Journal of Zoo and Wildlife Medicine 41(2): 331–333, 2010

USE OF XYLAZINE HYDROCHLORIDE-KETAMINE HYDROCHLORIDE FOR IMMOBILIZATION OF WILD LEOPARDS (*PANTHERA PARDUS FUSCA*) IN EMERGENCY SITUATIONS

Aniruddha V. Belsare, B.V.Sc. and A.H., and Vidya R. Athreya, M.Sc.

Abstract: In India, leopards (*Panthera pardus fusca*) inhabit human-dominated landscapes, resulting in encounters that require interventions to prevent harm to people, as well as the leopards. Immobilization is a prerequisite for any such intervention. Such emergency field immobilizations have to be carried out with limited tools, often amidst large uncontrollable crowds. An effective and practicable approach is discussed, based on 55 wild leopard immobilizations undertaken between January 2003 and April 2008. A xylazine hydrochloride (1.4 ± 0.3 mg/kg)–ketamine hydrochloride (5 ± 2 mg/kg) mixture was used for immobilization of leopards, based on estimated body weight. When weight could not be estimated, a standard initial dose of 50 mg of xylazine–150 mg of ketamine was used. Supplemental doses (50–75 mg) of only ketamine were used as required. No life-threatening adverse effects of immobilization were documented for at least 1 mo postimmobilization.

Key words: Emergency, field immobilization, leopard, *Panthera pardus fusca*.

BRIEF COMMUNICATION

The leopard (*Panthera pardus fusca*) occurs throughout India, and like striped hyenas (*Hyaena hyaena*) and Indian wolves (*Canis lupus pallipes*), inhabits human-dominated landscapes with varying degrees of conflict. During the last decade, there has been an apparent increase in human–leopard conflict in many parts of India, with more than a thousand people attacked by leopards in the states of Gujarat, Maharashtra, Uttaranchal, and West Bengal (Athreya, unpubl. data). Instances of leopards inadvertently trapped in wells, houses, crop-fields, or in snares and traps intended for other animals are frequently reported. Almost always, the presence of an uncontrollable and reactive crowd in such situations necessitates that the State Forest departments rapidly remove the leopard from the site to ensure safety of people as well as the animal. Instances of crowds killing leopards in such situations are not uncommon. Immobilization is a prerequisite for most interventions in field emergencies involving leopards, but it is usually avoided because the State Forest Department personnel have to work without the assistance of experienced wildlife veterinarians. Another limiting factor is the unavailability of remote drug delivery systems, lack of training in their use, or both. As a result, many such interventions result in injuries or even deaths of leopards and humans; such reports are routinely publicized by the media.

The need for training of Forest Department personnel and veterinarians in the use of remote drug delivery systems and wildlife immobilization is of foremost importance, and such projects have been initiated in many states (Athreya and Belsare, unpubl. data).

The anesthetic regime used in such emergencies is influenced by drug availability, budgetary limitations, and administrative constraints. The modern repertoire of drugs such as medetomidine, tiletamine, zolazepam, and atipamezole are not available in India, whereas xylazine hydrochloride and ketamine hydrochloride are readily available. The xylazine–ketamine combination has been used for immobilization of many wild carnivores, including leopards, but data on dosages for wild leopards in field emergencies is not readily available.[1–7] The xylazine–ketamine approach currently represents the sole practical option for immobilization of leopards in emergency situations in India. A standardized regime for such situations, based on 55 immobilizations of wild leopards between 2003 and 2008, is discussed.

Leopards trapped in cages, houses, traps, and snares were darted in the hind leg muscles (caudofemoralis or biceps femoralis) by using a blowpipe (Quality Engineering Reclaimers Pvt. Ltd., Pune 411037, India). In total, 55 wild leopards (27 adult males, 27 adult females, and one female cub) were immobilized. In emergency rescue situations when the animal was partially

From the Kaati Trust, D-3, Raanwara, Bavdhan, Pune 411021 Maharashtra, India (Belsare and Athreya). Present address (Belsare): Department of Fisheries and Wildlife Sciences, University of Missouri, Columbia, Missouri 65201, USA. Correspondence should be directed to Dr. Belsare (avbxv8@mail.missouri.edu).

Table 1. Range of vital signs monitored postinduction in immobilized leopards.

	Minutes postinduction					
	20	30	40	50	60	70
Rectal temp (°C)	39.1–40.6	38.2–40.5	38.2–40.1	38.1–40.1	37.8–39.8	37.8–38.8
Respiratory rate (breaths/min)	6–28	8–28	8–25	11–25	11–23	11–30
Heart rate (beats/min)	70–88	65–102	55–97	59–97	59–95	55–95

visible (e.g., leopard hiding in an attic or rescue operations carried out at night), a standard initial dose of 50 mg of xylazine (Ilium Xylazil, 100 mg/ml; Troy Laboratories Private Ltd., Smithfield NSW 2164, Australia) and 150 mg of ketamine (Ketamil, 100 mg/ml; Troy Laboratories Private Ltd.) was used irrespective of body weight. For leopards in trap cages, 1–2 mg/kg xylazine and 3–6 mg/kg ketamine was used, based on estimated body weight and subjective assessment of the physiologic status. For example, an exhausted leopard was administered a lower dose compared with a leopard still furiously reacting to the people around the cage. Twenty-six leopards were immobilized with a standard initial dose of 50 mg of xylazine and 150 mg of ketamine irrespective of body weight, and 29 leopards were immobilized with an initial dose calculated using the estimated weight. Supplemental doses of ketamine (increments of up to 50% of the original dose) were administered intramuscular in cases where the depth of immobilization was not satisfactory.

The induction time and first reaction time (in minutes) were noted in all cases. Induction time is the time from delivery of the immobilizing drug until recumbency, when the animal can be safely approached. The first reaction time is the time from complete immobilization until the first sign of arousal, during which the animal can be safely handled. In rescue situations, leopards were transferred to transport cages immediately after induction of immobilization. Vital signs, including rectal temperature, respiratory rate, heart rate, and capillary refill time, were monitored regularly after induction of immobilization until the first sign of arousal (Table 1).

The induction was smooth in all cases; regurgitation was noted in six leopards and three leopards had seizures typical of ketamine use during induction. The seizures were self-limiting, with one or two episodes of up to 30-sec duration, and the leopards were not treated. During the induction, leopards exhibited licking movements of the tongue and salivation, followed by ataxia and sternal or lateral recumbency. Eyelids remained open and pupils were dilated after immobilization, so care was taken to protect the eyes. Recovery was smooth and uneventful in all the animals; one leopard regurgitated during recovery. No mortality or abnormal physiologic observations were recorded during or after these immobilizations. The leopards were housed in rescue facilities and were observed for at least 1 mo after immobilization. This regime of xylazine–ketamine resulted in smooth and relatively rapid induction, smooth recovery and a first reaction time sufficient for emergency interventions (e.g., rescue from a foothold trap or a snare and transferring to a cage, wound treatment, passive integrated transponder [PIT] tagging), with no incidents of sudden recovery or any other life-threatening effects during or after the immobilization episodes. Only one leopard was not satisfactorily immobilized in spite of a total dose of 1.4 mg/kg xylazine and 8 mg/kg ketamine (based on estimated body weight). This was thought to be because of the stimuli provided by her cubs in the adjoining cage. The PIT tagging and physical examination of this leopard was carried out on a later date at the permanent rescue center.

Thirty-five leopards were weighed after immobilization, and the actual dose of xylazine and ketamine administered was calculated (Table 2). A single induction dose was sufficient to immobilize the leopard on 44 occasions; three leopards injected with the standard initial dose and eight

Table 2. Weight, actual dose of xylazine and ketamine, induction time, and first reaction time for 35 wild leopards immobilized in field emergencies.

	Mean ± SD	Range
Weight (kg)	37.8 ± 11.8	17–75
Xylazine (mg/kg)	1.4 ± 0.3	0.6–2.1
Ketamine (mg/kg)	5 ± 2	3–11
Induction time (min)	10 ± 4	3–22
First reaction time (min)	66 ± 27	20–151

leopards injected with the calculated initial doses required supplemental doses of ketamine. Repeated injections resulted in longer induction period, additional stress, and poor immobilization. Ketamine can be given in supplemental doses (33–50% of the original dose) to increase the depth, duration of immobilization, or both, but use of xylazine in supplemental doses should be avoided.[1–3] It is thus necessary to estimate body weight of the leopard to calculate the induction dose, especially for xylazine because underdosing results in unsatisfactory immobilization and increased risk. In field emergencies, whenever estimating the body weight of a leopard is problematic, we recommend an induction dose of 50 mg of xylazine and 150 mg of ketamine irrespective of body weight. During the study period, 26 leopards (actual weight range, 24–45 kg) were successfully immobilized with an initial dose of 50 mg of xylazine and 150 mg of ketamine. Even for a leopard weighing 75 kg (the maximum we have encountered), the induction dose would be 0.66 mg/kg xylazine and 2 mg/kg ketamine. Supplemental doses of ketamine can then be used to achieve satisfactory depth of anesthesia.

Unlike captive leopards, conditions before immobilization cannot be controlled in wild leopards. Furthermore, wild leopards are stressed by proximity of humans, making interventions like rescue and treatment potentially dangerous and thus challenging. It is important to minimize external stimuli by controlling the crowd and covering the cage during the immobilization process.[1,3] An anesthetic antagonist, such as yohimbine hydrochloride, was not used nor is it recommended in such emergencies, because sudden revival of an immobilized leopard amidst a crowd can be disastrous. Even after transferring the leopard to a cage, immediate recovery from immobilization is not desirable due to the omnipresent crowd surrounding the cage in such situations. A conscious or recovering leopard reacts violently to such stimulation resulting in self-inflicted injuries and stress.[3] Allowing the leopard to recover naturally as the drugs are metabolized gives an opportunity for extended monitoring, especially during the procedures that follow rescue operations such as treatment and transportation. Covering the cage during recovery is strongly recommended.

A dose of 1.4 mg/kg xylazine and 5 mg/kg ketamine is recommended for immobilization of wild leopards in field emergencies. If weight estimation is deemed problematic, a standard initial dose of 50 mg of xylazine and 150 mg of ketamine, irrespective of body weight, also can be used. Supplemental doses of only ketamine may be given (50–75-mg increments) to increase the depth, duration of anesthesia, or both.

Acknowledgments: Our work was supported by the Maharashtra Forest Department; the Rufford Maurice Laing Foundation, United Kingdom; Wildlife Trust of India, New Delhi; and the Wildlife Protection Society of India, New Delhi. We thank K. Subramaniam (retired Principal Chief Conservator of Forests), B. Majumdar (Chief Wildlife Warden, Maharashtra), and all the field officers for interest and support. Dr. Matthew Gompper, Dr. Abi Tamim Vanak, and Ashok Captain assisted in the preparation of this manuscript.

LITERATURE CITED

1. Gunkel, C., and M. Lafortune. 2007. Felids. *In:* West, G., Heard, D., and N. Caulkett (eds.). Zoo Animal and Wildlife Immobilization and Anesthesia, 1st ed. Blackwell Publishing, Ames, Iowa. Pp. 443–457.

2. Kreeger, T. J., and J. M. Arnemo. 2007. Handbook of Wildlife Chemical Immobilization, 3rd ed. International Wildlife Veterinary Services, Inc., Laramie, Wyoming.

3. McKenzie, A. A., and R. E. J. Burroughs. 1993. Chemical capture of carnivores. *In:* McKenzie, A. A. (ed.). The Capture and Care Manual. Wildlife Decision Support Services and The South African Veterinary Foundation, Pretoria, South Africa. Pp. 224–243.

4. Nath, I., T. K. Pattanaik, N. Sahoo, V. S. C. Bose, H. K. Mohapatra, and P. K. Roy. 2006. A case of histiocytoma in a leopard *Panthera pardus*. Zoos Print J. 21: 2302.

5. Pathak, S. C., A. Mukit, J. Saikia, and J. Lekharu. 1985. Excision of a leiomyofibroma in a leopard (*Panthera pardus*) under ketamine anaesthesia. J. Zoo Anim. Med. 16: 125–126.

6. Sabapara, R. H. 1995. Chemical restraint and sedation of leopards (*Panthera pardus*). Indian Vet. J. 72: 655–657.

7. Sontakke, S. D., G. Umapathy, and S. Shivaji. 2009. Yohimbine antagonizes the anaesthetic effects of ketamine-xylazine in captive Indian felids. Vet. Anaesth. Analg. 36: 34–41.

Received for publication 8 April 2009