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Stray and Wild Animals Restraining Techniques

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Abstract: Stray animals are those found unaccompanied by a responsible person in a public place or animals and/or whose owners have revoked all care giving responsibilities. Animals may be cared for by one or more members of a community, allowed to roam and permitted to reproduce. Nevertheless, they are genuinely dependent upon human caregivers who provide access to the resources essential for their survival. Wild animal refers to free ranging and captive wild vertebrates' including amphibians, reptiles, birds and mammals. Three fourths of all emerging infectious diseases of humans are zoonotic; most originate from stray and wild animals, including plague, rabies, leptospirosis, hydatidosis and toxoplasmosis and tularemia. Wildlife can also serve as vectors for non-zoonotic diseases of livestock such as tuberculosis and brucellosis likely were transmitted or to native wildlife species and to livestock. The frequency of emergence and reemergence of infectious diseases in wildlife reservoirs has recently appeared to increase, posing new questions about disease pathogenesis and epidemiology and heightening the urgency of finding effective wildlife disease management techniques. Therefore, stray and wild animals should be restrained in order to reduce or eliminate such diseases. Furthermore, wild animals have become an integral part of society as source of income, refreshment, nutritional, aesthetic, scientific and educational so that will continually be restraint. Restraint techniques must be appropriate for the species and minimize distress and the risk of injury to the animal and handler. Personnel handling animals should be thoroughly trained in the planned procedure as well as in contingency methods of restraint that may be required.

Key words: Drugs · Experience · Restraint · Stray · Welfare · Wild animal

INTRODUCTION

Restraint varies from confinement in an unnatural enclosure to complete restriction of muscular activity or immobilization. No single ideal restraint technique can be successfully used for all occasions on a particular species because success depends on many biological, ecological and practical factors including topography, season, climate, age, condition, sex and costs [1]. Many techniques for capture of free-ranging wildlife were developed in the latter part of the twentieth century and were extrapolated from zoos and wildlife parks. Properly applied physical restraint can be the most safe and efficient way to handle even large, dangerous animals if the people involved are knowledgeable about the likely behavior of the target animal [1, 2]. However, chemical capture is most commonly accomplished technique by projection delivery of a dart containing an anesthetizing drug from a remote delivery system [3].

Restraint practices were evolved with the domestication of animals for food, fiber, labor, sport and companionship. Domestication necessitates special husbandry practices. As people began to minister to animal's needs, they found the importance to restrict their activity by placing them in enclosures. If animals resisted when wounds were treated or medication administered, it was necessary to further restrain them [1]. Each restraint incident has some effect on the behavior, life or other activities of an animal. Each time it is proposed to restrain an animal the following questions must be asked: why must this animal be restrained?, What procedures will produce the greatest gain with the least hazard?, When will it be most desirable to restrain the animal?, who is the most qualified personnel to accomplish the task in the least amount of time and with the least stress to the animal? and what location would be best for the planned restraint procedure? [4].

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All personnel involved with the use of wildlife for research, teaching and testing must be adequately trained in the ethics of animal use and receive the necessary training and experience to perform the procedures described in the restraining protocols. Procedures likely to have lasting negative effects on a population or to affect the existence of a population should not be undertaken, except under extraordinary circumstances. Before initiating field projects involving capture, investigators must be familiar with the study species and its response to disturbance, as well as its sensitivity to capture and restraint. In addition, investigators should be familiar with the advantages and drawbacks of available methods of live capture, particularly those that have been used with the study species [5].

Animal control and welfare professionals, as well as zoo and wildlife workers, face many challenges in capturing stray and/or fractious canines, wildlife and other animals that elude confinement by traditional trap and restraint methods. Stray and wild animals create public safety issues that include: potentially fatal attacks on humans and other animals, risk of the spread of communicable diseases such as rabies and other vector-related zoonoses [3]. For example, it was reported that stray dogs caused higher number of bites than owned dogs in Addis Ababa attributed to the presence of many stray dogs roaming on the streets. Stray dogs may also pose the highest risk of transmitting rabies and other zoonotic diseases such as echinococcosis to humans as strays receive the lowest level of health care service. Previously employed techniques of dog population control like the use of poisons, traps, gas, or shooting were all associated with some degree of hazard as they may affect non targeted groups. Moreover, these methods of population reduction may instigate an adverse public response based on animal welfare concerns. Therefore, an attempt must be made in selecting the most appropriate method of capturing stray animals for the area [6]. Therefore, the objective of this review is to give the highlight of the appropriate and commonly practiced of stray and wild animal's restraint techniques.

Back Ground to Stray and Wild Animals Restraining Techniques: The art of physical restraining of wild animals for food and clothing is as old as human existence on this world. However, the capture of bears with an oral mixture of honey and strong spirits by Winchell in 1820 is probably the first documented case of the use of chemicals to restrain wild animals. From then on, a number of oral mixtures were used with variable success. Oral administration of anesthetics and tranquillizers for the capture or handling of wild animals has been described as virtually impossible and frustrating. The true birth of chemical restraint of wild animals coincides with the use of the first 'drug dart' by Hall and co-workers in 1953. Neuromuscular blocking agents, ranging from early synthetic curare, nicotine salicylate and strychnine salts were the first agents successfully used to provide chemical restraint [7]. Curare showed neither sedation nor anesthetizia, but merely paralysis the animal. Furthermore, therapeutic index of curare is narrow. Respiratory arrest is common and unless rapid assistance is provided the animal is likely to die. Curare has never been used for chemical immobilization today. Yet the techniques of drug delivery and experience gained from working with this drug served as a foundation for modern chemical restraint practices [8].

A significant breakthrough was made in 1960 by Harthoorn. Working with the ranger team of the Natal Game and Fish Preservation Board, he pioneered the use of a mixture of morphine or synthetic morphine, hyoscine and various tranquillizers. The development and use of newer, extremely potent synthetic and semi-synthetic opioids, cyclohexylamines, phenothiazine derivatives and alpha-2-agonists, then followed. These groups of agents, alone or in different combinations, now form the basis of non-domestic animal immobilization [6]. A more technological approach traces back about 50 years ago with the development of darts that contained liquid immobilizing agents, which were injected into the animal through a hollow needle on the front of the dart. The delivery systems went to a modified shotgun-style gun. While the early immobilizing drugs were also paralytics, evolution moved toward safer, more humane anesthetic drugs [3].

Importance of Stray and Wild Animal Restraint

Economic Importance: The entire range of wildlife activities produces revenues and brings added value which contributes to the gross national product. In Tanzania and Kenya, wildlife tourism holds either the first or second rank in exporting activity depending on the year [9]. In North America, programmers have been in place for many years to document or estimate the expenditure of individuals who participate in wildlife-associated recreation. In addition, nutritional, aesthetic, therapeutic, scientific experiment, educational and ecological values may be ascribed to wildlife [10].

In today's world, reasons for catching wild species are more diverse. Millions of wild animals are captured each year as part of damage and disease control programs, population regulation activities, wildlife management efforts and research studies [11].

Disease Control and Prevention: Management of diseases in stray and wild animals may be needed for the reason that the diseases may have serious negative effect on a valuable wild species; disease in wild animals may have a risk to human health like rabies, carried by a number of wild and feral canines and disease in wild animals may bear a risk to domestic animals as *Mycobacterium bovis* and *Brucella abortus*. For example both *Mycobacterium bovis* and *Brucella abortus* have been eradicated from cattle throughout Canada after a decade's long, expensive struggle; but, the bison found representing a potential reservoir of infection for other herds of disease free bison, cattle and humans [12]. Experience from the control of rabies risks to humans and livestock suggest that vaccination of both domestic dogs and wild canids may be powerful tools for the protection of threatened species from acute disease threats. Direct vaccination of wild reservoir hosts (foxes, raccoons, coyotes and skunks) has successfully reduced the incidence of rabies on a large scale in Europe and in the United States. Moreover, large-scale vaccination of domestic reservoirs is commonly conducted for a variety of reasons in the animal health sector [13].

General Considerations During Restraint: There are four basic factors which should be considered before selecting a restraint technique. These are: safety of the involved personnel and the animal, the effectiveness of the restraint method for the intended procedure, the availability of skilled personnel to provide constant observation and attention post administration [1].

Personnel Safety Considerations: To ensure the safety of the personnel involved in the restraining and handling of wild animals, care must be taken when handling live animals and carcasses as they may carry diseases that can affect humans and other animals e.g. hydatidosis, leptospirosis, brucellosis, rabies, tuberculosis and so on. Routine hands and other skin surfaces washing, using of personal protection equipment such as face mask, safety glasses, gloves and ear plugs, as well as correct restraint techniques need to be practiced after handling all animals, carcasses and body fluids to minimize risks. Bite wounds from some animals (e.g. feral cats and dogs, foxes, wild dogs) can result in serious infections and should be treated. Vaccination against tetanus, rabies and other diseases, depending on the species restraint, is highly recommended, as part of health and safety program, for people who come into regular contact (laboratory technicians, field workers, veterinarians and so on) with potentially infected animals [14]. The first concern when dealing with stray and wild animals should be the safety of human beings. Those who own or have administrative responsibility for wild animals must recognize that the animal, no matter how valuable, cannot be handled in such a way as to jeopardize the safety of those who must work around it. Known techniques that can safeguard both animal and operator have to be used [4].

Animal Welfare Considerations: Certain environmental factors need to be considered prior to using chemical capture. Accordingly chemical capture should never be used near uncontrollable risks such as traffic on roadways and water bodies since once the chemical enters the animals' system; they may stumble into harm's way [3]. Drug choices and combinations must be of proven safety for each species and calculated for the weight, age, physiological and reproductive status, body-condition [15]. Restraint devices should be suitable in size, design and operation to minimize discomfort and injury to the animal. Restraint may cause distress and/or pain, if, not carried out properly. Species-specific methods of restraint should always be used [16]. Restraint and handling are significant stressors for wild animals which also present a great risk of injury. Handling and restraint techniques must therefore aim to minimize the pain and stress on the animal and maximize the safety of the animal and also the operator [14].

Immobilizing drugs have the potential to disturb normal regulatory systems, particularly respiratory and thermo-regulation. Drugs may behave differently in combination and in individual animals depending on their physiological status. Dosages often have to be estimated (for animals of unknown weight) and where drugs are remotely delivered by unpredictable darts to a moving target animal delivery of the correct dosage is very difficult to control [17, 18]. To understand and potentially reduce the impact of restraint and handling procedures on animals, the researchers must have a thorough knowledge of the habits and behaviors of the species under study and be experienced in handling the species. If an animal is

injured during restraint and handling procedures it must receive appropriate treatment. Animals that are suffering intractable pain and/or distress should be euthanized using a technique that is suitable for the species. Precautions must be taken to prevent the spread of infectious disease from one animal to another. Contaminated equipment should be disinfected between animals [19, 20].

Major Techniques of Animal Restraining

Physical Restraint Techniques: Determining the most suitable physical restraint method for stray and wild species will depend on a number of factors like: the experience and abilities of handlers, the species involved, the animals' normal flight/fight response, the animals' defense mechanisms or delicate structures, behavioral aspects and health status [21]. Physical restraint should only be performed by operators who are familiar with the normal behavior patterns of the species that is to be restrained. The duration of the procedure should be kept to a minimum. Appropriate restraining devices may be required to avoid injury to the animal or researcher. Personnel should approach the target animal in a calm and quiet manner. Unnecessary people should keep away from the area to avoid making the animal more agitated. For many species, it is important to cover the animal's head (e.g. with a blindfold, bag, blanket etc.) to impair its view of the environment and reduce stress. Excessive noise and sudden movement should be kept to a minimum [22].

Effective methods of physical restraint that minimize the possibility of physical injury and physiological and psychological stress should be chosen within the limits of human safety. The least amount of restraint and the shortest possible time necessary for the procedures being undertaken should be used. Personnel handling animals should be thoroughly trained in the planned procedures as well as in alternative methods of restraint that may be required [5]. The successful capture and restraint of wild species often requires a combination of physical and chemical restraint using a wide variety of capture and handling devices that are constantly evolving. Properly applied physical restraint can be the safest and efficient way to handle even large, dangerous animals if the people involved are knowledgeable about the likely behavior of the target animal(s) under stressful situations and are experienced with the technique being used [2, 22]. Physical restraint is appropriate for simple procedures such as physical examination, injections, venipuncture etc. Many physical restraint techniques applicable to both stray and wild animals are available [1, 2].

Catchpole: Catchpole is one of the most versatile tools used to capture and restrain animals. Basically, a catchpole is a long stick with a noose on one end. For most species, the loop is placed over the animal's head and then the cable is tightened to hold the animal (Fig. 1). Since bobcats and housecats can accidentally suffocate if the loop is only placed around their necks, it's better to place the loop over the cat's head and over one front leg. It is important to minimize the amount of time an animal spends in this restraint [23]. Commercial catchpoles that often lock once the cable is pulled tight and have a quick-release are available. Modified catchpoles are also available for restraining snakes. They are often called snake "sticks, " "tongs, " or "hooks." These devices pin the snake's head to the ground. They have to be used carefully, since it is hard to tell how much pressure is exerted to accidentally injure the snake's spine or even dislocate its head. Once the snake's head is restrained, it can be grasped just behind its jaws with thumb and forefingers. This will give a chance to control its head. The snake's body needs to be supported with an arm, a stick, or a pole when it is carried. This will minimize its stress and prevent it from thrashing about [19, 24].

Scruff: Feral or street dogs are often handled with equipment such as snare poles or nets. Physical restraint is a valuable tool for the dog handler. Good physical restraint requires a calm dominance. Dog handlers should be confident in applying several types in order to be versatile in successfully and humanely capturing dogs [26].

Remote Capture Techniques: Helicopter net gunning has proved to be a very successful method for capturing large carnivores, especially grizzly (*Ursusarctos*), black bears (*Ursusamericanus*) and wolves (*Canis lupus*). Medium-sized canids such as coyotes (*Canislatrans*) and wolves can be safely and successfully restrained with helicopter net gunning [23]. Hobbles are useful to restrain the legs and nylon dog muzzles or duct tape can be used to restrain the mouth safely without chemical immobilization (Fig. 2). Safe handling of bear species generally requires chemical immobilization after netting, with the net providing a quick way of immobilizing the animal so it does not injure itself in terrain with natural hazards (water, steep slopes). A common complication of net large carnivores is the ability of the animal to chew its way out of entanglement; therefore, animals need to be either darted or restrained very quickly (within minutes) after the net is fired [27].

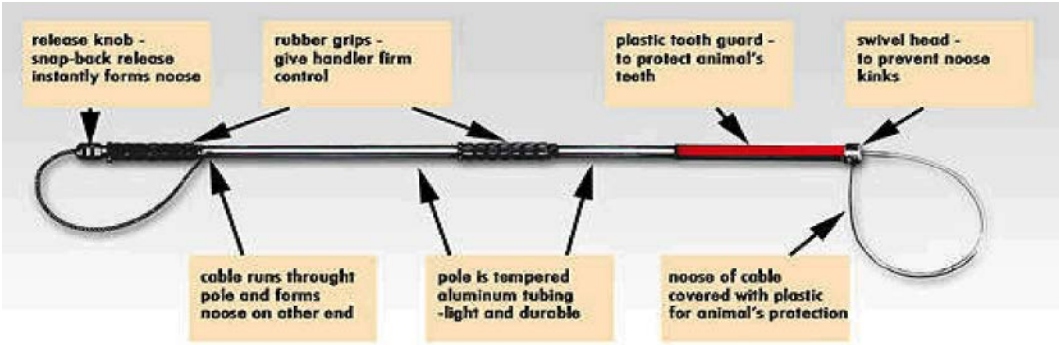

Fig. 1: Catch pole Source: [25]

Fig. 2: Helicopter net gunning Source: [28]

Fig. 3: Dive in traps that used to capture birds Source: [29]

Dive-In Traps: As the name implies, baited dive-in traps are effective for capturing aquatic diving birds, primarily diving ducks. Dive-in traps can be constructed in relatively shallow water (<1.25m) habitats that are frequented by diving birds and accessible to handlers in small boats or wearing chest waders. Some familiarity with tide levels will be necessary when deploying traps in tidal wetlands. Dive-in traps may be constructed during low tides when the trap site may be completely exposed, but will need to be checked whenever the tide rises to inundate the site and birds move in to feed (Fig. 3). Because diving ducks have some difficulty taking off directly from the water, fine mesh netting placed over traps may not be necessary [29].

Chemical Restraint Techniques: Certainly, chemical capture can be an important method for animals that are a danger to humans, other animals and/or danger themselves. Chemical restraint methods should be considered as a last resort, only when other means have been exhausted or would not be appropriate. Only trained individuals who are comfortable and knowledgeable about

the appropriate procedure and drugs for the target animal should use the dangerous chemical capture drugs and equipment [3].

Delivery System: The first challenge facing anyone using chemical agent for restraint is to administer drug agent in a site that allows absorption. The most satisfactory techniques vary from species to species and animal to animal according to size, distance from the operator, ability to partially confine the animal, operator skill and effectiveness of available equipment [4, 30]. All of the drug delivery equipments can be effectively used to immobilize wild animals but, there is no one type of system that can be used on all animals at all times [31].

Oral Administration: Effectiveness of oral medication (with food and water) is minimal, because of lack of acceptance of drugs by animals (especially primates), minimal absorption or destruction of the drugs by the digestive tract. However, sometimes oral medication is the only choice as some primates may be provoked to come to side of an enclosure and scream at the strange or disliked person allowing medication to be squirted into the mouth. Though some of the drug may be lost, enough may be ingested to effect sedation or mobilization. Non-human primates are frequently conditioned to accept fruit juices and yogurt for treats and as means of medication. Diazepam may be used as a calming drug an hour before anticipated immobilization. However, oral administration is generally used only for premedication [32, 33].

Hand Held Injection: This requires the animal to be physically restrained before administration. Intra-muscular injection may be administered quickly with syringe held in the hand. Aspirating before injection is not possible in wild animals. Plastic syringe will not break if knocked from the hand or if an animal kicks, strikes or pushes it into the side of cage. Use the gauge needle to deliver the liquid in the syringe quickly and use the largest syringe that will measure the quantity accurately. The plunger will have less distance to travel and greater mechanical advantage will be obtained. Tighten the needle securely on the hub, so the pressure build up by rapid injection will not below the needle from the syringe [4].

Remote Drug Administration System (RDAS): Most animal immobilizations are done remotely, i.e. there is no direct contact between the operator and the animal. Darts propelled by variety of means are usual way of delivering drugs remotely to animals. Systems capable of propelling darts are termed as remote drug administration system (RDAS) and are defined as mechanical device capable of administering a single dose of drugs to unrestrained animals, usually by means of ballistic projectile. By using RDAS specific animal can be targeted, wide range of volumes of drug can be delivered and RDAS can treat, mark or biopsy individual animal. However, many RDAS are inherently complex, noisy, used only on larger animals (the shot could either misplaced, causing injury or death or could miss the animal, or penetration depth could be injurious or lethal to smaller animals (<15Kg) and the target animal must be first located and approached closely [31].

There Are Four Basic Types of RDAS

Pole Syringes: They are exactly syringes on the end of a pole. These are very useful tools with broad applications such as administering drugs to trapped animals or cage animals or safely giving additional drugs to animals. It is usually preferable to withdraw drugs with conventional handheld syringe and letting to transfer the drug into that syringe. Pole syringes are cheap, safe and quiet, but are only useful when the animal is physically restrained. Care must be taken to ensure that needles do not break off (e.g. when administering large volumes or using a long needle) and placement of the needle in large muscle masses needs to be accurate as pole syringes may harm the animal if incorrectly placed [14].

Blow Pipes: Blow pipes are the cheapest and safest systems. However they only have a range of 10–15m and experience is required for them to be used effectively; Darts propelled by blowpipe cause very little impact trauma to the animal, so they are generally safe for use on smaller species. With the appropriate equipment, animals as small as 3kg can be treated. Blowpipes are used primarily on captive animals but can be used effectively on free-ranging animals under the right circumstances, such as treed animals or animals approached closely by vehicle [31].

Dart Pistols: They are more accurate and have a range of approximately 20m, but their greater power represents an increase in the risk of danger to the animal. The physiological results of immobilization drugs delivered by dart depend on dosages, the success of dart placement and drug delivery in good muscle and physiological status of an animal prior to and during anesthetic induction [14].

High-Velocity Dart Rifles: Rifles have the greatest range (up to 50m) and accuracy; however they also present the greatest risk of injury to the animal. Accidental death of the animal can occur from using excessive velocity to propel the dart and/or missing the target area, causing penetration of a vital organ, body cavity and/or broken bones. As large skeletal muscle masses are usually the most appropriate sites, regular practice with RDASs and knowledge of the anatomy of the target species is required to ensure consistent hitting of the appropriate injection site. Anaesthetized animals require close monitoring of their cardiovascular, respiratory and thermoregulatory systems. Constant monitoring is necessary, with operators trained to recognize and alleviate potential complications. The depth of anesthesia should also be closely monitored. Reversing agents should be readily available so as to be used to facilitate recovery [34].

Needles may have collars or barbs to prevent the syringe from bouncing away from the injection site before the entire drug is expelled. Barbed needles may require minor surgery for removal from the skin. Most chemical immobilizing agents are designed for intramuscular injection. Any large muscle mass is suitable. For shooting from the helicopter, the dorsal gluteal muscles or the back muscles on the either side of spinous processes of vertebrae are aimed [4, 35].

The Ideal Restraint Drugs: Obviously, no perfect restraint drugs exist. However, the characteristics of an ideal injectable restraint may serve as the guidelines to the evaluation of currently available immobilizing drugs for wildlife. These criteria include physiological and pharmacological properties as well as desirable properties for immobilization. These are: high therapeutic index (TI), potency (sufficient dose delivered in small volume), fast acting, smooth onset of action, stable in solution over a large range of temperatures, minimum excitement phase (anesthetic induction is rapid), non-irritation following IM and IV administration. Good muscle relaxation, minimum adverse effects, capable of being antagonized, rapid degradation in to inactive and nontoxic metabolites, compatible with other drugs and darts (no chemical reaction with darts), produces amnesic effect, safe for pregnant animals, minimum withdrawal time for save human or animal consumption [31].

An ideal drug should have high TI (lethal dose /effective dose). A high TI allows a margin for errors in estimating body weight or for individual variation in physiological response. In order to increase the TI, many chemical restraint agents are combined with other agents; Combination often decreases required dose of each agents, while increasing the effectiveness of drugs. Therefore the ideal drugs should be compatible with other useful drugs and darts (no chemical reaction with dart). Because the majority of many chemical restraint agents are administered intramuscularly, the ideal drug should not irritate muscle tissue. Most currently used agents meet these qualifications. Some agents like diazepam cause transient local pain up on injection, but cause no damage [1].

With chemical agents currently available, immobilization is affected in 10-20 minutes following IM injection. This is serious drawback when working with free ranging wild animals, because after animal is injected, it may escape in to the bush and be lost to the restrainer. Furthermore, unassisted animal may die from respiratory depression or be killed by predator while under the influence of the drugs. Ideal drug should have reversal agents or antagonists and pharmacologic investigations have indeed developed numerous reversal agents. Antagonists are now available for narcotics (etorpine, carfentanil,), alpha 2 agonists (xylazine, determinidine) and benzodiazepine agents (diazepam). The concentration of the ideal drug should be high enough or the effective dose should be low enough to allow its use in the small volume syringe necessary for dart injection [4].

Important Chemicals for Restraint

Neuromuscular Blocking (NMB) Agents: They are some of the first drugs used for chemical immobilization of wildlife. However, these drugs are inferior to modern drugs because of low therapeutic index [36] and lack of CNS effects. The animal paralyzed with NMB drugs is conscious, aware of its surrounding, feel pain and experience psychogenic stress due to their inability to cross BBB. But, NMB drugs are very fast acting and duration of action lasts only for short times [31]. They act by depolarizing the motor endplate and disrupting impulse transmission to the skeletal muscles. The animal retains consciousness and may be affected by auditory, visual and psychological stimulation [4].

Neuromuscular blocking agents (e.g. vecuronium, pancuronium and succinylcholine) should not be used as the sole method of chemical restraint and their use even with anesthetics is not recommended for invasive procedures as they mask many of the signs used in monitoring anesthesia. Animals that have been chemically restrained require an appropriate recovery environment that is quiet, dark and free from physical hazards

and disturbance but still able to be monitored [14]. For instance, Succinylcholine is excellent immobilizing drugs but they should no longer be used in chemical capture. They have narrow safety margins and they impart no calming, analgesic, or anesthetic effect. Slight overdoses can cause the animal to suffocate to death while being fully conscious and able to feel pain [3].

Narcotics: Narcotics are excellent for field immobilization agents mainly used for wildlife restraint. The various narcotic drugs are very potent, fast-acting and have antagonists for quick reversal. They also are very dangerous to humans through accidental exposure or abuse. Some examples of these drugs are etorphine and carfentanil [3]. Etorphine is highly potent analgesic agent with up to 10, 000 times the analgesic potency of morphine hydrochloride. It produces pharmacological effects like respiratory depression and coughs centers, decreased gastrointestinal motility, behavioral changes and elevated blood pressure accompanied by tachycardia. Etorphine is particularly useful for immobilizing large, ungulates such as elephant and rhinoceros and hippopotamus [1, 8, 22, 37-39].

On the other hand, Carfentanil (wildnil): is the most potent agent being used for immobilization. It becomes the opiate of choice when etorphine was temporarily unavailable. It is usually combined with xylazine or another alpha 2 agonists. It is administered through any parenteral route, preferably deep IM. It produces side effects similar to that of etorphine, however, high prevalence of recycling or renarcotization, but can be reversed by natrexone and naloxone [22, 39, 40]. Fentanyl citrate, a similar drug to etorphine, but with less potency, has less suppression of respiration and less immobilization effect. Animals may remain standing. It is injected IM, IV for immobilization and pain suppression in small carnivorous or small herbivorous animals and is reversed by natrexone [8, 40]. Carfentanil features excellent properties for field immobilization. Because of DEA restrictions on its availability and use, however, it is not available to animal care and control personnel. It will be found mainly for zoo or wildlife uses. The various narcotic drugs are very potent, fast acting and have antagonists for quick reversal. They also are very dangerous to humans through accidental exposure or abuse [3].

Tranquilizers and Sedatives: Both are used to calm aggressive domestic animals. They are frequently used in combination with immobilizing drugs to counter undesirable pharmacologic effects of the primary drug. A new and important use of long acting tranquilizers is to calm animals during stressful periods. They act by binding to specific regulatory site on the GABA receptor, thus enhancing the inhibitory effects of GABA inducing reduction of anxiety and aggression, Sedation and induction of sleep and reduction of muscle tone and coordination [37, 41]. Example: xylazine and diazepam are the popular tranquilizers.

Xylazine (Rampun): It is non-narcotic, sedative, analgesic and muscle relaxant. These effects are mediated by CNS depression. Animals appear to be sleeping. Stimulation during the induction stage may prevent optimum sedation and when animal is subsequently approached too rapidly, a seemingly sedated animal may rouse explosively, jeopardizing the safety of the operator. It is a popular immobilizing agent, used either singly or in combination with other drugs for wide variety of species [36, 38]. Xylazine may be given IV, IM or epidural. There is wide species variation in the optimum dosage. Immobilization occurs within 15-20 minutes after IM injection. Analgesia lasts from 15-30 minutes so that painful procedures should not proceed after 30 minutes. Xylazine produces additive effect when combined with tranquilizers and barbiturates. When it is combined dosage should be reduced and caution exercised [22].

Diazepam: It acts on the thalamus and hypothalamus, inducing calm behavior. It has no peripheral autonomic blocking action. Ataxia may develop with higher doses as muscle relaxation progresses. Diazepam may be given as orally, IM, IV. Oral administration is not recommended for immobilization but may be used to calm animals prior to immobilization. The dosage varies from 0.05-3.5mg/kg, depending on the species and degree of excitement during injection. Diazepam is metabolized slowly in normal liver. Clinical effects usually disappear within 60-90 minutes [4].

Inhalation Anesthetics: The delivery of vaporized drugs after breathed is directly into lung, taken up by blood and delivered to brain resulting in general anesthesia. Its application is limited in field immobilization; however, it can be used effectively for small mammals and birds or for maintaining general anesthesia in larger animals initially anesthetized with injectable drugs. Vapor pressure can be affected by temperature and flow rate. When the drug or oxygen mixture reaches the lungs, it must achieve sufficient partial pressure within the alveoli to cross into blood. This partial pressure is a function of inspired

concentration of drug which can be determined by vaporizer setting. In general, the greater the ventilation, the quicker gas concentration will rise in the alveoli [42, 43].

Assuming cardiac output and blood flows are normal, drug uptake by brain is relatively rapid because of its reach blood supply. Tissues with poorer blood supply such as fat tissues absorb drug much more slowly. Thus patient with lots of fats stores that undergo extended anesthesia will have prolonged recovery due to the release from fat back into the circulation. Elimination of inhalation anesthetics is just the opposite of the uptake. Once drug is eliminated from alveoli (by turning off the vaporizer), arterial blood tension falls, followed by falls in tissues tension. Because of high blood flow to the brain, anesthetic tension falls rapidly resulting in fairly quick anesthetic recovery with agent such as isoflurane, sevoflurane, enflurane and halothane [31, 44].

Injectable Anesthesia (Ketamine): It is non barbiturate dissociative anesthetic agent. Animal usually retains normal pharyngeal-laryngeal reflexes. This desirable effect minimizes inhalation of food or ingesta near the glottis. It does not cause skeletal muscle relaxation. Excessive salivation can be alleviated with atropine. Ketamine crosses placenta in all species, however it is not known to produce abortion when used on pregnant animals. It is detoxified in the liver and excreted with urine [37, 45]. Ketamine is in use for humans, domestic cats and non-human primates; and particularly effective for wild carnivores, reptiles and birds. Ketamine may be administered via either IM or SC routes in wild species. When used as an anesthetic, IV dosage is usually required except for very short procedures [40, 46]. Parenteral injection take effect within 3-5 minutes and complete immobilization is produced within 5-10 minutes. Duration of effect varies with species and dosage administered. Recovery is usually smooth, animal is usually ambulatory within 1hour, however, recovery periods of as long as 5hour is not rare. Some felids may show slight depression for 24 hour following injection [22, 39].

Drug Combination: The drugs currently recommended capturing both domestic and wildlife species are xylazine, ketamine and Telazol. Some protocols call for ketamine and xylazine to be combined into a cocktail that improves the results of both drugs. While ketamine is the dominant drug, the addition of xylazine makes for a smoother induction, immobilization and recovery. For carnivorous animals, such as dogs, a 5:1 mixture of ketamine (100 mg/ml) and xylazine (100 mg/ml) is recommended. Ketamine is more quickly metabolized from the body. The complexities of drug dosages require close consultation with a veterinarian experienced in immobilization [3].

There are some possible drug combinations. These are ketamine/medetomidine, etorphine/xylazine and carfentanil/acepromazine and so on. Advantages of these combinations are reduction of doses of all drugs reducing total cost, reduction of total drug volume, reduction of undesirable side effects and improved recovery. However, difficulty in assessing individual drug effects, increased complexity in calculating initial drug doses, prolonged recovery and potentiation of adverse side effects are some of the drawbacks of them [31].

Euthanasia: It has been banned except in special justified cases such as seriously or incurably ill or proven to be over population. However, euthanasia can also be acceptable in animals unsuitable for homing or to alleviate shelter overcrowding which compromise the welfare of animals. When euthanasia is considered, several methods are available but not all are considered acceptable. However, because of the safety for personnel, efficacy and costs, the preferred method is the intravenous injection of sodium pentobarbitone. A reliable method will produce rapid loss of consciousness until death occurs. Regardless of the method used, it is important to minimize distress, anxiety and pain [47]. Agents that are unacceptable and condemned for use as euthanasia agents are strychnine, nicotine, caffeine, magnesium sulfate, potassium chloride, methoxyflurane, trichloroethylene, nitrous oxide cleaning agents, solvents, disinfectants and other toxins or salts and all neuromuscular blocking agents. Other methods such as drowning, concussion (adults), decapitation, asphyxia, strangulation or air embolism are also not considered as euthanasia methods [48].

Complications of Restraint and Monitoring

Capture Myopathy: Capture myopathy is a syndrome that causes fatality and debilitation in stray and wild animals following capture or prolonged exertion. It is characterized by degeneration and necrosis of skeletal and cardiac muscle. Fear and anxiety triggers overexertion, exhaustion, hyperthermia and unnecessary disturbance. Severe stress and immobilizing drugs cause hyperthermia and/or acidosis that cause capture myopathy. Itis very difficult to treat once clinical signs occur. But, Supportive care like fluid therapy (stimulate diuresis and prevent renal damage

due to myoglobin), anti-inflammatory and antioxidants may be used as treatment option. Vitamin E 5-7 IU/kg IM, Vitamin C, selenium 0.05-0.1 mg/kg IM, sodium bicarbonate (muscle relaxant) IV drugs of choice. It can be prevented by minimizing excessive struggling/restraint and under dosing, maintaining body temperature and ventilation [8].

Pneumothorax: Pneumothorax is a potential complication encountered following dart misplacement into the thoracic wall or cavity. In animals with a heavy hair coat, dart misplacement may not always be readily identified during initial immobilization. If this does occur and the animal fails to become immobilized, another dart may be necessary to complete the immobilization. Pneumothorax is potentially a rapidly life threatening incident and its identification and treatment should not be delayed. Upon immobilization the animal immediately should be given supplemental oxygen and the chest should be auscultated for lung sounds. If lung sounds cannot be auscultated and there are additional typical signs of a pneumothorax (e.g., rapid respirations with minimal chest excursions, tympany associated with percussion, barrel-shaped chest) it is likely that a significant pneumothorax is present. If a pneumothorax is not present, the dart should be carefully removed and the hole in the chest wall closed. Once the chest wall is closed the chest should be re-auscultated for lung sounds should be evaluated [22].

CONCLUSION AND RECOMMENDATIONS

Stray and Wild animals may try to avoid restraint during which they are capable of inflicting damage to themselves and their potential captors. When physical contact is necessary, the safety of animals and operators should be the primary consideration. The physiological results of immobilization drugs delivered by dart depend on dosages, the success of dart placement and drug delivery in good muscle, as well as the physiological state of the animals prior to and during anesthetic induction. Chemical immobilization of animals can result in significant morbidity and mortality. To ensure that chemical restraint is performed both humanely and effectively, personnel must be experienced with all aspects of drug use and assessment/monitoring of anesthesia. They must also be familiar with the target species and have knowledge of the best techniques available. It is also important to choose a drug delivery system that will deliver the appropriate volume of drug with the minimum amount of physical trauma to the animal. It is hoped that by bringing all this information together in one source, more people will be able to share in saving stray and wild animals. Depending on the above conclusion the following recommendations are pin pointed.

- Community education must be under taken to aware the societies about humane management, socioeconomic and health problems associated with stray and wild animals.
- Personnel restraining stray and wild animals should be thoroughly trained in the planned procedure as well as in contingency methods of restraint that may be required.
- Government agencies should be aware of their responsibility for the development and enforcement of legislation relating to dog ownership (e.g. registration, vaccination and abandonment), the control of stray dogs and the alleviation of the problems stray dogs cause in their jurisdiction.

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