Reducing Drug Induction Time in the Field Immobilization of Elephants

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ABSTRACT

Individual elephants have been routinely immobilized by remote injection (darting) methods for research, translocation or the treatment of injuries. Any operation to immobilize an elephant is both expensive and a considerable logistical exercise in which much can go wrong. Logistical problems, veterinary complications, danger to people and wastage of money can be largely avoided by limiting the animal's post-darting travel. Although operator technique plays a large part, safe recumbency can be greatly facilitated through the rapid knock-down effect of high doses of the immobilizing drug propelled in a type of dart which overcomes two common problems: poor placement and malfunction of the internal detonation mechanism,

RESUMMEE

L'injection à distance (darting) est une méthode cornmunément employée pour immobiliser un éléphant à des fins de recherche, de transfert ou pour le traitement de blessures, Toute opération d'immobilisation est coûteuse et en même temps un exercice logistique considérable sujet à de nombreux problèmes. Les problèmes logistiques, les complications vétérinaires, le danger pour les humains et le gaspillage des fonds peuvent être largement évités en limitant le déplacement de l'animal après l'injection. Bien que l'adresse de l'opérateur joue toujours un rôle primordial, la chute sans danger de l'animal peut être considérablement facilitée grâce à l'effet assomant rapide de fortes doses de la substance immobilisante propulsée dans un type de flèches qui surmonte deux problèmes courants: mauvais positionnement et dysfonctionnement du mécanisme de détonation interne.

INTRODUCTION

Individual elephants have been routinely immobilized for research (Thouless, 1995; Elkan et al., 1998; Whyte and Grobler, 1998), translocation (Putterill, 1993) or the treatment of injuries. Translocation is becoming an increasingly common practice in the management of elephants and is being used for the purposes of restocking (du Toit, 1998), problem elephant removal (Karindawaro, 1998), or movement of semidomesticated 'working' elephants. A recent proposal to offer an alternative form of trophy hunting, called "green hunting" (Douglas-Hamilton ,1997) involves immobilizing elephants and could be linked to research. The immobilization of elephants in very dense vegetation has presented particularly serious problems (Njumbi et al., 1996, Elkan et al., 1998), which have in turn prejudiced important research studies or much-needed management interventions in certain wild populations.

The principal immobilizing drug used in wild herbivores (Etorphine hydrochloride-M99, C. Vet, UK), has a high therapeutic index and therefore appears to be safe at higher doses in African elephants (R. Kock et al., 1993). M99 is a very concentrated synthetic opiod drug which induces narcosis, not anaesthesia or tranquillization. Combinations of various classes of immobilizing and tranquillizing agents which are sometimes applied to other species are nor required in elephants immobilized for short-duration procedures (M. Kock et al., 1993; ZVA, unpubl.). Any operation, however, to immobilize an elephant is both expensive and a considerable logistical exercise, The

cost of hiring professional people, using aircraft and vehicles and providing for ground teams and equipment means that failed immobilization efforts can waste enormous sums of money. The efficiency of the immobilizing drug in a very large, very mobile and potentially dangerous animal is therefore crucial.

No two immobilizations proceed in exactly the same manner and post-darting problems can present themselves in many different and often surprising ways. Partially sedated but still mobile elephants are distressed and can be dangerous or induce their group mates to become aggressive. Delayed effect from the drug may result in the animal disappearing from sight in difficult terrain and remaining unrecovered, The elephant could die if it does become immobilized, falls in the wrong position (e.g. occludes its trunk) or remains unattended for a long time. Particular dangers to unattended animals are (1) prolonged sternal recumbency which may cause severe respiratory distress and (2) hyperthermia.

It is the remote delivery of the drug via a dart which presents the most problems in immobilizing elephants in the field. I report on the immobilization of 65 elephants, mostly for research, over a period of five years in Zimbabwe (Hoare unpubl., 1997, 1998). The techniques used are recommended to reduce the induction time by the drug, thereby rendering the animal safely recumbent and humanely manageable in the shortest possible time.

MATERIALS AND METHODS

Of the 65 elephants immobilized, 58 were carried out by personnel on foot, supported by a fixed-wing aircraft with observer and pilot in radio contact with the ground team. The remaining seven were darted from a helicopter. With the aircraft method animals were located from the air and the ground team directed to them by radio. The movement of the elephant after darting was monitored and the ground team was directed to the animal when it was recumbent, The aircraft crew also observed the elephant's behaviour in the recovery period after reversal of the immobilizing drug.

If a helicopter can be afforded it is the method of choice because target animals can be split from the herd, driven to a convenient location or repeatedly darted if there is insufficient restraint, all with minimal risk to the operator. Operations to immobilize elephants in dense forest (Elkan et al., 1998), however, cannot use any form of aerial support and as such are particularly vulnerable to failure,

Operator technique, which comes only with experience, is very important in immobilizing elephants. Due to the legal restrictions in handling the M99 drug which is exceptionally dangerous to humans, a veterinarian is usually involved in elephant immobilizations. Darting elephants in savannas is done from a maximum range of about 40 m with most cases being carried out at about 20-25 m. It is important not to use a high power setting on the gun or a powerful charge to propel the dart otherwise it will be damaged by the impact and fail to deliver the drug properly. A sharp needle will penetrate the thick skin of an elephant (2-3 cm) even in a relatively slow travelling dart. Accurate dart placement and deep intramuscular injection are required with the low fluid volumes used in wildlife immobilizing drugs (<2 ml for an elephant). The greatest contributor to poor dart placement is the operator being too hasty to fire a shot.

I used both a South African-made 'Kruger dart' (Fauncap, South African National Parks Board, P Bag X402 Skukuza, RSA) which on contact with the animal has a spring detonation mechanism and the Pneudart (Pneudart, Pneu-Dart Inc., Williarusport, USA), which has an internal explosive mechanism.

RESULTS

I found two main problems with drug delivery in elephants, both involving the dart. One was malfunction of detonation in darts that inject their contents via an internal explosive charge. The other was poor penetration or incorrect placement of the dart needle, often due to the difficulties of stalking and approaching wary elephants at close range. But with experience I found the problems of remote drug delivery could be largely overcome using a 'triple strategy' involving

1) a spring loaded type of dart,
2) high doses of M99 (15-18mg), and
3) the routine addition of hyaluronidase to M99.

Hyaluronidase (Hyalase 2000 I.U./ampoule, Fisons Pharmaceuticals, RSA), an enzyme which facilitates drug absorbtion from any application site, and high doses of M99 have been both previously recommended (M. Kock *et al.,* 1993; R. Kock *et al.,* 1993; ZVA, unpubl.) for use in free-ranging elephants. Hyaluronidase has a limited life in solution at ambient temperatures (Morton and Kock, 1991) and has to be replaced if the dart is not used for 2-3 days, a situation which does arise quite frequently.

The Kruger dart proved absolutely reliable, delivering drug in 100% of cases (n=57). When using a Pneudart with an internal explosive charge I experienced a *25%* failure rate with good dart placements (n=11). The Kruger elephant dart has a 70 mm needle which is longer than that on any other commercially available dart. This length of needle usually achieves the required depth of penetration into muscle layers even if the dart placement is poor. In combination with high doses of M99 and hyaluronidase this means that even if the dart was poorly placed, enough of the drug was usually absorbed to at least slow the animal down considerably and greatly reduce awareness of its surroundings. The Kruger dart has an advantage if there is a need to alter the dart contents. Adding new hyaluronidase or altering the dose of M99 can be relatively easily achieved because the needle point of a Kruger dart has a removal rubber cap. With reasonable initial narcosis, a 'top-up' M99 dose sufficient to induce recumbency in such an elephant, was relatively easily administered. In other types of darts (e.g. Palmer, Pneudart) the needle tip is sealed with vaseline which makes the alteration of the dart contents messy and possibly dangerous.

The drug induction time (time from darting to recumbency) was recorded in 48 of the 65 elephants (Figure 1). The negative correlation between dose and induction time was significant (r= - 0.46, p=0.01). Figure 1 shows that variation is high at lower doses. Once higher doses are employed, the data suggest that (1) higher doses are more efficient in all sizes of elephant and (2) that a 'threshold dose' of about 14 mg may exist above which the problems associated with remote injection can be minimized.

I did not experience evidence of respiratory depression in any immobilized elephants, even with

Figure 1. Induction time (time to recumbency) in a sample of 48 African elephants immobilized with different doses. of etorphine hydrochloride (M99).

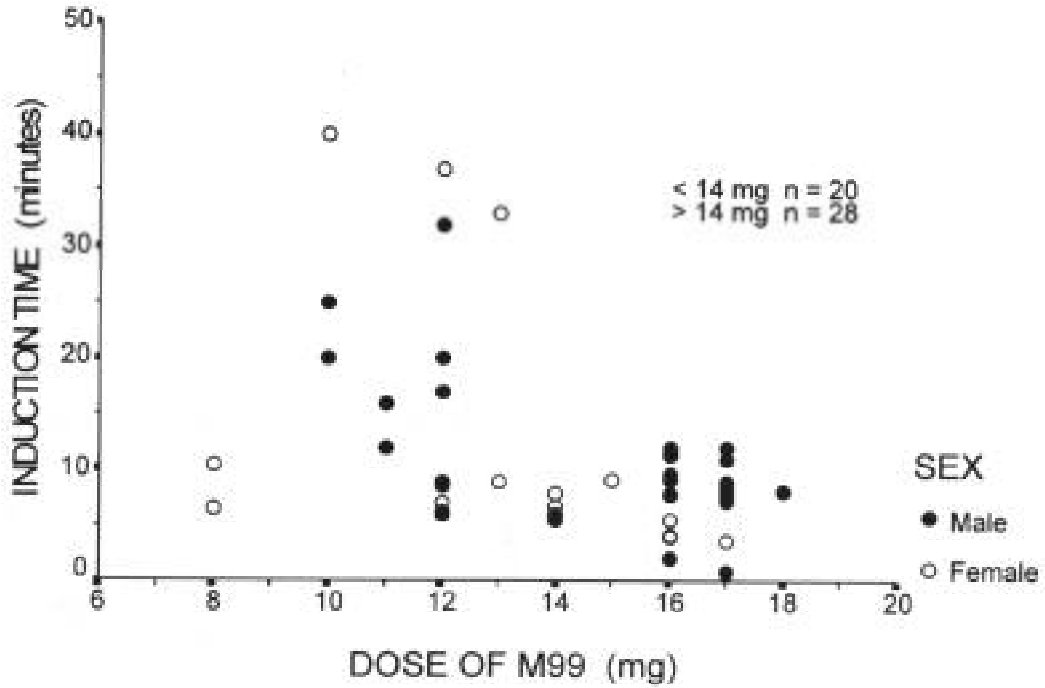

Photo credit: The Zambezi Society

Photo 1. Immobilised elephant being fitted with a radio tracking collar. (The author is standing to the right.)

small females having received high doses of M99 or animals having fallen in an awkward recumbent posture. As these animals were immobilized for fitting or removal of radiocollars or removal of snares, revival was relatively prompt, usually within 20 minutes of induction. One elephant in very rugged terrain was not located for 2.5 hours but when found in lateral recumbency was radiocollared and revived without incident. Partial revival was tried on one occasion to try to get another subject to alter its head position slightly for collar fitting. A minute dose of the M5050 antagonist drug (far less than the recommended revival dose) rapidly restored full mobility with consequent embarrassing failure of the operation.

DISCUSSION

Although the above sample of elephants in Zimbabwe was immobilized in savannas, field conditions were often characterized by thick vegetation and low visibility. Over the five year period both sexes of elephant of a great variety of sizes were immobilized, latterly all with the higher doses of M99. Cows and young bulls, easily as small as most forest elephants, were included.

Swapping darts and adjusting dart contents in the pressured conditions of field operations places particularly stressful demands on the operator who is faced with difficulties of weight estimation and therefore, in theory, dose adjustment.

The results show that a 'one dose for all' regime (16-17 mg M99+2000 I.U. Hyaluronidase) should maximize the chances of inducing recumbency of any elephant within about 10 minutes. This is in agreement with R. Kock et al. (1993) who found a significant decrease in induction time in a paired sample of fifteen elephant cows immobilized with 12mg M99 and re-immobilized with 15mg M99.

A standardized initial darting technique for all elephants makes field operations much easier. I believe that both post-darting location problems and respiratory complications were avoided in my sample because of a combination of:

1) lateral recumbency usually induced by the rapid knock-down effect of the higher doses of M99 (ZVA, unpubl.),
2) timely opportunities for the ground team to adjust recumbent posture, and
3) quicker revival of any animal in difficulty. As a strategy, this amounts to preferably managing

the known side-effects of opiod drugs rather than risking the unpredictable complications of under-dosing. Expressed more simply, in a veterinary training manual on wildlife immobilization (ZVA unpubl.): "many more animals are killed by too little M99 than by too much".

An example of extreme difficulty in immobilizing elephants is given by Elkan et al. (1998) in the Cameroon forests. They experienced 50% failures in twelve elephant immobilization attempts and of the six elephants immobilized, two were found dead after 32 minutes due to cardio-respiratory complications. Their greatest difficulty was limiting post-darting travel despite employing various technological aids e.g. crossbows to fire darts silently or darts equipped with miniature radio-transmitters or 'gametracker string'. They relied on ground tracking to guide them to the immobilized elephant but suspected that sometimes the trackers were not sufficiently competent.

Elkan et al. (1998) mostly used darts with explosive internal charges (Cap-chur darts, Palmer Chemical Co., Atlanta, USA) containing low doses of M99 (range 4.9-6.1 mg). They may have believed their low M99 doses were appropriate for relatively small forest elephants and although well aware of the potential benefits of hyaluronidase, did not use it because of the need to keep darts loaded for long periods.

Poorly executed immobilization attempts on elephants can cause danger to people, distress to the animals, waste money and attract adverse publicity. Vital research on important wild populations (e.g. forest elephants) or much-needed management interventions like translocation therefore may have been foregone due to lack of confidence in the cost-effectiveness of elephant immobilization. Similarly, the proposal on "green hunting" (Douglas-Hamilton, 1997) will never gain acceptance if in practice there are elephant deaths or welfare concerns. In elephant translocation operations described by Njumbi et al. (1996) in Kenya, the need for experience and close logistical co-ordination amongst members of the capture team was highlighted as essential for avoiding undue stress to immobilized animals. A most important veterinary experience gained in this Kenyan operation was evidence of the elephant's intolerance to immobilization whilst acidotic at a time of vegetation flush.

By advocating a slightly modified immobilization technique. I am not suggesting operator preference for different equipment combinations be ruled out. Large numbers of elephants (a total of nearly 1,000) have been successfully translocated in recent years in southern Africa (Putterill, 1993; Coetsee, 1996; du Toit, 1998). Coetsee (A.M. Coetsee, pers. comm. 1996.) used Pneudarts with internal charges and only 37 mm needles to immobilize and translocate 670 elephants in southern Zimbabwe but at all times he had the benefits of the use of a helicopter.

While acknowledging the considerable difficulties of immobilizing elephants in forests, I believe some of the problems experienced by Elkan et al. (1998), who were forced to experiment continually with their approach, might have been overcome through the use of a more standardized technique. In my case refinements to detail and technique prior to ground-based operations seemed to minimize dart failures so that subsequent cascades of potential problems were avoided. This meant whole operations became largely free of logistical and veterinary complications making the 'research processing' of studying elephants more routine and cost-effective.

The future application of some elephant translocation and research may be more limited by financial (e.g. prohibitive cost of helicopters) and political constraints than by difficulties in immobilizing the subjects. Nevertheless, with an increasing need to immobilize elephants and an increasing media interest in elephant management in general, it is imperative that wildlife professionals have at their disposal a fairly routine technique which can virtually guarantee a safe and humane method of elephant immobilization.

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