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IMMOBILIZATION OF FREE-RANGING AFRICAN LIONS (*PANTHERA LEO*) WITH A COMBINATION OF XYLAZINE HYDROCHLORIDE AND KETAMINE HYDROCHLORIDE

L. H. Herbst,[1] C. Packer,[1] and U. S. Seal[2]

ABSTRACT: The combination of 55 mg/ml xylazine hydrochloride and 200 mg/ml ketamine hydrochloride was effective for immobilizing African lions in Tanzania. Nineteen adult females were given between 55 and 110 mg xylazine hydrochloride in the first dart. Initial doses of 110 mg xylazine hydrochloride and 450 mg ketamine hydrochloride equivalent to >0.9 mg/kg xylazine hydrochloride were most effective in achieving rapid immobilization. Lower doses of xylazine hydrochloride required supplementation with ketamine hydrochloride. These doses could be delivered easily in 3-ml darts. The use of lightweight darts and a blowgun was found to be useful as a supplement to longer range dart projector systems since many animals could be approached at short range.

INTRODUCTION

Several drugs have been used successfully to immobilize large felids. Lions have been immobilized with succinylcholine chloride (Schaller, 1972); phencyclidine hydrochloride, alone or in combination with various tranquilizers (Campbell and Harthoorn, 1963; Pienaar et al., 1969; Seal and Erickson, 1969; Ebedes, 1970; Seal et al., 1970; Holmes and Ngethe, 1973; Bertram, 1976; Smuts et al., 1977); tiletamine hydrochloride-zolazepam (Krahwinkel, 1970; Bennett et al., 1972; Bertram and King, 1976; King et al., 1977; Van Orsdal, 1984); and ketamine hydrochloride (Smuts et al., 1973). Bush et al. (1978) tested a variety of drug combinations on lions and described their effects on blood gases and blood pH. Problems were experienced with the routine use of several of these drugs, e.g., respiratory paralysis (succinylcholine hydrochloride), long recovery times (phencyclidine hydrochloride), or large volumes needed for an effective dose (ketamine hydrochloride). Other drugs while found to be relatively problem-free have not been commercially available (tiletamine hydrochloride-zolazepam).

This report describes the use of xylazine hydrochloride in combination with ketamine hydrochloride to immobilize wild lions. This report also evaluates the use of a blowgun and lightweight plastic darts to deliver drugs to free-ranging but relatively tame lions.

MATERIALS AND METHODS

We attempted to dart selected female lions from prides in Serengeti National Park and Ngorongoro Crater, Tanzania. These prides have been under study for nearly two decades and most lions are individually recognizable by ear notches and whisker spot patterns. Lions were immobilized by intramuscular injections of a mixture of xylazine hydrochloride (55 mg/ml) (Rompun, Haver-Lockhart Laboratories, Division of Bayvet Corporation, Shawnee, Kansas 66201, USA) and ketamine hydrochloride (200 mg/ml) (Ketaset, Bristol Laboratories, Division of Bristol-Myers Co., Syracuse, New York 13201, USA). To obtain these concentrations, we freeze-dried the commercial drugs and reconstituted them. Additional injections of ketamine hydrochloride (100 mg/ml) were given as necessary to adjust or prolong the level of anesthesia. Diazepam (Valium, 5 mg/ml, Roche Laboratories, Hoffman-LaRoche Inc., Nutley, New Jersey 07110, USA) was kept on hand to arrest any convulsions. The drugs were delivered in 3-ml plastic dart syringes equipped with 3.8-cm 16-gauge needles using a 1.8-m blowgun

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(Zoolu Arms of Omaha, Omaha, Nebraska 68107, USA). This system uses a charge of butane gas behind the plunger to inject the drug on impact.

The heart girth of each lioness was measured and used to estimate body weight (Bertram, 1975). Blood samples were collected from all animals and six lions were radio-collared. Respiratory rates were monitored during anesthesia and minimum rates were recorded. If it was very hot, rectal temperatures were monitored and the lions were doused with water to prevent hyperthermia.

RESULTS AND DISCUSSION

A total of 19 female lions were immobilized. The dosage of xylazine hydrochloride ranged from 55 to 110 mg per animal (0.46 to 1.17 mg/kg). Total dosages of ketamine hydrochloride ranged from 450 to 1950 mg per animal (3.8 to 16.7 mg/kg). However, the doses were spread out so that lions received secondary injections (100–300 mg ketamine hydrochloride) not less than 20 min after the initial xylazine hydrochloride–ketamine hydrochloride dart and not less than 5 min apart.

Early signs of drug effects such as mydriasis and/or hind limb ataxia were observed within 2–14 min of darting ($\bar{x}$ = 7.2 ± 3.6 min, n = 17). The time elapsed from darting until first signs were observed was negatively correlated with the estimated dosage of xylazine hydrochloride ($r = -0.735$, $P < 0.001$, df = 15). The onset of full anesthesia (when a lion could not lift its head) often required supplemental doses of ketamine hydrochloride. However, five lions required only an initial dose (110 mg xylazine hydrochloride and 450 mg ketamine hydrochloride) to achieve full relaxation. These animals were unable to lift their heads 11–22 min after being darted ($\bar{x}$ = 17.2 ± 4.4 min). The dose of xylazine hydrochloride for these animals ranged between 0.92 and 1.17 mg/kg.

Another way to describe the time course of induction is to measure induction time, i.e., the time elapsed since first darting until the last secondary dosage was administered or the animal was handled. We handled the lions almost immediately after the final drug injection. Lions were able to be handled between 22 and 92 min after first darting ($\bar{x}$ = 37.3 ± 18 min). Induction time was negatively but not significantly correlated with xylazine hydrochloride dosage ($r = -0.386$, $P > 0.10$) but was significantly positively correlated with ketamine hydrochloride dosage ($r = 0.913$, $P < 0.0005$). This second result reflects the fact that additional injections of ketamine hydrochloride were given at not less than 5-min intervals to complete the induction process.

Since the median induction time was about 30 min, we compared the initial dosages of xylazine hydrochloride for lions that were handled within 30 min with those for lions that were handled after 30 min. As expected, the faster group had a higher average dose of xylazine hydrochloride (0.84 versus 0.73 mg/kg), but this was not statistically significant ($P < 0.10$, one-tailed t-test).

One solitary lioness had a very long induction time and required the largest supplemental dosage of ketamine hydrochloride. She may not have received the full amount of xylazine hydrochloride. She was also outside of her usual home range and appeared very nervous. Only one female became excited during induction, jumping and crawling away from other pride members when they approached.

Minimum observed respiratory rates during the course of anesthesia ranged from eight breaths per min for a lioness given 1.17 mg/kg xylazine hydrochloride in the morning to 42 breaths per min for a lioness given 0.72 mg/kg xylazine hydrochloride at midday.

No convulsions occurred although two lions were given 10 mg diazepam injections as a precaution. Six lionesses retched or vomited during induction. There were no deaths.

Quantitative data on recovery times were collected for only 13 animals. Six lions were left in sternal recumbency. All of these females were left in the company of other pride members and were checked 1–2 hr later or, if it was too dark, the following morning. Most lions were left if they were "chest up" or could stand. Five lions were observed to lift their heads 21–80 min after their last drug injection ($\bar{x}$ = 51.8 ± 23.5 min). Seven lions were "chest up" or could crawl after 22–159 min ($\bar{x}$ = 86.1 ± 39.9 min) and five were able to stand or walk after 54–128 min ($\bar{x}$ = 99.8 ± 28.7 min). All of the lionesses were seen on several occasions after they were darted.

This is the first report of the use of a xylazine hydrochloride and ketamine hydrochloride combination to immobilize African lions in the field. This combination resulted in satisfactory immobilization within a reasonable amount of time and without complications experienced with other drugs or with ketamine hydrochloride alone (Smuts et al., 1973).

Most of the captures were carried out while females were with other pride members. The response of other pride members to a darted female was always to approach and "head rub" with her after she first reacted to the dart. The presence of other pride members seemed to calm the darted animal. When we approached and handled the darted animal, the other lions retreated about 20–30 m away and then ignored us.

We attempted to immobilize 26 lions with the blowgun system. However, two lionesses were too shy to let us within range (ca. 5 m). Twenty-four lionesses were darted and of these, 19 were successfully immobilized. A total of 47 darts were fired. Only 29 darts successfully hit the target and delivered drug. Seven darts missed or glanced off the target, four darts broke on impact where the needle joined the syringe barrel, causing a loss of drugs, and seven darts bounced out before discharging drug. Eleven lionesses were darted without mishap, but because of system malfunctions during initial dartings, five lionesses became too shy for us to immobilize successfully.

The most costly problems with the darting system involved dart breakage and bouncing out before discharge. Both result in loss of drugs. Tests on captive animals have established that these problems were the result of an excessive impact force resulting from the use of too long a tube and too hard blowing. This can be alleviated by use of a 1-m tube at these ranges and adjustment of the puff power. An important additional problem was dart leakage. Because the system is under pressure when charged, gas can leak out of the tail seal and drug can lead from around the plug over the needle port. These problems often caused delays and allowed the lion to move back out of range. The vaporization of the butane is temperature dependent and high afternoon temperatures contributed to the problem. The quality of the silastic glue used for preparation of the plugs contributed to this problem also. Use of a medical-grade preparation has reduced this problem. Another alternative is to use darts designed to use air pressure rather than butane behind the plunger.

Overall the system has advantages in that it is relatively silent and non-traumatic to the lions. We recommend this system for field use as a supplement to more powerful darting systems when animals are tame enough to be approached closely.

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