

The Ethics of Dart Anesthesia on Captive Mammals

An Honors Thesis (HONR 499)

by

Cassidy Houston

Thesis Advisor

Dr. Emily Ruth Rutter

**Ball State University
Muncie, Indiana**

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Abstract

Dart anesthesia is an important medical procedure that has its necessary uses in field research. Despite its usefulness in the field, the ethical basis for using it on captive animals should be explored due to the detrimental effects that could potentially occur from the procedure. This paper will explore the uses of dart anesthesia and the potentially harmful effects that come from administering medicine with this method. It will also give alternative options to the use of this type of chemical immobilization and the benefits of using these options. The paper will conclude with an overall analysis to provide the best possible understanding of the current administration of anesthesia of wild mammals in captive environments.

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Process Analysis Statement

When considering what I wanted to write for my thesis, I knew I wanted to focus on something that felt like a critical problem. To find this problem, I started to explore my personal life experiences looking for something that stood out to me. The one thing that stood out to me was my recent internship and work experience at a local zoo. This opportunity allowed me to explore what it was like to work firsthand with a wide range of animals and learn how to provide for their needs. Working at the zoo highlighted all the fantastic work done for conserving animals, but it also pointed out problematic practices still being used.

One problem I found was done by the only veterinarian locally willing to work with large cats such as lions and tigers. Most other local veterinarians were unwilling to work with these cats due to the potentially dangerous working environments that came with handling them. The willing veterinarian was an older gentleman who kept to the older practices that he had originally learned. One of these is using a dart gun to anesthetize the cats. The carnivore keeper wanted to explore other methods, such as training the cats to walk along the caging and pricking them with a needle. The veterinarian agreed to allow this once, and it proved to be successful as the cat went down with the first dose and did not show signs of stress as they recognized and trusted their keeper. Despite the successful attempt, the veterinarian continued using dart anesthesia as he claimed it was safer for everyone involved. The keeper expressed her displeasure, but since the options for care were limited, she had to accept his choice. After hearing about this interaction, I started considering why we even use dart anesthesia on captive mammals.

“The Ethics of Dart Anesthesia on Captive Mammals” is a research paper exploring the different ethical standpoints of dart anesthesia on captive mammals, especially lions and tigers. The basis of the arguments came from an extensive literature review of journals, books, and manuals. This research will add to the scientific literature on the methods of anesthesia used by zoological veterinarians, which is currently an under-researched topic. Research is needed on the influences that specific procedures such as anesthesia have on an animal’s mental and physical well-being. The American Veterinary Medical Association principles states that the decision regarding animal care and welfare should be made by balancing scientific understanding and professional judgment. Therefore, it is imperative to investigate these procedures so that there is more scientific knowledge that someone can use to provide the best care for the sake of the animal’s well-being.

Overall, I learned a lot from this project about myself and what I want to do with my future career. This research has solidified that I want to pursue a career in zoological medicine because I want to be involved in research to provide new methods of past procedures that consider an animal’s welfare before, during, and after the procedure. I want to be a veterinarian willing to listen to new research and change as the field does. Science is constantly evolving, and so should we. This is how the project allowed me to develop my career and self by providing a space for professional learning. While writing I felt that I strengthened my critical thinking skills by identifying the need for research. By providing alternative solutions to the current procedures, I further the point of the need for research for the sake of captive mammals. While I was identifying this need, I made sure to explore the various reasons for the procedure to make sure I was making a decision based on knowledge and logic rather than emotion.

Introduction

Animal welfare is constantly evolving as the detrimental effects of procedures are being discovered. Animal welfare is defined as the status of an animal's overall well-being. An animal is only considered in good welfare if it is well fed, in a safe environment, and exhibiting healthy mental and physical behaviors (AVMA, 2023b). To help determine if an animal is of positive welfare, the American Veterinary Medical Association (AVMA) created eight principles: the use of animals has to be beneficial for both humans and animals; the decision of use should be balanced by professional judgment and scientific knowledge; animals must receive proper care for their species' biology and behavior; the animal must receive care that minimizes fear, pain, and suffering; procedures use be continuously evaluated and then refined and replaced; conservation and management plans for populations should be humane and scientifically necessary; the animal should be treated with dignity and respect and only given a humane death if necessary; and the veterinary profession should strive to continuously improve animal welfare through research, education, advocacy, and creation of regulations and legislation (AVMA, 2023a). Principles and policies are necessary to help the increasing conflict between animal welfare activists and members of the research community (Prentice et al., 1986). Animal welfare activists often equate laboratory animals to our household pets. This is a difficult distinction to give as laboratory animals are often required to be exposed to sometimes painful experiments for the sake of furthering medical research for humankind (Prentice et al., 1986).

Philosophers of the past had thought that animals were incapable of feelings and thus did not need special consideration as they only existed for our use. However, modern-day research has proven that animals are capable of feeling and wellbeing is now a factor considered in

research and the care of captive mammals (Prentice et al., 1986). Research has determined a couple of indicators for the measurement of an animal's welfare; the successfulness of an animal to reproduce, the amount of body damage such as broken bones or wounds an animal may possess, the level of disease they may suffer from, behavioral reactions that are abnormal to what is expected of the species, and life expectancy. Setting indicators such as these not only helps assess if an animal has good welfare but also alleviates the emotional subjectiveness that could come with making this assessment (Broom, 1991).

We as scientists have an ethical responsibility to provide all animals, especially research and captive, with space that allows them to experience positive well-being throughout their lives and as necessary their death (Brando and Norman, 2023). This is why older procedures must be explored to weigh the benefits and costs of the procedure on an animal's welfare. Specifically, dart anesthesia needs to have its uses on captive mammals explored as some research has shown it can do more harm than good and there are alternative routes available. This paper will build upon the current research on medical procedures given to captive mammals by exploring the ethical basis for using dart anesthesia. This paper will look at several components such as the current use of dart anesthesia, the potentially harmful effects of using it on captive mammals, current alternatives available, and an overall analysis to provide the best possible understanding of the current administration of anesthesia of wild mammals in captive environments.

What is Dart Anesthesia?

Chemical immobilization is a method of administering anesthetic drugs to animals to calm, restrain, or sedate them. The chemicals can be given in multiple different ways including orally, through hand-held syringes/jab sticks, and darts with blowpipes and guns (Sontakke et al., 2017). Chemical immobilization is intended to create a safer means to administer the necessary drugs while minimizing the animal's stress, injury, and mortality that result from physical immobilization (Isaza, 2014). It was also created as a safety measure for the staff members of zoos and field researchers working with wild animals, as it provided a way to successfully avoid the trauma of restraining the animal manually (Bush, 1992).

Dart anesthesia is one form of chemical immobilization where the anesthetic drugs are administered through the use of pistols and rifles loaded with darts (Sontakke et al., 2017). Dart guns can also be used to remotely give vaccines, fertility control treatments, and antibiotics (Hampton et al., 2021). The pistol method is the simplest model with either a foot pump or carbon dioxide cartilage that will build up the pressure to fire it. However, it has limited range and non-accurate sight, so it is only recommended for close-range use and pre-restrained animals (Sontakke et al., 2017; Figure 1a). The rifle method is a more complex model that has modifications that help it to remain silent to not startle the animal and can be used long range. However, it requires specialized darts and must consider factors such as wind for accuracy (Sontakke et al., 2017; Figure 1 b, c).

To use dart anesthesia, there is required knowledge of not only the guns but also specific knowledge of doses of the anesthetic chemicals, as the use of too much or too little could be detrimental (Ebedes et al., 2006). Expertise is also required as there are specific requirements to

where the darts should land as the goal is to hit the area with the most muscle development to have the likelihood of seeing injuries decreased (Sontakke et al., 2017). Comparative to other wildlife management tools, there is a lack of standardization in the ways shooting methods are chosen. Rather than using an evidence-based approach, experts guided the decisions to generically transfer the same methods of recreational hunting to wildlife management (Hampton et al., 2021). Regardless of the expertise of the shooter, an injury is a risk that is inherent with all darting either from the impact on the animal or the dart's contents expulsion (Hampton et al., 2021).

Figure 1: Photographs of three types of dart guns



Note: (a) Palmer Cap-Chur Model pistol (b) Pneu-Dart Model air pump rifle (c) Palmer Cap-Chur Model long-range rifle. Reprinted from “Remote Drug Delivery In: Zoo Animal and Wildlife Immobilization and Anesthesia”, by Isaza R., 2014, p. 165, John Wiley & Sons Inc.

What are the potential harmful effects of using Dart Anesthesia?

With every medical procedure, some biological and genetic factors could increase the risk of having potentially harmful effects during and after the procedure. These factors include: age as younger animals require more anesthesia and elderly animals require less anesthesia than a healthy adult; sex as males require a higher dose than females, size as smaller animals require higher dosing to keep up with their high metabolic rate; pregnancy as the female will require more to keep with the high metabolic rate associated with a having a fetus; and physical condition of the animal as sick animals require a lower dosage (Sontakke et al., 2017). With using chemical anesthesia, it is crucial to make sure the dosage is correct otherwise there could be lasting effects. Improper dosage results are an underdeveloped part of this field, but some scientists believe it can pose a danger for both the handler and the animal as they could wake in a frightened state and attack (Isaza, 2014).

Some detrimental effects of dart anesthesia could come from the failure of the tools themselves as darts are prone to high failure rates (Isaza, 2014). Precision and accuracy are required for ballistic methods such as darting as it could determine if an animal is harmed depending on the landing location of the dart. However, darting is less precise as darts require a posterior drag, an anterior center of gravity, and a stable area to dart from (Hampton et al., 2021). The dart could have an unintended effect due to how the mechanism expels its contents (Hampton et al., 2021). This effect could be severe tissue trauma and bone fractures. Landing incorrectly could also cause contamination of the dart site which results in an infection. This infection could become clinical and require medical intervention to prevent death (Isaza, 2014).

A final potentially harmful effect that can occur after dart anesthesia is capture-related stress. It is known by many names such as capture myopathy, capture stress, and stress myopathy but capture myopathy is generally the most preferable term. Capture myopathy is a non-infectious condition where biological stress defenses that animals possess have failed or are in the process of failing which causes morbidity and mortality (Breed et al., 2019). Capture stress can present as both physiological and psychological behaviors (Ebedes et al., 2006).

The physical symptoms can present as muscle stiffness, weakness, partial paralysis, lethargy, and incoordination (Breed et al., 2019). Symptoms such as muscular necrosis which is the death of muscle cells, acute kidney failure, and multiple organ failure are often associated with low recovery rates and often followed by death within two weeks (Breed et al., 2019).

The psychological symptoms include perception of fear, anxiety, rapid breathing, and restlessness. This condition is hard to diagnose as it requires close monitoring and immediate necropsy (Dechen et al., 2014; Paterson 2014; Breed et al., 2019). However, it is easily distinguished from other forms of exertional rhabdomyolysis, skeletal muscle breakdown, as it affects both the heart and skeletal muscles. Some treatments such as fluid therapy have been shown to work in minimizing the symptoms of metabolic acidosis and hypotension but overall the condition is considered fatal (Dechen et al., 2014; Paterson, 2014; Breed et al., 2019).

Capture shock syndrome or acute death syndrome can arise at the same time as capture myopathy during the immobilization of an animal. This syndrome typically ends in death within hours of post capture (Paterson, 2014). The clinical signs are depression, tachycardia which is a higher heart rate than normal, increased body temperature, weak pulse, and hyperpnea which is heavy labored breathing. Even if identified, there is a low success rate for rehabilitation once the syndrome starts to affect the heart with the usual treatment being to administer opioids,

sedatives, and some analgesia to make them as comfortable as possible before they pass (Paterson, 2014).

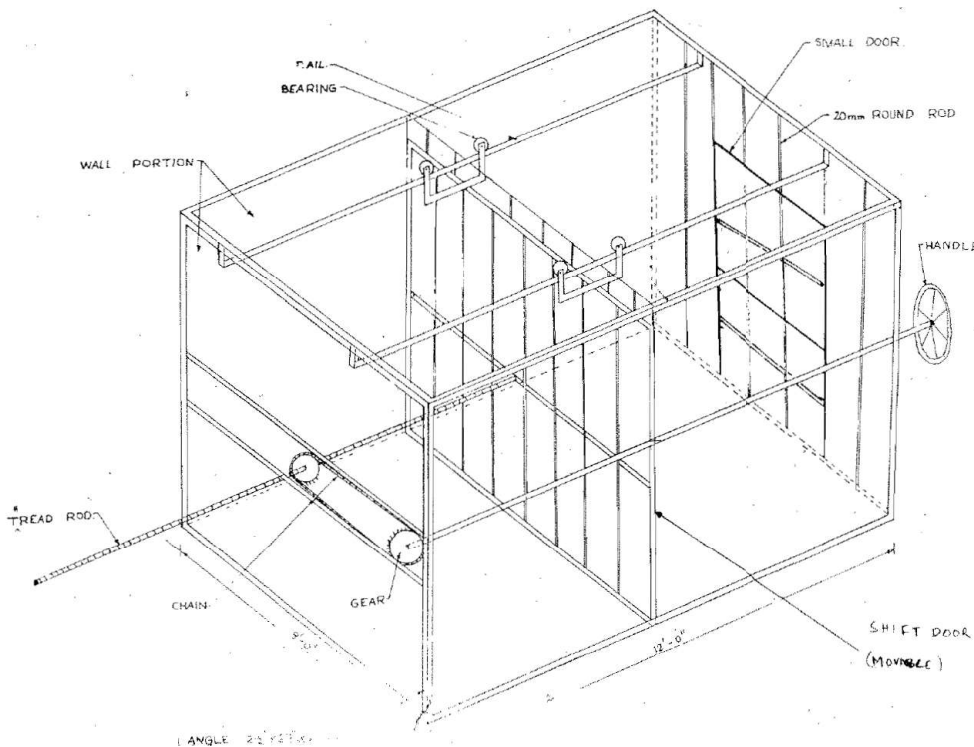
What are the alternative routes to provide anesthesia?

With the multitude of potentially detrimental effects of using chemical immobilization, especially dart anesthesia, the possibility of switching to an alternative route to administer necessary medical care should be considered. One possibility is the use of a squeeze cage. Squeeze cages are a tool that restrains and confines the animal so that medical personnel can work at close range. It is a cage of varying sizes with iron bars and side panels that come together to squeeze the animal to have its movements restricted for injections, minor surgical operations, and other necessary care (Yadav, n.d.). Once the animal becomes adjusted to the new addition to their habitat, it has been reported at Arignar Anna Zoological Park that it becomes an easy and quick process for both the handlers and the animals themselves (Rao and Manimozhi, 1996; Figure 2).

Despite the positive responses recorded from the animals and handlers, there are some downsides to using this method of physical restraint. Building and maintenance is one of these cons to installing a built-in squeeze cage. On average, a squeeze cage can cost up to twenty thousand dollars which is an expensive investment compared to other cheaper methods of chemical restraint (Holder, 2023). Another con to the use of these squeeze cages is the presence of stress-related behaviors. There have been signs of animals being stressed when being compressed in these cages. However, because the handler can quickly reach the animal and

perform the care, the levels are much lower and have not shown the fatality rates as seen with dart anesthesia through capture myopathy (Reinhardt et al., 1995).

Figure 2: A diagram of a squeeze cage



Note: A diagram of a squeeze cage built into a panther exhibit at Arignar Anna Zoological Park. Reprinted from: “Built In Squeeze Cage A management tool for restraining wild animals in captivity”, by Rao M.J., Manimozhi A., 1996, p. 17, Zoos’ Print Ten Years.

Another alternative to the use of dart anesthesia is the use of positive reinforcement training (PRT). Positive reinforcement training is promoting animals to voluntarily participate in procedures by encouraging them through rewards (Brando and Norman, 2023). There is wide

recognition of the usefulness of (PRT) for the management of species in a variety of housing situations and social contexts. It has shown the greatest successes in improving husbandry and medical care, social management, and improving psychological well-being (Laule and Whittaker, 2007).

Husbandry training allows an animal to take a role in receiving medical care such as an injection of a vaccine or having blood drawn for testing. It not only makes the event less frightening and stressful but it also makes it easier for the animal's caregiver to administer preventive medicine for better welfare overall (Laule and Whittaker, 2007). Socialization training allows group living of a species without aggression and wounding. It allows housing such as zoos and sanctuaries to peacefully introduce new animals to the native group without fearing for the animal's well-being (Laule and Whittaker, 2007). These training techniques make necessary medical care seem less invasive and reduce the level of anxiety that an animal might feel. Studies have shown that it can be beneficial to overall psychological well-being and decreased levels of physiological responses to stress in chimpanzees and can see the usefulness for other species of mammals (Videan et al., 2005; Laule and Whittaker, 2007).

The only consequence of using positive reinforcement training (PRT) over dart anesthesia is the time commitment. While it is a recognized form of animal management, it is not considered standard practice and is instead only used when there is time (Brando and Norman, 2023). Results of studies done on chimpanzees indicate that training sessions have to be continued even after the skill is learned in order to keep the same levels of success. There is a relationship between compliance and the number of training sessions, so they must continue for the benefit of both the animal and their care staff (Videan et al., 2005).

Conclusion

Chemical immobilization, especially dart anesthesia, is an important medical technique that has its necessary uses. It is extremely useful when working with an uncooperative, untrained animal that could be a danger to staff but also themselves. It is also valuable for field research that requires working with wild animals that can pose a true threat to field staff (Isaza, 2014). However valuable it is, it should not be the first method employed for providing medical care to captive animals. This is because it poses a serious risk of suffering from capture myopathy. Capture myopathy has incredibly high fatality risks that are preventable if the animal is given care that does not invoke a fight or flight response (Breed et al., 2019).

Methods such as squeeze cages and positive reinforcement training (PRT) are a way to minimize this fear that is better not only for the animal but for the animal care staff as well. Squeeze cages while initially expensive, have been shown to be a worthy investment as the animal suffers for less time as it increases the efficiency of medical care administering (Rao and Manimozhi, 1996). Positive reinforcement training is an underrated tool that should be encouraged for daily use rather than sparingly. It not only reduces stress and fear associated with medical procedures, but it creates improved psychological well-being of the captive animal and a better relationship with their care staff (Brando and Norman, 2023). The benefits of using an alternative mode like squeeze cages and positive reinforcement training outweigh the cons of pricing and time commitments as they provide the best care for an animal to have the best welfare possible in captivity.

As researchers, veterinary care personnel, and scientists, we have moral and ethical obligations to provide the best care for an animal's well-being (Mason, 2010). It is because we

have this obligation that we should continue to review the usefulness of older procedures in captive environments such as zoos and sanctuaries. The implications of using procedures such as dart chemical immobilization on captive mammals should be known when there are alternatives that have shown success in studies. Educating members of the field could not only improve an animal's quality of life but also ease the tension of the ongoing fight between researchers and animal welfare activists.

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