Module 3 - Component 1

Drugs for the Capture of Wildlife

Introduction

In this Component, principal drugs and their mode of action in the immobilisation of wild animals are discussed.

These include:

- Cyclohexylamines
- Dissociative anaesthetics
- Long-acting neuroleptics
- Narcotics
- Sedatives
- Their antagonists
- Tranquillisers
- Other supporting drugs commonly used in the capture of wildlife.

There are three important principles for achieving successful capture:

- Stress management at all points of the capture exercise.
- The need to manage the whole process from field to destination.
- Prevention of problems before they occur, rather than managing them thereafter.
Chemical Immobilisation

The field of drugs and delivery systems for the chemical capture of wildlife has been advanced considerably by work done in Europe and the United States. Progress has been made in all the groups of drugs associated with capture, including narcotics, sedatives, tranquillisers, dissociative anaesthetics and paralysing drugs. Similar work has been carried out in the development of delivery systems so that most animals are now well within range of the various systems currently available. With suitable experience, darting can be successfully carried out on foot, on horseback, on a motorcycle/quadbike, from a vehicle or even from the air, depending on the situation. Drugs are used directly for chemical immobilisation and indirectly in supportive therapy for mechanical operations.

The use of drugs has a profound effect on the physiological functions of the animal and many experienced operators consider it a high-risk venture, compared with the use of purely mechanical systems. As a matter of principle, therefore, the use of drugs, particularly tranquillisers, should be reduced to a minimum, focusing more on reducing stress by proper control of the animals and of the operation. Rather than treating the symptoms of stress with drugs after stress has occurred, which seldom works in the long term, it is preferable to take steps to prevent inducing stress in the first place.
A good rule of thumb during mechanical capture is to avoid the use of drugs unless the animals are to be individually handled. Exceptions include the loading of animals into crates for transportation, or when tranquilising difficult animals to obtain blood. The use of drugs, narcotics, in particular, creates added stress in the animal, a fact that should be borne in mind when the decision to dart is taken. Although the drugs are relatively safe for use, chemical immobilisation is a high-risk venture, sometimes resulting in unexplained deaths. At particular risk are animals that have lost condition for some reason or another, and animals that are obviously old or heavily tick-infested as a result of disease, age or poor condition.

Drugs nevertheless play an important role in preventing trauma where it is otherwise unavoidable. The use of drugs by non-veterinarians for game capture is strictly controlled and requires a specific drug licence from that country’s Medical Control Council.
Drugs used to calm (tranquillise) and capture (immobilise) wild animals have usually been developed, in the first instance, for human treatment. These drugs and their combinations act at various sites within the brain to produce calming (tranquillisation), depression (sedation), loss of pain (analgesia), a trance-like state and, finally, complete loss of consciousness (anaesthesia). There are also curares or drugs that produce paralysis by blocking the transmission of nerve messages to the voluntary muscles. These are known as paralytics or muscle relaxants.

**The principles of selecting the drugs and dosages for animal capture are as follows:**

- Drugs with a wide therapeutic index (i.e. ratio of the effective dose to the lethal dose) are preferred, as they are safer to use on animals.
- A rapid effect is needed to increase the chances of finding darted animals.
- The drug must have minimum side effects, such as excitement, muscle tremors, respiratory and circulatory depression, change in body temperature, salivation and bloat.
- It must immobilise the animal effectively.
- It must require a small volume, to fit in a 3 cc dart.
- A reversal agent must be available.

Narcotics, or dissociative anaesthetics, are usually combined with a sedative or tranquiliser. Narcotics used alone often cause muscular tremors, while the cyclohexylamine dissociative anaesthetics often produce a state of excitement or convulsions. Although the use of each drug is described separately in this Course, emphasis must be placed on the use of combinations of drugs, such as:

- Etorphine (M99), A3080 or Carfentanil, plus either Xylazine, Detomidine or Azaperone
- Ketamine plus Xylazine, Detomidine or Medetomidine
- Zoletil, a combination of the dissociative anaesthetic Tiletamine with the sedative Zolazepam

**Situations requiring the use of chemical immobilisation include the following:**

- Direct capture of selected animals, either from the ground or from the air
- Bleeding of selected animals for veterinary testing purposes
- Treatment of physical injuries
- Treatment of primary and secondary effects of parasitic invasions, both internally and externally
- Removal of snares
Narcotics

Narcotics are powerful painkillers (analgesics) acting on the central nervous system, causing depression of brain function and anaesthesia. Respiratory and cardiac depression are side effects that are very important to bear in mind in sick, stressed or excited animals. Because narcotics usually produce a state of muscular hyper-toxicity, particularly in the early stages of drug absorption, they should always be administered in combination with a tranquilliser or a sedative.

The combination of a narcotic and a tranquilliser has an added effect due to drug synergism. After drug reversal, the tranquilliser remains in effect. Species vary considerably in their requirements. For example, 4–5 mg of Etorphine (M99), a dosage that is sufficient to knock down a tsessebe, is the same as that required for an adult black rhinoceros. An eland bull, on the other hand, requires 12–13 mg, which is the same dosage needed to bring down an elephant.
Etorphine Hydrochloride (M99)

M99, a morphine derivative, is one of the most versatile drugs ever to have been used for capture. It has revolutionised game capture worldwide and is probably the most important event in the recent history of the industry. It can be used on a wide range of animals, although it is not generally recommended for carnivores. M99 has a wide therapeutic index, rendering accidental overdosing of animals less likely. The drug can be reversed quickly and effectively, should complications occur or when crating is complete. This is an important consideration when releasing free-ranging animals back into the wild.

The drug can be administered in relatively small doses of 1 ml, depending on the drug concentration available (ranging from 1 mg/ml to 10 mg/ml). The drug is rapidly absorbed into the system, producing quick anaesthesia. Where good, deep muscular injection is achieved, the animal is usually knocked down after 7–10 minutes. This can, however, extend to 13–15 minutes where the drug induction has been poor, usually as a result of a poorly placed dart that injected subcutaneously for example. Experience has repeatedly shown that darts placed into the animal’s shoulder provide for quicker knockdown than those placed in the rump. Where a major blood vessel is struck, for example near the base of the tail, knockdown times are reduced to two minutes.

Hyalase (Hyaluronidase) is an enzyme available in powder form in vials of 2000–5000 international units (IU). When mixed with the drug, it accelerates the absorption of the drug in the muscle and reduces knock down times to 3–6 minutes. This mixture is ideal for capture situations requiring rapid knockdown and is the ideal answer for capturing giraffes, hippopotami and rhinoceroses. Care should be exercised during its use, however, because of similar absorption capabilities in humans during the handling of the drug. Personally, the author prefers to keep dose combinations simple without Hyalase, unless the situation demands it.

The time from intravenous injection of the reversal drug to the animal standing up is generally two minutes, with possible extension to eight minutes when administered by deep muscular injection. Generally, the reversal drug of choice is Diprenorphine (M5050), although Naltrexone is longer acting. It is also more expensive and should only be used in desperate situations or where re-narcotisation is suspected, such as for a white rhinoceros. Nalorphine is the least effective drug, but it is important for partially reversing an animal under control, when “walking” the animal into a crate, for example. It is also important to ease the animal’s respiration when the respiration rate falls to six or fewer breaths per minute. The most serious disadvantage of Etorphine is its potential danger to humans – it is 10000 times more potent than morphine. Even a mere scratch of M99, i.e. 0.03–0.12 ml, is lethal. Consequently, the drug should only be used with human antidote ready to hand. Narcan (Naloxone) is no longer the antidote of choice, a 10 ml is considered the minimum dose necessary and the drug often expires when kept unused in the drug box. Naltrexone is a pure antagonist that is far more concentrated, and 1 ml (50 mg) is considered sufficient to reverse the narcotic completely in most cases. Naltrexone is also used to reverse M99 in animals, negating the need to use a different drug in cases of accidental human poisoning.
A competent bystander should be recruited and duly informed regarding its administration in the event of a problem developing. In the absence of either Naltrexone or Narcan, the reversal drug Diprenorphine can be administered at twice the amount of the estimated injection of M99. It must be remembered, however, that Diprenorphine has agonist properties of its own that may cause problems. Therefore, it must be used only as a last resort. The reversal agent should be given intramuscularly if there is no competent person on hand to administer it intravenously. For this reason, many operators, particularly those in the United States, favour alternatives like Carfentanil, which are less lethal to humans. (See the next Component for more information on drug accidents.) Following administration of M99, the symptoms are characteristic, starting within 3–4 minutes after infusion. They develop from the head backwards and can be recognised as “stargazing”, with the tail held stiffly backwards, progressing to an aimless wandering with a typical high-stepping trot or hackney gait and, eventually, separation from the herd. The animals’ sight is impaired, and they blunder into obstacles, often becoming entangled. This effect is particularly noticeable in rhinoceroses.
Usually, the symptoms progress until the animal finally collapses, provided, of course, that sufficient narcotic has been absorbed. Depending on the dose injected, the animals sometimes remain in the excitement phase, requiring additional drugs to knock them down. On no account should an animal be manhandled unless it can be restrained immediately. Any chasing or physical restraint to pull the animal down will further traumatise it. Should a second dart be necessary, it is better to administer another full dose rather than to attempt to estimate the amount already absorbed. Provided the animal is not a juvenile, it is unlikely to be overdosed. Etorphine, like most narcotics, depresses respiration and this aspect, therefore, should be monitored constantly.

Dopram V (Doxapram), or preferably small volumes (5–10 mg) of Nalorphine – often less in antelope (e.g. 1–2 mg) – is sufficient depending on the species. It should be administered intravenously if the animal’s respiration becomes too shallow. In most species, the other members of the herd first notice the onset of the drug and immediately try to render assistance or even attack the darted individual. Occasionally, these efforts can lead to severe goring about the face of the anaesthetised animal. Plains game herds often run off initially, then are located after ten minutes and thereafter are seen running off again. This initial gathering point is most often the area where the darted animal has gone down and a thorough search should be made of the immediate area.
Where possible, the number of animals comprising the herd should be noted upon darting, so that one can quickly ascertain whether an animal is missing when the herd is next located. All species go down differently. Tsessebe, for example, usually stand and appear to be eating before final collapse without a noticeable excitement phase. Waterbuck, on the other hand, show a marked excitement phase, often bolting for 3–4 minutes in one direction and running 1–2 km before suddenly collapsing, often landing in a dangerous position. Once darted, ruminants should be maintained in a sternal recumbent position, preferably with their left side up in their natural lying position rather than on the right side, which induces bloat. Many species, depending on the dosage administered, go down in this position.

Others collapse on their side or upside down, having no control of their heads. This can be fatal if the animal is not found quickly and its position corrected. This is especially true of nyala, tsessebe and waterbuck. Simple-stomached animals, such as zebra, do not have this problem and most often the animal is best left on its side. Elephants and hippopotami, because of their relative size, should always be pulled over onto their side. This will prevent excessive strain on the heart and lungs, which occurs with these species when in a sternal recumbent position. This is particularly important in the case of elephants, as the lungs are connected to the rib cage muscles, and when lying upright the stomach contents press onto the lungs, thereby restricting breathing.
Rhinoceroses, on the other hand, fare better when lying stnially, because this is how they naturally lie. As heat regulation is a problem with M99, fatal hypothermia may occur on extremely hot days if the animal does not go down quickly enough. After being chased at the time of immobilisation, stressed animals experience an immense build-up of body heat, which can be dangerous. Prolonged chasing produces a state of metabolic acidosis caused by the abnormally rapid metabolism of glycogen, which results in the production of large amounts of lactic acid. This produces a situation known as capture myopathy. It is reported that capture myopathy can be controlled to a degree by administering a 4% solution of sodium bicarbonate intravenously, but experience has shown that it is seldom effective. In practice, then, the experienced operator can and should prevent the situation from developing, as treatment is often ineffective. Body insulation and central depression of the thermoregulatory systems may inhibit heat dissipation, which further compounds the problem. Smaller animals are more prone to thermal stress than larger species. It is therefore important to monitor their temperature and preferably to maintain it between 36.5 °C and 39 °C. Temperatures exceeding 42 °C may be fatal and the animal should be cooled down or revived immediately to prevent coma and death. Temperatures in this range can be noticed even without a thermometer, simply from the heat radiating from the animal.

Once the animal has been crated, the drug should be reversed completely, even though the animal may have stood up with little sign of drug effect. Experience has shown that the drug may recycle several hours after darting due to different rates of metabolisation of M99 and the antidote. This often occurs during transportation and could result in the animal suffocating if it is jammed into a corner and is unable to respond. Animals can be transported over considerable distances involving several hours under M99, should the situation require it. For example, difficult animals like roan are better kept under narcosis when transported over long distances.
Narcosis is maintained by occasionally topping up the narcotic at a rate of 1 mg increments each time. These may be given intravenously over as much as ten hours at a stretch, provided the animals are kept under constant surveillance. Narcotic recycling is sometimes observed 5–6 hours after the capture exercise, with the animal slumping back into a partially narcotised state. A further dart, preferably of Naltrexone or M5050 (Diprenorphine), may be necessary to prevent injury to the animal, should it start wandering aimlessly about, particularly in the heat of the day when it obviously is still under the effect of the drug. Where Naltrexone was used in the first instance, however, the need for re-narcotisation is unlikely.

Certain species, such as kudu and particularly eland, often show a pronounced excitement phase, wandering aimlessly for several minutes before going down. This is because the excitement phase of the drug progression in these species is more defined than in most other species. Using Etorphine (M99), which in future may not necessarily be the drug of choice for these animals, relatively large amounts of tranquiliser is necessary to smooth over this phase of induction. Eland and kudu are two of the few species for which the author would consider using up to 50 mg of Xylazine (Rompun) in the dart cocktail, with some Azaperone as a muscle relaxant to help the animal over this stage of induction. For these species, it is possible that Carfentanil would be a better choice, as it possesses better knockdown qualities than M99, with less of the excitement associated with M99. Trials indicate that A3080 may be the drug of choice for these species. Recent thought is that A3080 quickly brings the animal to a standstill within two minutes, where it remains before going down. Carfentanil, or Fentanyl, increases body temperature significantly, a fact that must be considered under hot conditions. The author believes Carfentanil needs further investigation for use on African mammals before it can be adopted for general use.
Narcotics are always best used in combination with tranquillisers or sedatives, as mentioned. These include Xylazine, Detomidine or Azaperone, which potentiate the effect of the narcotic. This allows for the smoother induction of the narcotic, with less of the observed excitement phase before the animals go down. Generally, also, less of the drug is required to achieve the desired result because of this potentiating effect. Tremors and muscle rigidity are also largely prevented during immobilisation. Azaperone is preferred by most operators and is certainly the author’s tranquilliser of choice. Xylazine is reported to raise body temperature further, which has an adverse effect on the animal’s heat regulatory system. It also stimulates salivation and relaxes the oesophageal sphincter, which could lead to regurgitation. This is a problem particularly in eland and buffalo, as they can inhale stomach content, which often causes secondary complications later on, like foreign body pneumonia.

Detomidine, a related drug, does not produce this effect to the same extent. Azaperone, on the other hand, actually helps to reduce these adverse effects. Apart from the thermoregulation problems indicated, the author’s experience is that the reported differences between Azaperone and Xylazine are not as marked as suggested. Xylazine is probably widely used because of its availability and its specific usefulness on excitable species. It is more potent than Azaperone and has a wide effect, ranging from mild sedation to deep slumber. Caution should be exercised, however, as Xylazine in relatively heavy doses can quickly produce narcosis when used by inexperienced personnel, particularly on tame animals. However, with the introduction of Yohimbine, and Tolazoline or Atipamezole, a complete reversal of Xylazine is now possible. This is ideal when combined with cyclohexylamines for the capture of carnivores, rendering the drug extremely safe.
Narcotics have a profound effect on the animals’ cardiovascular and respiratory systems. Respiration, in particular, has to be kept under constant surveillance and should never be allowed to drop below six breaths per minute – it should preferably be maintained at a rate of around 8–12 breaths per minute. The inclusion of Azaperone instead of Xylazine combats the drop in respiration from the narcotic to a degree but is not sufficient to combat an overdose of the primary narcotic. When severe respiratory problems occur and antidote cannot be given immediately, Dopram V, at the rate of 0.5 mg per kg, should be injected intravenously to improve respiration. The response is usually immediate, and treatment can be repeated at twenty-minute intervals until the narcotic is finally reversed. Alternatively, Nalorphine may be a better choice over Dopram because of its graduated response, which partially reverses the drug. It is widely accepted in capture circles that it is better to overdose with narcotics rather than underdose, as the effect in animals can be quickly reversed should problems develop. Underdosing causes all sorts of complications, usually requiring an additional dart, whilst the stress levels accelerate as the animal stumbles around. When this occurs, a further full dose should be administered to ensure that the animal succumbs as quickly and positively as possible without further complications. Certain species, for example, hippopotami, giraffes and impala, are more sensitive to high levels of M99, and consideration must be given to this should further M99 need to be administered.
Captured animals that are to remain restrained and begin to show signs of recovery (indicated by sweating and struggling, with an obvious increase in respiratory rate) should be given a further small amount of M99, usually at the rate of 1 mg at a time, injected intravenously to restore narcosis. It is never wise to allow the animal to continue struggling unless it is about to be released. Once the antidote has been administered, no attempt should be made to re-narcotise it over the following 24 hours, as some of the antidote will still be circulating in the animal’s system. However, should re-narcotisation be unavoidable, 3–5 times the normal dose is usually necessary to achieve the desired level of narcosis. To summarise, the greatest advantage of narcotics is that they can be reversed quickly and effectively with a suitable antidote. The antidote or antagonist displaces the narcotic from the binding site in the brain or peripheral nerves because of its higher affinity for the site, effectively cancelling out the effect of the narcotic. The most widely used antidote is Diprenorphine (M5050), which is supplied with M99 and used at a rate of twice the total M99 dosage administered.

For giraffes or white rhinoceroses, this dose is occasionally increased to three times the dose of M99. The initial administration of antidote should provide for the most complete reversal of M99. Where animals require partial reversal to combat a particular problem, or when they need to be loaded into a crate, as in the case of rhinoceroses, it is better to use the antidote Nalorphine. Depending on the dose given, Nalorphine produces a graduated response providing controlled reversal management to aid partial recovery, in order to walk buffalo and rhinoceroses, for example. In certain species, particularly zebra, recycling of the antidote can occur some hours later, requiring more M5050 to cover the M99 still present in the system. If recycling is anticipated, a further full dose, i.e. twice the dose of M99, or preferably a longer-acting antidote such as Naltrexone, should be given intramuscularly. Recycling results when the antidote cancelling the effect of M99 is metabolised faster than the M99 component, allowing the remaining M99 to act on the central nervous system again until it is finally metabolised.
Fentanyl

Fentanyl is approximately 15 times less potent than M99, depending on the species. In general, the use of this drug is becoming less common because of its adverse side effect of increasing the animal's body temperature and, consequently, inducing abnormal sweating even after the drug has been reversed. This is particularly noticeable soon after the animals are reversed and they become excitable, which may be due in part to recycling. A rough guide for determining the dosage rates for Fentanyl is to use a dose 15 times greater than that recommended for M99. For example, most large plains antelope, with the exception of eland, require 4 mg of M99 or 60 mg of Fentanyl.

Fentanyl is usually supplied as a white powder, Fentanyl Citrate, which requires dissolving in distilled water, preferably by a pharmacist, before it can be used. This involves dissolving 1.57 g of Fentanyl Citrate, which is equivalent to 1 g of Fentanyl base, in slightly warmed distilled water at a volume to achieve the desired concentration. The author always had it dissolved in Dimethylsulfoxide (DMSO), also at a rate of 40 mg per ml to provide for better absorption of the drug. This preparation, however, renders the drug extremely dangerous to the operator, as DMSO is readily absorbed through the skin. The capture of rhinoceroses in an operation during 1988 showed conclusively that a combination of M99 and Fentanyl in DMSO produced quicker knockdown times than M99 on its own (Kock et al., 1990). Today, better results are achieved using Hyalase mixed with M99. Reversal of Fentanyl is achieved with M5050 at a rate of 3 mg per 10 mg of Fentanyl. Fentanyl must not be used for zebra, but it is better for the smaller antelope species, such as impala, duiker and steenbok, for whom M99 can be a problem.
Carfentanil

Carfentanil has been used extensively in the United States, South Africa and Tanzania. Indications are that it is 1.3–1.5 times more potent than M99. It is reported to have had major advantages over M99 on excitable species, such as kudu and eland, due to its far smoother induction phase and better knockdown qualities. Apparently, it is not advisable to use Carfentanil on zebra as, like Fentanyl, dangerously high dosages are necessary to produce the desired narcosis. This narcotic is less dangerous to humans than M99 and for this reason, is preferred in some circles. However, it is extremely prone to recycling even when using the antidote M5050 and should only be used in conjunction with Naltrexone developed specifically for it.

Carfentanil is marketed as a 3 mg per ml solution, called Wildnil. To reverse its effect using M5050, six times the amount administered must be given. Dosages used in Tanzania by Dr E. Anderson (personal communication) were 2.1–3 ml of Wildnil plus 20–26 mg of Xylazine for buffalo (one-year-olds to adults), 1.8 ml of Wildnil plus 20 mg of Xylazine for wildebeest (adults). He reports the knockdown time for buffalo and wildebeest as 4–7 minutes. The average time taken to get on their feet after receiving M5050 intravenously was 3–5 minutes, which is longer than with Etorphine. Body temperature rose to 40–41 °C, the pulse to 60–130 per minute, and respiration to 30–60 breaths per minute, indicating a general increase all-round over Etorphine. Naltrexone, the preferred antagonist as mentioned, remains in the system for 24 hours, covering the total time it takes for Carfentanil to be metabolised. Although Carfentanil is 1.5 times more potent than M99, the recommended dosage rates are not comparable with M99 for all animals. Combinations of Carfentanil and M99 are not advised, as the combination appears to potentiate the effect of each one, resulting in severe respiratory depression. Limited experience with the drug has shown that it must be used with extreme caution and for this reason, the author prefers to use M99.
A3080

The narcotic A3080 has shown promise, particularly for excitable species such as nyala, eland and waterbuck, where down times generally have been reported to be less than three minutes. The drug is approximately half to three-quarters the strength of M99 and is reversed using M5050 or Naltrexone. (See Appendix I for suggested dosage rates.) The product should be used with care in rhinoceroses. Dosage rates of narcotics are provided in several publications and the author’s experience has been that doses tending towards the upper limits produce the most satisfactory results in the field. New operators who are unfamiliar with drug dosages should consult the various capture publications. Dosage rates used differ a great deal, even among experts, with each finding their own comfortable margins.

The author personally keeps dosages and drug choices simple and only varies them as the situation demands. One should not be too concerned about slight variations indicated in the different publications, as they make little difference under field conditions. Rather determine the general requirement for the species in question, and marginally increase or decrease this depending on the specific situation.
Narcotic Antagonists

These have been mentioned under the application of the various narcotics discussed above. Drugs used specifically to reverse narcotic drugs are known as narcotic antagonists. Simply put, the action of these antagonists is to bind with the narcotic already functioning in the nerve synapses of the animal. It releases the narcotic from binding with other chemicals found there, thereby preventing the chemical transfer of electrical impulses either side of the synapses. The antagonist cancels the action of the narcotic, leaving the chemical functions of the synapses to operate normally.

Importantly, though, one should bear in mind that both the narcotic and the antagonist remain in the animal and are excreted through the kidneys in the normal way over the next 24 hours. Provided that both drugs are excreted at the same rate, the concentration remaining at any one time cancels the other out. If the reversal antagonist is excreted more rapidly, then some narcotic will remain to re-narcotise the animal partially a few hours later. Some of the older and no longer used generation of antagonists often necessitated a second injection of the antagonist to reverse the problem. Diprenorphine hydrochloride (M5050) is considered the antagonist of choice for all darting with M99, except when used on white rhinoceroses, where it is only partially effective. It then requires Naltrexone, the specific antidote for Carfentanil, to provide for the complete reversal of the narcotic. The three antagonists currently in use are Nalorphine, M5050 and Naltrexone.
Nalorphine

This substance has both agonist and antagonist properties and is the least effective for the full reversal of M99. However, it is extremely useful for the partial reversal of overdosed animals because of its graduated response characteristics. It is therefore effective to “wake up” the animal partially to be able to walk it under control, as is sometimes required. Nalorphine is supplied in a concentration of 20 mg per ml, usually requiring 2–4 mg every ten minutes until the desired degree of consciousness is achieved.

Diprenorphine hydrochloride (M5050)

M5050 is the antidote of choice for M99 despite having both agonist and antagonist properties. It is used to reverse completely, except in the case of white rhinoceroses, where it is used more as a partial antidote. The dose of M5050 needed to reverse the narcotic largely depends on the dose of narcotic delivered, with a marginal increase for larger animals. The general guide for recommended dosages of Diprenorphine hydrochloride (M5050) to antagonise M99 immobilisation is as follows: for elephants, white rhinoceroses and giraffes it is 3–5 times the dose of M99. For other animals, it is 2–2.5 times the dose of M99.

Naltrexone

Unlike the antidotes described above, Naltrexone is a pure antagonist with more long-lasting properties available to reverse any of the narcotics. Its pure form is ideal for use as a human antidote. It is expensive, which may be a problem when animals need to be redarted within 24 hours, requiring some 3–5 times the amount of M99 to be effective. Naltrexone is supplied and used at a rate of 50 mg per ml, which is normally sufficient to reverse 3 mg of M99. Where it is used in conjunction with M5050 to deal with a problem case, 1 ml is usually sufficient.
Dissociative Anaesthetics or Cyclohexylamines

These drugs are mostly used on felids and canids, as morphine derivatives cause a severe excitement phase requiring dangerous levels of the drug to be effectively anaesthetised. Drugs that have been used in southern Africa are Phencyclidine, Ketamine, and Zoletil.

Phencyclidine

Phencyclidine, a PCP drug, produces intense side effects on animals in the form of muscle spasms. Like Ketamine, it should never be used without tranquillisers. In 1978, this substance was removed from the world market because of its habit forming properties and abuse by humans. It has largely been replaced by Ketamine and Zoletil, which are reported to be more effective for use on animals, being shorter acting and less traumatic. Phencyclidine is useful for anaesthetising problem animals like lions or leopards orally through laced bait. The drug is useful in reducing aggression, even at low dosages that are insufficient to immobilise the animal.

Phencyclidine is supplied as a white crystalline powder, which is easily soluble in distilled water, in concentrations up to 200 mg per ml. As a powder or solution, the drug is extremely stable. An intramuscular infusion takes 10–15 minutes to take effect and lasts for 2–5 hours, depending on the dosage. Unfortunately, there is no antidote and the animal needs to be watched until it moves off, to prevent it from being attacked by predators.
Ketamine

Ketamine is more widely accepted than Phencyclidine, although it also induces convulsions. These spasms can be controlled using Xylazine or Atropine. Ketamine is commercially supplied as a solution of 100 mg per ml concentration, and as a powder that can be mixed in distilled water or, more often, in Xylazine, to form a cocktail for capturing carnivores.

Although the drug may be administered intravenously, intramuscular or subcutaneous routes are preferred. Intravenous infusions take effect within 3–5 minutes and complete immobilisation is achieved within 5–10 minutes. The duration of the effect is dependent on the species and the amount administered. Usually, the operator has 15–30 minutes to complete surgery or other painful procedures before the animal begins to revive. Ataxia is characteristic of Ketamine induction. The animal lies down and a typical licking motion called “serpentine tongue” follows. The animal then becomes insensitive to external stimulation as anaesthesia progresses. Recovery is usually smooth in carnivores but not so with plains game. There is no antidote for Ketamine, however, and depending on the amount used, the animal is usually on its feet within two hours. This may extend to periods of up to five hours with heavy doses. As recovery is more sudden than with Phencyclidine, those operators who are experienced with the use of Sernylan should take care. Salivation may be profuse but is readily controlled using Atropine at a dosage rate of 0.04 mg per kg given intramuscularly. Ketamine is not known to induce abortion when used on pregnant animals.
The combination of Ketamine and Xylazine is effective on a large range of species, as it exhibits a marked synergistic effect. This represents a major benefit, as it reduces the prohibitively large volumes of Ketamine normally required for use on large animals. Its use on plains game is not advisable and it is better to use one of the opioid narcotics that can be reversed, should problems occur. Recently, there is some debate for its use in combination with M99 where prolonged anaesthesia is required. Xylazine in the cocktail provides the advantages of a tranquilliser as well as enhancing the painkilling and muscle-relaxing qualities of Ketamine. Modern thinking is to reduce the Ketamine component as much as possible while increasing the content of Xylazine, which can be reversed.

A mixture of these two drugs, known as the “Hellenbraun mixture”, can be prepared by putting 4 ml of 100 mg per ml Ketamine directly into a bottle of 500 mg per ml Xylazine dry powder base, and dissolving it to give a 1 ml ratio of 100 mg Ketamine to 125 mg Xylazine for use in the immobilisation of large carnivores.
The second variant of this mixture is to formulate the powdered Xylazine into a mixture of 100 mg per ml and add 2.5 ml (250 mg) to 1 g of Ketamine powder. Add a further 1.5 ml of distilled water to permit the Ketamine to dissolve, providing a concentration of approximately 200 mg of Ketamine and 50 mg of Xylazine per ml. (The powdered Ketamine adds approximately 1 ml to the volume.) In a 3 ml dart, this equates to a total dose of 600 mg of Ketamine and 150 mg of Xylazine.

A further variant of this formula is to concentrate 1 g of Ketamine powder to 250 mg per ml and add all of this to 500 mg of Xylazine base to provide a concentration of 250 mg of Ketamine and 125 mg of Xylazine in each millilitre. It may be necessary to administer extra Ketamine, particularly to lions, to achieve the desired degree of narcosis if there is insufficient Ketamine in the primary dart. As mentioned, unlike with morphine-based drugs, Ketamine cannot be reversed, and the animals are left to come around on their own. This can be a problem when releasing animals in the wild. The Xylazine component, however, can be reversed with Yohimbine, Tolazoline or Atipamezole. This does not present a problem under captive situations and variants of Ketamine/Xylazine combinations are the author’s personal choice.
Zoletil

Most operators in southern Africa prefer Zoletil to Ketamine, as it is quicker acting with fewer of the side effects seen in both Ketamine and Phencyclidine. Zoletil consists of a combination of two active substances known as Tiletamine, which is a general anaesthetic from the cyclohexylamine family, and Zolazepam, a tranquilliser derivative from the Diazepine family. The combination of these two drugs improves the quality and security of anaesthesia and does not produce the undesirable effects of either ingredient if used alone.

The onset of anaesthesia takes 3–5 minutes and lasts for one hour or longer, depending on the dosage given. Animals may remain anaesthetised for longer periods under larger dosages. The combination of these two active ingredients gives excellent anaesthetic properties, resulting in the animal remaining calm and recovering rapidly thereafter. With lions, for example, down times of less than five minutes, and sometimes only 2–3 minutes, are regularly experienced. There are no convulsions and the drug is generally safer to use. In the case of lions, a dose of 500 mg is generally given.

The major advantage of the drug is its higher concentration to volume compared with either Ketamine or Phencyclidine, enabling the entire dose to be administered in standard 2–3 cc darts in strengths of 250 mg per ml, up to 500 mg per ml. This is achieved by using the required volume of buffer solution supplied in each box of Zoletil with the dry ingredients. In large animals, where the recommended dose is 4–5 mg per kg, anaesthesia lasts for 40–60 minutes and at 10 mg per kg narcosis can be affected for up to ten hours. (See Appendix II.) The author’s personal preferences concerning dosage rates for the various species are provider later in the course.
Sedatives and Tranquillisers

Xylazine hydrochloride (Rompun)

Xylazine is particularly useful in the translocation of elephant calves at the following dosages:

<table>
<thead>
<tr>
<th>Shoulder Height</th>
<th>Dosage in the field</th>
<th>1 - 3 days after capture</th>
</tr>
</thead>
<tbody>
<tr>
<td>107 cm (42 in.)</td>
<td>40 – 60 mg</td>
<td>20 mg</td>
</tr>
<tr>
<td>107 – 122 cm (43 – 48 in.)</td>
<td>50 – 60 mg</td>
<td>25 mg</td>
</tr>
<tr>
<td>124 – 137 cm (49 -54 in.)</td>
<td>60 – 90 mg</td>
<td>30 mg</td>
</tr>
</tbody>
</table>

Using these rates, the calves will sleep standing, but they can be awakened sufficiently for loading purposes or for walking out of cull sites, for example.
Azaperone (Stresnil)

Azaperone is supplied as a 40 mg per ml (Stresnil) or a 100 mg solution, which often crystallises out in cold weather. The author more often uses Stresnil in the dart combinations, preferring less of the tranquilliser – enough only to provide synergistic effects for the narcotic – and administers Haloperidol instead as the principal tranquilliser before reviving the animal.

Valium and Haloperidol cannot be used in dart cocktails because they precipitate in solution. Azaperone is the author’s drug of choice for use in a darting cocktail with the narcotic, as it does not have Xylazine’s side effects of vomiting and respiratory depression. It also counteracts, in some measure, the side effects of the narcotic without having an effect on the heat regulatory system. It is not a muscle relaxant like Xylazine but does provide marked synergistic properties when combined with a narcotic, even at low dosage levels. Azaperone is also used on its own as a short-acting tranquilliser, starting from 10–15 minutes and lasting for a few hours. It is particularly effective on impala and in some circles is preferred to Haloperidol as a short-acting tranquilliser. The duration of Azaperone is considerably shorter: 4–6 hours compared with 8–10 hours in the case of Haloperidol. Azaperone may be given intravenously or intramuscularly, depending on the urgency of the situation. It is very safe to use on a wide range of species. (See Appendix III for dosage rates.)
Long-acting tranquillisers and depot neuroleptics

Haloperidol

Haloperidol has become one of the most important post-capture drugs in the history of animal capture. While its properties have been known for some time, its importance was highlighted by Dr Hyme Ebedes (Ebedes & Burroughs, 1989), especially as regards the practice of combining its effect with that of other long-acting neuroleptics to calm captured animals. Assuming that the capture has been carried out relatively stress free, Haloperidol reduces further stress on the animal and the result most often is 100% capture success. Its timely administration to animals, particularly when using net bomas, has excellent results. It makes net boma capture, which can be the most stressful method, one of the most effective capture techniques for small and medium game.

Haloperidol is considered the best of the short-acting tranquillisers for calming animals sufficiently to provide a platform for enhancing better performance of the long-acting neuroleptics, in particular, Trilafon. Haloperidol can be injected intravenously, intramuscularly or subcutaneously, but cannot be mixed with another drug as it immediately precipitates. It should be administered as soon after capture as possible. The animals are held if individually caught and blindfolded or are left to rest for 15 minutes in a mass capture situation until the drug has taken full effect. Where animals are caught in nets, it is important to blindfold the animals first and then to hold them securely for a full ten minutes after the last animal has been injected. Loading too early results in the animals panicking, possibly injuring themselves. The drug then also takes longer to calm the animals. There is no need to administer Trilafon immediately; rather wait until the Haloperidol has taken full effect. Some operators believe that Haloperidol should be administered to all captured animals as a matter of routine; however, this depends more exactly on the species, the capture system used and the situation pertaining at the time. As always, the experience is the best guide. Automatic syringes are not advised, as each dose needs to be metered for bulls, cows and juveniles.
The drug will modify peck order in a group – as a rule, therefore, if one is treated, all should be treated. It is possible to overdose animals with Haloperidol and only experienced persons should administer it. The procedure should rather be carried out by one individual only, to ensure that all the animals are treated, and none is dosed twice.

**Figure 3.1** A Lichtenstein’s hartebeest blindfolded.

Dosages provided in this Course for Haloperidol and Trilafon are taken from personal experience and are generally less than recorded elsewhere. Haloperidol provides tranquillisation within ten minutes of injection, lasting for 16 hours, which is ideal for most transportation situations. It may be administered either intravenously or intramuscularly and there is little difference between the two methods in terms of time taken to have full effect.
Trilafon (Perphenazine enanthate)

Trilafon is one of three longer-acting neuroleptics most commonly used in southern Africa to provide tranquillisation over several days.

They are:

- Clopixol-Acuphase, which is effective in one hour and lasts 72 hours, peaking after 36 hours
- Trilafon, which is effective in 12 hours and lasts seven days
- Piportil, which is effective in 48 hours and lasts 21–28 days

Haloperidol is effective up to 16 hours, during which time Trilafon kicks in if used in combination. Tranquillisation is provided from ten minutes to seven days and is the combination drug of choice. Trilafon, like all the long-acting neuroleptics above, is based in a depot of sesame oil to form an ester bond. It is slowly broken down in muscle tissue, releasing the active component of the tranquilliser into the body. For this reason, **Trilafon must not be given intravenously!**
For transport purposes, Haloperidol is generally sufficient. However, where the animals are to be placed in pens or when transport is protracted, Trilafon should also be given upon capture. It is important not to overdose with the long-acting neuroleptics, which will cause extra-pyramidal effects that can be fatal if not reversed with Akineton. It is important not to use the neuroleptics as a matter of course, but rather only when necessary. As regards animals that will be placed in pens, the long-acting neuroleptics should be administered after capture and the animals then left to tame down without tranquillisation thereafter. One should only resort to additional tranquillisation to combat a specific problem, such as aggression. The effect of properly administered neuroleptics is not easily recognised, in that the animals do not appear drowsy but remain alert, although functioning as if tame. The animals simply lose their fear and are no longer anxious. If they appear tranquillised, they have probably been overdosed.
Clopixol-Acuphase (Zuclopenthixol acetate)

Acuphase is preferred to Trilafon for animals requiring a shorter duration of effect after capture, particularly in the case of rhinoceroses.

Neuromuscular Blockers

Gallamine triethiodide, or Flaxedil, is used exclusively for the capture of crocodiles, as it is a neuromuscular blocking agent that causes both muscle relaxation and paralysis. The crocodile remains conscious although it is paralysed and therefore this drug cannot be used on other species. The drug is reputed to wear off after twelve hours but, in practice, it frequently takes considerably longer, requiring reversal with Neostigmine (Prostigmine) when temperatures are low, and the crocodiles are inactive. Using a pole syringe, the drug is injected in the top of the hind leg or at the base of the tail.
Supportive Therapy Drugs

Additional drugs are considered necessary to assist in immobilising animals and preventing drug-related problems. These substances are well within the scope of the average operator.

Hyaluronidase (Hyalase)

Hyalase is available as a powdered substance at 2000 or 5000 IU per vial, which is added to the drug cocktail to speed up the rate of drug absorption. It does this by breaking down intracellular tissue and thereby improving on down time from an average of 6–7 minutes to 3–4 minutes, which is ideal for the capture of rhinoceroses and giraffes. It is unnecessary for other species, except in circumstances where the animal is likely to run off, making it difficult to find, such as with eland and waterbuck bulls.