionally calm. In both species, haloperidol had a marked anxiolytic effect and there was a pronounced change in disposition of the animals, with complete loss of fear for people (Fig. 7). Duiker ewes at full term pregnancy responded well to haloperidol therapy. They were not distressed and there was no evidence of abortions.

During tranquillization, the animals either lay or stood and urination and defaecation were normal. In 3 duiker the haloperidol dose was increased to 12,5 mg. They appeared more drowsy and were inclined to sternal recumbancy, but no pronounced soporific effect was evident.

Twenty-seven duiker were transported 275 km inside a steel crate in a 15-ton truck. The animals were in the truck for 11 h and were completely at rest in the stationary vehicle, but during transportation the noise of the rattling steel crate and bumpiness of the truck caused restlessness amongst certain animals. Apparent extrapyramidal effects of a transient nature, noticeably chewing and licking of objects, occurred but these effects completely disappeared when the vehicle stopped.

The other 7 duiker and 2 steenbok were transported 420 km in a 1,25-ton truck fitted with a canopy and canvas flaps. They were in the vehicle for 12 h. In this vehicle the animals became restless when the truck commenced travelling with the flaps raised, but they immediately calmed down once the canvas was lowered. However, as soon as the animals became conditioned to the moving vehicle, the flaps could be rolled up again without causing alarm. Transportation with raised flaps was necessary to ensure adequate ventilation and cooling by convection at that time of year. These observations are important and clearly show that desirable psychomotor effects of haloperidol will be influenced by the immediate surroundings of the animal and that certain occular and auditory stimuli influence the degree of neuroleptic effect produced.

Therepeutic levels were maintained for at least 12 h, possibly longer and the animals were still calm when they were released. Observations continued for 48 h after transportation; no losses occurred and all animals fed and drank water.

## Dik dik

Five dik dik were captured at night in a net and placed in an enclosed truck. They showed profound tractability soon after the injection of 2,5 mg (0,42-0,64 mg/kg) haloperidol. However, one animal required an additional 2,5 mg haloperidol after 3 h. Maintenance doses (2,5-5,0 mg) were necessary in all the dik dik approximately 10 h later. During a separate investigation a single dik dik required 27,5 mg (5,5 mg/kg) haloperidol over a 12 h period. Apart from a mild soporific effect, no other side effects developed. In dik dik, haloperidol dosage rates are somewhat higher than in the other species investigated.

## Other species

### Eland

Adult eland bulls may be particularly pugnacious and can fatally injure other eland when captured in a boma or transported in a communal crate[11].

Although 3 adult bulls which were captive for 3 months were successfully transported together following haloperidol therapy at 0,1-0,125 mg/kg[11], communal transportation was not possible with 3 free ranging bulls which were immobilized, injected with 150 mg haloperidol (approximately 0,22-0,3 mg/kg) and then revived. In view of these findings, the communal transportation of free ranging adult bulls tranquillized with haloperidol is not recommended and problems may also be experienced with the communal transportation of captive bulls.

The effects of haloperidol when used alone, that is without the after effects of or interaction with immobilizing drugs, were not determined.

### Kudu

Haloperidol produced a favourable response in 2 young kudus, one of approximately 150 kg and another of approximately 50 kg body mass, when injected intravenously with 30 mg (0,2 mg/kg) and 12,5 mg (0,25 mg/kg) haloperidol respectively. However, an adult bull darted with 60 mg haloperidol and which showed a neuroleptic response after 30 min, became decidedly aggressive and dangerous when attempts were made to herd it on to a ramp and charged the author.

Although untranquillized kudu cows and calves remain calm inside suitably enclosed transport crates, haloperidol may be indicated for the release of kudus into pens. Dr T. van Wyk, veterinarian of the game capture team, Department of Agriculture and Nature Conservation, South West Africa/Namibia (personal communication), found haloperidol useful for the handling of kudu calves which had been caught in drop nets.

### Gemsbok

This is one of the aggressive species which present significant problems during capture operations. Ten gemsbok darted with 80 mg (approximately 0,36 mg/kg) haloperidol did not show any favourable drug effect, neither did 5 gemsbok which were each injected with 90 mg (approximately 0,40 mg/kg) haloperidol. The animals fought and remained restless.

### Roan antelope

Although roan antelope have been successfully air-lifted under narcosis[8], their transportation by road in communal crates, remains a problem. Following the immobilization of 43 boma-captured roan antelope, the intravenous injection of 5-10 mg haloperidol for 21 calves and 20-30 mg for 22 adults, did not produce favourable psychomotor sedation. During the 6 h 425 km journey, hypertonia, allotrophagia, hyper-excitability and occasional, but severe, fighting were observed which resulted in 6 casualties, of which 2 were the victims of fighting and 4 died of capture myopathy.

### Sable Antelope

Sable calves, 45-70 kg body mass, captured in drop nets, and transported in communal crates, showed favourable psychomotor sedation, but were not fully tractable

when injected with 20-25 mg haloperidol at dosage rates of 0,29-0,42 mg/kg.

### Reedbuck

Although a subadult semi-tame reedbuck ram was very tractable during an airlift operation when injected with 7,5 mg haloperidol, suitable tranquillization could not be achieved in 8 free ranging reedbuck which received as much as 90 mg haloperidol without producing soporific effects in certain individuals. In this species 30-40 mg xylazine produced suitable tractability but it was accompanied by pronounced soporific effects.

## GENERAL CONCLUSIONS AND SUMMARY

Janssen[15] points out that one surprising fact about tranquillizers in veterinary practice is their marked species specificity, which generally limits the usefulness of a particular neuroleptic to a few species only. During these investigations, haloperidol was shown to be particularly effective in the majority of small and medium antelope species, especially red hartebeest, blesbok, springbok, duiker, steenbok and dik dik. In these animals it produced a pronounced psychomotor effect. It was shown to effectively control psychological stress, injuries and additional exertion after capture and to suppress the alarm reaction during handling, transportation and even initial acclimatisation. The very successful application of this drug has made it possible to overcome innumerable problems associated with the handling, treating, sorting and transportation of game.

In the author's experience, haloperidol has greatly enhanced the management and survival rate of the above species during translocation operations. In particular, farmers who received animals tranquillized with haloperidol, have been most impressed with the favourable responses produced by this drug. Haloperidol also shows considerable promise in tsessebe.

In the larger ungulates, variable results were obtained. However, haloperidol produced a favourable response in young kudus and sable calves, and in Burchell's and Hartmann's zebra. Recent studies have shown it to be a useful and effective neuroleptic for the transportation of black rhino (*Diceros bicornis*) (personal observations).

Side effects of an extrapyramidal nature were observed in roan antelope, Black-faced impala, red hartebeest and to a lesser degree in blesbok and duiker. Springbok tend to show transient restlessness. Although certain animals may show an individual predisposition to side effects, there is substantial evidence that these effects are enhanced by hyperthermia, noise, excitability and a concommitant catecholamine reaction. Care should therefore be taken not to over-excite the animals during capture and handling and not to exceed recommended dosage rates in species which are prone to extrapyramidal symptoms. It is essential to keep animals calm after injection to enable haloperidol to exert its desired effect. In addition, in view of the abnormal feeding behaviour which occasionally accompanies haloperidol therapy, special care should be taken to prevent the ingestion of foreign bodies such as syringe needles or bits of wire as this can lead to a traumatic reticulo-pericarditis. Extrapyramidal effects, particularly excitomotoric phenomena, combined with ex-

ertion and hyperthermia, may lead to irreversible capture myopathy. Severe extrapyramidal effects should therefore be controlled with biperiden or preferably with the potent longer acting dexetimide.

The fact that pronounced soporific effects and concommitant ataxia are not a feature of haloperidol, are major advantages for the mass translocation of game. Mild soporific effects were seen mainly in Hartmann's zebra and Black-faced impala. It should be noted that haloperidol therapy following immobilization was generally not entirely successful and results were inconsistent, possibly because of unfavourable drug interactions. Neuroleptics such as azaperone would tend to potentiate extrapyramidal side effects and xylazine would enhance soporific effects.

As haloperidol is almost devoid of anti-adrenergic and other autonomic effects at normal dosage rates[13][14], tractability is enhanced by placing the animals in a suitably enclosed crate and by having them in groups, particularly those species which are gregarious by nature. For instance, red hartebeest, blesbok, impala, springbok, duiker and steenbok showed pronounced tractability inside crates but not outside. In addition, it was possible and indeed advisable, for an attendant to supervise and remain with the animals during transportation. *However, it should be emphasized that large and medium-sized herbivores tranquillized with haloperidol, should be handled with caution and respect as they tend to show aggression to people and may become extremely dangerous when on their own.* When retained individually in pens or crates adult kudu bulls, adult male hartebeest and blesbok rams, may attack without provocation when under the influence of haloperidol.

Another interesting feature of these studies was that haloperidol doses and effects differed significantly in certain species between free ranging and captive animals as well as between wild and semi-tame animals. In captive animals stress and/or taming produced by captivity, may account for these differences. Hence zoo animals may not only respond differently to haloperidol but may also require different dosage regimens.

Haloperidol produced a rapid neuroleptization in the majority of species which was evident within 5 min of intravenous injection. As with any tranquillizer, a major drawback is the disturbance and handling associated with giving the injection. Therefore, the most suitable technique for injection must be sought and the advantages of haloperidol therapy need to be weighed against the disadvantage of handling or possible disturbance of the animals. In animals which are successfully captured in nets, drug administration is no problem.

As losses during transportation may be high, especially when animals are moved after a short captivity period, Harthoorn[7] recommends transportation immediately after capture, or only after a lengthy period of captivity to allow for rest, readaptation, change of diet and taming. Even a lengthy period of captivity may present problems with psychological stress and management, and result in increased losses, unless there are proper holding facilities and supervision. During these studies, the translocation of red hartebeest and blesbok immediately after capture, thus avoiding a captivity period, was most successful. Therefore, in view of the long-acting properties of haloperidol, the transportation of game direct to their destinations is recommended, if this is practicable.

The therapeutic effects of haloperidol were maintained for 10-12 h in most cases. Sedation of a longer duration, particularly when animals are transported over long distances, may be obtained by maintenance therapy, although results may not be as consistent and there is the added problem of having to reinject the animals. The use therefore, of longer acting neuroleptics such as bromperidol (R11333, Janssen Pharmaceutica, Beerse, Belgium)[18][20]and haloperidol decanoate (R13672, Janssen Pharmaceutica, Beerse, Belgium)[3] which have effects lasting for up to 24 h, and 30 d respectively, is worth considering.

In conclusion, haloperidol holds considerable promise in game capture operations especially for the small antelopes, notably the Cephalaphinae and Neotraginae, and the medium-sized species, particularly the Antilopinae and Alcelaphinae. Furthermore, haloperidol may be advocated for the members of the Tragalaphinae and Equidae. It should be emphasized that haloperidol therapy should not be a substitute for but must go hand-in-hand with sound game capture principles.

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## ADDENDUM

According to the manufacturer's instructions the formulation of haloperidol at the following concentrations should be prepared as follows:

| Formula | Concentration | | |
|---|---|---|---|
| | 10 mg/ml | 20 mg/ml | 40 mg/ml |
| Haloperidol | 4,0 g | 8,0 g | 16,0 g |
| Lactic acid U.S.P. (85%) | 4,40 ml | 8,80 ml | 17,60 ml |
| N/1 Sodium Hydroxide (Analar) appr. | 1,20 ml | 2,40 ml | 4,80 ml |
| Water for injection | 400 ml | 400 ml | 400 ml |

1. Determine the mass of the haloperidol and place it in a glass beaker. Add the lactic acid. Mix well whilst heating on a hot water bath at 80 °C and stir until the mass is liquefied.
2. Boil about 200 ml of the water and stir in the material from stage 1 until dissolved. Cool.
3. Make almost up to volume with water, stir in thoroughly the sodium hydroxide, check pH to 3,2 ± 0,1 then adjust to final volume.
4. Stand the solution for 24 h protected from light.
5. Clarify the solution through a No. 3 sintered glass filter, or membrane filter and distribute into suitable amber multidose vials. Seal.
6. Autoclave the ampules at 115-116 °C for 30 min to sterilize. The pH of the final solution is 3,2. Care must be taken to add no more than the correct amount of sodium hydroxide, otherwise haloperidol may be precipitated.

During processing the solution should be protected from direct sunlight as far as possible, and the bulk or filled vials stored in the dark as necessary.