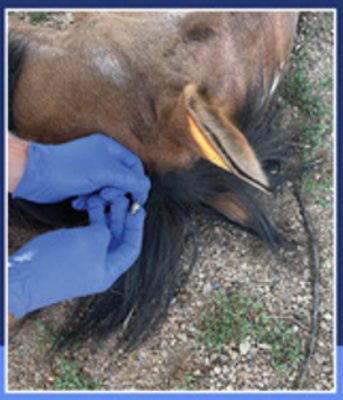
Second Edition

Veterinary Euthanasia Techniques

A Practical Guide





Edited by **Kathleen A. Cooney**



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A Practical Guide

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Dedication

To my colleagues who asked how to do euthanasia better and all the animal patients who inspired me to ensure things go well. Good endings matter to everyone.

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Author Biographies

Bruce A. Connally, DVM, MS, received his DVM from Colorado State University in 1979. He spent the next 11 years in a mixed animal practice in Wyoming. Then he joined a large veterinary drug company as a technical services veterinarian. In 1993, he completed a residency in equine field service and a master's degree in Large Animal Clinical Sciences at Michigan State University. He was a federal veterinarian for a year before returning to WY to open an equine ambulatory practice. In 2004 Dr. Connally joined the faculty at Colorado State University as assistant professor in equine field service. He spent seven years at CSU before returning to private practice. Currently, he has a mobile equine practice in WY and CO. For the last 10 years, he has been the veterinarian at the Colorado Horse Rescue. In 2019, he was recognized for that work by The Right Horse Initiative as the outstanding veterinarian for the central region of the United States.

Kathleen A. Cooney, DVM, MS, CHPV, CPEV, DACAW, has been practicing advanced end-of-life care since 2006, as both a mobile end-of-life practitioner and serving families at her euthanasia comfort center in Colorado. A graduate of Colorado State University in 2004, Dr. Cooney is the founder and now Senior Director of Medical Education for the Companion Animal Euthanasia Training Academy (CAETA). She is well known for her work in companion animal euthanasia and has authored three books on the subject, along with numerous articles, research papers, and independent book chapters. Dr. Cooney has developed euthanasia and animal hospice guidelines for veterinary groups around the world. Dr. Cooney is a diplomate in the American College of Animal Welfare and is on the faculty at Colorado State University where she teaches end-of-life topics and animal welfare. She loves all things old and gray.

Angela M. Lennox, DVM, DABVP-Avian, Exotics; DECZM-Small mammal, is a graduate of Purdue University School of Veterinary Medicine and has practiced exclusively exotic animal medicine since 1991. She has practiced exclusively exotic animal medicine at Avian and Exotic Animal Clinic in Indianapolis since 1991 and is an adjunct professor at Purdue School of Veterinary Medicine. She is a diplomate in the American Board of Veterinary Practitioner (ABVP) in both Avian and Exotic Companion Mammal Medicine, and a diplomate of the European College of Zoological Medicine, Small Mammal Medicine. Dr. Lennox has a special interest in the end-of-life and palliative care for exotic pet species.

David S. Miller, DVM, DACZM, DACAW, is a veterinarian who has experience with all major zoological animal taxa and all domestic animal species. He has worked in zoo, university, private practice, research, nonprofit, and government settings as a veterinarian, wildlife biologist, researcher, and zookeeper. Dave is boarded in zoological medicine (DACZM) and animal welfare (DACAW). He led the development of Guidelines for Euthanasia of Nondomestic Animals

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published by the American Association of Zoo Veterinarians and had leadership roles on the Panels on Euthanasia and Depopulation. Dave has also served on multiple other committees and task forces concerned with animal welfare. He has taught animal welfare, zoological medicine, One Health, and epidemiology courses at colleges; has provided continuing education at veterinary and wildlife professional meetings; has developed wildlife handling training for professionals; and has also provided animal welfare presentations to the public.

Jan K. Shearer, DVM, MS, DACAW, received a veterinary degree from The Ohio State University in 1975. He served five years as an Associate Veterinarian with the Orrville Clinic, Inc., in Orrville, Ohio, before returning to OSU to pursue graduate studies in nutrition and immunology. He became an Assistant Professor in the Department of Veterinary Preventive Medicine at The Ohio State University before moving to the University of Florida to become Professor and Dairy Extension Veterinarian in 1982. After 27 years with the University of Florida, he accepted his current position at Iowa State University as Professor and Dairy Extension Veterinarian. Dr. Shearer's primary areas of research interest are bovine lameness, euthanasia, and welfare issues of beef and dairy cattle. He presently serves as the Beef and Dairy Cattle Lead on the AVMA Panels on Euthanasia and Humane Slaughter, and as a member of the AVMA Panel on Depopulation.

Grey Stafford, PhD, began his zoological career training marine mammals and later, many terrestrial species. He earned his doctorate in biological sciences from Kent State University studying marmoset energetics. Dr. Grey is the author of the animal training book, *ZOOmility: Keeper Tales of Training with Positive Reinforcement* and served as president of the International Marine Animal Trainers' Association. His long-running zoo-and-aquarium-focused weekly podcast, *Zoo Logic,* features animal professionals, best-selling authors, scientists, conservationists, and influencers. Grey was a long-time member of the editorial advisory board for IMATA's journal *Soundings* and continues to serve as an editor for the peer-reviewed journal *Aquatic Mammals* published by the European Association of Aquatic Mammals (EAAM). Grey was an original member of the Scientific Advisory Committee for the American Humane Association that developed Humane Conservation, an animal-centric welfare audit and certification program for zoos and aquariums. More recently he has advised with American Humane on a new certification program for global sustainable tourism. As a member of the Association of Zoos and Aquariums (AZA) for more than 30 years, Grey has served on the animal welfare and PR committees and conducted a variety of presentations and publications on improving animal well-being through reinforcement-based operant conditioning.

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Foreword from the Editor

Euthanasia means good death and is much more than the medical act of ending life. It is about giving time to reflect on the "why" behind the decision to euthanize, thinking through the best technique for the animal patient, applying that technique in a skillful way, and protecting the mental health of all those in attendance. Euthanasia is a hard topic, and an unpleasant consideration for many readers. Death is a part of life and makes the possibility of euthanasia unavoidable for animal caregivers, therefore learning how to safely facilitate it becomes necessary. When everything comes together in a meaningful way, animal patients are sure to be in trustworthy hands.

If the past and present are indictive of the future, euthanasia will mature to become even more mindful of stakeholders: the animal patient, client/owner, veterinary personnel, witnesses, and society at large. It is evident that endings matter, and the more attention given to gentleness, the greater the likelihood of an anxiety-free, pain-free death. Euthanasia is deeply rooted in animal welfare principles wherein the patient's experience is the top priority. If the patient has a traumatic euthanasia, death may have been achieved, but at what cost? A dysthanasia (bad death) is avoided through preplanning and attention to what's ultimately best for the animal. When the animal has a good death, the remaining stakeholders are sad but grateful for the peaceful, thoughtful way euthanasia was carried out. This is what this book excels at, giving the reader the tools to prevent dysthanasia and appreciate what a good death really means.

While significant detail into euthanasia methods can be found within, there are some techniques that have been purposefully left out because of their lack of usefulness in veterinary practice with client-owned animals. The American Veterinary Medical Association's Guidelines for the Euthanasia of Animals document holds an overview of available euthanasia techniques for use in a wide array of species beyond the scope of this book. Also not included are instructions on how to perform slaughter or depopulation events, which demand their own robust training and explanation. We also felt it beyond the scope of this book to discuss the human–animal bond and its effect on euthanasia in great detail. Readers will undoubtably understand the complexity behind the difficult choices people make regarding the decision to euthanasia. For those performing the procedures, we acknowledge that empathetic strain is very real and must be addressed.

If this book is to have a third edition, research is needed to answer the call of these key directives. The findings will be of greatest use to animals when they are applied in practice. A little professional attention to euthanasia on a regular basis will move us away from outdated approaches to newer, more effective ways to end life. All stakeholders expect this and will hold veterinary practitioners to greater accountability. I, along with these authors, and all those dedicated to the "good death revolution," ask you to consider how you can improve euthanasia methodology for the future welfare of all animals.

Dr. Kathleen A. Cooney

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Preface

This second edition has been in the works since 2013 ever since the first edition was completed. While it may not seem it at times, changes happen fast in veterinary medicine, and this includes death-related services like euthanasia. New techniques, and smart improvements to older ones, gives opportunity to improve patient care. In 2024, I became a Diplomate in the American College of Animal Welfare. This four-year journey gave me the chance to appreciate how euthanasia is carried out in all manner of animal industry beyond companion small animal work, my area of specialty. Learning from others, I found a renewed passion to evolve euthanasia best practices yet again. When we know better, we have an obligation to do better, and teach others the skills to protect an animal's welfare through the last moments of life.

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1

Euthanasia Standards in Modern Times

Kathleen A. Cooney

1.1 A Brief Look at Euthanasia's History

This book is written to be a practical guide for veterinarians and all professionals performing or assisting with euthanasia, especially during times they find themselves in unfamiliar situations. It is meant to help readers form a foundation of euthanasia best practices, while building confidence in the procedure and all it entails. To achieve this goal, it's important to understand a bit of euthanasia's history and appreciate how veterinary medicine has evolved to protect the animal's experience and support those who witness the death.

1.1.1 Defining Euthanasia and Original Methods

As with any significant movement in the right direction, changes take time. Euthanasia is a very old term, Greek in origin, combining the words εὖ (eu), meaning good, and Θᾰ́νᾰτος (thanatos), meaning death. The first use of it dates back to around 121 CE to describe the ideal human death; loved ones gathered around, affairs in order, and comfortable. It referred to a natural passing, not tied to the act of purposefully ending life like it is today (Dowbiggin 2007). The meaning changed in the late 1800s when it was suggested that suffering persons of the world would be better served with a quick death. Veterinary medicine eventually took on the word to describe intentional, active (not passive) animal death. It reflects the veterinarian's desire to bring about the best possible outcome for the animal, including to end its life if mental and/or physical suffering persists (Figure 1.1).

Early euthanasia methods were physical in nature (e.g. blunt force trauma, drowning) until pharmaceutical drugs, both gas and injectable, became available. Some poisons were tried as euthanasia agents (e.g. strychnine, cyanide) but proved to be highly distressing to the patient. With attention placed on reducing pain, anxiety, and fear, euthanasia methods began to put more emphasis on producing rapid unconsciousness, the hallmark of any safe killing method.

Some of these early euthanasia methods were less than ideal and understandably resulted in what today would be referred to as "dysthanasia," or a bad death. Dysthanasia is what practitioners

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Figure 1.1 A cat owner grappling with the reality of the euthanasia decision and hoping things progress smoothly. *Source:* CAETA (2025).

aim to avoid, not only for the animal's sake but for those who are present during the procedure and may experience emotional harm. The following illustrates the terms' differences:

Euthanasia:

- The animal feels minimal to no anxiety, pain, or fear.
- Proper technique is delivered.
- The procedure is in line with professional and societal animal welfare expectations.
- Observers feel safe and supported.

Dysthanasia:

- The animal feels unacceptable pain, anxiety, and/or fear.
- Improper technique is used.
- Observers experience distress and anguish.
- Support among the patient, client, and veterinary team breaks down.

Through improved research, euthanasia methods and techniques are more reliable than ever before. While there is always room for improvement, evidenced by new research coming out each year, practitioners find themselves with effective options for a multitude of circumstances. Many euthanasia methods are the same as they were decades ago to great success. However, others are set to change for the better or fade out of use altogether.

1.1.2 The Guidelines We Follow

To help euthanasia practitioners, animal industries have developed guidelines that follow the collective body of euthanasia research. These industries (e.g. food animal production, research, wildlife management, small animal general practice) create euthanasia best practices for the species they care for, with the vast majority of them drawing some, if not all, of their information from the American Veterinary Medical Association (AVMA). When the first AVMA Euthanasia Panel report was published in 1963, the panel members drew from only 14 known reference articles related to euthanasia. It was clear there was much to improve upon, and in time, more research and superior

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euthanasia methods would emerge. By 2001's AVMA panel report, the number of utilized articles, presentations, and books had grown to over 200. The 2020 document, titled *Guidelines for the Euthanasia of Animals*, took the expertise of more than 70 individuals and included references near the 700 range.

The AVMA developed categories to help classify euthanasia methods for veterinary practitioners to follow. The euthanasia methods are either "acceptable," "acceptable with conditions," "unacceptable," and "adjunctive." The following description is shared directly from the 2020 AVMA Guidelines for the Euthanasia of Animals:

> *Euthanasia methods are classified in the Guidelines as acceptable, acceptable with conditions, and unacceptable. Acceptable methods are those that consistently produce a humane death when used as the sole means of euthanasia. Methods acceptable with conditions are those techniques that may require certain conditions to be met to consistently produce humane death, may have greater potential for operator error or safety hazard, are not well documented in the scientific literature, or may require a secondary method to ensure death. Methods acceptable with conditions are equivalent to acceptable methods when all criteria for application of a method can be met. Unacceptable techniques are those methods deemed inhumane under any conditions or that the panel found posed a substantial risk to the human applying the technique. The Guidelines also include information about adjunctive methods, which are those that should not be used as a sole method of euthanasia, but that can be used in conjunction with other methods to bring about euthanasia.*

Practitioners determine which euthanasia method to use based on their knowledge of these categories and what they feel is suitable for their patients. The methods themselves have already been reviewed by experts using a criteria checklist with these considerations:

- Ability to induce loss of consciousness and death without pain or anxiety
- Time required to induce loss of consciousness
- Reliability
- Safety of personnel
- Irreversibility
- Compatibility with requirement and purpose
- Documented emotional effect on observers and operators
- Compatibility with use of tissue, examination
- Drug availability and human abuse potential
- Compatibility with species and health status
- Ability to maintain equipment in working order
- Safety for predators/scavengers should the body be consumed
- Legal requirements
- Environmental impacts of the method or carcass disposition

Most euthanasia technique publications around the world use these criteria as their basis for acceptable methods. If a particular technique does not meet one or more criteria, the technique becomes less acceptable, therefore requiring additional reflection and precaution to be taken. For example, an intracardiac (IC) injection of a euthanasia drug must be preceded by the administration of an anesthetic because, by itself, the euthanasia drug injection will induce pain in the animal. Another example is the gunshot technique of a client-owned horse. This may have an

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Figure 1.2 A deceased horse following firearm euthanasia. Afterward, loved ones were invited to approach and safely say goodbye. *Source:* CAETA (2025).

emotional effect on the observers but may be necessary to keep euthanasia drug out of the body when burial is the aftercare choice (Figure 1.2).

It is the practitioner's responsibility to examine available methods to make the best judgment on how to proceed. It is important to remember that guidelines are not considered the law or legally bound. However, practitioners would be expected to justify why they performed euthanasia outside of a guideline's recommended methods, especially since the methods are rooted in scientific justification. Note that euthanasia methods are viewed differently from slaughter or depopulation killing methods. The AVMA deliberately created separate guidelines for them, and they are not described further in this book.

In 2017, the Companion Animal Euthanasia Training Academy (CAETA) created the 14 Essential Components of Companion Animal Euthanasia for private practitioners to follow (Table 1.1). The components are appropriate for a variety of euthanasia settings when bonded clients are present and are meant to be a blueprint for veterinary teams to follow as they prepare for the euthanasia appointment. They can be used to help develop a euthanasia manual, discussed later in this chapter.

1.1.3 How Death is Achieved

Euthanasia techniques are divided by methodology, relating to how death is achieved within the body. Based on current knowledge of the body, death can occur through three mechanisms:

1) Direct depression of neurons necessary for life (pharmaceutical agents that shut down the body's nervous system). Examples include:
   - Barbiturate overdose via the kidney
   - Lidocaine overdose into the subarachnoid space
   - Carbon dioxide inhalation

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Table 1.1 The 14 essential components of companion animal euthanasia.

G	Grief support material provided
O	Outline caregiver and pet preferences
O	Offer privacy before and after death
D	Deliver proper technique
E	Establish rapport
U	Use pre-euthanasia sedation or anesthesia
T	Thorough complete consent
H	Helpful and compassionate personnel
A	Adequate time
N	Narrate the process
A	Avoid pain and anxiety
S	Safe space to gather
I	Inclusion of loved ones
A	Assistance with body care

Source: Author's / with permission of Companion Animal Euthanasia Training Academy / www.caetainternational.com.

2) Hypoxia/anoxia to prevent oxygen delivery to the tissues (pharmaceutical agents or physical methods). Examples include:
   - Potassium chloride overdose via the vein
   - Exsanguination through neck vessel laceration
   - Carbon monoxide inhalation
3) Physical disruption of brain activity (brain destruction). Examples include:
   - Gunshot
   - Penetrating captive bolt

The goal is to achieve permanent, irreversible death using one euthanasia method. However, sometimes multiple euthanasia methods will be needed. If the patient is only rendered unconscious from the primary technique, another one must be immediately performed. All of the various euthanasia methods may or may not be available to the veterinary practitioner. They will choose their preferred techniques and obtain the necessary supplies to perform them.

1.2 Ethics and a Focus on Animal Welfare

1.2.1 Ethical Considerations

From a moral point of view, veterinary practitioners must examine all possible life-sustaining options before euthanasia is chosen. Practitioners have the right to euthanize patients without attempting therapeutic interventions (e.g. pain medication). However, ethically they should be offered for clients to consider (Mota-Rojas et al. 2023). Anyone performing euthanasia has the potential to slow down and give critical thought to the permanency of ending life. Once the procedure is carried out, there is no reversal. In other words, the best time to reflect on the morality of euthanasia is always before, not after.

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Questions need to be answered by the practitioner before proceeding with euthanasia:

- Am I comfortable with the decision to euthanize?
- Was the decision-making process thorough and motivated by proper reasoning?
- Did I offer every viable treatment or rehoming option?
- Am I acting in accordance with the law, and do I feel certain that public opinion would show favorably on the decision to euthanize?
- Is electing euthanasia causing the patient more harm than good?
- Am I the right person to perform the procedure?

Those performing euthanasia may harbor guilt and resentment toward their decisions if the answers to these questions have not been explored. One may need to ask themselves if their reason for euthanasia became public, would they feel certain events played out in the best interest of the animal and client? Ethically-indicated euthanasia has been defined as "euthanasia performed in what are believed to be the animal's interests and which is not considered to be primarily motivated by convenience, economics or reasons to which veterinary team members object" (Quain 2021). Ethical dilemmas arise when practitioners are asked to euthanize an animal when it is not in the animal's best interest (Kipperman et al. 2018). It's a reminder of how complex euthanasia decisions are and that having the skills to perform euthanasia is only part of the picture.

When a client does elect euthanasia for their pet, practitioners will need to hear the reasons before passing judgment as to whether it is ethically right or wrong. They can help clients determine if euthanasia is the best option for everyone. Veterinary training should provide the necessary tools to assess the animal and determine what physical changes will worsen as the end of life approaches. Age, disease, species, financial reserves, beliefs, etc., can all play a role in the decision to euthanize. The client may be considering euthanasia as the only option. It is the practitioner's role to identify suffering and make sure all options are explored. Clients typically understand their animals very well, especially pertaining to quality of life, and their contributions to the conversation are crucial (Figure 1.3). The trick is not to let fear of the unknown be the guiding factor but rather have logical reasoning and knowledge be the prevailing rationale.

1.2.2 Euthanasia and Its Relationship to Animal Welfare

Animal welfare relates to what an animal needs throughout life, including its death. The mission during euthanasia is to maintain the patient in a neutral or positive affective state, meaning the patient is void of negative thoughts and feelings. All sentient animals have some level of cognition, and most, if not all, have the ability to feel pain (Mellor 2010). Therefore, in order to achieve the gentlest death possible, the animal must be handled in a way that matches their tolerance.

To help ensure the animal has a death free of unnecessary harm, only those trained in euthanasia should perform the procedure. This includes veterinarians, shelter staff, trained farm personnel, and other professionals that the government (state, province, or federal level) deems appropriate. Only those with these rights should attempt euthanasia, as a matter of animal welfare. There are numerous animal cruelty cases that resulted from animal owners attempting to euthanize their own animals, with painful results, e.g. burning, drug overdoses, and misplaced gunshots. To prevent such attempts, practitioners and support staff can talk openly with clients about the importance of proper euthanasia methods by trained professionals.

Animal welfare utilizes what's known as the five freedoms (freedom from pain/injury/disease, discomfort, fear/distress, hunger/thirst, and freedom to express normal behavior). During the final

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Figure 1.3 A young boy bonded to his rabbit.

moments of life, one must consider how to provide the animal with a sixth freedom – the freedom to die a good death (Pierce 2012). All efforts are made to ultimately prevent animal suffering before and during the final moments of life.

1.2.3 The Importance of Training Euthanasia Methods

One of the wisest ways to provide euthanasia and avoid dysthanasia is to know how to perform the procedure. As this book shows us, there are many layers to euthanasia that can take years to master. Seasoned veterinary practitioners have seen all manner of cases, some easy, some challenging, and some that have made them question if they ever want to perform euthanasia again. The more a practitioner knows about the procedure, the better prepared they are to meet and exceed the needs of the patient and client (Figure 1.4).

In 2019, a survey of 30 US veterinary colleges revealed that the average number of hours devoted to euthanasia methods and techniques was 2.8, yet euthanasia facilitation was considered a core competency by all schools responding. The most frequent methods taught for euthanasia were intravenous and intracardiac injections for dogs, cats, horses, livestock, and/or exotics (Cooney et al. 2021). In this author's opinion, it can appear that as long as future veterinarians are taught how to give an injection during schooling, they know how to perform euthanasia in practice. A lack of euthanasia education places veterinary practitioners, especially new graduates, in a risky position and less qualified to end life. Ideally, learning institutions require a minimum of 4 hours of detailed technique training, with additional hours dedicated to client communication and

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Figure 1.4 A client prepares to say goodbye to a beloved pet. The dog has significant health issues that could lead to a more challenging euthanasia procedure. *Source:* CAETA (2025).

handling moral dilemmas. It would also be good for veterinary students to be present during euthanasia appointments within clinical rotations.

1.3 Writing Today's Euthanasia Story: The Who, What, When, Where, Why, and How

Depending on the type of animal and the setting, each euthanasia will have its own story and outcome. A smart euthanasia appointment increases the knowns and decreases the unknowns. When euthanasia practitioners are able to plan ahead, they set the stage for greater technical accuracy, reduced patient struggle, and improved client satisfaction. Let's consider the who, what, when, where, why, and how of a euthanasia appointment to paint a clearer picture of the available options and the details that should be addressed.

1) Who can be present – essentially anyone can be present for euthanasia as long as the procedure can be safely completed. This includes physical and emotional safety for the patient, veterinary personnel, clients, and others, including children and other animals.
2) What is taking place – everyone must clearly understand that death is the intended outcome. The purpose of euthanasia should be stated and agreed to by all responsible parties. Clients and witnesses will need to be told enough detail about the euthanasia method to allay concerns.
3) When euthanasia occurs – the timing is primarily focused on when it's right for the patient, to reduce unnecessary suffering. The appointment is scheduled when the practitioner is available and others can be there to lend support. In the case of strong human bonds to animals, loved ones will want to gather and say goodbye.

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4) Where euthanasia is done – the ideal location for euthanasia is away from busy areas. Privacy is important in almost every setting. Attention is given to where the patient is most comfortable and stress-free.
5) Why euthanasia is happening – while it may be clear to most why euthanasia is being done, openly stating the reasons behind it is beneficial to those with lingering questions. This is also an opportunity for deeper reflection on euthanasia before it's performed, to ensure it's the right plan.
6) How euthanasia will be conducted – the method is determined by the practitioner and described in simple terms to people in the area. The goal is to inform without overwhelming. As far as the patient is concerned, the method should hold minimal to no pain, fear, or distress.

1.3.1 Deciding to Euthanize an Animal Is Hard

Entire books have been written about the struggles clients and veterinarians face when deciding to euthanize an animal. Making the decision to euthanize is hard, even when it seems easy, i.e. the animal is clearly suffering, and death will be a welcome release from pain/misery. Justifying the decision to euthanize is based on one's cultural norms, previous experiences, and beliefs. These have to align with what other stakeholders think too.

Many animal industries use quality-of-life scales to help veterinary teams and animal owners assess how well an animal is coping with a life-limiting disease or age-related changes. The purpose of a scale is to reduce subjectivity and give a rank or number to show how well the animal is actually doing. In chronic or long-term situations, quality-of-life scales can be used repeatedly until it's obvious the animal is no longer able to cope with symptoms.

Whether the animal in question is client-owned or is kept for production-based purposes, the veterinarian will need to consider the following factors regarding disease before deciding to proceed with euthanasia:

- Is the animal free of pain?
- Can pain (and other conditions) be controlled enough to make the animal comfortable and maintain a reasonable quality of life?
- Is the client willing to care for the animal in its current state of health?
- Is the client able/willing to finance care that would heal or palliate the animal's condition?
- Is the animal suffering?

Suffering is a very subjective term and difficult to define for any one situation. One must take all factors into consideration to help determine if suffering is occurring, and once recognized, how it can be lessened or stopped altogether, perhaps through euthanasia. Many people look at suffering as the presence of constant pain that cannot be managed. Others view suffering as the inability to do what the heart desires. Both concepts are viable and can further be classified as being physical and/or mental in nature. When death becomes imminent, except maybe in pure crisis situations, preparations and mutual understanding should already have been established. Suffering by the animal and client can hopefully be better avoided. With respect to this final decision, euthanasia is the ultimate treatment to end suffering (McMillan 2001).

What practitioners will want to remember is that most clients would rather have an alternative outcome to euthanasia (Bussolari et al. 2018). If the clock could be turned back and more quality time given, that would be preferable. The feasible alternative is to offer palliative medicine and comfort care to reduce disease symptoms until the time is right for euthanasia or the animal dies

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naturally on their own. In many situations, a peaceful natural death is not a viable option. If it is, and that is what the client prefers, it should be attempted, meaning euthanasia is only elected if a peaceful death is no longer achievable. It's about helping clients see the worst-case and the best-case scenarios. Sometimes choosing euthanasia sooner rather than later is the right course of action.

In terms of euthanasia decision-making, it is important to consider the animal's state of suffering as well as the client's. Substantial caregiver burden will move up the euthanasia date, and rightfully so. An animal that is hard to care for is more likely to experience physical and mental hardships. Educating clients about the disease process and how to proceed is important so that if they choose euthanasia for their animal, they know that they are doing it for the right reasons. This will ultimately lessen the guilt and help them achieve healthier mourning (Wolfelt 2004).

Beyond some of the who, when, and where questions that clients themselves will answer, practitioners will have other professional questions to consider:

- What does the client need to know about euthanasia?
- Has deceased aftercare been decided?
- Is pre-euthanasia sedation or anesthesia being offered, based on current standards?
- Is the person making the euthanasia decision authorized to do so?
- Should a necropsy be chosen, or diagnostics done on other animals in the immediate vicinity when a communicable disease is suspected?
- If the client cannot afford euthanasia, do we still proceed?

Euthanizing for behavioral reasons is also hard and wrought with conflict for both veterinary professionals and clients. Aggression toward humans tends to be the leading cause of behavioral euthanasia in dogs (Siracusa et al. 2017; Hitchcock et al. 2024), followed by aggression toward other animals and destruction of property. Many species may face euthanasia if unwanted behaviors cannot be controlled. An alternative to euthanasia is always preferred. However, sometimes ending life is the safest, most responsible option.

1.3.2 Establishing Rapport, Building Trust, and Supporting Grief

The best way to approach end-of-life is to set the type of relationship with a client that has the best interests of the animal in view as the goal of treatment (Rollin 2006). This can be done early in the veterinarian's communication with the family, long before a terminal diagnosis or any other reason for euthanasia presents. The client must feel safe talking to the veterinary staff about their concerns. Opening up dialog about euthanasia early in the end-of-life (EOL) discussion is important so that everyone involved works together as a team and trust is established. Professionalism and respect for the situation go a long way in demonstrating compassion.

When the option of euthanasia enters the discussion, the goal is for the client to feel safe talking about it. The topic needs to be introduced delicately so that they do not feel that the veterinarian has given up prematurely (Cohen and Sawyer 1991). Ultimately, it is the disease or extenuating circumstance that is ending the animal's life, not the practitioner's desire to do the work. Hard conversations like this are best in calm and controlled settings where clients can talk openly with veterinarians, in partnership. Clients should feel safe to ask questions at any time during the procedure. When they do make the decision to euthanize, the client will be looking for affirmation that they made the right choice (Matte et al. 2020).

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Figure 1.5 A practitioner and client establish rapport and agree to work together for the sake of the animal. *Source:* CAETA (2025).

Rapport is established through an authentic desire to make a connection. Practitioners do this by asking the client's name, listening closely to stories about the animal, and having a genuine interest in making the euthanasia procedure as smooth as possible. A practitioner needs rapport to be formed with their client early in the euthanasia appointment to increase client trust (Figure 1.5). A trusting client is more likely to hear and believe the important information being told to them. They also tend to be more relaxed and stable during what could be a very emotional event. Ideally, clients remain present during euthanasia. However, they should never be forced to watch an animal die. It is a choice. If a dysthanasia does occur, the client is more likely to forgive because trust was established, knowing the practitioner tried their hardest (Kogan and Cooney 2023).

When a veterinarian and client form a professional relationship, wherein the client agrees to follow the veterinarian's recommendations, this is called a veterinarian-client-patient relationship (VCPR). VCPRs are based on trust and are critical during euthanasia discussions and procedures. Once established, the veterinarian can direct care using their knowledge and expertise.

Rapport and trust building are done with everyone in the room/area. The veterinary team will strive to make everyone feel welcomed and comfortable regardless of the setting. Children do remarkably well when introduced to euthanasia in a positive and safe manner (Cooney 2011). The presence of other pets may also be allowed if the client and practitioner think it appropriate. The calmer the area, the more relaxed clients and veterinary staff will be. The utilization of comfort rooms, quiet stalls, home cages, etc., increases trust and safety.

Before, during, and after euthanasia, clients feel a wide range of emotions: sadness, anger, relief, guilt, helplessness, and more. Even if they have experienced a loss before, each time is unique and reflects directly upon the relationship they had with their animal. Veterinarians and their staff should know how to discuss grief, offer guidance, and be informed on what the community can offer with aftercare options and pet loss support. More on grief is discussed in Chapter 7.

In a continued effort to build trust and reduce client concerns, the euthanasia method can be discussed with the client before it is attempted. Many people understand the varying techniques

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that may be performed to achieve death, but just as many will not. Practitioners can describe the technique of choice given the circumstances and still allow the client to voice any concerns they may have. It is important to reassure those present that the goal of euthanasia is to provide a stress-free and painless death. Honesty as well as thoroughness is key when talking about euthanasia so that unexpected situations are minimized.

1.4 Euthanasia Technique Selection

Because the focus of this book is on euthanasia techniques, this section will highlight both generalizations and unique factors that may affect various animal industries. Earlier, the methodology behind euthanasia was defined. Veterinary practitioners will be familiar with the techniques and can choose the one they feel is most suitable for their patients. Careful consideration of each one, along with the technical know-how to facilitate it, is the trait of a skilled practitioner.

1.4.1 Choosing an Appropriate Euthanasia Method

The method of euthanasia chosen by the veterinarian will depend on the following factors:

- Comfort with the technique
- Available supplies
- Presence of clients and observers
- Type and amount of euthanasia drugs
- Animal's state of consciousness
- Signalment and physical condition of the patient
- Need for a postmortem examination
- What's allowed by governing bodies

Each factor has special considerations that a knowledgeable practitioner will be able to address. Unless the situation is an emergency, there is usually ample time to find the most appropriate method and determine one or two backup techniques.

1.4.1.1 Comfort with the Technique

When a practitioner has experience with a particular technique, they know what to expect and what to do if something unexpected happens. While many will have their preferences, all practitioners should know at least two alternative methods. Each technique has pros and cons. The goal is to move seamlessly from one to another without raising alarm in those watching. Consider too that sometimes multiple techniques are needed to guarantee death, e.g. topical anesthetic overdose in a frog followed by cerebral pithing.

1.4.1.2 Available Supplies

As supplies are prepared, things should be included for a standard euthanasia procedure as well as emergency equipment. For injectable methods, various needle sizes, syringes, catheters, cleaning gauze, etc., need to be accessible at all times. For physical methods, the equipment must be cleaned and ready for use. Practitioners are encouraged to keep an ample amount of supplies/equipment with them.

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1.4.1.3 Presence of Clients and Observers

Practitioners understand death and are familiar with the process of euthanasia. Clients, however, may not be. The least aversive yet reliable technique should be chosen. As long as clients know how the procedure will take place, and the approximate time frame, most clients will be accepting of the method chosen (Kogan and Cooney 2023). Keeping communication open and answering any questions they have will help decrease their stress. Sometimes, the practitioner needs to prompt questions due to the client's emotional state of mind. Clients might not know what questions to ask or how much detail they should hear. For example, when a slow euthanasia method is chosen, such as an intraperitoneal (IP) injection, observers should be told that death may take longer than an intravenous (IV) injection. In the case of large animals, gunshot is often the most practical method, but the reaction of observers must be considered. People typically handle the technique very well when they understand why it is done and that their animal is safe and supported. Education is important to lessen fears of the unknown.

1.4.1.4 Type and Amount of Euthanasia Drugs

Euthanasia injection techniques should be fully understood before attempting. Drugs work in the body via different pharmacodynamics, and depending on where they are injected, they hold varying pharmacokinetics and absorption rates. Pentobarbital sodium is a common euthanasia drug that can be injected into the vein or into an organ, or even fed to patients. Where it is administered affects the dose and time to death. Many drugs require a large volume to be given, and this will affect where they should be administered. For example, an intrarenal (IR) injection can only accommodate a small volume of drug before the renal capsule swells. The euthanasia drug potassium chloride must be given IV or into the heart under general anesthesia. Factors such as these should be understood before euthanasia is performed. If only a small amount of euthanasia solution is available, a technique should be chosen that requires the smallest volume possible, such as an IV injection. If there is not enough drug, the practitioner will be unable to complete the euthanasia unless they have a backup technique ready. Anesthetic gases are another form of euthanasia drug and are considered aversive in most situations (AVMA 2020). These should be carefully considered before using, not only for the patient's comfort but also for the safety of people in the area.

1.4.1.5 Animal's State of Consciousness

A conscious animal has the potential to experience pain during euthanasia. If unconsciousness can be achieved first, euthanasia technique options increase. Currently, in the United States, any intraorgan euthanasia injection with a pharmaceutical agent requires the patient first to be rendered unconscious, with the exception of intrahepatic (IH) pentobarbital injections in cats per the AVMA Euthanasia Guidelines. However, this author advises caution, especially when clients are present. Based on the species, unconsciousness can be accomplished by injecting, feeding, topically applying, or immersing a patient in an anesthetic drug, or by physically stunning the brain with a physical method like non-penetrating captive bolt or electrocution (not described in this book). Having a patient unconscious during euthanasia can relieve considerable pressure on the practitioner, knowing that whatever technique they elect, the patient is completely unaware and pain-free.

1.4.1.6 Signalment and Physical Condition of the Patient

The signalment and physical condition of the animal being euthanized should always be a factor when choosing the technique. Weight, size, disease, species, and even breed, all contribute to how well a particular technique can be expected to work (Figure 1.6). For example, obese animals make it harder to locate peripheral veins. Neonatal animals may have lung fluid, making inhalant

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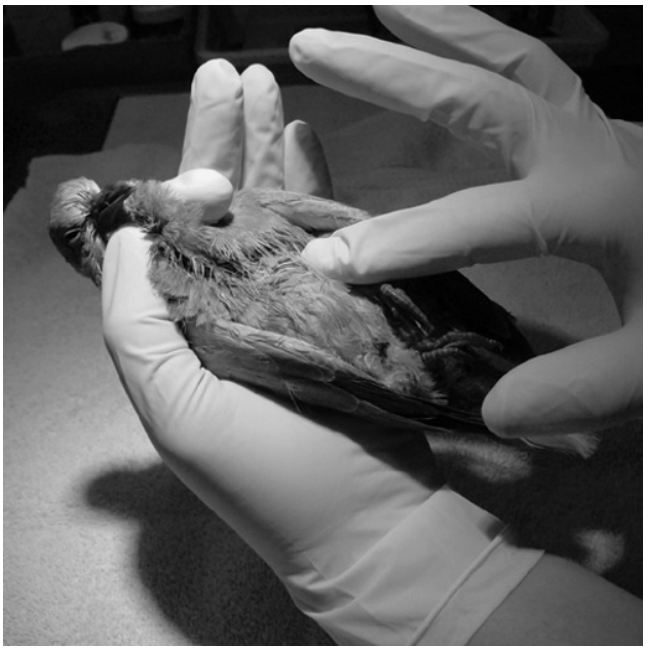


Figure 1.6 Feeling for injection landmarks in a bird. While skeletal structures tend to remain consistent, patient musculature can vary based on age, sex, and health status.

euthanasia methods less effective. Certain livestock species, even breeds, can have thickened craniums that are harder to penetrate with gunshot or captive bolts. A veterinarian considers the patient's signalment to determine the ideal euthanasia technique.

1.4.1.7 Need for a Postmortem Examination

It is important to know whether or not an animal's body will be studied following euthanasia. If so, techniques should be chosen that minimize organ and tissue damage. For example, if a feline patient is enrolled in a heart study, an intracardiac (IC) injection should not be performed. If a rabies test needs to be done, a gunshot to the brain should be avoided. When necessary, practitioners can communicate with the place of study to determine which method of euthanasia is most appropriate.

1.4.1.8 What's Allowed by Governing Bodies

Some regions of the world may have restrictions on euthanasia methods. These are typically established by the government or leading veterinary organizations focused on protecting animal welfare. Veterinarians are responsible for knowing what they themselves are allowed to do and what those working under them are approved for. For example, as of 2025, in the state of New York, veterinary technicians are allowed to perform euthanasia with indirect supervision, but they are not allowed to perform an IC injection on an owned animal outside of the shelter setting. In Canada, the lethal IV dose of pentobarbital is set at 107 mg/kg, while in the United States, it's 85 mg/kg. It's nuances like this that make staying current on modern euthanasia practices so important.

1.4.2 The Growing Use of Pre-Euthanasia Sedation and Anesthesia

The whole premise behind a good death is to help the animal die in a comfortable manner, and for many, pre-euthanasia sedation or anesthesia is a great way to facilitate that. The AVMA, the American Animal Hospital Association (AAHA), the Fear Free Program, CAETA, and others have

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declared that sedation should be provided when practicable. The goal is to impart some level of sleep to reduce stress and pain during euthanasia. In a 2023 study, small animal pet owners indicated that their pets' sleeping was among the top five most important parts of euthanasia. The other factors included help with preplanning, a pain-free procedure, the ability to be with their pet for the entirety of the appointment, and the option of home euthanasia (Kogan and Cooney 2023). Even if it takes their pet up to 20 minutes to succumb to sleep, to many clients, it is worth the wait.

Veterinarians who sedate or anesthetize their patients find their euthanasia technique options increase, especially when the patient is rendered unconscious. This opens up the door to more techniques that would be considered painful in awake or sedated animals. Additional benefits of using pre-euthanasia sedation or anesthesia are listed in Table 1.2.

1.4.2.1 Sedation is Not the Same as Anesthesia

There is a distinct difference between sedation and anesthesia; however, the terms are commonly interchanged. Practitioners need to understand these differences. Sedation is a term used to describe a light state of anesthesia wherein the pet is generally unaware of its surroundings but remains responsive to painful stimulation (Tranquilli and Thurmon 2007). Sedation relaxes a patient and can be given at high enough doses to impart sleep, though sedation does not lead to unconsciousness. With enough stimulation, the patient will regain awareness. Anesthetic drugs given at anesthetic doses provide patients unconsciousness. When a euthanasia method needs pre-euthanasia unconsciousness (e.g. intrathecal lidocaine administration), only anesthetic drugs given at anesthesia doses or physical stunning methods meet this requirement.

Common injectable sedative drugs include α_2-adgrenergic agonists (e.g. dexmedetomidine), phenothiazines (e.g. acepromazine), benzodiazepines (e.g. midazolam), and opioids (e.g. butorphanol). Many are administered in combination to impart sedation plus analgesia. Oral sedatives (e.g. gabapentin) may also be given to patients who respond well to them. Anesthetic drugs include

Table 1.2 Reasons for and against pre-euthanasia sedation or anesthesia in domestic animals.

Pros
Minimizes distress in animals familiar with handling
Provides chemical restraint to reduce physical restraint
Eliminates pain from an animal's pre-existing condition
Lessens danger to handlers
Increases technique options
May lessen active signs of death
Cons
More expensive
May alter body physiology, making certain techniques more difficult
Unpredictable transition into sedation or anesthesia
Potential for side effects, e.g. vomiting, dyspnea
May slow time to death in large animals
Appointment length is extended

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gases (e.g. isoflurane), dissociative agents (e.g. ketamine), neurosteroids (e.g. alfaxalone), hypnotic drugs (e.g. propofol), and barbiturates (e.g. pentobarbital). Sedatives and anesthetics are routinely mixed together for synergistic effects. When a drug protocol contains an anesthetic drug, the protocol is considered an anesthetic protocol that leads to unconsciousness, assuming the dose is adequate to impart stage three (surgical depth) of anesthesia.

The amount of drug is based on the drug's dosing requirements, patient weight, and route of administration. Many drugs can be mixed together in the same syringe and injected intramuscularly (IM) or subcutaneously (SC). Even those drugs that are labeled for only IM use can be given more gently via the SC route to the same ultimate effect (Robertson 2020). Sedatives and anesthetics can also be given IV, keeping in mind that this may cause more stress than it is worth. Some drugs can be given orally (PO) in food or placed on the oral mucosa (TM) for absorption. The goal is to not allow the administration of pre-euthanasia drugs to be more stressful than the euthanasia itself.

If sedation is all that is desired before proceeding with euthanasia, the animal will need to be assessed to determine if they are ready. Animals should be calmly sitting or lying down with minimal response to stimulation, i.e. sound, sight, and touch. In the case of large animals, they may remain standing but appear obtunded and uninterested in their surroundings. There will be times when administering a pre-euthanasia drug to an animal is more distressing than performing the euthanasia itself. For example, a horse that has never been handled will be more fearful of an injection than a distant yet accurate gunshot. The use of pre-euthanasia sedation or anesthesia must be based on what's right for the patient, available drugs, the skill of the handler, and the planned method of euthanasia.

1.4.2.2 Assessing for Unconsciousness

The unconscious animal is unable to stand and therefore lies recumbent, without the ability to right itself to a normal posture. The animal will typically lack normal ocular reflexes including the pupillary light reflex (Figure 1.7). The animal will lack conscious sensation to pain and thus will not demonstrate a response to painful stimuli such as a needle stick or extreme pinching the



Figure 1.7 Checking for blink response in a canine patient to assess depth of unconsciousness. *Source:* CAETA (2025).

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Table 1.3 Evidence of patient awareness during the euthanasia procedure.

Signs of unconsciousness
Recumbency with a lack of a righting reflex
Absence of a corneal reflex
Absence of a palpebral reflex
Loss of spontaneous eye blink
Absence of eye movement tracking an object
Fixed and dilated pupils
Absence of normal rhythmic breathing
Absence of a pain response
Signs of regaining consciousness
Return of coordinated breathing
Return of corneal or palpebral reflex
Constricted pupils or return of a pupillary light reflex
Attempt to raise the head
Return of a righting reflex
Return of ocular movement and a blink
Vocalization
Response to painful stimulation, such as a needle stick

ear or extremities. This must be differentiated from simple peripheral reflexes that may still be intact. All of these signs can be quickly assessed during the euthanasia procedure (Table 1.3).

Drugs are not required to achieve unconsciousness, but they are used to facilitate it in most instances for the euthanasia of client-owned animals. Humane physical stunning methods induce immediate unconsciousness and are more commonly used in larger animals and others that are hard to hold for drug administration. Examples include penetrating and nonpenetrating captive bolts or electrical stunners. This will then be followed by a secondary method to achieve death, such as cerebral pithing or injection of KCl.

1.4.3 A Concise List of Euthanasia Techniques

Euthanasia is a term used to describe a singular animal's death. It is chosen for an animal to prevent suffering from physical and/or mental harm, or for instances when resources are lacking to provide sustainable long-term care. The reasons behind euthanasia are unique from slaughter (for food) or mass depopulation (to prevent the spread of disease or prevent large-scale animal suffering). Table 1.4 holds a list of common euthanasia techniques, many of which are further described in this book, due to their usefulness in owned animals, including those in zoo settings. Some techniques are intentionally left out due to the infrequency of use in the species this book covers. Additional euthanasia techniques may be found in species-specific publications that align with current governing-body guidelines.

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Table 1.4 A concise list of euthanasia techniques that practitioners may consider for animals in a wide variety of settings. The effectiveness of a technique is dependent on the species' anatomy and physiology. Huge variations among phylogenetic taxa exist. One size does not fit all. Each technique has qualifications related to "acceptable" or "acceptable with conditions" as defined by the AVMA but is not specified in this table.

Direct depression of neurons necessary for life
Mechanism of action: euthanasia through anesthetic overdose
Injectable agents: pentobarbital, lidocaine, magnesium sulfate, propofol, T-61®
Immersion/topical agents: benzocaine hydrochloride (HCl), tricaine methanesulfonate (MS-222), alfaxalone, propofol, isopropyl alcohol, phenoxyethanol, eugenol
Inhalants: anesthetic gases, carbon dioxide
Hypoxia
Mechanism of action: cessation of oxygen delivery to the brain and heart
Injectable agents: potassium chloride
Immersion/topical agents: oil over eggs
Physical methods: exsanguination, decapitation
Inhalants: carbon monoxide
Physical disruption of brain activity
Mechanism of action: destruction of brain and nervous tissue
Direct destruction: gunshot, penetrating captive bolt, pithing, blunt force trauma, rapid freezing, cervical dislocation

1.5 Professional Best Practices to Support Euthanasia

Veterinarians and support staff will want to adhere to professional standards before, during, and after the euthanasia procedure. Certain requirements related to staff training, recordkeeping, obtaining permission to euthanize, and more need to be met to ensure euthanasia is conducted properly. There is an opportunity to reflect on whether the veterinary team is routinely meeting legal and professional standards or perhaps falling short, placing themselves in jeopardy of no longer being able to perform euthanasia services.

1.5.1 Euthanasia Standard Operating Procedures

Every veterinary service offering euthanasia should have a euthanasia manual outlining the standard operating procedure (SOP). Manuals include details that improve consistencies and answer questions that could arise throughout the duration of the procedure. They are designed to be fluid so that adjustments can be made quickly, based on team experiences and evolving euthanasia research. Example categories to include in a euthanasia SOP manual include:

- Language used with clients
- Handling cases of convenience
- Appointment length
- Location selection

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- Fee structuring
- Consent forms and recordkeeping
- Restraint and handling standards
- Use of sedation or anesthesia
- Approved euthanasia techniques
- Memorialization and grief support
- Body care management
- Policies around dysthanasia
- Team support

The following contains more context behind some of the standards veterinary teams utilize when offering euthanasia to patients. Management determines what are the "must-haves" and what's more flexible based on team culture, community norms, and veterinary preferences.

1) Staff utilization and training – veterinary personnel should be fluent in safe handling techniques, including how to euthanize with minimal patient restraint. Those performing the procedure need to understand how death is achieved and what the alternative methods are. One of the quickest ways to train euthanasia techniques is to have new veterinarians and staff members observe a quality euthanasia appointment. Professional standards and expert association guidelines, specific to the animal industry one is working for, will indicate who can perform the procedure and what techniques are allowed. These must be followed to avoid malpractice claims and prevent poor animal welfare conditions.
2) Consent to euthanize and prove ownership – practitioners will need to obtain consent to euthanize from the owner of the animal, e.g. pet owner, rancher, shelter, or zoo management. A signature is collected and entered into medical records. Proving ownership can be challenging in private practice and is often determined by who is willing to pay for euthanasia services. Reasonable diligence should be conducted to prove that who claims to be the owner of the animal is in fact legally allowed to make a euthanasia decision. Examples of diligence include reviewing previous medical records, talking with the owner about the reasons for euthanasia, checking for microchip identification, and watching for emotional/moral conflict. The euthanasia consent form should define what euthanasia means to reduce confusion, e.g. "humanely terminate life."
3) Pricing – it can be difficult to collect money during an often-emotional procedure like euthanasia. The cost of euthanasia reflects the expenses associated with it: drugs, medical equipment, staff wages, deceased body storage/transport, profit margins, etc. Ideally, the price of service correlates with what the practitioner must charge and what the client can afford. When euthanasia is too expensive, clients are more inclined to avoid the procedure, leaving the animal to continue in a negative state. Conversely, if euthanasia is free or low cost, clients may consider euthanasia prematurely to avoid higher-cost medical treatments. Practitioners and veterinary companies will need to reflect on what animal owners in their communities can afford.
4) Recordkeeping – with the modernization of euthanasia comes the need for greater recordkeeping. Medical records have always been important in veterinary medicine; however, euthanasia details have historically been lacking, perhaps due to the terminal nature of the procedure without the need for further medical treatment. According to Gray and Radford (2022), euthanasia is an emotionally laden procedure, and owners may misinterpret what occurs. Complete euthanasia records protect veterinarians in the event of a formal medical review. Detailed records hold veterinary teams accountable for all procedural elements and encourage ethical behavior. Clinical practice guidelines for euthanasia are recommended as they make recordkeeping easier

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and improve efficiencies. Decisions to delay euthanasia should include an EOL care plan, including owner emotional support and palliative medicine options (Gray and Radford 2022). Additionally, it is recommended to label the completed euthanasia appointment according to how it went; green for "good with no complication," yellow for "minor concerns were raised such as mild patient discomfort," or red for "major concerns with significant patient discomfort" (Cooney 2022). Labeling the euthanasia appointment provides management with information they can use to address the situation and make long-term adjustments to euthanasia SOPs.

5) Controlled substance use – many pre-euthanasia and euthanasia drugs are classified as controlled substances and are monitored by drug enforcement agencies, e.g. Drug Enforcement Administration (DEA) in the United States. All drugs are categorized based on human abuse potential. Anesthetic drugs and euthanasia agents are among the most regulated. Veterinarians must either obtain licensure to order, carry, and administer such drugs, or rely on another veterinarian's licensure (Figure 1.8). However, increased restrictions mandate when these drugs can be used. Practitioners will want to leverage noncontrolled and controlled drugs appropriately, recognizing that many controlled drugs tend to have an increased capability of inducing unconsciousness and permanent death. Off-label drug use is common for euthanasia purposes when alternatives are unavailable or undesired.
6) Preparing the space – Before gathering with the client and patient, all supplies should be ready. In the clinic setting, all drugs and equipment should be available, the lights set to a comfortable level, and the staff alerted to the time and location of the euthanasia. There are usually many people involved with euthanasia in the hospital setting: receptionists, technicians, doctors, and vet students where teaching is performed (Martin et al. 2004). In the field, those gathered may simply be the practitioner and client, as is often the case on farm calls. All drugs and supplies should be drawn at the time of use, and drugs recorded and readied for the patient. If there are other people in the vicinity who could see or hear euthanasia being conducted, they should be informed. When possible, the surrounding area should be kept quiet to prevent distractions. Regardless of the temperament, all animals should be treated with kindness and compassion before and during euthanasia.
7) Managing complaints – challenging euthanasia events will occur, even for seasoned practitioners. An actual dysthanasia is subjective however, and veterinary teams may feel differently about the euthanasia experience compared to a client. Communication and interaction



Figure 1.8 A mobile drug safe is used to transport controlled substances out of the office and into the field. Veterinary drugs should be secured to prevent diversion. *Source:* CAETA (2025).

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problems between the client and the veterinarian, and the client's feelings, underlie many of the euthanasia complaints (Berg and Vickers 2024). Establishing rapport and showing considerable compassion for what the client/owner is going through has a tremendously positive effect on the euthanasia outcome, even when technical challenges arise. If the client is upset, the appointment record should be labeled accordingly, and management or the leading veterinarian should reach out to talk about what occurred. In this author's experience, based on work with CAETA's Euthanasia Review Department, clients want to know that their pet's death had meaning, and that if things went poorly, other animals would not have a similar outcome because the veterinary practitioner learned from the experience.

8) Team support – veterinarians and management will want to monitor the mental well-being of all personnel involved with euthanasia work. The implementation of regular compassion satisfaction and fatigue surveys is one example. Monthly euthanasia rounds for case discussion and to share thoughts/feelings around euthanasia is another. During hiring interviews, management may explore previous euthanasia experiences and feelings around euthanasia before placing staff in morally compromising situations. Team support also comes in the form of ensuring they have what they need to successfully perform the medical aspects of the procedure.

1.5.2 Finding Meaning and Purpose in Euthanasia Work

Providing euthanasia for animals is both rewarding and onerous. How one feels about the procedure depends on the past, present, and future circumstances surrounding the decision to euthanize. When veterinary practitioners feel positive about the act of euthanizing, they have found a positive outcome. They are able to end animal suffering and help their patient avoid a worse fate. Ending life can still weigh heavy on the heart of veterinary professionals. However, devotion to finding meaning and purpose in euthanasia work remains paramount.

Euthanasia is one of the most common medical procedures in veterinary medicine. Because of the demand and the desire to help animals/clients in times of need, some professionals are devoting their careers to EOL work. A career in EOL specialty work means a high volume of euthanasia appointments, but this is also true at emergency hospitals and some clinical specialties, e.g. oncology. Euthanasia is expected on a daily basis, meaning mental preparedness is necessary to maintain balance and harmony. Veterinarians find navigating complex decision-making with clients harder than the actual event (Matte et al. 2019), and that resolution through euthanasia, especially when it goes well, can lead to increased professional well-being.

Because of client/family dynamics, current medical options, public opinion, ethics, etc., involved in euthanasia decisions, veterinary practitioners are encouraged to reach outside themselves for answers to difficult questions. When appropriate, multiple professional viewpoints can be heard before euthanasia is chosen. Staff members can be brought into conversations so that life-saving options are not overlooked. Hasty decision-making can fuel moral distress, leaving veterinary staff feeling troubled and upset.

Regular access to controlled substances and euthanasia drugs is a concern in veterinary suicide rates, and some experts believe that changes need to be made to prevent diversion. In a 2019 study, access to pentobarbital was identified as a risk factor in both male and female veterinarian suicides, with females using it more frequently (Tomasi et al. 2019). While the need to euthanize animals was not cited as the direct cause of veterinary suicide, a veterinarian's familiarity with the procedure and awareness of how to overdose pentobarbital was also a risk factor. Limiting access to lethal drugs, increasing drug monitoring, and changing drug transport regulations may help reduce suicide attempts (Platt et al. 2010; Tomasi et al. 2019; Larkin 2020).

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Practicing "emotionally intelligent" euthanasia is an important tool in veterinary medicine and EOL-related work. Emotional intelligence focuses on five key pillars: self-awareness, social skills, empathy, motivation/passion, and self-regulation. Anyone performing euthanasia has the opportunity to reflect on their emotions during the procedure, and determine if they are feeling positive, neutral, or negative. Those who build emotional intelligence, aka a greater awareness of what they feel and why they feel it, are better suited to deal with the emotional complexities of euthanasia work.

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2

Canine and Feline Euthanasia

Kathleen A. Cooney

2.1 Species-Specific Considerations

According to the American Veterinary Medical Association (AVMA), there were an estimated 90 million dogs and 75 million cats living in homes across the United States in 2024 (Larkin 2024). Around 95% of people consider them to be members of their family (Brown 2023). Many are treated like surrogate children, and the pending loss of life can be overwhelming for those who have devoted so much love and time toward their care. With dogs and cats living close to human dwellings, usually in the home or within the confines of the property, the connection these two species have with "their people" could be considered unparalleled to other species in today's society, especially with their linked evolution over that past 15,000 years (Grimm 2014). Dogs and cats, referred to commonly as pets in this chapter, present unique challenges with regard to euthanasia, not because of any great anatomical differences to other mammals, but rather from the kinds of requests and wants that come from their human owners. They are companion animals above all else, and although some are used for research, work, and entertainment, their role does not typically change the way euthanasia is conducted (Figure 2.1).

The injection of a euthanasia drug somewhere in the body is the most common form of euthanasia and is regularly done in front of clients. The veterinary practitioner determines the best euthanasia method based on the dog or cat's signalment (age, health status, breed), the available supplies, etc. The method will need to be described in enough detail to inform people without raising alarm about some of the challenges that euthanasia holds.

Because dogs and cats are so intertwined with our daily lives, clients commonly request unique locations for euthanasia. In the typical hospital setting, comfort rooms may be an option. In the home, requests such as "on the bed" or "under the favorite tree in the backyard" are expected. Any place may be accommodated within reason as long as the euthanasia can be conducted safely, and it's allowed by local regulatory agencies.

Pets develop lasting human relationships within the family and community. It is common for extended family and friends to be present during euthanasia. For dogs and cats, this may include pet sitters, groomers, breeders, kennel attendants, and veterinary personnel bonded to their patients. For people who may have a particularly difficult time saying goodbye, pet loss support personnel may also be present.

Many households have more than one dog or cat. This means that the client will need to decide if other pets will be allowed to remain during the euthanasia procedure. The decision to allow

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Figure 2.1 A cat enjoying the comfort of its owner. Euthanasia can be carried out in the home environment when deemed best for the patient.

another pet to remain in the area will depend on their beliefs, the temperament of the pets, the practitioner's recommendations, etc. Ultimately, this is up to the client, unless other pets are disruptive to the procedure, wherein the practitioner may suggest that the others be allowed in after the procedure to view the body.

How the euthanasia procedure itself is conducted can also be affected by dog and cat owners, commonly called pet parents (Volsche 2021). They may request pre-appointment sedatives for their anxious dog or request a slower euthanasia method like an intraperitoneal (IP) injection for their cat because they want time to sit with them while they gently "slip away." Small animals can be euthanized on the client's lap, in their arms, etc., keeping the human–animal bond strong up until the end. These are matters that can be talked about before euthanasia. The Companion Animal Euthanasia Training Academy (CAETA) has developed the "14 Essential Components of Good Euthanasia" to be used as a guide for appointments. See Chapter 1 for more information. (Table 2.1).

Before death occurs, clients should know the common physical changes their dogs' or cats' bodies will undergo. They should be prepared for urination and defection, possible agonal breathing, and muscle fasciculations. If they know what to expect, any changes they see should be more acceptable, especially when they know that the actions are completely involuntary.

Table 2.1 The top five things pet owners look for during euthanasia.

1	Help with preplanning
2	A pain-free, stress-free experience for the pet
3	The pets sleeping in their final moments of life
4	The ability to remain present during the entirety of the procedure (never separated)
5	The option of home euthanasia

Source: Cooney and Kogan (2022).

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Whenever possible, aftercare arrangements, such as cremation or burial, should be determined before euthanasia. Dogs and cats can be easily transported to a cremation facility or pet cemetery for internment or buried on the owner's property if local law permits. Large dogs can be moved using stretchers and smaller dogs and cats can be carried in blankets, baskets, and burial boxes. Dogs and cats commonly fill the role of surrogate children and clients expect their bodies to be treated with a high level of respect (Cooney et al. 2021). Veterinary teams should strive to meet the level of care expected by the client. See Chapter 7 for more information on aftercare support.

2.2 Equipment and Handling

For all species, gentleness during euthanasia is important. Most dogs and cats will be used to handling by humans, and this will prove advantageous for the procedure. There will be times when they will be more challenging to work with, but with planning ahead, patient comfort and safety will be met. Veterinary teams will want to consider the euthanasia methods they might use, and the necessary supplies and gentle restraint that will meet the needs of the canine and feline patient.

2.2.1 Positioning and Restraint

In the hospital setting, positioning of the patient will be determined in large part by where the euthanasia is conducted. In the typical examination room, dogs and cats are placed on the examination table, either directly on its surface or preferably on top of a towel/blanket. Providing a nonslip surface will help the patient feel more secure (Riemer 2021). A larger dog may be euthanized on the floor to avoid lifting. Many hospitals provide floor mats for improved comfort. When space allows, a "comfort" room should be established to provide a calm and relaxing space for both animals and humans. Comfort room features can include ample seating, soft lighting, natural elements like plants, and soft surfaces that mimic a home's living room. The patient is made to feel relaxed to reduce the need for restraint. However, there will be times when restraint is necessary.

If restraint is needed beyond controlled yet gentle holding, a more fractious patient can be immobilized using blankets, squeeze cages, and carriers. Muzzles and cat bags can be used on those patients who will allow it. High-value food or toys should be offered generously throughout the visit. In the interaction with the animals, low-stress handling methods, brief pauses, and adjusting the procedure based on the animal's body language help them feel secure. Ideally, chemical restraint is offered to calm the dog or cat and keep the handler safe (Riemer 2021). The use of pre-visit pharmaceuticals for anxious or aggressive dogs and cats has become mainstream (Coleman 2024). Common sedatives and anesthetics that can be given well in advance of, or at the start of, the euthanasia appointment. If drugs are unavailable, euthanasia should be carried out as quickly as possible to avoid a drawn-out, stressful situation (Figure 2.2).

In the home setting, there are usually more factors affecting patient positioning and handling. Euthanasia may be carried out in small or large spaces, the latter of which leads to greater complications and the need for more confinement. Carriers, leashes, harnesses, and blankets/towels should be nearby. Mobile practitioners will need to bring all supplies they could need for the patient's euthanasia, plus extra items in case challenges arise. Families choosing home euthanasia appreciate the practitioner's flexibility in accommodating their wishes (Cooney 2011) (Figures 2.3 and 2.4, Table 2.2).

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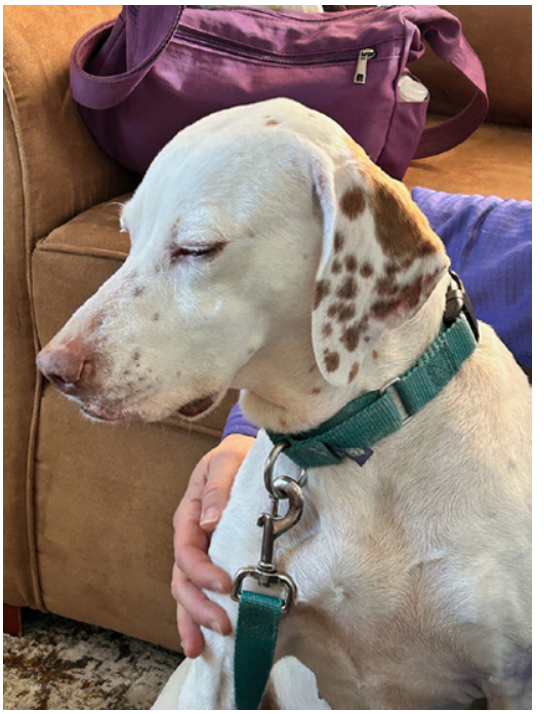


Figure 2.2 Calm dog free of environmental stressors in the home. Handling should be attempted with the least amount of stress to the patient. *Source:* CAETA (2025).



Figure 2.3 Mobile euthanasia bag showing various euthanasia supplies for canine and feline patients. *Source:* CAETA (2025).

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Figure 2.4 Euthanasia supply tote for use in veterinary hospitals. These supplies are kept in or brought directly into the euthanasia room. *Source:* CAETA (2025).

Table 2.2 Standard equipment list for canine and feline euthanasia appointments.

Bandage scissors	Rubber gloves
Clippers	Tourniquet
Stethoscope	Needles and syringes
Intravenous and butterfly catheters	Skin tape
Male adaptors	Extension lines/sets
Sharps container	Trash container
Restraint devices	Towels, blankets, and potty pads
Cadaver bags	Memorialization items (e.g. paw print kits)
Euthanasia drugs	Pet loss literature

2.2.2 Medical Supplies

The euthanasia of dogs and cats is usually accomplished by the administration of non-inhalant pharmaceutical agents, e.g. pentobarbital. Because these species, particularly dogs, come in a variety of sizes, medical supplies like needles and syringes of various sizes should be on hand. Syringes ranging up to 20 mL will be adequate. However, evolving euthanasia agents may require a higher volume of drugs. Needle sizes used for administering pre-euthanasia sedation/anesthesia and euthanasia solution range from 18 to 27 gauge with a typical length of 0.5–2 in.

When families are present or when the patient is awake for the euthanasia injection, ideal circumstances have the practitioner placing an indwelling intravenous (IV) catheter (AVMA 2020). Catheters typically range from 20 to 24 gauge in size for dogs and cats. Tape can be used to anchor the catheter to the leg. When necessary, bandage scissors and hemostats may be needed to remove catheter setups following death. This is done to remove any medical waste from the body before aftercare.

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Figure 2.5 Hand subtly shielding needle and syringe from the view of the client. *Source:* CAETA (2025).

When venous access is less desirable, longer needles up to 3 in. in length or longer may be needed to perform an intracardiac (IC) or deep organ injection. Intraorgan injections have gained popularity in recent years as a way to administer euthanasia drugs outside of veins in other areas of high perfusion. If watching a technique like this is difficult, a small cloth drape can be used to shield the injection from view. However, it is not advised. Hiding injections can raise concerns that what is being done to the pet isn't safe to watch, or comfortable for the animal to endure. It is more advisable to simply shield needles and injections with one's hand held in a natural position. Some people are needle phobic therefore a gentle tucking of needles/syringes out of view is welcomed (Figure 2.5).

Euthanasia via gunshot and captive bolt are physical euthanasia methods listed as "acceptable with conditions" for use on dogs and cats in the 2020 AVMA Guidelines for the Euthanasia of Animals document (hereafter referred to as the 2020 AVMA Euthanasia Guidelines) and are being included in this book. Firearms and captive bolt guns need to be kept in working condition to ensure proper firing for effective euthanasia. Disuse and disrepair can lead to misfirings and increase the risk of injury to the handler, witnesses, and patient (Gibson et al. 2015).

The use of inhalant agents such as anesthetic gases, carbon monoxide (CO), and carbon dioxide (CO_2) for dog and cat euthanasia are also considered "acceptable with conditions" by the AVMA, meaning multiple factors must be met for their use. Anesthetic gases may be delivered via intubation tubes during surgery or via a gas mask. CO and CO_2 may be delivered in closely monitored chambers. They will not be discussed further in this chapter due to their infrequent use in private practice.

2.3 Pre-Euthanasia Sedation and Anesthesia

Providing pre-euthanasia sleep has become the gold standard for canine and feline patients and is now expected by pet owners (Kogan 2023). Sleep refers to a reduced awareness of what is happening to and around the body. It's important to note that depending on the types of drugs used, sleep will be light (sedation) or deep unconsciousness (anesthesia). Therefore, sedation and anesthesia are two different things and must be viewed as such in the context of pre-euthanasia sleep (see Chapter 1).

Pre-euthanasia anesthesia is used to induce complete unconsciousness which is necessary for certain euthanasia techniques used in dogs and cats. Unconsciousness is required for techniques

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considered to be painful in patients who are awake or lightly sedated, e.g. intraorgan pentobarbital injections and intrathecal (ITh) lidocaine injections. Practitioners will need to select the proper drugs that induce the depth of sleep they want for their patients.

Common injectable sedatives for dogs and cats include alpha-2 adrenergic receptor agonists, opioids, benzodiazepines, and phenothiazines. They are frequently combined in one syringe and given as a pre-euthanasia sedation cocktail. They may be given subcutaneously (SC), intramuscular (IM), or IV. SC injections are commonly given between the shoulder blades or under the skin in the lower back (epaxial region) or rump area. IM injections are typically given in the epaxial muscles along the back or the quadriceps and are shown to absorb well in both (Autefage 1990). Most if not all sedatives can be given orally (PO) or transmucosal (TM) to effect.

Common injectable anesthetics for dogs and cats include the hypnotic drug propofol and dissociative anesthetics like ketamine and tiletamine. Propofol is believed to reduce active signs of dying (e.g. agonal breathing, body stretches). However, it may be no more effective than other anesthetics (Bullock 2019). It must be administered intravenously, typically through an IV catheter, followed shortly after with an injection of euthanasia solution. Ketamine or tiletamine can be administered SC, IM, or IV, usually in conjunction with sedative drugs mixed into the same syringe and should produce reliable anesthesia within 5–10 minutes. Ketamine and tiletamine are not labeled for SC injection but work effectively in dogs and cats via this route for the purpose of pre-euthanasia anesthesia (Robertson 2020). Due to their acidic pH, both have the potential to sting when administered outside the vein, so clients should be warned their patient may react briefly. Both sedatives and anesthetics should be administered slowly with small gauge needles to minimize pain on injection. Added protection from pain can be had by asking if the pet is painful anywhere which can then be avoided. If the patient is expected to react to any drug injection, oral drugs should be considered first. Most drugs listed in Table 2.3 may be given transmucosally or orally to effect, often by doubling the doses shown (propofol and alfaxalone are not to be given orally).

Each sedative and anesthetic drug has side effects that should be considered. For example, dogs and cats are prone to vomit with alpha 2-agonists and may show signs of Cheynes-Stokes breathing. Phenothiazines such as acepromazine may lower cardiac output (Lumb et al. 2007). Ketamine can increase intracranial pressure and can also lead to patient dysphoria (Drobatz 2023). Practitioners working with dogs and cats should fully review drug pharmacokinetics and pharmacodynamics of their drugs of choice. Once administered, their full effects can typically be seen within 5–10 minutes depending on the site of injection and overall health of the patient. Time to full effect may take upward of 20 minutes, which pet owners share is acceptable as long as their pet is comfortable (Cooney and Kogan 2022) (Figure 2.6).

Common inhalant anesthetics, like isoflurane, halothane, and sevoflurane, can be administered to small dogs and cats. These patients may be placed within chambers or made to breathe in the gas using facemasks. They should be fully assessed for unconsciousness before proceeding with a euthanasia technique that requires it, e.g. intraorgan injection of pentobarbital.

The depth of sedation or anesthesia needs to be assessed before the euthanasia technique starts. The practitioner assesses the patient's body by stimulating it and/or checking for deep pain awareness. A strong toe pinch is the most common way to check for deep pain. The patient should not withdraw the foot in an unconscious state. General patient alertness can be tested by tickling in between the toe pads or touching the caudal thigh to check for tail tucking. Dogs and cats generally keep their eyes open though they remain unresponsive. A complete lack of the blink reflex is not expected even in an unconscious state. Some will urinate and defecate in direct response to the level of relaxation and the drugs used. Once the patient is in the desired level of sleep, the practitioner may move forward with the euthanasia method of choice (Figure 2.7).

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Table 2.3 Pre-euthanasia sedative and anesthetics for dogs (D) and cats (C) or both (B).

Sedative drug	Dose and route	Comments
Dexmedetomidine (Alpha-2 agonist)	0.01 mg/kg SC or IM (B)	This and other alpha-2 agonists may cause Cheynes-Stokes breathing in dogs and vomiting in cats. Preferred over xylazine.
Medetomidine (Alpha-2 agonist)	0.02 mg/kg SC or IM (B)	May cause Cheynes-Stokes breathing in dogs, vomiting in cats.
Detomidine (Alpha-2 agonist)	0.16 mg/kg TM (D)	This is a very high dose for pre-euthanasia purposes only. Profound sedation.
Xylazine (Alpha-2 agonist)	2 mg/kg SC or IM (D)	May cause Cheynes-Stokes breathing and vomiting in dogs. Should be avoided in cats.
Butorphanol (Opioid)	0.2 mg/kg SC or IM (B)	Common addition to almost all sedation or anesthesia euthanasia protocols.
Hydromorphone (Opioid)	0.1 mg/kg SC or IM (B)	Less commonly used than butorphanol.
Midazolam (Benzodiazepine)	0.2 mg/kg SC or IM (B)	Always given in combination with other drugs, e.g. ketamine.
Acepromazine (Phenothiazine)	0.2 mg/kg IM or SC (B)	Always given in combination with other drugs.
Anesthetic drug	**Dose and route**	**Comments**
Propofol (Hypnotic)	6 mg/kg IV (B)	Given via an indwelling IV catheter before pentobarbital or other euthanasia drug that requires unconsciousness.
Ketamine (Dissociative)	2–10 mg/kg SC or IM (B)	Always given with drugs like midazolam, butorphanol, and acepromazine to reduce dissociative effects.
Tiletamine/zolazepam (Dissociative)	2–10 mg/kg SC or IM (B)	Regularly given with drugs like butorphanol and acepromazine to reduce dissociative effects.
Alfaxalone (Neurosteroid)	3–5 mg/kg IV or IM (B)	Given IM in combination with other drugs like butorphanol, dexmedetomidine, and acepromazine (Kato 2021). Only labeled for IV injection.
Pentobarbital (Euthanasia drug)	85–255 mg/kg IP or PO (B)	Pentobarbital may be used as an anesthetic to induce unconsciousness. Varied success with TM due to poor taste.

2.4 Euthanasia Techniques

Canine and feline euthanasia techniques are commonly used as guides for other mammalian species. This section may be used to inform about other species; however, practitioners will want to prepare for anatomic differences before attempting euthanasia. When in doubt, added time should be spent reviewing the best approach to ensure a reliable and safe death event. Examples of canine and feline euthanasia methods include the overdose of pentobarbital, physical methods using a firearm, or the inhalation of an anesthetic gas.

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Figure 2.6 Subcutaneous injection of an anesthetic in a small dog. *Source:* CAETA (2025).



Figure 2.7 Applying a firm toe pinch to test for loss of deep pain is a common way to assess depth of sleep before the euthanasia procedure. *Source:* CAETA (2025).

2.4.1 Overview of Non-inhalant Pharmaceutical Euthanasia Agents – Pentobarbital, Potassium Chloride, Lidocaine, Magnesium Sulfate, and Propofol

The injection of a lethal drug is the most common form of euthanasia for dogs and cats. Injections offer a higher level of control compared to physical methods (e.g. gunshot) or gas inhalation. Because dogs and cats are companion animals in much of the world, use of injections is considered more pleasant when loved ones are gathered close. The type of euthanasia drug will mandate where it is given in the body and how long it will take for the patient to die. Depending on the

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Table 2.4 Euthanasia agent dosing for canine and feline patients (US standards).

Euthanasia drug	Dose and route	Comments
Pentobarbital or pentobarbital-combination product	85 mg/kg IV, IC 170 mg/kg IH 255 mg/kg IR, IP, PO	Intraorgan techniques may take longer to achieve death. IV, IC, and IR tend to be faster than IH, IP, and PO. PO takes the longest and has variable success rates. The PO dose of 255 mg/kg may only induce unconsciousness and more drug may be needed to achieve death. Pentobarbital-combination products are less suitable for PO administration.
Potassium chloride	150 mg/kg IV, IC	Requires unconsciousness before administration. Death in 3 minutes or less. Give more if needed.
Magnesium sulfate	750–1000 mg/kg IV	Requires unconsciousness before administration. Death in 2 minutes or less. Give more if needed.
Propofol	50+ mg/kg IV	Administer until cardiac arrest is confirmed. Rapid boluses preferred.
Lidocaine or mepivacaine	4 mg/kg ITh 28 mg/kg IV, IC	Requires unconsciousness before administration. Death from 1 to 5 minutes depending on the injection route.
T-61 (embutramide, mebozonium iodide, and tetracaine hydrochloride)	0.3 mL per kg IV	Not available in the United States. Slow administration is required to induce unconsciousness before muscle paralysis; however, pre-euthanasia anesthesia is advised. Death in under 2 minutes.

pharmacodynamics of the drug, it may be given into the venous system (most common) or into the central nervous system (CNS), e.g. lidocaine. Either way, the end effect is the ultimate shutdown of the CNS to induce permanent death. See Chapter 1 for further clarification of how euthanasia methods work. Table 2.4 includes the euthanasia drug T-61 but it will not be discussed further in this chapter due to low availability.

2.4.1.1 Pentobarbital Sodium

As of 2025, the most common method of euthanasia in dogs and cats that are client-owned, live within shelters, or in laboratories, is by injection of a barbiturate or barbiturate-combination solution like pentobarbital sodium. Pentobarbital is a veterinary anesthetic drug. However, most practitioners today have had little to no clinical experience using it outside the context of euthanasia (Meyer 2024). It is ultrafast acting and typically achieves death in less than 1 minute when given into areas of high perfusion, e.g. into the vein or the heart. Barbiturates like pentobarbital are reliable when adequately dosed in both dogs and cats and are the only euthanasia agents listed as acceptable, without additional considerations, in the 2020 AVMA Euthanasia Guidelines. If a barbiturate is not the best fit for the patient given the circumstances, other euthanasia drugs or methods may be used.

The standard lethal barbiturate dose in the United States is 85 mg/kg for IV and IC injections. Some countries have variations to this, e.g. Canada at 107 mg/kg. Barbiturate solution concentrations in the United States are 390 mg/mL, which equates to 1 mL per 4.5 kg body weight for both dogs and cats. Pentobarbital may be given in other parts of the body which will raise the dosing requirements, e.g. intrahepatic (IH). If the exact weight of the patient is unknown, an educated

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guess is made and a bit more euthanasia solution than the required amount is given (Cooney 2011). Giving more than the recommended amount will hold true for any kind of euthanasia solution when the patient's weight is unknown. If the pentobarbital is extremely viscous/thick, it can be diluted with saline to ease its movement through the needle and/or catheter, although this is less advised during intraorgan injections.

2.4.1.2 Potassium Chloride (KCl)

KCl induces death via cardiac arrest, which is considered to be highly stressful and painful in awake animals. Pre-euthanasia sedation protocols by themselves are not enough. Therefore, anesthetic protocols must be used to induce unconsciousness. KCl can be purchased as a medical-grade solution or it can be created. This is done by adding 350 g of KCl salt to 1 L of water to generate 350 mg/mL of saturated solution (mix frequently to reduce particulate matter from accumulating). The IV KCl dose is 150 mg/kg or 2 mEq/kg, which equates to around 25 mLs for a 45 kg patient of a 350 mg/mL saturated solution, or around 45 mLs of a 2 mEq/mL pre-bottled solution. Having extra on hand is advisable. Cardiac arrest is fast and expected in under 2–3 minutes. The heart should be auscultated for as long as is necessary to ensure death is complete. Agonal breathing is possible along with muscle fasciculations. The solution is administered rapidly in unconscious animals via IV injection only. A colored dye can be added to the solution to identify it for euthanasia purposes.

2.4.1.3 Magnesium Sulfate ($MgSO_4$)

$MgSO_4$ is a neuromuscular blocking agent leading to cardiac and respiratory arrest (Tasker 2008). $MgSO_4$ has a large dose range from 750 to 1000 mg/kg via rapid IV administration. $MgSO_4$ solution is either purchased as medical grade solution (500 mg/mL) or is created by dissolving 350 g pure magnesium sulfate (Epsom salts) in 1L of room-temperature water to saturation (particulate matter accumulating in the bag/bottle). $MgSO_4$ is only for unconscious patients and is administered until cardiac arrest is complete. Physical effects of death can include minor body stretching, muscle fasciculations, and agonal breaths, with cardiac arrest in under 2 minutes. Like KCl, a colored dye can be added to the solution to identify it for euthanasia purposes.

2.4.1.4 Propofol

Propofol is a popular anesthesia injection agent in veterinary medicine and is given only through IV injection. The typical anesthetic dose ranges from 2 to 6 mg/kg (AAHA 2020). While the exact lethal dose in dogs and cats is hard to pinpoint, a cat accidentally given 20 mg/kg of propofol survived (Klonner 2022). This author recommends a minimum dose of 50 mg/kg (Hospira 2014), with the intent to continue giving propofol until cardiac arrest is confirmed. Propofol has also been shown effective as a supplemental agent if pentobarbital is scarce, e.g. administration of propofol at 6.6 mg/kg and pentobarbital at 43 mg/kg (Cooney and Titcombe 2022).

2.4.1.5 Lidocaine and Mepivacaine

These local anesthetics have been shown to be fatal when injected into the thecal (subarachnoid) space in the spinal column (Aleman et al. 2016; Alexander et al. 2023), and when administered IV or IC (Cooney et al. 2025). In a study published in 2025, ITh injections in dogs and cats using both lidocaine and mepivacaine proved fatal at a dose of 4 mg/kg. IV and IC injections are fatal at a dose of 28 mg/kg. Active signs of death (e.g. opisthotonus stretches, agonal breaths) are greater with IV/IC injections compared to the ITh method, including obvious full-body "jolts" in larger dogs. In both dogs and cats, the ITh route led to cardiac arrest from 4 to 5 minutes, while the IC/IV route took around 2–3 minutes total (Cooney et al. 2025). These drugs are useful when pentobarbital is

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unavailable or safe body disposal is a concern. Note that bupivacaine may also work for canine and feline patients. However, the volume of drugs will be higher as well as the cost.

2.4.2 Euthanasia Injection Methods – Intravenous, Intracardiac, Intrahepatic, Intrarenal, Intraperitoneal, and Intrathecal

2.4.2.1 Intravenous Injections

In order to perform an IV euthanasia, the practitioner will need to find a vein that can be injected with euthanasia solution. The cephalic veins in the front leg, the medial and lateral saphenous veins in the back leg, and the dorsal pedal vein of the foot are generally easy to locate. Each has its pros and cons. The practitioner should pick the one that is most appropriate under the circumstances. Euthanasia drugs like pentobarbital, KCl, $MgSO_4$, propofol, and lidocaine are given intravenously to both dogs and cats.

Veins will be superficial just under the skin and usually lie on top of or in the grooves between neighboring muscles, tendons, and ligaments. Depending on the dog or cat, it may be necessary to first shave the intended area of injection. Shaving close to the skin provides a better view of the vein, thus minimizing multiple injection attempts. Awake patients may be stressed by the sound of clippers. So, their use should be avoided or a pre-euthanasia sedative given to lessen anxiety.

The vein will need to be occluded by either a tourniquet or an assistant "holding off" the vein to build pressure distally. Occlusion of the vein should be done proximal to the injection site and with enough pressure that the vein can be easily seen and felt. In an awake animal, this should be done gently to avoid added stress. When choosing the injection site, consider skin diseases, masses, and edema/swelling that will make placement difficult (Figures 2.8–2.10).

IV injection of euthanasia solution may be done with or without the use of an indwelling IV catheter. According to groups like the AVMA and CAETA, indwelling IV catheters are considered the gold standard for IV injections, even in sedated dogs and cats. Catheters help ensure that the euthanasia solution given will not accidentally be placed outside of the vein, as can happen with direct venipuncture. Direct venipuncture, either with a needle or butterfly catheter, creates a risk of the needle puncturing through the vein at any time. However, many practitioners prefer using butterfly catheters. Catheters can be sealed with a male adapter or an extension set. Luer-locking mechanisms are recommended to help prevent the leaking or dislodging of the syringe from the



Figure 2.8 Example of a highly visible medial saphenous vein in a cat after shaving.

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Figure 2.9 Preparing to place a catheter in the left lateral saphenous vein in a dog.



Figure 2.10 Extension set with an IV catheter in the cephalic vein of a dog. The extension set allows room for the client near the head of the pet while the practitioner sits back.

catheter hub. The catheter is secured to the leg using a small piece of tape. Many hospitals remove the patient back to the treatment area for catheter placement. However, this may disconnect the family and their pet at a very critical time. When possible, technically skilled staff members or the practitioners themselves should prepare the injection site in the room with the family present (Kogan 2023).

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When families are present, the injection preparation can be a difficult time. They know that with every completed step, they are getting closer to the end. Offering reassuring words that things are proceeding as they should is helpful. If venous access is proving difficult, practitioners can inform those present that everything is under control and their pet is doing fine. In this author's experience, clients do not want to know technical details more than necessary.

When performing an IV injection, death occurs very quickly in usually less than 2 minutes' time. The exception to this is administration of lidocaine, which can take up to 3 minutes. Death with a barbiturate should start within 30 seconds (AVMA 2020). Anyone present for euthanasia should be told what to expect and how fast the death will occur. If the patient is sitting, it should be gently guided down toward the table or floor to avoid a rapid drop following the IV injection. Although changes in respiratory rate do not necessarily indicate discomfort or distress on the part of the pet, rapid changes in respiratory rate may be perceived by pet owners as distressing (Marchitelli 2019).

2.4.2.2 Intraorgan Injections

In an effort to avoid finding veins in canine and feline patients, injections of euthanasia solution into the heart and other organs have gained popularity. The goal is to inject an area of high perfusion to rapidly move the drug throughout the body to effect. The most common intraorgan injection sites are the heart, liver, and kidney. Lung injections are mentioned in the 2020 AVMA Euthanasia Guidelines. However, little is known of their overall effectiveness and average time to death. The spleen may engorge and hold euthanasia drugs and should be avoided (Grier 1990).

Intraorgan injections require pre-euthanasia anesthesia and unconsciousness before attempting, and clients may have questions about why the technique is being performed. The patient must be pain-free and unresponsive when the injection is given. It is advised to inject a little bit of euthanasia solution to test the patient's depth of unconsciousness, e.g. 0.1 mL a second for 5 seconds. If no response, the rest of the solution may be given with more confidence. An 18-gauge needle or similar size is common, especially when giving a large volume of drug. Most clients will be satisfied with general descriptions of where the drug is being given. Placing a hand over the pet's chest or abdomen to indicate the injection location has been sufficient in this author's experience.

2.4.2.2.1 Intracardiac Injections While not a new technique, IC injections have evolved to remove some of the stigma around them, namely the concerns that come from inserting a needle into the heart and the visible blood that follows (Kogan and Cooney 2023). Practitioners choose this technique for a variety of reasons, most often when veins are not accessible. However, some practitioners have made this their primary technique over other options (Hendrix and Smith 2022). The challenge is to perform the procedure accurately, and when the client is present, perform it close to perfect on the first attempt.

The heart is like a vessel with muscle around it. It can be approached from the lateral and ventral sides of the chest. The pre-anesthetized canine or feline patient is laid in lateral recumbency on either their right or left side. The left ventricle is usually the easiest chamber to locate due to its size. Thickened myocardium, tumors, displacement, and pulmonary edema/effusion increase the complexities. A large lipoma over the chest wall can also make an IC injection difficult.

The heart in most dogs and cats will reside from the second or third intercostal space to the fifth or sixth, and from the sternum to about two-thirds of the way up the thorax (Pasquini and Spurgeon 1992). The apex of the heart will rest near the sternal vertebrae. The heart is usually more cranial and ventral than one might think (Figures 2.11 and 2.12).

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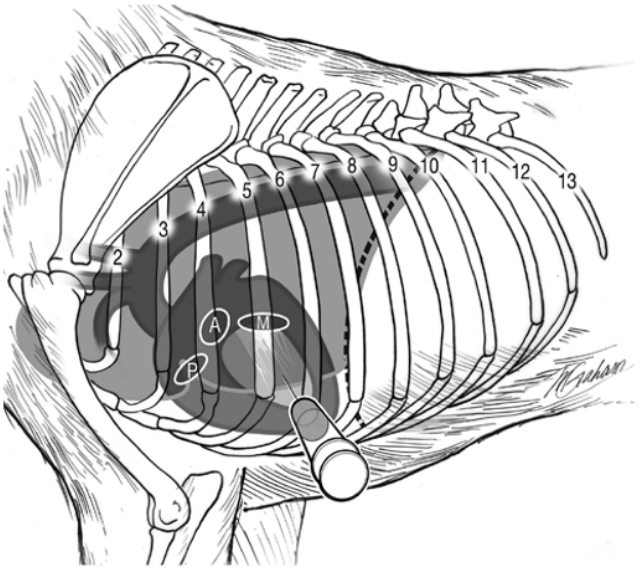


Figure 2.11 Anatomical landmarks for left-sided cardiac injection. Practitioners aim for the ventricle. However, any heart chamber is sufficient.

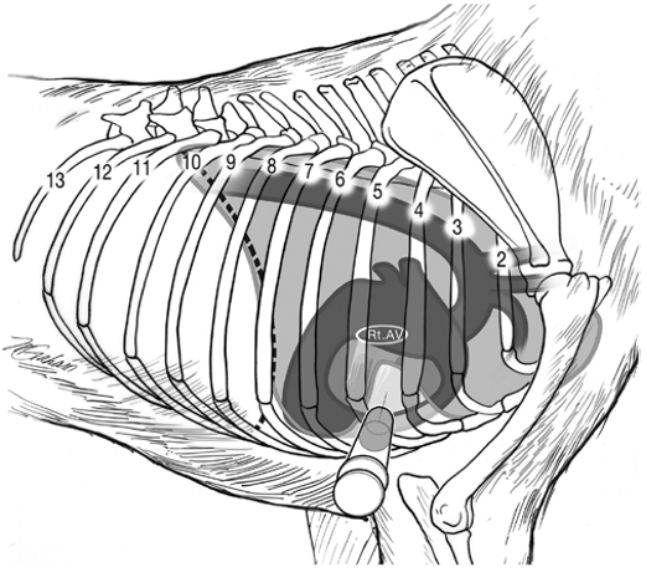


Figure 2.12 Anatomical landmarks for right-sided cardiac injection. The illustration shows the point of the elbow (olecranon) near the needle insertion point on the chest wall.

When planning an injection on the lateral side of the chest, the practitioners may use their hands to feel for the heart's beat and inject in this area. If necessary, they may hold the lower antebrachium and press the elbow up the chest wall to simulate where it would normally be if the dog or cat were standing. A good place to insert the needle is usually just a bit cranial to the point of the elbow. Combining the location of the heartbeat, also known as the point of maximum intensity (PMI) with this landmark should help locate the heart.

The heart can also be injected from the ventral side of the patient at the point of the xiphoid process. A long needle is inserted on either side of the xiphoid, aiming cranial toward the heart, just above the sternal vertebrae. The needle will pass through the diaphragm into the chest cavity to reach the heart.

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Tips for a Successful IC Injection in a Dog and a Cat

1) Ensure a long enough needle to reach the heart.
2) Select a large syringe to hold the euthanasia drug and blood/thoracic fluids.
3) Feel for the heartbeat to identify the best injection area.
4) While the needle is inserted, apply negative pressure to the syringe until blood is found.
5) Once the heart is located, inject slowly and steadily.
6) If the heart cannot be located on the first attempt, try again or move to another organ injection.
7) Consider the use of a short extension set to reduce visible blood and allow greater angling of the syringe (Figures 2.13–2.15).



Figure 2.13 Standard IC injection in a feline patient on the left side of the chest, using a direct needle and syringe. *Source:* CAETA (2025).

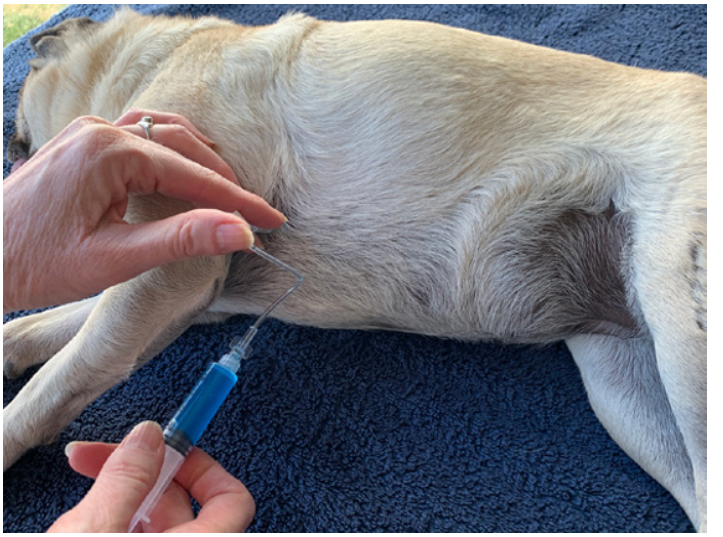


Figure 2.14 IC injection on the left side of a dog using a short extension line. The extension allows the syringe to be placed lower out of view. The line can be tucked within the hand to shield visible blood (see Figure 2.5). *Source:* CAETA (2025).

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Figure 2.15 An IC injection in a dog from the ventral approach. The needle is inserted next to the xiphoid process in the cranial direction, angled superficially just above the sternal vertebrae to penetrate the apex of the heart. *Source:* CAETA (2025).

2.4.2.2.2 Intrahepatic Injections The liver is a large organ that can be injected with pentobarbital as an effective euthanasia technique. It is not appropriate for other euthanasia drugs as of 2025. Practitioners choose IH injections because of the improved uptake of pentobarbital compared to a simple IP injection. The liver resides up against the diaphragm near the stomach, gall bladder, and proximal small intestine. When an IV injection is not viable, an IH injection can be a great alternative.

Like IC injections, IH injections need to be done in unconscious patients. They may cause pain in an awake patient due to parenchymal swelling and irritation from pentobarbital. Note that the 2020 AVMA Euthanasia Guidelines indicate that IH injections may be suitable in awake cats. However, this author has seen negative pain responses. Before injecting the liver, absence of deep pain and reflexes should be checked. When no response is seen, the practitioner is safe to slowly inject. Because the patient is unconscious, it will be laterally recumbent making hepatic injection easier.

To inject the liver, the needle is inserted in the notch on either side of the xiphoid process. The liver is best reached by aiming cranially at a 45-degree angle, up under the last rib of the laterally recumbent patient. The needle length is dependent on the size of the patient. For small patients less than 7 kg, a 1-in. needle should be adequate, but in larger patients, a 1.5- to 3-in. needle may be necessary. Aspirating and detecting blood usually indicates the needle is correctly placed. However, the absence of blood does not mean the placement is wrong. IH injections are effective in patients lying both left and right lateral recumbency (Figures 2.16 and 2.17).

IH injections require the administration of more pentobarbital than the IV or IC technique. Death should occur within about 2 minutes with a well-performed IH injection (Grier and Schaffer 1990; Cooney 2011). Cessation of breathing should be almost immediate. In case the injection does not penetrate the liver, anyone present should be prepared that death may take up to 10 minutes or more. Another injection may be given to shorten time to cardiac arrest.

2.4.2.2.3 Intrarenal Injections Intrarenal (IR) injections are a viable option for cats and small thin dogs. This method is a great choice if venous access is difficult or when preparing a catheter site is too obtrusive. The IR technique is noninvasive and works well when clients want to hold their pet during euthanasia. As with IH injections, renal tissue will improve the rate of absorption over an

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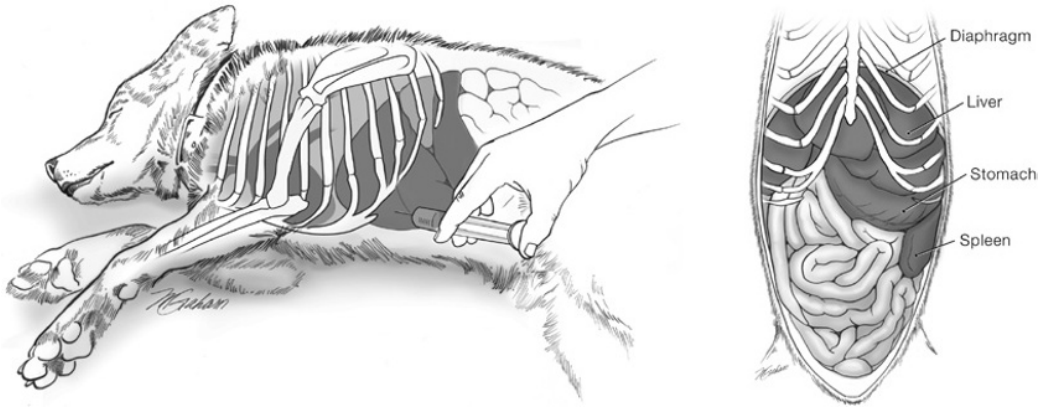


Figure 2.16 Anatomical landmarks for intrahepatic injections in dogs and cats.



Figure 2.17 IH injection in the liver of an anesthetized cat. The needle is inserted next to the xiphoid process, at a 45-degree angle to the body wall. *Source:* CAETA (2025).

IP injection. Complete unconsciousness is required and pentobarbital is the only euthanasia agent for IR injections known to be effective.

Cat and small dog kidneys are usually easy to palpate, especially if the patient has a normal to thin body condition score. The kidneys are a paired structure lying adjacent to the sublumbar muscles alongside the vertebral column. Increased abdominal fat decreases one's ability to isolate either kidney. Assuming both kidneys are present, the practitioner will be able to choose the most appropriate one to inject.

In general, the right kidney sits more cranial than the left. It is usually located just under the last two ribs along the dorsum. The left kidney in contrast is more caudal and freer of the overlying ribs. In cats, the left kidney rests outside the retroperitoneal space making it easier to isolate than the right.

When choosing which kidney to inject, the practitioner can use the one they feel and isolate the best. This author, being right-handed, prefers to use the left kidney. If a pet is in renal failure, the kidneys may be smaller, have a nodular feeling, or seem impossible to locate. Abdominal

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masses or fecal balls in the colon are sometimes confused with kidneys. Should one kidney be deemed unusable, the other may be tried (Figures 2.18 and 2.19).

Once the patient is completely anesthetized, it should be laid in a laterally recumbent position. The practitioner will move their hands along the abdomen to find the kidney and feel for any abdominal muscle tensing. If the patient tenses, it is not ready for injection. More pre-euthanasia anesthesia will need to be given until no response. When ready, the practitioner will locate the kidney and cup it with the fingers of their less dominant hand, raising it as far dorsal as possible. The kidney will need to be held in place throughout the entire injection. When loved ones are present, any manipulation of the abdomen should be subtle.

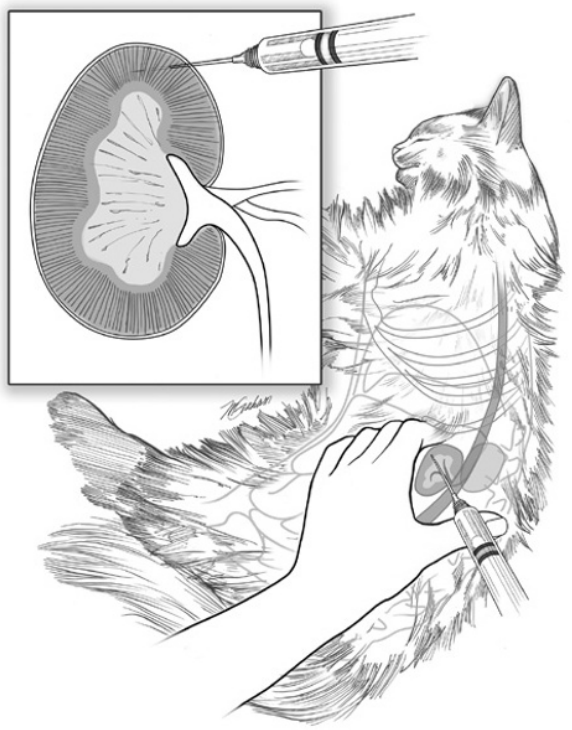


Figure 2.18 Anatomical landmarks for the IR injections, using the cat as a model. The needle is inserted into the renal cortical or medullary tissue. The kidney should swell during injection.



Figure 2.19 Cupping the kidney in a cat (shaved for added visualization only).

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To inject, the practitioner will hold the syringe alongside the body directed toward the dorsum. A 1-in. needle should be sufficient to easily penetrate the kidney in cats and dogs with minimal body fat. The syringe can be shielded from view by tucking it below the hand holding the kidney. This is a very effective way to hide the injection from needle-phobic onlookers.

The needle should be inserted deep within the renal parenchyma, avoiding the renal pelvis. Injecting the pelvis will likely move the pentobarbital into the ureter, limiting absorption. The kidney is a highly perfused organ, as one might expect based on its function, making it an ideal organ for rapid uptake of solution to the brain.

Whatever the volume, the kidney should swell due to increased pressure within the renal capsule. This is a good indication that the needle is positioned properly within the renal cortex. Kidney swelling does not guarantee immediate death, but it does increase the odds that death will occur faster (Cooney et al. 2022). A proper injection within a viable kidney should produce respiratory and cardiac arrest in under 1 minute. Depending on the volume of solution given, the patient may pass before completing the injection. As with IH injections, clients should be informed their pet may pass immediately or within just a few minutes.

2.4.2.3 Intraperitoneal Injections

An IP injection is generally considered easier to perform than most other methods and is not the same as an intraorgan or IV injection. The euthanasia solution pentobarbital is given into the peritoneal space, aka the abdomen. The drug must miss neighboring organs or the administration would be considered intraorgan, which without anesthesia is considered painful. IP injections are very common, especially in animal shelters, and are effective in cats and small dogs, including young kittens and puppies.

Animal shelters use this technique on a regular basis due to the low level of skill needed to perform it and sedation is not required for pure sodium pentobarbital administration. According to the 2020 AVMA Euthanasia Guidelines, only pure barbiturates are approved for IP injection in awake animals. Barbiturate-combination drugs are only approved for IV or IC injection because of the added component phenytoin sodium which is cardiotoxic. It is still advisable to give patients sedation before an IP injection to reduce the need for restraint.

There are two approved sites for IP injection: (1) ventral midline caudal to the umbilicus and (2) low on the right lateral abdomen (HSUS 2013). These locations prove most reliable for avoiding abdominal organs. Smaller needle length such as 0.75–1 in. is recommended to avoid deeper organs. If the body wall is abnormally thickened, a longer needle should be used. To minimize pain, the needle bore size should be appropriate to the size of the animal and the solution given at a rate of 1 mL/s.

The needle is inserted just through the body wall into the peritoneal cavity and the syringe plunger is pulled to check for fluid. If no blood or fluid is seen in the syringe, the practitioner may inject the solution. Because the euthanasia solution is moving into the bloodstream through absorption across abdominal organ membranes and serosal linings, it may take longer to achieve cardiac death. An awake patient may take up to 10–15 minutes to reach unconsciousness with another 5–10 minutes before cardiac arrest (Grier 1990; HSUS 2013), although it is common for unconsciousness to set in much faster. When necessary, the abdomen can be gently massaged to help the solution absorb (Figure 2.20).

Dogs and cats will succumb better to the effects of an IP pentobarbital injection in a quiet, calm area. This will allow a smoother transition into unconsciousness and death. Although rare, the animal may paddle, appear disoriented, lick their lips, and vocalize as the drug starts to take effect. These movements correlate to Stages 1 and 2 of anesthesia. If the client is present, they can hold

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Figure 2.20 Feline patient receiving an intraperitoneal injection.

their pet offering comfort, but due to the unpredictable nature of Stages 1 and 2 anesthesia, risk of personal injury should be considered.

If more than one injection is needed, those present can be updated on why more is being given. Because waiting for a patient to die can be difficult for some, injecting an area of high perfusion such as the liver or kidney under anesthesia is recommended over the IP injection. Death must be verified closely to make sure deep unconsciousness is not confused with death and the patient subsequently recovers.

2.4.2.4 Intrathecal Injections of Anesthetic Agents (e.g. lidocaine)

Both dogs and cats may be euthanized using lidocaine and mepivacaine via the ITh route (Cooney et al. 2025). The patient is anesthetized and laid in lateral recumbency. After assessing the patient for complete unconsciousness, a spinal needle is placed in the atlanto-occipital (AO) or lumbosacral (LS) joint to locate cerebrospinal fluid (CSF). CSF is removed proportionate to how much anesthetic is being given. For example, if a 35 kg dog needs to receive 7 mL of lidocaine, 7 mL of CSF will be removed first. This is standard practice as of 2025. However, future research may indicate this is more or less important. When the CSF is removed, the anesthetic drug is slowly infused into the thecal space. Gloves should be worn to reduce exposure to pathogens in CSF.

Respiratory arrest is expected in less than 1 minute in both dogs and cats. Cardiac arrest is expected in less than 5 minutes. Active signs of death include mild opisthotonus stretching and muscle fasciculations. Agonal breathing is rare but does occur. Because anesthetics like lidocaine and mepivacaine can be used as IV and IC euthanasia agents, the ITh route is best reserved for larger dogs over 22 kg. Larger dogs have increased active signs of death when euthanized with IV or IC lidocaine/mepivacaine, and these can be avoided by giving the drugs ITh (Cooney et al. 2025). Note that this method is believed to be just as effective when giving the anesthetic into the LS space rather than AO. However, this was not included in the AJVR 2025 study. The AO space is likely easier to access for many practitioners. However, it is close to the head where loved ones like to gather (Figure 2.21).

Clients will need to know why this technique is being performed compared to other techniques they may be more familiar with. The manner of description will depend on why this technique is chosen (e.g. no access to pentobarbital) and how it will achieve death in the patient. In this author's experience, people want to know the dog or cat is free of pain and anxiety, and that the method will bring about a smooth death. An ITh injection can be described as, "giving an overdose of an

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Figure 2.21 Dog receiving an ITh injection of mepivacaine into the AO space. *Source:* CAETA (2025).

anesthetic drug directly into the CNS to speed absorption and facilitate a smooth passing." Owners are allowed to remain present and provide love and support to their pets, which is important to so many (Cooney and Kogan 2022).

2.4.3 Oral Administration of Pentobarbital Euthanasia Solution

Euthanasia using oral pentobarbital administration in dogs and cats is not a common practice, although the lethal dose has been proposed, as shown in Table 2.5. When necessary, as in the case of feral or aggressive dogs or cats that prove hard to handle, barbiturates can be fed in powder (Fatal Plus®) or liquid form. The purpose of this method is to distance the animal from human contact as much as possible to limit injury. If patient unconsciousness can be achieved through oral dosing of pentobarbital, a secondary method of euthanasia may be done that is more reliable.

The lethal oral pentobarbital dose is presumed effective at three times the IV dose. Using US pentobarbital concentrations of 390 mg/mL, a 23 kg dog needs a minimum of 15 mL for death. A 4.5 kg cat will need 3 mL for death. Since barbiturates are poor tasting, administration of them in a liquid form is difficult and true ingestion becomes hard to determine. Liquid pentobarbital may be injected into gel caps and immediately fed in high-reward foods to hungry dogs. In the case of extremely aggressive animals, it can be squirted through cage walls into the mouth of a barking dog or hissing cat. The powdered version may be placed in capsules and fed or mixed directly into meatballs, cakes, etc. Proposed lethal oral pentobarbital dosing can be found in Table 2.5.

A patient receiving adequate oral dosing of a barbiturate should be in Stage 3 of anesthesia within 40 minutes of ingestion and deceased within 2 hours. However, in this author's experience, this is rarely the outcome. Times will vary depending on overall health of the animal, the rate of absorption, and environmental stimulation. Whenever possible, the patient should be kept in a quiet, dark space to encourage relaxation. The patient may move slowly through Stages 1 and 2 of anesthesia and exhibit unpredictable behaviors. Euthanasia by PO administration of a barbiturate

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Table 2.5 Oral pentobarbital dosing chart for dogs and cats (US doses).

Oral dosage									
Weight		**Species**	**Liquid**	**Amount of powder**			**Presentation**		
lb	**kg**	**Example**	**mL**	**Grains**	**mg**	**g**	**5 grains/ capsule**	**Teaspoon**	**Tablespoon**
1.5	0.68	Kitten (6 week)	1.0	6	390	0.39	1	1/10	
2	0.9	Kitten (8 week)	1.0	6	390	0.39	1	1/10	
3	1.4	Kitten (12 week)	1.0	6	390	0.39	1	1/10	
8	3.6	Cat	3.0	18	1,170	1.17	4	1/4	
10	4.5	Puppy (8 week)	3.0	18	1,170	1.17	4	1/4	
15	6.8	Cairn Terrier	4.5	27	1,755	1.76	5	1/2	
20	9.1	Fox Terrier	6.0	36	2,340	2.34	7	1/2	
25	11.4	Beagle	7.5	45	2,925	2.93	9	3/4	1/4
30	13.6	Cocker Spaniel	9.0	54	3,510	3.51	11	3/4	1/4
40	18.2	Springer Spaniel	12.0	72	4,680	4.68	14	1	1/3
50	22.7	Irish Setter	15.0	90	5,850	5.85	18	1 1/2	1/2
60	27.3	Labrador	18.0	108	7,020	7.02	22	1 1/2	1/2
70	31.8	Airedale	21.0	126	8,190	8.19	25	2	3/4
80	36.4	German Shepherd	24.0	144	9,360	9.36	29	2	3/4
90	40.9	Rottweiler	27.0	162	10,530	10.53	32	2 1/2	3/4
100	45.4	Great Dane	30.0	180	11,700	11.70	36	2 3/4	1
150	68.2	Mastiff	45.0	270	17,550	17.55	54	3 1/2	1 1/2
200	90.9	St. Bernard	60.0	360	23,400	23.40	72	5	2

Source: Vortech® Pharmaceuticals Ltd. 7/95
Weight: 1 kg equals 2.2 lb.
Solution: Liquid dosage is calculated on 390 mg/mL or 6 grains/mL.
Recordkeeping: Subtract the amount of powder removed in grams.
Presentation: Number of capsules, based on 5 grains per capsule. Amount per teaspoon is based on approximately 4.5 g per teaspoon. Amount per tablespoon is based on approximately 13 g per tablespoon.

is very unreliable and the practitioner should never assume that death has occurred, even when all of the drug was properly consumed. As with all euthanasia methods, verification of death must be done before disposing of the body (see Chapter 7) (Figure 2.22).

2.4.4 Miscellaneous Pentobarbital Administration Routes

Pentobarbital may be given in other areas of the body beyond what has been discussed so far, although these alternative methods are rare in dogs and cats. They include intraosseous (IO) injections into the bone marrow, rectal administration, and intrapulmonary (lung). IO injections are given through catheters placed into the greater trochanter of the femur, the greater tubercle of the humerus, or the medial aspect of the proximal tibia, and require pre-euthanasia unconsciousness (AVMA 2020). One reported pentobarbital IO dose in birds listed 700 mg/kg (Paul-Murphy et al. 2017) as effective, which is eight times the IV dose.

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Figure 2.22 Powdered pentobarbital being prepared for oral administration in a canine patient. *Source:* CAETA (2025).

In theory, pentobarbital may be given rectally in patients who can tolerate a rectal infusion of drugs. Rectal pentobarbital is given in human pediatric medicine as a sedative (Belo et al. 2021) and should be viable in dogs or cats. This author has heard reports of practitioners using rectal pentobarbital as an anesthetic. However, a published lethal dose was not located. Practitioners have also anecdotally reported that intrapulmonary pentobarbital injections in pre-anesthetized patients are an effective euthanasia method. However, more research is needed to understand the best dose and injection location.

2.4.5 Euthanasia by Inhalant Gas Methods in Dogs and Cats

Inhalant euthanasia methods are used infrequently in privately owned dogs and cats. They are more commonly used in shelter settings when injectable drugs are unavailable or too costly. Whatever the situation, an ideal inhalant will be free of odor, nonirritating, and lead to rapid unconsciousness regardless of the size of the patient. The method in which it is delivered is also important. A device should be chosen with respect to the animal's comfort and familiarity whenever possible.

Anesthetic gases like isoflurane are the most common inhalants for privately owned and shelter animals in the United States. Carbon dioxide and carbon monoxide are listed in the 2020 AVMA Euthanasia Guidelines as "acceptable with conditions," requiring considerable skill to achieve as peaceful a death as possible. Respiratory disease, anemia, and other diseases being experienced by the dog or cat may increase the time to unconsciousness and should be considered when choosing between an inhalant or injectable agent. Due to the superiority of other methods such as barbiturate injection, inhalant agents are generally reserved for small and/or highly fractious animals that cannot be handled.

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2.4.6 Physical Methods

There are only a few physical methods of euthanasia available for dogs and cats. They will only be briefly addressed due to the infrequency of their use in veterinary practice. For obvious reasons, these are undesirable methods of euthanasia when clients are present unless significant suffering necessitates their use.

2.4.6.1 Gunshot

Euthanasia by gunshot is considered conditionally acceptable in dogs and cats in the 2020 AVMA Euthanasia Guidelines. There are other, more reliable methods of euthanasia and these should always be considered first. If attempted, the patient should be quieted as much as possible. Due to the need for precision, awake fractious patients should be completely restrained using muzzles, cat bags, large blankets, etc., to render them immobilized. This will not only keep the handler safe but help guarantee the gunshot is properly performed. Better yet, patients should be heavily sedated or anesthetized to minimize movements, especially for cats (Longair et al. 1991).

Euthanasia by gunshot can be accomplished with a variety of firearms. If the approach is made within 3 ft. of the patient, handguns or small caliber rifles are preferred. Close-range shooting is commonly performed with .22-caliber rifle or handgun or .410-gauge shotgun with slugs or pellets within 1–2 in. of the skull (Longair et al. 1991). Longer range attempts up to 2 m can be accomplished with a .308 rifle or larger gauge shotgun. The farther the distance from the dog or cat, the greater the risk of improper placement. This will endanger not only the patient but also those gathered nearby.

Whether the patient is standing or lying down, the gun will be aimed directly toward the rostral forehead, as seen in Figure 2.23. The bullet should travel directly through the forehead into the brain with continuation down into the neck whenever possible. This directs it through the brainstem causing instant unconsciousness and death. Even with properly executed shots, the patient's body may



Figure 2.23 Anatomical landmarks for gunshot or captive bolt use in dogs and cats.

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spasm for a short while and bleeding will occur (Longair et al. 1991). Anyone watching should be prepared for these physical signs and reassured that they are purely involuntary.

In dogs, the firearm is aimed at the point midway between the level of the eyes and ears. Some literature suggests aiming slightly off to one side to miss the thick midline bony ridge. With respect to the ears, the lines should be drawn to the dorsal medial edge closest to the medial plane. Because dogs have many different ear types, the shooter will have to use their best judgment. Imaginary crossing lines can be visualized from the ear to the medial canthus of the opposite eye. To help position the dog perfectly and keep it still, food may be placed in front of something elevated. This elevation will keep the neck parallel to the ground.

For cats, the gunshot technique should only be used in the most extreme of circumstances. Pre-euthanasia sedation is highly recommended to limit free movement of the head. Fractious cats can also be offered food to help them remain still. Restricting movement for any animal being euthanized is not ideal as this will cause stress and anxiety, but it may need to be done when aiming at a small target such as a cat's forehead. The firearm should be aimed at the center of the cat's head slightly below a line drawn connecting the base of the ears.

2.4.6.2 Captive Bolt

Captive bolt guns can be penetrating (rod inserted through the skull) or nonpenetrating (compressive force against the skull). The worldwide frequency of the captive bolt euthanasia technique in owned dogs and cats is unknown, although one report shows its use is rare (Hing 2019). When inhalant or injectable agents cannot be used, this technique may be applied as long as instant stunning (unconsciousness) or death is achieved.

Penetrating captive bolt guns can be used on dogs in any position, keeping in mind that the body will drop rapidly to the ground. Dogs euthanized in lateral recumbency eliminate this falling motion. The bolt gun is centered on the forehead exactly like the gunshot location. For best penetration, the end of the barrel should rest against the skin, be aimed toward the medulla oblongata, and trigger pulled for rod penetration into the skull (Dennis et al. 1988). Brain disruption, including the medulla oblongata, is needed to achieve immediate unconsciousness and death. Some objectionable side effects such as extensor rigidity, reflexive movements, and urination/defecation may make the technique difficult to watch, but all movements appear to be involuntary. The bolt will carry skin, debris, and bone into the head. So, brain tissue sampling is not recommended following this method. Both forms of captive bolt euthanasia may be overtly destructive in cats and small dogs, and more research is needed in this area. The procedure is safer than the gunshot technique when observers are present.

The penetrating captive bolt technique destroys brain tissue and may be used by itself to accomplish death. No other technique will need to be used secondarily unless signs of death are uncertain, and the practitioner feels another method needs to be applied. The nonpenetrating captive bolt gun causes brain tissue damage through skull fracture and concussive force in piglets, which may be a model for dogs and cats (Grist 2018).

2.5 Special Circumstances

2.5.1 The Euthanasia of Unbirthed Young

Unbirthed young may need to be euthanized following spay procedures. Research shows that embryos and fetuses cannot experience pain and breathlessness during pregnancy and "cannot suffer while dying in utero after the death of the dam, whatever the cause" (Mellor 2019). Once their first breath is taken following birth, it is perceived that they experience pain, and appropriate

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techniques should be utilized. Pregnant bitches and queens may be euthanized via any method, causing death of the fetuses naturally from anesthetic overdose or anoxia soon afterward. This may take up to 15–20 minutes after the mother is confirmed dead (AVMA 2020). IP injections of pentobarbital should be avoided during the later stages of pregnancy to avoid accidental injection of the uterus which may slow absorption in the mother. However, IP injections are perfectly acceptable for newborns since venous access can be very difficult. It may be necessary to euthanize fetuses still within the uterus during caesarian section of the pregnant bitch or queen. This can be safely accomplished by clamping the uterine blood vessels, thus allowing the fetuses to die from anoxia.

2.5.2 Aggressive Dog and Cat Euthanasia

It is an unpleasant experience to euthanize an aggressive patient, regardless of the species. There is an increased risk of personal injury, and the nature of an aggressive reaction to handling is evidence that the animal doesn't want to be hurt, let alone have its life ended. It generally feels like a lose-lose situation. The best approach is to reduce patient anxiety and keep everyone safe.

Pre-euthanasia drugs should be given whenever practicable, either orally in advance of the appointment or at the start of it. Strong sedatives help calm the canine and feline patient. However, anesthetics should be used to ensure unconsciousness before the actual euthanasia method is carried out. Patients, both dogs and cats, can still react to stimuli while sedated so inducing anesthesia is best. Drugs can be fed in food, squirted into the mouth, or injections given while the patient is restrained, e.g. dog behind a squeeze gate or a cat pressed using a towel in a carrier. Injection doses are found in Table 2.3. Note that many drugs may also be given orally in liquid form if an injection cannot be completed, and drugs may be given in combination with each other for synergistic effects. (Table 2.6).

CAETA teaches the use of a modified Chill Protocol for dogs, developed originally by Tufts University (Costa et al. 2023). The original Chill Protocol is for routine veterinary appointments of fearful or aggressive patients, and not specifically for euthanasia appointments. It recommended the owner feed gabapentin (25 mg/kg) the evening before the appointment, followed the next day with more gabapentin (25 mg/kg) with melatonin (5 mg) given at least 2 hours before the appointment, plus liquid acepromazine (0.05 mg/kg) TM 30 minutes ahead. The CAETA-modified Chill Protocol for dogs recommends feeding gabapentin (25 mg/kg) and melatonin (5 mg) the night before the euthanasia appointment, followed the next day with gabapentin (60 mg/kg) and melatonin (5 mg) at least 2 hours before the appointment. Liquid acepromazine (0.1 mg/kg) is given TM followed soon after with TM detomidine gel (0.16 mg/kg). Detomidine liquid may be used if gel is unavailable. The canine patient will typically succumb to deep sleep within 30 minutes if all meds are properly administered by the owner. This protocol does not induce anesthesia, however, and aggressive dogs should be given an IM injection of anesthetic drugs at the start of the appointment to induce unconscious until euthanasia is carried out. Cats do well with the higher-dosed Chill Protocol without the detomidine gel (causes vomiting).

Aggressive patients should be handled as little as possible. Multiple veterinary personnel are often needed to help ensure a safe approach and reduce the need for pet owners to get involved. If pre-euthanasia drugs are not administered, there will be a greater need for restraint devices like cat bags, carriers, towels, press boards, squeeze gates, and squeeze cages (Figure 2.24).

2.5.3 Undesirable Physical Euthanasia Methods

There will be times when canine and feline patients will need to be euthanized using less common physical methods, for the sake of ending life quickly and minimizing suffering brought

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Table 2.6 Oral pre-euthanasia drugs and doses for aggressive dogs (D), cats (C), or both (B). This list has been compiled from various anesthesia resources. Many drugs are shown off-label from manufacturer recommendations.

Drug and type	Dose and route	Comments
Dexmedetomidine (Sedative)	0.03 mg/kg TM (B)	Cats may vomit, 0.02 mg/kg may be better. Sedation in dogs may take up to 30 minutes (Cohen 2015).
Detomidine (Sedative)	0.16 mg/kg TM (D)	This is a very high dose for pre-euthanasia purposes only. Profound sedation.
Gabapentin (Sedative)	60 mg/kg PO (B)	Give as much as they will take. Difficult to overdose.
Trazadone (Sedative)	15 mg/kg PO (B)	Variable response. Best given with other drugs.
Acepromazine (Sedative)	0.1 mg/kg TM (B) 2 mg/kg PO (B)	Always given in combination with other drugs. Never alone.
Buprenorphine (Sedative)	0.3 mL TM (C)	Can give a second dose if minimal sedation in 30 minutes.
Phenobarbital (Sedative)	10 mg/kg PO (B)	Different from pentobarbital. Not anesthesia.
Ketamine (Anesthetic)	10 mg/kg TM (B)	Will likely cause drooling, especially in cats. Best given with sedatives to lessen the dissociative effects.
Tiletamine/zolazepam (Anesthetic)	10 mg/kg TM or PO (B)	TM will likely cause drooling, especially in cats. Best given with sedatives to lessen the dissociative effects. Powder can be fed in high-reward foods.
Pentobarbital (Anesthetic)	85–255 mg/kg PO (B)	Liquid may be placed in gel caps and immediately fed. Very foul-tasting; so, be prepared to waste uneaten drug.



Figure 2.24 A canine squeeze cage to reduce handling of aggressive or fearful patients. An anesthetic drug protocol can be safely injected without the need to touch the animal. Once unconscious, the patient is removed for the euthanasia procedure. *Source:* CAETA (2025).

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about through life-threatening injury or disease. These include exsanguination, blunt force trauma, and purposeful electrocution. They will only be used if no other euthanasia technique is available to provide a less stressful death for the animal(s) and will not be discussed here in further detail. If used, mental hardship for witnesses including the veterinary practitioner is expected. It is recognized that technical challenges may happen during the use of more preferred techniques, and that physical methods must then be used. Observers should be prepared for physical changes in the patient that will undoubtedly occur and the reasons for the change in technique should be discussed. As with so many other euthanasia methods, unconsciousness should be provided before the undesirable method is attempted, to prevent unnecessary pain and suffering of the canine or feline patient.

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3

Exotic Pet Euthanasia

Angela M. Lennox

3.1 Species-Specific Considerations

Exotic pet ownership is growing, and owners are increasingly presenting birds, mammals, reptiles, and fish for veterinary care. Of interest is the observation that pet reptile ownership alone has seen a 23.3% increase from 2012 to 2022, according to an AVMA survey (AVMA 2024). Euthanasia is performed more frequently in an all-exotic practice compared to traditional pet practice, partially because fewer owners elect routine care. Many exotic species (not all) also have shorter lifespans and commonly hide signs of illness until very advanced. Veterinary visits are related to exotic pets suddenly presenting for signs of illness ("he was fine yesterday") that are clearly severe or end-stage conditions. When neither definitive treatment nor euthanasia is chosen or appropriate for a sick exotic pet, a palliative care plan should be developed, implemented, and adjusted as the patient's condition changes (Lennox 2020). It also must be mentioned that the owner's emotional attachment to exotic pets (e.g. reptiles, small mammals, birds) can be as strong as for dogs and cats, and this fact should be assumed, respected, and protected.

The expected lifespan of exotic pets varies tremendously from a few years for hamsters to possibly a century for large tortoises. Table 3.1 presents general information on what has been published on exotic pet life spans. Life spans are affected by poor husbandry, which is encountered frequently, especially in species where ideal captive diets are unknown. In addition to pet exotic animals, many veterinarians are presented with ill or injured wild birds, mammals and reptiles; for all but minor conditions, euthanasia is both appropriate and often required by state and/or federal wildlife laws.

Recommendations for euthanasia techniques for exotic animals were updated in the 2020 AVMA Guidelines for the Euthanasia of Animals (AVMA 2020). Numerous experts in exotic animal medicine contributed to the updates which resulted in marked improvements from earlier versions, including more recommendations and pivoting away from techniques such as freezing for reptiles/fish and thoracic compression in birds. Updated guidelines considered recommendations for traditional pet species, modified for behavioral and physiologic/anatomic differences between various classes of exotic animals including birds, rabbits and rodents, reptiles, fish, and even invertebrates. The AVMA Euthanasia Guidelines have shifted from intravenous (IV) injection techniques which have proven problematic for many exotic patients, in particular the smaller ones with hard-to-locate veins, as well as many reptiles and any patients that are hypothermic or hypovolemic.

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Table 3.1 Average lifespans for exotic pets based on limited published and anecdotal information. Poor husbandry is a common cause of morbidity and mortality in exotic pets, and lifespans can be much shorter than expected.

Common exotic pets	Average lifespan in years
Rabbit	6–8 (up to 15 reported)
Guinea pig	4–6
Ferret	6–8 (up to 12 reported)
Chinchilla	10–20
Rat	1.5–3
Hedgehog	4–8
Hamster	1.5–3
Prairie dog	8–10
Sugar glider	4–7
Mini pig	15–18
Bearded dragon	7–10
Iguana	15–20
Leopard gecko	6–10
Chameleon	4–8
Ball python	20–35
Corn snake	20–25
Boa	15–20
Semi-aquatic turtle	30–50
Tortoise	50–150
Land turtle	50–100
Frog	10–20
Large parrot	50–100
Medium parrot	20–80
Small parrot	10–20
Small bird	4–7
Chicken	8–12

While vascular access for diagnostic testing and for administration of fluids and certain drugs are routinely performed in exotic patients, this often requires significant practice and an understanding of diverse anatomy. In practice, most patients are sedated for venipuncture and vascular access to mitigate stress and increase chances of success. Since the goals of euthanasia include minimizing stress and discomfort, no patient should be conscious of restraint for an IV injection unless required (e.g. anesthetics and sedatives are unavailable).

Using a non-IV approach for euthanasia is doable even for practitioners unfamiliar with these types of animals. The challenges that remain include reducing the stress of handling, performing brief restraint for intramuscular (IM) or subcutaneous (SC) administration of anesthetics, and delivering pentobarbital in a manner most appropriate for the species. Practitioners should

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remember that drug absorption and distribution (both anesthetic and euthanasia drugs) is slower in patients that are cold, hypovolemic, and/or dehydrated, especially in reptiles. For this reason, a brief period of rewarming and even rehydration is highly recommended.

3.2 Equipment and Handling

Equipment used for exotic euthanasia appointments will vary widely depending on the species and chosen method. Medical supplies can include needles, syringes, IV or injection extension sets, tape, and in rare cases where other options are not available, a chamber suitable for induction of anesthesia with inhalant anesthetics. A stethoscope, and for reptiles, an ultrasonic doppler, are important to aid in confirmation of death. Physical euthanasia methods will require more specific equipment and are covered in Section 3.4. Needle size is chosen based on size of the patient and volume of drug to be administered. For many very small patients, a 29-gauge needle insulin syringe can be used for both pre-euthanasia anesthetic and euthanasia solutions. The viscosity of pentobarbital varies significantly. For small exotic patients, products that are less viscous and able to be administered via very small syringes are preferred.

Beyond the medical supplies themselves, access to towels for wrapping and swaddling is very important. Many exotic animals are less tolerant of handling and the presence of strangers. They can be safely moved and supported using towels or small blankets and returned to familiar enclosures (if available) equipped with hide boxes following handling and injections. All interactions with exotic pets presenting for euthanasia should be as brief as possible and conducted in a quiet space keeping voices and movement slow and calm. Once handling and injection are completed, consider leaving the room while anesthetics take effect. This is particularly important for highly stressed pets.

Many owners of exotic pets wish to be present during euthanasia. In the author's practice, owners are given the choice between staying with the pet for injection of anesthetics, injection of euthanasia solutions, or both, or not being present for any of the procedure. Many exotic pets are bonded to or are at least familiar with their owners and appear to benefit from their presence. Some exotic species such as rabbits, guinea pigs, rats, and birds are naturally social and may have a bonded companion. Accommodations can be made for companions to accompany the pet presenting for euthanasia, which is likely comforting for the ill pet and may be beneficial for the companion. Several experienced exotic pet owners, including volunteers with a large national rabbit rescue, have reported a quicker time to return to normal behaviors in surviving rabbits allowed to be present for the euthanasia of a companion.

In select cases, owners may be able to hold ill pets for injection of anesthetics, depending on the size of the patient, ability to resist, and general temperament. If there is any possibility of excessive patient movement, brief separation for injection and immediate return to the owners may be safer, especially in very small animals. This eliminates the owner's risk of inadvertent needle sticks and bite injuries during injection.

Exotic pets vary in their tolerance for entering carriers, traveling in vehicles, and handling in a novel location like a veterinary hospital. In-home euthanasia can be considered, and some national home euthanasia companies are now offering limited services for exotic pets.

Depending on species and patient condition, some consideration can be given for pre-visit pharmaceuticals (PVP) prior to home euthanasia or travel. PVPs provide mild to heavy chemical relaxation. For example, gabapentin has been shown to reliably mitigate stress in rabbits at 30 mg/kg PO (Conway 2023). Gabapentin can also be considered for exotic cats using pet feline dosing strategies.

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However, in a study of gabapentin in Amazon parrots, 15 mg/kg IV produced only mild transient sedation for 20–30 minutes (Baine 2015). Effects on other mammal species, other birds, and reptiles are unknown.

Midazolam can be considered for pre-visit anxiolysis and has been used in mammal, bird, and reptile species, although mostly without formal studies. Administration can produce effects via multiple administration routes including intranasal, per rectum and oral. Providing injections for owners to use at home is problematic but could be considered under special circumstances. The injectable formulation can be given orally, but human patients find it extremely bitter, which may complicate administration (Isik 2008). More palatable oral formulations available for humans could be considered, or specific flavors could be compounded for veterinary patients. Intranasal midazolam has been suggested for birds, and while effective, may be challenging for owners to administer (Mans 2014).

3.2.1 Handling Exotic Companion Mammals

Common pets in this group include rabbits, guinea pigs, ferrets, rodents, hedgehogs, sugar gliders, and more. Depending on state and local regulations, some owners may present primates, minipigs, exotic cats, and other exotic species. Many exotic pets are tame and accustomed to human presence and at least limited handling. In general, the less handling the better. SC and IM injection sites for exotic mammals are identical to those that might be considered for dogs and cats, and depend on the size of the patient, and the location most accessible during brief restraint. These commonly include the SC space over the back, and the hind limb musculature. This author does not usually inject anesthetics while the owners are holding the pet, especially smaller pets, due to risk of human needle injury. Some very ill exotic mammals will tolerate quick IM or SC injections without actual restraint (e.g. sitting quietly in the carrier or covering part of the body with a towel). Specific details for how to prepare individual species for pre-euthanasia anesthetic injections are presented below.

3.2.1.1 Ferrets and Rabbits

Ferrets generally relax using a scruff technique and can be injected IM into the pelvic limb musculature or SC over the dorsum. Like all exotics, they can move quickly even when sick. So, handlers should be ready to react swiftly yet safely so as not to cause harm. Early veterinary literature recommends firm towel restraint (burrito method) for rabbits to prevent kicking and injuring the back. However, experience shows that highly stressed rabbits may react negatively to firm restraint which accelerates the stress response. The majority of rabbits respond well to minimal handling after placement on a towel or nonslip surface, or with a towel covering the eyes. For the rare rabbit that struggles for even an SC injection, a towel wrap can be considered (Figures 3.1–3.4).

3.2.1.2 Guinea Pigs, Rodents, Sugar Gliders, and Hedgehogs

This group of patients can often be gently guided with a towel without actual restraint, with a brief hold (often a towel covering the head) during injection (Figures 3.5–3.7). Hedgehogs are unique. All but the very calm or markedly debilitated hedgehogs will roll into a defensive ball with handling. Injections of anesthetics can be given into the mantle, or muscle/fat layer covering the dorsal body, which when contracted, produces the defensive posture. A pharmacodynamic study of intra-mantle hydromorphone demonstrated analgesia for up to 4 hours, demonstrating that administration into the mantle can result in adequate drug uptake and efficacy (Peterson 2024).

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Figure 3.1 Gentle scruffing of a ferret for IM injection of anesthetics into the pelvic limb musculature. Scruffing is a natural behavior in the wild between mother and kits. If tolerated and the patient can safely swallow, ferrets can be distracted with veterinary high-calorie supplements during the process. *Source:* Angela Lennox, DVM.



Figure 3.2 Simple IM injection of anesthetics into the pelvic limb musculature of a debilitated ferret sleeping in a familiar bed the owners brought from home. *Source:* Angela Lennox, DVM.

3.2.1.3 Pet Pigs

These mammals vary tremendously in size, from mini-pigs to large farm-sized pets. Larger more mobile pigs are powerful and can injure would-be handlers. Some may attempt to bite or use tusks to avoid restraint. Livestock sorting panels can help guide larger pigs into a corner or small

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Figure 3.3 SC injection of anesthetics into a calm rabbit using minimal restraint. This approach should be selected whenever possible. *Source:* Angela Lennox, DVM.



Figure 3.4 Injection of anesthetics into the caudal limb musculature in a rabbit not tolerating minimal restraint techniques. The head and face are covered in a towel. Some highly stressed rabbits may require a firmer, complete towel wrapping exposing only area to be injected. *Source:* Angela Lennox, DVM.

area for injection. A 22 g butterfly catheter is placed into the dorsal muscle of the neck allowing more ability to complete the anesthetic injection, especially in a highly reactive pig. Oral midazolam, diazepam, or acepromazine at canine dosages may be useful in pigs willing to eat. Additionally, there are reports of owners offering higher-proof alcohol or beer along with favorite foods prior to the veterinary visit for euthanasia. The AVMA Euthanasia Guidelines include

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Figure 3.5 Use of a small cloth for brief restraint of a sugar glider for injection of anesthetics. *Source:* Angela Lennox, DVM.



Figure 3.6 Use of a small cloth for brief restraint of a guinea pig for injection of anesthetics into the pelvic limb musculature. Rodents generally do not tolerate scruffing well. *Source:* Angela Lennox, DVM.

information on the use of firearms for humane euthanasia of livestock, which may not be appropriate for companion pigs when other methods are available.

3.2.1.4 Unusual and Potentially Dangerous Exotics

The restraint of some exotic mammals may not be safe, depending on the level of debilitation. These include larger primates, pet raccoons, exotic cats, foxes, coatimundi, and others. Severely ill patients may not require special handling, but caution should be used at all times. Patients still able to resist handling may be guided from the carrier into an appropriately sized squeeze cage for injection of anesthetics The movable side of the cage is slowly advanced until the injection can be given, and then the cage side is released. Once the injectable anesthetic is given, staff may leave

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Figure 3.7 IM injection of anesthetics into the mantle (composed of muscle and fat) in a hedgehog. Sicker hedgehogs incapable of rolling into a defensive ball may allow simple IM injection of anesthetics into the pelvic limb musculature. *Source:* Angela Lennox, DVM.



Figure 3.8 Use of a squeeze cage for safe injection of anesthetics into a pet serval cat alert enough to resist and bite. Debilitated large and potentially dangerous exotics may not require a squeeze cage, but caution should be used at all times. *Source:* Angela Lennox, DVM.

the room while anesthetics take effect. Ideally, any animal which has been given an injection is still monitored even from afar or through an observation window (Figure 3.8).

3.2.2 Handling Birds

Birds include a wide range of species including easy-to-handle pet chickens, to small finches to very large and powerful parrots or even birds of prey. Some will accept the presence of strangers, but many may be fearful or act defensively. In all cases, the goal is to complete the restraint and

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anesthetic injection as quickly as possible and release the bird (Figures 3.9–3.11). Chickens, other poultry, and doves/pigeons generally do not bite, and can be gently cradled or wrapped in a towel, keeping the wings close to the body to prevent flapping. Parrots frequently bite unfamiliar handlers, and larger parrots can deliver serious bite injuries. Parrots are restrained with an appropriately sized towel or cloth with a firm contact point around the neck, taking care not to restrain firmly around the body. The trachea of birds is a complete ring. So, the risk of tracheal collapse is very low.



Figure 3.9 Cradling a tame duck for IM injection of anesthetics into the breast muscle. When stressed or alarmed, ducks, chickens, and geese may flap powerfully. For this reason, it is best to firmly control the wings. *Source:* Angela Lennox, DVM.



Figure 3.10 Gentle restraint of a large bird using the neck as the contact point, controlling wings with a towel. Care is taken not to compress the body of any bird which can result in injury and asphyxiation. The injection of anesthetics is given into the breast muscle, which is clearly visualized in this bird with feather-destructive behavior. *Source:* Angela Lennox, DVM.

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Figure 3.11 Larger more aggressive birds may be pinned against the back of the enclosure to avoid complete capture and restraint. Once the head is secured, the breast muscle is located and injection completed. *Source:* Angela Lennox, DVM.

Compressing the body may result in suffocation as the avian lungs are solid and do not inflate, and the body cavity must expand to allow air to enter, like a bellows. This is demonstrated by the fact that "thoracic compression" is a recognized euthanasia technique used in the field for wild birds and should not be inadvertently performed during firm handling (AVMA 2020). In the ideal hold, the fingers/hands (depending on size) firmly control the neck, and the towel wrapped gently around the body controls the wings and feet. The towel is quickly deflected to expose the pectoral muscles (breast muscles) and the injection is delivered quickly, then the bird is released. For large powerful birds that are challenging to towel, an alternative technique is to leave the bird in the carrier and gently press it against the back of the cage. The handler controls the head with the towel, locates the pectoral (breast) muscle by palpation, and injects the anesthetic rapidly before releasing the bird.

Birds of prey owned by licensed falconers are accustomed to their handlers. These birds are generally transported and presented wearing a hood, which provides a calming effect. As falconers are usually adept at handling their birds, it's often best to have them restrain (cast) the birds themselves, which allows the veterinarian to safely give the injection of anesthetics.

3.2.3 Handling Reptiles and Amphibians

This group of pets comes in a huge variety of body shapes and sizes, from very small frogs to large powerful iguanas and even larger snakes. Some tolerate handling while a rare few appear to seek out human companionship (e.g. some chelonians [turtles/tortoises] and bearded dragons); however, the majority do not prefer human contact. As with all exotics, restraint for administration of anesthetics should be efficient and quick to minimize stress (Figures 3.12–3.14). In most of these pets, IM injections are easier than SC, particularly in snakes.

Handling techniques are modified depending on patient size and ability to resist. For lizards and amphibians (with limbs), wrapping the body in a towel and isolating the leg muscle for IM

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Figure 3.12 Restraint of a bearded dragon using a towel for injection of anesthetics into the thoracic limb musculature. Lizards may be alert enough to bite during restraint and injection. *Source:* Angela Lennox, DVM.



Figure 3.13 Restraint of a snake for injection of anesthetics into the musculature in the cranial ½ of the body. Snakes may require multiple handlers to ensure safety. *Source:* Angela Lennox, DVM.



Figure 3.14 Restraint of a turtle for injection of anesthetics into the forelimb. Note many turtles will bite during restraint and injection, and a towel can be useful to cover the head. *Source:* Angela Lennox, DVM.

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injection or the dorsum area for SC injection may be the best route. Snakes come in a huge variety of sizes and are best restrained with a hand below the head to control it, with as many assistants as necessary to control the rest of the body. IM injections are given along the epaxial muscles of the front half of the snake.

In any reptile with scales, the needle is inserted beneath the scales rather than attempting to inject through scales. Chelonians can prove challenging, especially those able to retract their head and limbs into the shell (in particular, box turtles). Ideally, a front leg is captured and pinned against the side of the body for quick IM injection. More active chelonians may bite during restraint and injection. So, the head should be covered.

3.2.4 Handling Fish

Anesthesia for fish is administered via a water bath, so no handling of the conscious fish is required. Owners should transport fish in a sturdy container of water from the home aquarium/pond to avoid drastic water quality changes, which may be stressful. Stimulation can be reduced by covering the enclosure to reduce light. As accidents, leaks and spillage can occur, owners should bring additional water in tightly sealed water containers in case of unexpected loss. If handling of the fish is necessary (for example, transfer from a very large container to a smaller one, which reduces the required volume of anesthetics), use of a net or a wet cloth or towel can add rapid capture and transfer (Figure 3.15). Some stressed fish may jump out of the container, so covering the enclosure is a helpful precaution.

3.2.5 Handling Native Wildlife

Exotic practices are presented for injured wildlife for care, and euthanasia is frequently appropriate, and often required by state wildlife laws when the animal is not a candidate for release back into the wild. The keeping of injured and orphaned wildlife as pets should be discouraged and is regulated under each state's laws. However, as some endangered and rare species may be suitable for conservation or educational purposes, contacting local government agencies is recommended.

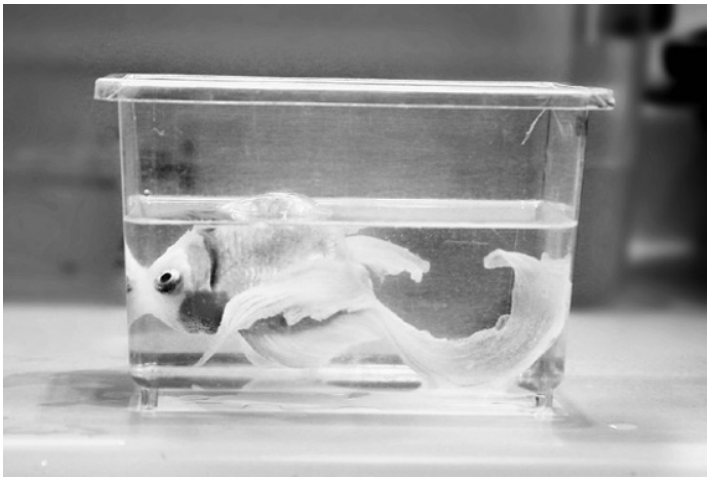


Figure 3.15 A severely debilitated fish with a buoyancy disorder in an anesthetic bath. *Source:* Angela Lennox, DVM.

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Because wild animals are much less tolerant of handling, when possible, a plan should be developed before capture and the patient assessed soon after presentation. If there is a delay, place wildlife in a quiet, dark enclosure with minimal disturbances. Practice rapid handling and delivery of anesthetics using techniques suggested for pet mammals, birds, and reptiles (Figures 3.16 and 3.17).

It should be kept in mind that some wildlife species represent a health hazard to humans, including potential rabies vectors such as bats, skunks, and raccoons. Bats in particular are commonly diagnosed with rabies in the United States. These animals should be handled with gloves, and in the case of aggressive larger animals, chemically immobilized in transportation carriers or squeeze cages prior to handling. Oral administration of pentobarbital advocated for highly aggressive dogs can be considered for potentially dangerous wildlife where injection of anesthetics is not practical or possible.



Figure 3.16 Veterinarians humanely euthanize a wild finch. *Source:* Angela Lennox, DVM.



Figure 3.17 Anesthetizing a wild raccoon requires extra attention to safety. *Source:* Angela Lennox, DVM.

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3.3 Pre-euthanasia Sedation and Anesthesia

The American Association of Anesthesiologists (ASA) defines a continuum of sedation and anesthesia that veterinarians may use to guide understanding of sleep states (ASA 2024). It is important to understand that minimally to deeply sedated patients are still capable of some degree of responsiveness and "purposeful" movement. For this reason, administration of pentobarbital using routes other than IV should only be performed in patients that are under general anesthesia, which is defined as "unarousable, even with painful stimulus." For this reason, it is important for practitioners to assure anesthesia has been achieved after giving anesthetic drugs. One method is a hard, discrete toe pinch. Once the patient no longer reacts, the patient is likely anesthetized, and unlikely to perceive pain during non-IV routes such as intraorgan injections, which are commonly the only practical routes in many exotic species.

3.3.1 The Use of Inhalants for Induction of Anesthesia

The AVMA Euthanasia Guidelines discourage the use of inhalants, either by mask induction with restraint or in an induction chamber in the conscious patient for the purpose of inducing anesthesia prior to euthanasia (AVMA 2020). Concerns are chiefly over stress associated with inhalant induction, which has been documented in humans. Adults undergoing dental treatment greatly preferred IV induction with propofol over mask induction with sevoflurane, which was rated as "unpleasant" (Ohkushi 2016). Another study showed a significant stress response in children undergoing mask induction with sevoflurane even after preconditioning with the mask. Stress responses were improved with the use of midazolam prior to mask induction (Lan 2012). Additional disadvantages of mask and chamber induction are increased exposure to waste gas, especially for owners who wish to be present during the entire euthanasia. The AVMA Euthanasia Guideline's chapter on euthanasia of avian patients presents inhalant anesthesia as an option, likely due to a long-documented history of use of inhalants as sole agents for immobilization of birds for various reasons, including for diagnostic sampling and imaging. However, it is unclear why a technique considered stressful in non-avian species can be expected to be different for birds. In the author's practice, face mask induction of anesthesia for immobilization or in preparation for surgery is only performed in the properly premedicated patient unlikely to experience stress. If induction with inhalants without premedication is the only option available, consider the smallest chamber possible to prevent large accumulations of inhalant gases and vent carefully to minimize exposure.

3.3.2 Injectable Anesthetic Protocols

Drug combinations are dosed above typical recommendations for premedication and induction for specific species before euthanasia. Typical doses to induce anesthesia are available from various sources and can be used as a starting point. In general, sicker pets require lower doses for effective anesthesia. Less debilitated patients and those with impaired drug metabolism from organ dysfunction or impaired circulation may necessitate higher doses and more time for optimal effect. Similar anesthetics can be chosen for mammal, bird, and reptile patients. Suggestions used by this author are presented in Table 3.2.

While no longer typically utilized for anesthesia in exotic pet practice, xylazine is potent, inexpensive, and appears minimally painful when injected IM or SC. There are specific species differences, including much higher dosages required for rodents than for rabbits. Ketamine is also

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Table 3.2 Agents and doses useful for anesthesia prior to euthanasia in exotic pet species. Selected agents (usually 2–4) are combined into a single syringe and injected IM or SC using low-stress minimal handling techniques. This is best accomplished in a warm, optimally hydrated animal.

Agent	Dose (mg/kg)	Comment
Xylazine	10–20	Inexpensive and effective, pain upon injection is minimal
	30–50	Doses in guinea pigs/rodents are significantly higher
Opioids	Standard therapeutic dosages	Enhances effects of other agents, analgesia
Dexmedetomidine	0.01–0.1	Very effective in high doses but is relatively expensive
Ketamine	5–10	Effective when combined with other agents but produces pain upon injection; use as co-induction agents at lower doses
Alfaxalone	5–20	Lower doses are highly effective when combined with other agents. Much higher doses (up to 10 times) are required when used alone; relatively expensive
	Above 10 mg/L of H_2O	Fish water bath
MS-222	Above 200 mg/L of H_2O	Fish water bath. Must be pre-buffered with sodium bicarbonate
Tiletamine-zolazepam	10–20	Effective when combined with other agents but produces pain upon injection; use as co-induction agents at lower doses
Midazolam	1–2	Anti-anxiety effects, used to enhance other agents listed above
Acepromazine	0.5–1	
5% ethanol/beer	Immersion	Invertebrates only

Source: Angela Lennox, DVM.

frequently chosen but elicits a stronger pain response and should not be given at higher than necessary doses/volumes. Dexmedetomidine is an effective sedative/premedicant but may be costly in larger species. Midazolam and opioids can be used to enhance the effects of anesthetic drugs. It should be kept in mind that if opioids are chosen specifically to provide analgesia prior to euthanasia, they may not achieve levels considered effective before the onset of unconsciousness. Some opioids, in particular morphine and morphine-like drugs such as hydromorphone, tend to cause emesis in ferrets (Wynn 1993).

3.3.3 Nasal, Oral, and Intracloacal Administration

Some pre-euthanasia drugs may absorb across mucosal linings, especially those that are highly lipid soluble. One study looked at ketamine (30 mg/kg) and midazolam (2 mg/kg) given intranasally to domestic chickens. Less than half of the birds reached anesthesia, and the rest were at least mildly sedated (Adao 2024). Intranasal midazolam has been shown effective as a sedative in many types of pet birds (Mans 2014). It is challenging to feed oral anesthetics at large doses to small exotic patients and is generally avoided. Intracloacal (ICl) administration of anesthetics and pentobarbital has been investigated in reptiles and used anecdotally in birds and can be considered in any situation where it is safer to avoid the head. Drugs are gently introduced into

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the cloaca using a teat cannula or a syringe with a soft IV catheter without the stylet. Drug absorption may be slower using this route, and immediate voiding may eject administered drugs.

3.3.4 Immersion Bath and Topical Anesthetic Application

For fish, anesthetic water baths are prepared using a secondary container with a known amount of the fish's accustomed water measured in liters. Anesthetics are gradually added and increased to effect. Useful drugs include tricaine methanesulfonate (MS-222), clove oil, and alfaxalone at higher doses normally used for anesthesia (Minter 2014; Weaver 2024). Table 3.2 includes these and many more. It should be kept in mind that variations are emerging in the concentration of anesthetic required to achieve anesthesia in different fish species. Continue adding drug until the fish is completely anesthetized. The anesthetized fish will become lateral, lose all purposeful movement of the fins, cease operculum (gill covering) motions, and will not respond to stimulus. The AVMA Euthanasia Guidelines do not recommend pentobarbital baths for conscious fish as these are associated with distress behaviors.

Pet invertebrates, such as giant land snails, are occasionally presented for care. A suggested anesthetic protocol for land snails prior to euthanasia is immersion in 5% laboratory-grade ethanol or beer (Gilbertson 2016). The study showed no stress behaviors in snails using either ethanol or decarbonated (flat) beer; however, snails showed evidence of stress when immersed in higher concentrations of ethanol. It should be noted that the average alcohol content of regular beer in the United States is from 5 to 6%. This technique is likely useful for other pet invertebrates as well. Another technique for cockroaches (Madagascar hissing cockroaches and other related species are occasionally kept as pets) involved anesthesia in a container with isoflurane-soaked cotton balls until nonresponsive, followed by euthanasia by immersion in 70% isopropyl alcohol for 15–30 minutes (Tucker 2023).

3.4 Euthanasia Techniques

Due to the variability of species anatomy and physiology, exotic pet species have the broadest list of possible euthanasia techniques compared to other animal subgroups. Before attempting euthanasia, the veterinary practitioner will need to understand species characteristics as well as acceptable euthanasia methods. These include injections of euthanasia agents, physical methods, and methods like drug immersion. As described above, overdoses of inhalants are not recommended for euthanasia due to unnecessary exposure of staff to waste gas, and the very protracted time/concentrations required to achieve death in some species such as reptiles. There are physical methods for euthanasia in birds, such as cervical decapitation, but these are generally not appropriate for pets especially when owners wish to be present. Injections of barbiturates are ideal for rapid euthanasia and are effective when administered IV if available, intraorgan and even IM, only in the completely anesthetized patient.

3.4.1 Delivery of Euthanasia Solutions

Once the patient is completely anesthetized as demonstrated by complete and repeated lack of response to noxious stimulation, there is a great deal of flexibility in terms of delivery of pentobarbital. If the patient is still responding in any way, administer additional anesthetics. Owners should be advised that some patients will die with anesthetics only, without the need for pentobarbital.

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Some owners feel being aware of the moment of passing is important and may be distressed to have "missed" it. In the completely anesthetized patient, owners can hold or touch their pet providing the euthanasia technique can be done without risk of human injury.

There are numerous options for delivery of pentobarbital, some understandably more practical than others.

- Intravenous (IV)
  - For staff with significant experience in this technique in exotic species
  - For patients that are not hypovolemic or hypothermic cue to underlying illness or as a result of administration of high dosages of anesthetics.
- Intraosseous (IO)
- Intraorgan – intracardiac (IC), intrahepatic (IH), intrarenal (IR)
- Intraperitoneal (IP)
- Intracoelomic (ICo)
- Intracloacal (ICl)
- Intramuscular (IM)
- Occipital sinus via the forâmen magnum
- Transmucosal (TM)
- Oral (PO)

Any route can be considered in the completely unconscious exotic patient (mammals/birds/reptiles). However, IV, ICo, ICl, TM, and PO may be acceptable in awake or sedated patients when stress of handling can be minimized or avoided. ICo is generally avoided in birds due to the presence of air sacs. For some hospitalized or surgical patients, vascular access may already be established via the IV or IO route. IO catheterization is frequently performed in exotic species, especially in smaller exotic mammals, birds, and even some reptiles. In that case, the catheter can be used for delivery of pentobarbital. As non-IV techniques are generally very effective, there is little compelling reason to attempt to place an IV for the purposes of euthanasia. Adequate doses of pentobarbital solutions are unknown in many exotic species. Canine/feline doses are considered good starting points, keeping in mind the need for higher amounts especially when given outside of the vein.

3.4.1.1 Small Mammals

Those experienced in IV access in exotic mammals may be able to use any accessible vein for administration of pentobarbital. Cephalic, jugular veins, and the vena cava are often used in ferrets, and the cephalic, auricular, lateral saphenous, and jugular in rabbits. In smaller patients, the cranial vena cava is often the easiest vessel to access. Correct needle position is confirmed by pulling back to identify blood in the hub of the needle. Inject slowly and watch for accumulation of pentobarbital outside the vessel; this is not possible when using the vena cava for injection (Figure 3.18).

Intraorgan (kidney/liver/heart) administration is relatively easy in many species with location exactly as expected (Figures 3.19–3.21). While IV administration is expected to produce death more rapidly, a properly placed intraorgan injection can be effective as well. A study compared IR pentobarbital administration to IV administration in laboratory New Zealand white rabbits (LeGrand 2024). Using Evan's blue dye, investigators reported that kidney injection was 100% successful. However, the time to cardiac arrest was significantly longer using this technique, and some rabbits required additional drugs. Mammalian anatomy in terms of major organ position is

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Figure 3.18 An anesthetized hamster undergoing euthanasia via IV injection of pentobarbital into the cranial vena cava. *Source:* Angela Lennox, DVM.

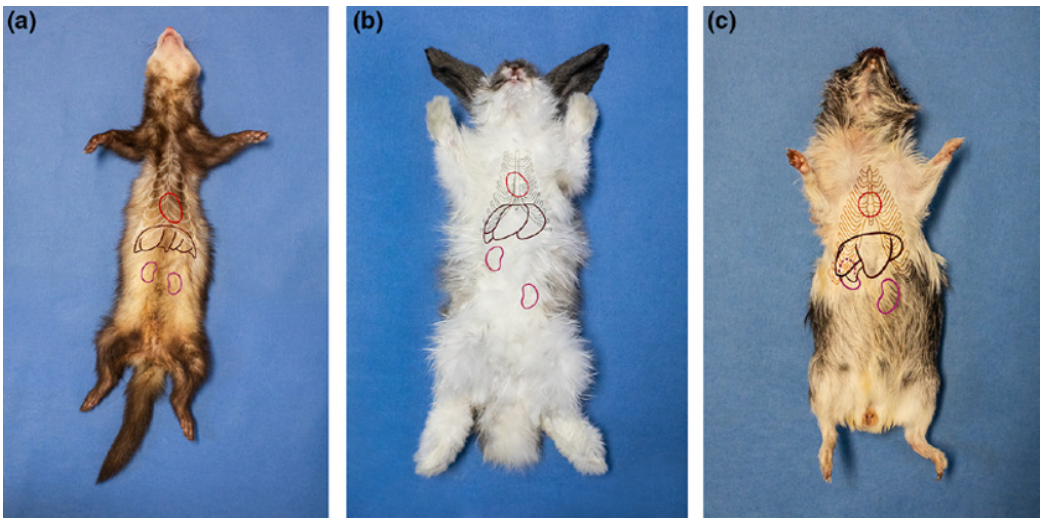


Figure 3.19 (a–c) Relative positions of the heart, liver, and kidneys in ferrets, rabbits, and rodents (guinea pigs). Note how the heart of the ferret is positioned far more caudally than in most other common exotic mammal species. *Source:* Angela Lennox, DVM.

conserved among species, with some notable positional differences such as the relative caudal position of the heart in ferrets, and relatively small thoracic cavity in rabbits. A barrier to identification of the liver and kidney is excessive abdominal fat, which varies from patient to patient. In hind-gut fermenting animals such as rabbits and guinea pigs, the volume of the gastrointestinal (GI) tract can be enormous, complicating palpation of the kidneys, and sometimes the liver.

Pentobarbital dosage recommendations for various animal species vary widely from product to product. Some provide dosages specifically for canine and feline patients, and others simply provide a suggested dose for "animals." The following are recommended IV pentobarbital doses in various species, based on label instructions and anecdotal practitioner reports. As dosages for specific

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Figure 3.20 Delivery of pentobarbital into the kidney in an anesthetized chinchilla while the owner holds the pet in a pet bed. *Source:* Angela Lennox, DVM.



Figure 3.21 Euthanasia of an anesthetized pet rat with IC pentobarbital. This technique avoids the difficulties related to IV injection in small patients. *Source:* Angela Lennox, DVM.

exotic species are rarely provided, pentobarbital administration is considered off-label. Other non-IV administration routes generally require doubling or tripling the IV/IC dose. Pentobarbital should be given until death is confirmed, meaning that on a case-by-case basis, the lowest recommended dose may not be enough. The following doses have been sourced from a variety of references and are considered anecdotal beyond what a pentobarbital drug label indicates.

- Mammals: 85 mg/kg IV and IC
- Birds: 150 mg/kg IV and IC
- Reptiles: 100 mg/kg IV and IC
- Amphibians: 85 mg/kg IV and IC
- Fish: 100 mg/kg IV and IC

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Time to death using intraorgan methods is generally quicker than that for other non-IV routes such as IP administration. Complicating factors for IP injection include the relatively large GI tract in some rabbits/rodents that are still consuming food, and excessive intraabdominal fat in obese animals which can slow down absorption. IP administration is often used for its simplicity. However, time to effect is not as quick as for intraorgan administration. The AVMA Euthanasia Guidelines state that IP pentobarbital injections are acceptable in conscious animals. However, the true extent of discomfort is unknown. For this reason, this author only performs IP injections when other methods are unavailable.

ICl administration of drugs has been studied in some species and could be utilized as well. While not much is known about pentobarbital use via the ICl route (not included in the AVMA 2020 Euthanasia Guidelines), other anesthetic drugs (highly lipid soluble is best) can be successfully absorbed through the cloaca (Morici 2017). However, death is unlikely unless extremely high doses can be given. Until more data is known, ICl pentobarbital administration may be better for inducing anesthesia than actual euthanasia. Care must be taken to prevent drugs from leaking back out after administration. A gloved finger pinch/occlusion of the anus for 60 seconds is helpful (Morici 2017).

IM administration of pentobarbital has been anecdotally shown to be effective in anesthetized patients when IV access or other methods are not possible. However, more research is needed before this method becomes mainstream. IM administration is very simple and effective but requires more time to effect than with IV or intraorgan methods. This route can be utilized by any practitioner, even those unfamiliar with exotic animal anatomy.

3.4.1.2 Birds

When considering intraorgan administration of pentobarbital, the liver is often the easiest in birds. The liver is located beneath the keel bone and is accessed by inserting the needle just beneath the ventral aspect of the keel. Some parrot species, or birds with cirrhosis have normally smaller livers which may be more challenging to locate. The kidneys are located dorsally adjacent to the spine within a bony fossa, and are non-pendulous, making access extremely difficult and is therefore not recommended. The heart is protected by the keel bone, and access is possible using a cranial approach beneath the sternum. The coelomic cavity contains well-developed air sacs, which must be avoided when attempting intraorgan injection. Practitioners need to understand exactly where these air sacs sit in the cavity to prevent anoxia/drowning from the injection of pentobarbital. In addition, many disease processes in birds (reproductive disease, heart disease) produce coelomic fluid or masses, including distention of the reproductive tract which may be filled with fluid or egg material. This can also complicate any form of coelomic injection (Figure 3.22).

While not evaluated scientifically, this author and others have noted that simple IM administration of pentobarbital into the large and well-developed pectoral muscles is particularly effective in the completely anesthetized bird. This approach requires no particular skill or knowledge of anatomy. The left jugular vein is relatively large in birds and can be used for pentobarbital injections. Another option for administration of pentobarbital in unconscious birds is via the occipital sinus. The head is hyperflexed and the needle is inserted on the midline at the base of the skull.

Transmucosal (TM) pentobarbital administration was evaluated for euthanasia of 110 conscious injured wild birds at three dosages. Drugs were administered by restraining conscious birds and applying pentobarbital to the oral mucosal taking care to avoid the glottis. Dosages were five, six, and seven times those recommended for IV administration for euthanasia. All dosages resulted in loss of consciousness within 5 minutes or less and were faster in the higher dosage groups. Time to asystole was the same for all dosages tested. The authors of this study comment that effects of the

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Figure 3.22 Location of the heart and liver in a bird. The heart is accessed cranially, and the liver caudally beneath the sternum. *Source:* Angela Lennox, DVM.



Figure 3.23 Simple IM administration of pentobarbital into the relatively large breast muscle of a completely anesthetized budgerigar. *Source:* Angela Lennox, DVM.

taste of euthanasia solution are unknown, as is the level of stress with this method when compared to IM injection of anesthetics prior to administration of euthanasia solution (Gardhouse 2023) (Figure 3.23 and 3.24).

3.4.1.3 Reptiles and Amphibians

Venipuncture is commonly performed in reptile species, e.g. the tail and jugular veins in lizards and jugular and subcarapacial veins in chelonians. Locating veins in reptiles/amphibians requires significant practice and may prove stressful for the practitioner when owners are watching. For this reason, IV administration of pentobarbital in the anesthetized reptile patient is typically

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Figure 3.24 IV administration of pentobarbital into a completely anesthetized pet chicken. The left jugular vein is particularly large in birds and can be utilized depending on practitioner comfort. *Source:* Angela Lennox, DVM.



Figure 3.25 Use of a doppler to detect heart sounds in a snake. In snakes, the heart is located 1/4–1/3 of the length of the body from the head. *Source:* Angela Lennox, DVM.

unnecessary and avoided. TM administration of pentobarbital-combination solution has been tried in bearded dragons with mixed results (Wong 2024).

Intraorgan administration in these species requires a good working knowledge of anatomy which is highly variable. IC, IH, and IR injections are common. In lizards and amphibians, the heart is generally positioned far cranially, almost within the thoracic girdle. Therefore, needle position for accessing the heart depends on the species and anatomy. Alternatives include through the thoracic inlet, cranial ventral midline, or possibly laterally through the ribs. In snakes, the heart is located approximately 1/4–1/3 of the body from the length of the snout. Heart location in many reptiles and amphibians can be confirmed with the use of an ultrasonic doppler. In any reptile with scales, the needle is inserted beneath the scales rather than attempting to inject through scales (Figures 3.25 and 3.26).

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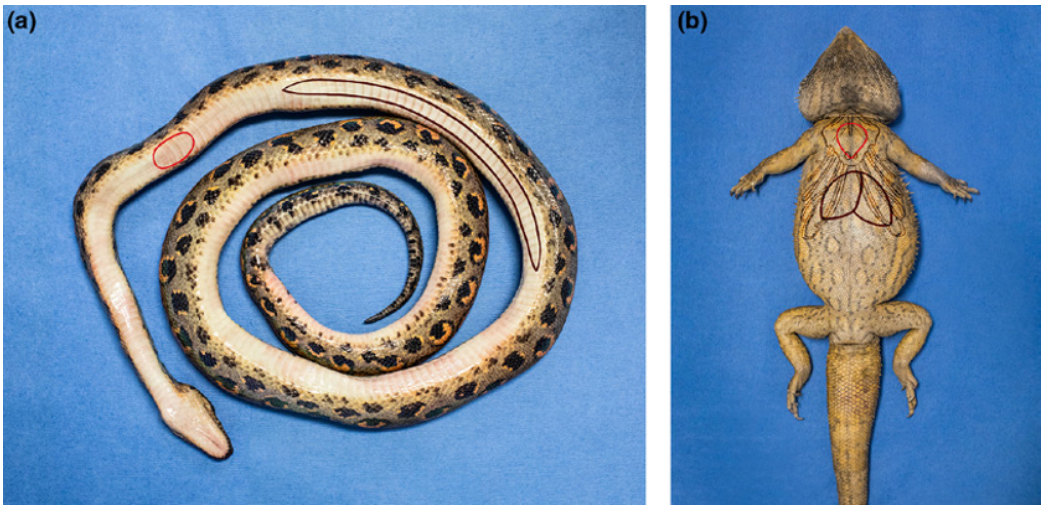


Figure 3.26 (a, b) Location of the heart and the liver in a snake, and a bearded dragon. Identification of the liver is challenging in snakes, and generally not utilized. *Source:* Angela Lennox, DVM.

Both ICo and IM administration of pentobarbital can be performed in anesthetized reptiles and amphibians and requires minimal technical skill. While likely less practical for use in pet practice, a 2023 paper described euthanasia of wild red-eared slider turtles with either 100 mg/kg pentobarbital delivered via esophageal gavage or cloacal infusion (Ready 2023). There were no signs of distress or irritation post-administration. However, there was significant leakage of a solution when given by gavage necessitating a secondary euthanasia method. Loss of corneal reflex occurred around 45 minutes (range of 15 minutes to 4 hours) and cessation of heartbeat from 6 to 26 hours emphasizing the challenges of assuring death in these species (Ready 2023). Either technique may be of benefit for euthanasia of wild chelonians, but it has limited utility for pet species, especially considering the handling required to pass an esophageal tube and the lengthy time to cardiac arrest.

3.4.1.4 Fish

The AVMA 2020 Euthanasia Guidelines mention a number of euthanasia methods for fish, including in research settings and fish produced for food. A few may be acceptable for anesthetized pet fish. This author's preference is ICo or IM injection of pentobarbital following pre-euthanasia anesthesia (Figure 3.27). Larger muscles are present in the tail or dorsum of larger fish.

Anesthetic agents such as propofol, alfaxalone, and MS-222 may be used for immersion euthanasia methods, at three to five times higher than normal anesthetic doses. However, some fish have been shown to recover at five times the anesthetic dose even after 1 hour out of water with no signs of life (Posner et al. 2019). For this reason, if anesthetic overdoses are used, a secondary method of euthanasia, such as pithing or decapitation (which may not be appropriate for pet fish) should be considered. The minimum propofol immersion dose for euthanasia purposes is 25 mg/L, and the minimum dose of alfaxalone is 50 mg/L.

Pentobarbital baths are not recommended for conscious fish due to observation of stress behaviors but could be considered in unconscious fish (AVMA 2020). Rapid chilling or freezing, decapitation, captive bolt, and blunt force trauma, as performed in food fish, are not appropriate for pet fish. Removing fish from water to suffocate until death is unacceptable.

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Figure 3.27 Intracoelomic administration of pentobarbital for euthanasia of a fish after complete anesthesia using an anesthetic water bath. *Source:* Angela Lennox, DVM.

3.4.1.5 Invertebrates

Practitioners will occasionally see unique invertebrate pets including scorpions, tarantulas, giant land snails, and more. Owners may request humane euthanasia, which has been investigated in laboratory specimens. The AVMA Euthanasia Guideline's two-part technique was adapted to the giant land snail. Anesthesia was induced by immersion in 5% ethanol (laboratory-grade ethanol or beer), followed by immersion in 70–95% ethanol or 10% neutral buffered formalin (Gilbertson 2016). The use of formalin is not appropriate when the pet is to be returned to the owner for burial. Safety precautions for the handling and disposal of formalin must be carefully observed. In 2023, a study looked at four different species of cockroaches to determine superior euthanasia methods. Across all species, isoflurane anesthesia followed by either 70% isopropyl alcohol immersion for 0.25 or 0.5 hours or isoflurane exposure for 24 hours resulted in euthanasia in 100% of cockroaches (Tucker et al. 2023). A more recent study evaluated euthanasia of two species of anesthetized cockroaches (cave and Madagascar hissing cockroaches anesthetized with CO_2 or isoflurane on a cotton ball in a tightly sealed container) either by immersion in 5% dishwashing detergent in water or by exposure to freezing at – 80°C, both for 30 minutes. It should be noted that in both methods, a very low number of cockroaches survived (Barnes 2024).

This technique was advocated for mass humane euthanasia. However, immersion in soapy water could be considered for individual pets as well. Other agents like pentobarbital and potassium chloride were used to euthanize with good but still variable success. Practitioners planning on euthanizing pet invertebrates will need to become very familiar with the best techniques, which is beyond the scope of this chapter.

3.4.2 Physical Methods of Euthanasia in Exotic Species

Physical methods of euthanasia include captive bolt, gunshot, cervical dislocation, decapitation, electrocution, focused beam microwave irradiation, exsanguination, maceration, stunning, thoracic compression, and pithing (AVMA 2020), only some of which are used in companion

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animal exotic species. When owners are present, considerable thought should be given to what they witness. If a physical method must be used with owners watching, they need to be gently told what to expect.

Pithing is considered best as an adjunctive method to another euthanasia method that has already been carried out, to ensure that death is permanent. If no other method is available, and the patient is anesthetized to the point of unconsciousness, it should prove effective if enough brain tissue, including brainstem, is destroyed. Pithing is performed by introducing a wide-bore needle into the occipital foramen and manipulating it around to damage as much tissue as possible. It should be noted there may be a drop of blood at the site of pithing once the needle is withdrawn, which should be cleaned in cases where the body will be returned to the owner.

Cervical dislocation of poultry is commonly performed in industry and for backyard farm birds (Jacobs 2019). The experienced practitioner can utilize this technique for euthanasia in the anesthetized bird if desired; however, this is not appropriate for euthanasia performed in the presence of pet owners. Cervical dislocation is also a common secondary euthanasia method in small rodents in the laboratory setting but is rarely used in small mammal pets.

Also of interest is the option of cooling/freezing to achieve death in small amphibians and reptiles (Shine 2019). Research into measurements of core body temperature and brain activity during cooling has resulted in conflicting opinions on whether cooling produces distress and discomfort. One group of authors contend that lack of increased electroencephalogram (EEG) activity and purposeful avoidance movement during cooling is evidence of absent pain sensation. It is also noted that some reptiles lack receptors for a response to cold (Shine 2019). While of interest, this author feels there is not enough information to recommend cooling/freezing for pet reptiles and amphibians (Table 3.3).

Table 3.3 Summary of euthanasia procedure used at this author's practice.

The owner is escorted to the comfort room to discuss end-of-life decisions and spend time with the pet, if desired.
A client care team member obtains written consent and goes over body care decisions.
Final financial transactions are completed.
Medical team member(s) explain(s) or reinforce(s) what to expect and ask(s) the owners to signal with the call button when they are ready to proceed.
Experienced team members administer IM anesthetics using low-stress handling techniques. The pet is briefly separated from the owner to avoid accidental needle sticks or bites at the time of injection.
The level of anesthesia is periodically checked. Additional anesthetic is administered if necessary.
Pentobarbital is administered via the best route based on patient signalment.
Death is confirmed, and the owner is allowed to visit as long as they would like.
The body and/or paw print are prepared for return to the owner if applicable. The owner is escorted out of the clinic after asking if there are additional questions or requests.
If cremation is selected, the body and paperwork are prepared as directed by the crematorium. If burial is selected, the owner is given burial guidelines.
"Euthanasia" is selected in the clinic software automatically and generates a reminder for a sympathy card.
"Cremation" is selected in the clinic software automatically and generates a reminder to ensure procedures are followed and the ashes returned to the owners.

Source: Angela Lennox, DVM.

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3.5 Special Circumstances

Exotic euthanasia poses inherent challenges due to its unique anatomy and physiology. It is common for practitioners to be asked, under unique circumstances, to euthanize exotic patients whom they may be unfamiliar with. All veterinarians should understand that exotic euthanasia takes time and patience, not only to perform the procedure but to guarantee that death is permanent. As a general rule, all euthanasia methods are permitted in exotic patients as long as they are unconscious and insensible to pain or incapable of stress. Practitioners will want to explain the technique to owners especially if a physical technique (e.g. cervical dislocation) is used, in particular, if the owner plans to take the body home.

3.5.1 Ensuring the Patient is Deceased

Ensuring death in exotic mammals and birds is straightforward and similar to other companion animal types. Reptiles, amphibians, and fish present a particular challenge in that heart sounds and body movement can be detected for many hours after the patient is likely without brain function, e.g. natural death or post-administration of pentobarbital. Evidence of what looks like continued life can be disconcerting. Heart sounds are best detected with the use of an ultrasonic doppler placed before euthanasia is conducted if possible. Attempting to find heart sounds with a stethoscope in these species is generally unrewarding. For invertebrate species, confirming death is usually through the absence of movement.

Several workarounds for confirmation of death have been proposed and practiced. These include:

1) Completion of the euthanasia procedure followed by confirmation of death the next day. Once death is confirmed, the body can be sent for cremation, or released to owners, if desired.
2) Pithing via the occipital foramen with an appropriately sized needle. Pithing after euthanasia may be unpleasant for owners to observe and can be performed when the body is prepared and wrapped to go home with the owners or submitted for cremation. This technique is particularly useful when owners do not consent to a waiting period to confirm death (Figure 3.28).



Figure 3.28 Pithing of a bearded dragon to ensure death following an intraorgan injection of pentobarbital. The pithing site may bleed afterward, and blood should be removed before returning the pet to the owner. *Source:* Angela Lennox, DVM.

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3.5.2 Aftercare

Most veterinary aftercare companies, such as cremation or aquamation operations, will accept exotic pet remains. Owners can expect ashes back from all species that have bones, although the smaller the animal, the lesser ash there will be. Memorial items are commonly made for beloved exotics too. Paw print impression materials used for traditional species are easily adapted for exotic pets, with tail prints, feathers, or scales incorporated into the design. Species-appropriate condolence cards are also available to send to owners.

Many exotic species are bonded to conspecifics and the living companions may mourn. Owners may be interested in allowing cage mates to see the deceased body before aftercare is carried out (Brown 2021). Anytime a pet is brought home for burial, the body must be safely buried deep in the ground, especially those euthanized with pentobarbital euthanasia solution. See Chapter 7 for more information on burial requirements.

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4

Equine Euthanasia

Bruce A. Connally

4.1 Species-Specific Considerations

4.1.1 The Importance of Horses in Society

The image of horses, donkeys, and mules has evolved in the Western world from primarily beasts of burden to noble animals whose manes and tails flow freely as they run across the hills. While this is obviously a romanticized view of horses, it has significance in the discussion of equine euthanasia. Many horses remain working animals on the racetrack, in the show ring, on the ranch, or in the mountains. A very large percentage of horses are now considered companions or pets by their owners. With a potential lifespan of over twenty years, horses and all equids may remain in a single family for extended periods. Emotional attachments are often strong between equine competitors and their horses as well. Observe the barrel racer or dressage rider interact with their horse at the end of a competition to recognize the bond that forms between horse and rider. Horses are also romanticized in literature and movies as majestic creatures with sometimes human-like characteristics (Davis and Maurstad 2016). All of this has added an emotional dimension to equine euthanasia that was not always given due consideration in veterinary medical contexts.

As with other species, people care about the way in which horses are euthanized. They wish for it to be gentle and humane with the least amount of stress to the horse as possible. Euthanasia is a term used for the ending of life of horses not intended for food purposes (i.e. slaughter). Currently available euthanasia methods include the administration of pharmaceutical drugs (e.g. pentobarbital) and physical methods (e.g. gunshot). In countries where equine slaughter is not allowed, and a horse is suffering from poor physical or emotional conditions, or when resources are lacking to continue care, individual euthanasia procedures will be carried out by veterinarians (Myers et al. 2019). To meet the needs of communities facing the challenges of large unwanted horse numbers, future equine euthanasia centers managed by veterinarians may be the answer.

4.1.2 Preparation and Planning

4.1.2.1 Deciding the Right Time to Euthanize

The euthanasia discussion may begin weeks or months before the actual euthanasia is performed. This may be a way for the owner to gradually accept the reality that ending their life is the most humane way to support their horse. Sometimes it is difficult for owners to recognize how much pain the horse is experiencing. The equine discomfort ethogram (Torcivia and McDonnell 2021)

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or the ridden horse pain ethogram (Dyson 2022) can be used to educate the horse owner about recognizing signs of pain. This and sage advice from veterinarians will often make the end-of-life (EOL) decision easier for an owner or trainer to accept as the best outcome for their horse.

Finances may also become a part of the discussion and affect the timing of euthanasia. Expensive therapies to prolong the life of an old or disabled horse may be legitimate financial burdens. The cost-benefit balance for the horse and the owner should be considered in the euthanasia discussion (Clough 2021). While financial considerations may be important for the owner, euthanasia of an animal strictly for financial reasons is considered unethical. Instead, other options such as rescue operations or rehoming to another owner must be considered as reasonable alternatives to euthanasia. The best interest of the horse should remain the overarching requirement in these decisions (Bell and Rogers 2021). Simply giving the horse to another owner who is incapable of providing a safe and healthy home is inappropriate and will often lead to poor welfare outcomes (Figure 4.1).

Equine owners have a few practical considerations that are best addressed early in the euthanasia decision-making process. The time of the year is an important factor to consider. A weak, older horse may not be able to survive the winter. Euthanasia before winter could prevent the pain and suffering of a horse that is down and unable to rise on a cold, snowy day. Who wants to be present, such as family members and caretakers, will be another factor to consider. Many people may be involved in the horse's life and request to be present to say goodbye. Owners may also have strong feelings about allowing other companion horses to be either present during euthanasia or see the body afterward. The sooner decisions like these can be made, the more likely the horse being euthanized will have a better death experience.

Another consideration is how to manage the large carcass after euthanasia. This includes the means of transporting the body and the actual final disposition. Transportation of the body may be accomplished in many areas by companies that specialize in hauling deceased large animals.



Figure 4.1 A bonded owner with their horse. Note that this position is unsafe, especially during the euthanasia procedure.

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They have specialized trucks or trailers which are fitted with equipment to load the body. If this option is not available, other means must be employed. It usually requires some heavy equipment such as a tractor with a loader to lift the horse onto a waiting truck or trailer with an open top. It is much more difficult to load the body into a covered horse trailer with any kind of tractor/loader. Open trucks or trailers will necessitate someone cover the dead horse during transport for aesthetic reasons. Flatbed automobile tow trucks work very well. They can load and unload the horse's body with the same equipment used to load cars but do so with respect and consideration for those who are watching. Almost every pet owner, including those of horses, is inclined to take one last look at their animal before departing (Butler and Lagoni 2006). Therefore, it is important to convey reverence at all times before, during, and after death, including during transport.

4.1.2.2 Deceased Horse Body Care

Some people would rather not cope with the details of body disposal after euthanasia. Many veterinary clinics or hospitals will offer euthanasia with aftercare of the body if the horse is transported to the clinic. The client may have input into disposal or may let the veterinary clinic handle all of the details. This certainly makes the process easier for the horse owner. There may be some additional costs associated with this service but may actually be more cost-effective in areas without ready access to companies that will dispose of the body.

4.1.2.2.1 Burial Deceased horse body care is best talked about early during euthanasia preparations and planning. As a species-specific consideration, it is one of the most important. Most horse owners will not have an appropriate site to bury their animal. Even if they do, burial may or may not be strictly regulated by local laws. Proximity to water sources or underground utilities must be determined before digging. If the horse was euthanized with barbiturates, special care must be exercised due to long persistence of the drug in the environment and the potential for contamination of groundwater (Kollias et al. 2023). Local authorities should be consulted first to ensure that burial complies with all applicable laws and regulations.

These are some common horse burial guidelines often recommended throughout the United States:

- Maintain a 150-ft separation from wells and waterways.
- Maintain a 150-ft down gradient from groundwater supply and a 5-ft separation above the groundwater table.
- Avoid tree roots and buried utilities.
- Bury the body with a minimum of a 3-ft soil cover. This minimizes the likelihood of scavengers or pet dogs digging to get access to the body.
- Do not bury in a low-lying area, gully, or ditch that is prone to flooding which could expose the carcass.
- Ensure permission to bury on the land.

When euthanizing a horse that is to be buried, it is expedient to have the horse as close to the burial site as possible but does add more potential danger/risk to the procedure. If the horse bolts or falls unexpectedly, the veterinarian may be pushed into the hole. It is even possible the horse could fall into the hole on top of that person. If the horse does fall directly into the hole, the attending veterinarian will have to climb in to verify death.

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Pet cemeteries may accept horses for burial, especially in rural areas. Some may even allow the horse to be transported to their property before being euthanized. Veterinarians can perform the euthanasia procedure somewhere safe on the cemetery property, which allows for easy movement of the deceased horse to the grave site. This is a significant convenience for the horse owner.

There is a cohort of horse owners who want to dispose of the body more in accordance with nature. They may elect to leave the body in an area where it can give back to the earth, i.e. scavengers can utilize it. Veterinarians may make suggestions but do not survey the area nor hold power of regulation over such decisions. Insects and scavengers will be drawn to the carcass; therefore, extra caution should be taken. It is generally illegal to use state or federal public lands for body disposal. Horses used on pack or hunting trips that die on federal lands where grizzly bears exist can lead to problematic human-bear interactions. The US Forest Service has used explosives to disperse the carcass, making it less of an attraction for the large bears (Roza 2022). Western ranches consisting of large areas of open prairie are the most appropriate places for natural disposition of a horse carcass. The horse must be euthanized using a method that prevents the ingestion of toxic agents by scavengers. Gunshot, intravenous (IV) potassium chloride or magnesium sulfate, and intrathecal (ITh) lidocaine are appropriate methods which leave minimal toxicity in the carcass. Barbiturate (e.g. pentobarbital) euthanasia is not acceptable when leaving the horse's body for scavengers or in areas where water runoff is expected. For more on pentobarbital risks in the environment, see Chapter 7.

4.1.2.2.2 Cremation and Alkaline Hydrolysis Crematoriums are available for horses in some communities. A few of these facilities can cremate the horse intact but many will need to dismember the body to include all of it in a furnace retort. Placing an entire body within the machine is likely preferred by horse owners wishing to avoid dismemberment. Some crematoriums are beginning to offer a chemical cremation known as alkaline hydrolysis (AH). AH machines designed for livestock are large and can accommodate whole bodies. AH is touted as more environmentally friendly and is gaining popularity in both urban and rural areas (Arnold et al. 2024). Whether a horse owner chooses traditional flame cremation or AH, they will have the option to receive ashes back or have them disposed of in accordance with the facility's policy.

4.1.2.2.3 Landfill, Composting, and Rendering Other possibilities must be considered if burial or cremation is not an option. Many landfills will accept horses for burial. These landfill operations maintain a special location which is designed to control leaching of barbiturates out into the environment. Other landfills that do not have this capacity may refuse to accept horse carcasses euthanized with barbiturates. Barbiturates have been shown to persist even when a carcass is composted to the point of complete breakdown of bones (Payne 2015). However, some data now shows that composting can be more effective than previously thought at reducing the amount of lingering barbiturate in soil (Lochner et al. 2022). Barbiturate residue has also been discovered in pet food despite complete processing of the food (Beynen 2018). This has contributed to rendering facilities refusing to take carcasses euthanized using barbiturates.

All of this planning is often for naught when an emergency situation arises. A young, healthy horse with untreatable colic or a life-ending orthopedic injury forces owners to make the choices previously discussed without the opportunity to plan. Veterinarians are in a position to help with the management of the post-euthanasia details. A simple means of supporting the client is to maintain a list of contact information for body recovery services and facilities in the area that can dispose of the body.

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4.2 Equipment and Handling

4.2.1 Safety First

In contrast to smaller companion animals, the actual process of euthanizing a horse, donkey, or mule is a potentially challenging and dangerous procedure. Many owners think of their horse as a gentle companion that would never harm them. The size of the animal and the reality that horses are flight animals require a completely different approach than with a dog or cow. If the horse is injured or suffering a painful disease, they become more unpredictable. The top two priorities for horse euthanasia will be safety for nearby people and for the humane treatment of the patient.

The entire euthanasia procedure may occur in a pen or even an open field. We cannot ask a horse to lie down quietly like a small animal, and we cannot restrain most horses with a physical squeeze chute as we would do with other hoofstock. In a hospital setting, there may be stocks to hold the horse for sedation and a padded room in which lateral recumbency is achieved. Regardless of the location, in most situations, the horse will transition from a standing position to lateral recumbency quite rapidly. This great variety of facilities and situations will influence which method of euthanasia is chosen.

Onlooker and owner emotions can sometimes complicate how the euthanasia procedure is completed and may put everyone involved at risk of injury. Owners often feel an emotional need to hold the horse during the procedure. It is best to first talk through the procedure and establish guidelines for everyone involved before euthanasia is attempted. Owners, trainers, and onlookers should then be placed at least 20 ft away from the horse. They may approach again only after the horse has been pronounced deceased, or when the veterinarian deems it safe. If a trainer is employed to restrain the horse, they must be physically able to move away quickly if the need arises. It is optimum to have a trained veterinary technician to assist with the horse if possible. Emergency situations may not allow time for these discussions to be held in detail, but control of nonessential personnel remains essential for safety (Figure 4.2).



Figure 4.2 Veterinarian and owner kneeling nearby once the horse is down following pentobarbital administration. Note how they are away from the legs. *Source:* CAETA (2025).

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In some cases, especially when using a firearm, the procedure may be performed without any assistance to minimize risk to those involved. Restraints such as stocks may be used to sedate the horse but are rarely used for actual euthanasia due to difficulties extricating the body afterward. Any confined space including stalls or horse trailers increases the risk for the people involved because avenues for escape are limited. It is important to emphasize to everyone involved that the horse's response to the drugs may be unpredictable. The administration of pentobarbital for euthanasia, or anesthesia drugs for inducing pre-euthanasia unconsciousness, should optimally cause the horse to sink quietly to the ground. However, these drugs may also result in the horse falling over backward or lunging forward, putting even an experienced horse handler at risk.

Distractions for the horse and involved personnel often translate into safety issues. The patient needs to be moved away from other animals if possible. It is worth remembering that having the horse isolated from other horses may trigger a fear response. A quiet companion horse may be used to calm the patient until sedation can be administered. The companion can usually be moved away once the patient is adequately tranquilized. This increases safety as the companion horse may react unexpectedly when the patient collapses to the ground.

4.2.2 Public Events and High-Profile Emergency Situations

Public events such as horse shows or rodeos, or horses requiring euthanasia in public settings such as equine boarding stables, add several complications. Often people want to help the poor horse, and while this is a noble offer, it is misguided. Too many people in the area increase the risk of someone getting hurt. An equine public event should have a team designated to respond to an emergency euthanasia situation.

Ideally, the horse is moved out of the public view as humanely as possible. Heavy sedation or general anesthesia may be used to expedite safe removal away from the public eye. A mechanism to remove the animal after euthanasia is also essential. Explanations to the public without using too much detail will help them understand that the procedures they are witnessing may be discomfiting but are necessary to minimize suffering for the horse.

Emergency situations such as an automobile crash involving a trailered horse are understandably unpleasant. It is almost always a public situation with the potential of onlookers. Emotions may be extremely high. The responding veterinarian must work with the law enforcement personnel to advocate for the injured animals, as many of these officers have minimal experience with large animals (Figure 4.3). Most law enforcement personnel will be unwilling to use their firearm to euthanize an injured animal, and in the United States, are never allowed to relinquish control of their firearm for the veterinarian to use. They also may be reluctant to allow the veterinarian to utilize their own firearm due to public safety concerns. In a perfect world, the responding veterinarian has adequate volumes of drugs for euthanasia when multiple horses are involved. However, this may not be the case, and more than one method of euthanasia may be required. A second veterinarian familiar with horses called in to help can improve the situation and lead to better outcomes.

4.2.3 Working with Untrained Horses

Euthanizing a severely injured and/or untrained horse presents a significant challenge. First, it must be determined if there is a humane method of moving the horse to a facility that will confine the horse and facilitate some means of safely approaching it. Restraint mechanisms such as a

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Figure 4.3 Potential for challenging euthanasia in a confined and public space. *Source:* Double D Trailers / https://www.doubledtrailers.com/managing-a-horse-trailer-accident/ (last access on April 18 2025).

rodeo bucking chute may be employed if available. Squeeze chutes designed for cattle are not recommended except in extreme cases. Horses often panic and injure themselves further with this type of physical restraint. The traditional method of restraining untrained horses was by use of ropes. This requires multiple people and sometimes other horses that are trained to hold the rope tight. People with this skill set are becoming much less common in the equine world today.

The goal of restraints may not be to perform euthanasia, but instead to give an intramuscular (IM) or IV injection of sedation drugs. The horse can then be removed into a holding pen for euthanasia by whichever method is available. It is extremely dangerous to reach through the bars of a stall or rodeo chute to administer an injection. A dart gun or pole syringe would be advantageous but are seldom available to the field practitioner (Figure 4.4). Detomidine, xylazine, acepromazine, and ketamine (in combination with these) all are effective drugs when given IM. Dosing will likely far exceed label recommendations if the horse is extremely agitated. Drug dosing of the pharmaceutical preparation is of lesser concern since the goal remains the euthanasia of the patient.

4.3 Pre-Euthanasia Sedation and Anesthesia

Modern euthanasia in companion animal species is leaning more and more toward providing pre-euthanasia sedation or complete anesthesia before attempting the euthanasia method itself (AVMA 2020; Robertson 2020). The goal is to relax the patient, often to the point of unconsciousness, to increase the odds of successful euthanasia with minimal to no pain or distress. This holds true for various species including horses and should be considered in many situations. It should also be noted that the depressant effect of sedation on blood flow may slow pentobarbital and other euthanasia drug uptake to the brain. This may lengthen the time to loss of consciousness resulting in a less smooth transition from standing to recumbency and death (AVMA 2020) (Figure 4.5).

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Figure 4.4 Pole syringe injection through a stall door for added safety with an untrained horse. *Source:* CAETA (2025).



Figure 4.5 Horse receiving an IM injection of sedatives to aid in relaxation. IV injections work faster and are more reliable.

Horses that are anxious or dislike needles can be sedated first using oral drugs or by using small needles for sedative injections before introducing the large bore needle required for euthanasia solution administration. Oral administration of detomidine or acepromazine can be helpful for horses who are needle-averse. Oral detomidine gel is available in the United States, but the injectable solution is also absorbed quickly through the oral mucosa, proving effective at relaxing the patient.

The α2-agonist group of sedatives are most commonly employed. These include xylazine, medetomidine, dexmedetomidine, detomidine, and romifidine. Xylazine is sought after because

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Table 4.1 Sedation and anesthesia drugs for horses, donkeys, and mules.

Drug or drug combination	Dosage and route	Comments
Xylazine plus butorphanol	0.4–1.1 mg/kg xylazine IV 0.002–0.01 mg/kg butorphanol IV	Combine in the same syringe
Acepromazine	0.5–5 mg/kg IM or IV	Use to calm an anxious horse 10 minutes before IV sedation
Detomidine	20–40 mcg/kg IV	More profound sedation than xylazine
Detomidine plus butorphanol	20–40 mcg/kg detomidine IV 0.002–0.01 mg/kg butorphanol IV	Combine in the same syringe More profound sedation
Ketamine	100 mg IM	Administer a few minutes after other listed combinations if needed to improve standing sedation
Xylazine plus diazepam	0.4–1.1 mg/kg xylazine IV 0.04 mg/kg diazepam IV	May be combined in the same syringe

it is inexpensive and provides adequate sedation for most equids. The dose ranges from 0.4 mg/kg to 1.1 mg/kg IV. In many cases, a dose in the lower end of the spectrum will produce adequate sedation without the ataxia often seen with the higher doses. Dexmedetomidine and detomidine are much more profound sedatives but cost significantly more. Label dosage for detomidine is 20 or 40 mcg/kg IV. Like with xylazine, the higher doses may produce ataxia. These drugs may be given IM at the upper dose if IV administration is impossible. Sedation is more variable, and the onset of sedation is delayed with IM administration. Other less commonly used sedatives such as romifidine and the tranquilizer acepromazine may be used at labeled dosages. Sedation in donkeys and mules is often not as effective as in horses, so larger doses may be required (Table 4.1).

Ketamine is an anesthetic drug used to induce complete unconsciousness. It is commonly given after the horse is first sedated into a 5-point stance (head held low to the ground). The administration of IM ketamine alone results in a long, rough transition to unconsciousness and is not advised. IM ketamine can augment standing sedation when 1 ml is used. IV administration of 1 mg/kg ketamine after standing sedation will force the horse to lie down as it becomes unconscious. This will be required for non-pentobarbital euthanasia techniques such as IV administration of KCl or magnesium sulfate or ITh lidocaine injection.

4.4 Euthanasia Techniques

4.4.1 Non-inhalant Pharmaceutical Agents – Pentobarbital, Magnesium Sulfate, Potassium Chloride, Lidocaine

4.4.1.1 Pentobarbital Sodium

The overdose of barbiturates has been the mainstay to facilitate equine euthanasia for many decades. These drugs historically have been relatively inexpensive and readily available. Barbiturate drugs like pentobarbital sodium induce anesthesia before death so are deemed to be a humane method of euthanasia (Aleman et al. 2015a). The technical requirements for IV barbiturate anesthesia are straightforward. Some veterinarians choose to use an IV catheter to ensure the drug is administered into the bloodstream. Many veterinarians, including this author, prefer a 14-gauge

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needle directly attached to the syringe rather than using an IV catheter and extension set. This facilitates easy administration of the barbiturate solution which is often viscous and difficult to inject through narrow tubing or a smaller bore catheter. The lethal dose of pentobarbital in the United States is 85 mg/kg (other countries may have other dosing standards). This can require a large volume of drug (often 60–120 mL) for the average horse. So, veterinarians will need to change syringes in the middle of the procedure. A second (and possibly third) syringe full of barbiturates should be readily available. If the veterinarian does not have a means to hold the extra syringes, an experienced assistant may hand them to the veterinarian when needed (Figures 4.6 and 4.7).

The barbiturate has to be administered at a rapid rate. When the first syringe is empty, it must be disconnected from the needle or catheter and quickly replaced with the second syringe. If the solution is administered too slowly, the horse may stumble and appear anxious before becoming recumbent. Horses may have unpredictable reactions to barbiturate-induced euthanasia. Some horses will drop before the first syringe full of barbiturates is completely administered. Others will remain standing for several seconds after the full dose has been administered. Many horses will



Figure 4.6 Pentobarbital injection in a horse using direct venipuncture into the jugular vein.



Figure 4.7 Pentobarbital injection in a horse using a short extension set from a catheter in the jugular vein.

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take a deep breath, then lose consciousness and fall. Some may stand for much longer than expected. Others may flip over backward or fall in various and unexpected directions. If the horse has not become recumbent within a minute of completing the first barbiturate injection, more drugs should be administered. Fifty to one hundred percent of the first dose is usually an effective second dose.

Many veterinarians and assistants will be tempted to try to influence the way the horse falls to make it more esthetically acceptable to the owner. This can be difficult or impossible and is potentially dangerous to the handler. Applying tension on the halter rope as the horse falls may or may not be effective in preventing the head from striking the ground. Understanding the horse's behavior and one's personal physical limitations hopefully prevents accidents as the horse transitions from standing to recumbency (Figure 4.8).

The horse must be monitored for several minutes after it is recumbent. Respiration ceases immediately after administration of the barbiturate, but a pulse may be detected for several minutes. Brain death occurs within 73–261 seconds of the infusion (Aleman et al. 2015a).

Additional doses of barbiturates may be needed in the recumbent animal if cardiac and respiratory functions continue. This author has seen animals with compromised circulatory systems that have required up to three times the expected dose of barbiturate to be effective. There are many sad stories of veterinarians who euthanized a horse with an inadequate dose of barbiturate and the horse "returned to life" several hours later. The patient's death must be verified by ensuring a loss of corneal reflex, absence of respiration, and a loss of cardiac activity until all signs of life are absent. A small amount of blood will often leak from the injection site once the needle or catheter is removed. An owner may interpret this as a sign of cardiac activity. Explaining what is normal and abnormal to the owner will make the process more bearable as they process their feelings around death (Figure 4.9).

Even in the most extreme circumstances, a veterinarian should never run out of a barbiturate euthanasia solution. In case they do, however, a backup method to complete euthanasia should



Figure 4.8 Injecting pentobarbital euthanasia solution in a blind horse. *Source:* CAETA (2025).

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Figure 4.9 A confirmed dead horse after pentobarbital euthanasia. Note eyes open and pupils dilated.

always be available. Adjunctive methods like ITh lidocaine or IV or intracardiac (IC) KCl administration would be appropriate if the horse is already unconscious. A physical euthanasia method such as exsanguination or gunshot would be ethically acceptable following barbiturate-induced anesthesia but would certainly require an explanation for observers as to why the additional technique was necessary.

Several disadvantages of barbiturate euthanasia have been recognized. First, the drugs are not as readily available as they were previously. Also, barbiturates are controlled drugs all around the world, and in the United States, require special licensure granted to the veterinarian by the Drug Enforcement Administration (DEA) to purchase and possess. Controlled euthanasia drugs must be kept in locked storage in the hospital or the ambulatory vehicle.

4.4.1.2 Magnesium Sulfate ($MgSO_4$)

A less common means of equine euthanasia is the administration of a large volume of a saturated solution of $MgSO_4$ (Epsom salt). This is cardiotoxic and would only be humane if it was used in a horse already under general anesthesia. The technique for IV administration is routine using a large bore needle or catheter with IV infusion set, which can allow large volumes to be administered in a short time. The dose range is 750–1000 mg/kg, which is a large volume, and 1–2 L of saturated $MgSO_4$ solution is often required (Cooney and Titcombe 2022). The product can be purchased as a medical grade solution or at the local drugstore as Epsom salts, which is inexpensive. This is considered an adjunctive method in the 2020 American Veterinary Medical Association (AVMA) Guidelines for the Euthanasia of Animals document, hereafter referred to as the 2020 AVMA Euthanasia Guidelines in this chapter.

4.4.1.3 Potassium Chloride (KCl)

A saturated solution of KCl may be administered by either IV or IC routes for euthanasia of horses. It is cardiotoxic but does not affect function of the brain. So, it must be administered to a horse while under general anesthesia. The dose reported to be most effective is 75–150 mg/kg. Euthanasia can be performed using a super-saturated lite salt solution in water and rapidly administering intravenously until cardiac arrest is attained (Turner 2018). Like $MgSO_4$, this is also an inexpensive product and is considered an adjunctive method in the 2020 AVMA Euthanasia Guidelines.

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4.4.1.4 Intrathecal Lidocaine

In more recent years, the ITh administration of local anesthetics to horses under general anesthesia has been used to effect euthanasia. This procedure was first reported in the veterinary literature more than a decade ago (Zolhavarieh et al. 2011) and has become more widespread as an alternative to avoid barbiturate environmental contamination. Lidocaine hydrochloride at a dose of 4 mg/kg has been used most commonly, but mepivacaine (4 mg/kg) has also been shown to be effective (Alexander et al. 2023). These products are inexpensive, especially lidocaine, are widely available around the world, and are not treated as controlled substances.

ITh lidocaine euthanasia requires general anesthesia. A combination of xylazine (0.5 mg/kg) and ketamine (1 mg/kg) is suggested to induce unconsciousness (AVMA 2020). If the horse requires more control, midazolam hydrochloride (0.05 mg/kg) may be added or xylazine replaced with detomidine hydrochloride (0.02 mg/kg). The goal is to ensure the horse is lying on the ground, unconscious and completely unaware of the procedure.

When the horse is in lateral recumbency, the neck is flexed to open the atlanto-occipital (AO) space. A 6-in. 18-gauge spinal needle is inserted parallel to the cranial edge of the atlas on midline. The needle is directed toward the lower jaw and advanced until the dura is penetrated (Turner, 2018). In some breeds, such as Norwegian Fiord horses, the exceptionally heavy mane makes this approach difficult, even when the mane is clipped. This author has been successful in approaching this technique just lateral to the mane. Approximately, 60 mL of cerebrospinal fluid (CSF) is removed and immediately replaced with around 60 mL of 2% lidocaine, making sure to achieve at least the lethal 4 mg/kg dose. The Aleman study found visual signs of respiration were no longer observed 2 minutes after lidocaine infusion. The mean time to a flat electroencephalogram (EEG) was approximately 145 seconds. Heart sounds still persisted for up to 10 minutes. These measurements are slightly longer than those observed when barbiturate overdose is used for euthanasia (Aleman et al. 2015b, p.1676) (Figures 4.10–4.12).



Figure 4.10 Spinal needle being inserted into the AO space in an anesthetized horse. The needle may be open or have a stylet inside to reduce a tissue plug. *Source:* Howard Ketover, DVM.

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Figure 4.11 ITh method with a spinal needle in position. The veterinarian has a gloved finger under the opening to better visualize drips of CSF and confirm proper placement. *Source:* Bruce Connally, DVM, MS.



Figure 4.12 ITh injection showing ideal angle. Note how the veterinarian has a box of supplies at the ready. *Source:* Howard Ketover, DVM.

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The levels of drug residue in the carcass would appear to be too low to present any danger to scavengers (Aleman et al. 2016). Horses euthanized by ITh lidocaine could safely go to the renderer or could be left for natural scavengers to dispose of. There is also no chance of a buried carcass contaminating a water source with dangerous chemicals. The primary disadvantage of ITh lidocaine euthanasia is the increased level of technical expertise required to perform the procedure. This technique also requires more time to perform than gunshot or barbiturate euthanasia. These factors may make ITh lidocaine euthanasia less esthetically acceptable to some clients. An additional concern is the potential for exposure to diseases such as rabies or eastern equine encephalitis from contact with spinal fluid. This technique is considered an adjunctive method in the 2020 AVMA Euthanasia Guidelines.

4.4.2 Physical Methods of Euthanasia – Gunshot, Captive Bolt, and Exsanguination

4.4.2.1 Gunshot

Gunshot is a traditional method of euthanasia of horses, donkeys, and mules. It has been used by horse owners for hundreds of years as a reliable way to destroy brain tissue, leading to irreversible death. Gunshot is a very inexpensive and a readily available means of euthanasia for those with regular access to a firearm. If it is performed correctly, a gunshot disrupts brain function instantly and is considered to be a humane euthanasia method (AVMA 2020).

Unlike barbiturate euthanasia, gunshot does not result in a carcass that is toxic to scavengers or the environment. There is a small amount of lead from the bullet that remains in the carcass and may pose a risk to scavenging birds. Lead-free bullets may be available in a few calibers. These bullets are more expensive and less available than lead bullets. An important disadvantage of the gunshot technique is the potential safety concern for onlookers. Veterinarians will also need to use caution when using a firearm for horse euthanasia in certain communities, e.g. suburban neighborhoods where the discharge of a firearm is illegal. Appropriate training in firearm safety and use is critical before euthanasia by gunshot is attempted. The firearm must be stored safely and legally in the ambulatory vehicle.

It is beyond the scope of this book to discuss the multitude of calibers and thousands of varieties of ammunition available. However, common sense would suggest that using a less powerful caliber such as the .380 automatic pistol would increase the likelihood of failure. Even a larger caliber gun may fail if inappropriate ammunition is chosen. This author has seen a .45 ACP fail to be effective for equine euthanasia even with proper target placement because low-powered target practice ammunition was used.

Guns and ammunition that have been developed for hunting would seem to be a good choice. Solid point bullets will have deeper penetration into the brain and brainstem, but hollow point bullets are designed to cause much more tissue disruption. Solid point bullets might be more appropriate for animals with heavy skulls such as draft mules. Guns designed to shoot many times in a short period of time such as assault-style rifles are inappropriate. The goal of humane euthanasia is to use a single round placed appropriately. This author uses a .22 caliber pistol with long rifle ammunition for most equine euthanasias. If the horse or mule is very large, such as a draft breed, a .41 magnum pistol is chosen by this author. The larger, more powerful weapon assures adequate penetration into the thicker skull. A rifle or shotgun may be effective, but these long guns are more difficult to use at close range and are much more difficult to transport/store in the ambulatory practice vehicle. Very high-powered rifles or shotguns will often produce large, unsightly exit wounds and extensive bleeding. Appropriate firearms training is required to choose a firearm that is effective and to train the person with safe operation of the gun.

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Figure 4.13 Gunshot image showing proper placement of the gun so the bullet trajectory is in line with the neck. The exact angle of the gun's muzzle is relative to the neck so the bullet does not exit the body. *Source:* Bruce Connally, DVM, MS.

Bullet placement in the brain is as important as the choice of a gun. Even a very large caliber firearm with powerful ammunition will fail if used inappropriately. It is imperative that the bullet remains in the body and does not exit into the surroundings. This increases safety for people and other animals in the area. It also results in a more cosmetic procedure as exit wounds are much larger and hemorrhage significantly more than bullet entrance wounds.

Attention to a few key details can dramatically increase the safety and efficacy of this technique. This author chooses to use a mild sedation before gunshot due to the advantages it provides. First, sedation helps owners and onlookers feel reassured that the horse is relaxed with minimal stress. Second, the horse is less likely to move during the procedure. This can make it much easier for the veterinarian to hold the lead rope in one hand and the pistol in the other, thus eliminating the need for an animal handler in a potentially dangerous position. A sedated, sleepy horse should reduce the need to tie it to a stationary object to prevent movement away from the veterinarian. Access to the forehead of a tied horse is often much more difficult. Stationary objects such as hitch rail may also impair one's ability to move safely away when the horse goes down.

Positioning the gun correctly above the forehead of the horse is critical (Figure 4.13). The barrel should not touch the horse as it may trigger the horse to move when the gun is fired, potentially affecting the bullet penetration point. The barrel of the pistol should be approximately 1–2 in. from the forehead. When the animal is facing the shooter, the target is the intersection of lines drawn from the base of the ear to the center of the eye on the opposite side (Figure 4.14). This target can also be visualized at the external sagittal crest of the head where the two temporalis muscles form an inverted V (Lund et al. 2021). Another very important point is to allow time for the horse to lower its head. If the shot is taken with the head elevated, the barrel of the gun will be level or pointed up. This may result in the bullet deflecting over the brain and exiting the back of the skull (Figure 4.15). The barrel of the gun must be aligned with the horse's neck, as shown in Figure 4.13, to maximize the likelihood of the bullet remaining in the neck. Mild sedation can help bring the head down. This author's preferred dose for the average, non-agitated horse is 150 mg xylazine given IV. Higher doses may be needed for some horses. This dose should calm the horse but prevent ataxia. Excessive sedation brings the head down near the ground making proper bullet placement more difficult. If the head is too low, the tendency is to point the gun downward, resulting in the bullet potentially exiting the ventral aspect of the neck. This may disrupt the carotid artery and jugular vein resulting in profound external bleeding (Figure 4.16).

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Figure 4.14 Lines drawn on the forehead to show the bullet entry point. *Source:* Bruce Connally, DVM, MS.



Figure 4.15 Improper gun angle placement in the horse gunshot method. This angle will cause the bullet to leave the back of the head, causing more damage from the exit wound and increasing danger to nearby people and structures. *Source:* Bruce Connally, DVM, MS.

With correct placement, the bullet will travel through the brain and brain stem causing immediate loss of consciousness and death. The bullet will remain in the neck, decreasing risk to other animals or humans in the area. If sedation is not utilized, the horse will usually raise their head as the veterinarian raises the gun. With patience, almost all horses will bring their heads down in a few seconds allowing for proper alignment of the gun with the head and neck.

Summary of the Ideal Gunshot Technique in the Horse

- Administer mild sedation
- Hold the horse's lead in hand (do not tie)

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Figure 4.16 This angle will cause the bullet to exit the skull through the throat area. The bullet may pass below the brain and disrupt the arteries in the neck resulting in excessive bleeding. *Source:* Bruce Connally, DVM, MS.

- Use adequate caliber of firearm with correct bullet type
- Avoid touching the gun to the forehead of the horse unless already unconscious
- Place the shot to ensure penetration of the brain and brain stem
- Keep the bullet in the body
- Go slow and be patient
- Repeat the shot immediately if the first one fails

A properly executed gunshot will cause the horse to drop straight to the ground. Those in the area should be prepared for this. If the bullet does not penetrate the brain stem correctly, the horse may stagger but remain standing. Another shot should be immediately taken. Occasionally, the horse will go down and lose consciousness but will continue erratic breathing. This may happen because the horse moved slightly before the shot was taken, or the bullet deflected off bone and did not disrupt the respiratory center. In this situation, a second shot may be taken or another method used such as rapid administration of KCl or $MgSO_4$. If ITh lidocaine is administered, the spinal fluid obtained will be blood-tinged. It is often not necessary to remove spinal fluid in this case as it has already been lost due to disruption by the bullet. This author has done this for a horse who continued to breathe after gunshot. It was not possible to withdraw more than just a few mL of spinal fluid which was indeed blood-tinged. Administering the lidocaine stopped the breathing.

A disadvantage of euthanasia with a firearm is the startling sound of the gunshot. This is an important consideration for people who are unfamiliar with guns or suffer from PTSD related to gun violence. It can also startle other horses in the immediate area. The esthetics of gunshot euthanasia may be another drawback. Horses that have been euthanized with gunshot to the brain will often bleed from the nose or occasionally from the ears. The amount of blood may range from a few milliliters to as much as a liter. This is unsightly and increases the effort required to clean up the area after the body is removed. A larger caliber gun will often result in more bleeding. Bullet placement slightly below the confluence of lines drawn from each ear to the opposite eye will also increase amount of bleeding, as well as when the body has an exit wound.

4.4.2.2 Penetrating Captive Bolt

Euthanasia with the penetrating captive bolt has many commonalities with gunshot. The main difference is the reduced danger to nearby people and animals. The captive bolt gun is powered by

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either gunpowder or compressed air, which propels the bolt approximately 3 in. through the skull and into the brain. The instrument is placed against the forehead of the horse using the imaginary "X" as described in the technique for gunshot euthanasia (Figure 4.14). Sedation may be helpful. The captive bolt gun must be held perpendicular to the skull and, unlike a firearm, should touch the forehead for maximum penetration of the bolt (Figure 4.17). If the bolt gun is held at an angle to the skull, the bolt may glance off the bone and fail to penetrate. This is painful, leaving the horse injured and attempting to escape.

Similar to gunshot, there will be a loud report and the horse will drop abruptly. The operator of the captive bolt must be safely positioned and ready to move back to prevent being impacted by the falling horse. Bleeding from the nostrils is similar to euthanasia by firearm. It is possible the bolt will penetrate but not kill the horse. If the horse is already down, the procedure can be repeated, or another method of euthanasia may be employed.

Captive bolt guns should be cleaned and properly maintained at all times to prevent misfires (Gibson et al. 2014). If the gun misfires, another technique will have to be immediately performed. This is never ideal for the horse or client. Attention to maintenance before the procedure is mandatory.

4.4.2.3 Exsanguination

Exsanguination is reserved for unconscious horses and is considered inhumane in the conscious horse. It should only be utilized in an emergency situation when no other options are available. Death by exsanguination in a conscious horse causes great agitation and fear while the brain slowly dies from lack of blood supply. Even a horse in shock will respond to the pain from transecting blood vessels and demonstrate great distress. Exsanguination in unconscious horses is listed as an adjunctive method of euthanasia by the AVMA (2020).

Exsanguination can be either internal or external and is considered technically challenging for even a seasoned veterinarian. Internal exsanguination is usually accomplished by placing a sharp instrument into the rectum and transecting the terminal aorta. This allows the animal to bleed into

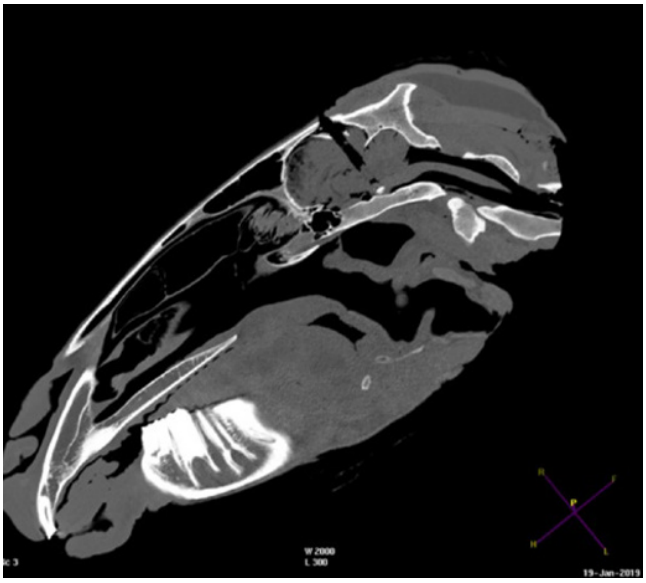


Figure 4.17 Penetrating captive bolt disruption path in a horse, shown in a CT scan. The brain stem is impacted due to proper placement. *Source:* Howard Ketover, DVM and Jane Renee Lund DVM, MS, MBA, DACVPM, and DACVR.

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the abdominal cavity, reducing the amount of blood outside of the body. Internal exsanguination cannot be carried out on an awake horse due to the severe pain it inflicts.

External exsanguination is usually accomplished by transaction of the jugular veins and the carotid arteries in the neck, similar to the technique used in livestock. It is performed using a large, very sharp knife. Scalpels are inadequate because the blade is too small and requires repeated cuts to be effective. The thick neck musculature and tissue also make it easy to break a scalpel blade. Transecting the jugular vein and carotid arteries in the neck requires significant force applied to the blade and potentially repeated cuts to achieve adequate depth. This method will produce copious amounts of blood and will be emotionally troubling for those performing the procedure and any bystanders. Veterinarians are encouraged to practice this technique on deceased animals before attempting it with a client present. External exsanguination in conscious horses is completely unacceptable.

4.5 Special Circumstances

4.5.1 Euthanasia of the Aggressive or Highly Fearful Horse

The behavior of the horse may have a huge influence on the method of euthanasia chosen. If the horse cannot be closely handled, such as in the case of an aggressive or frightened horse, a rifle can be used to place a bullet in the center of the forehead or at the base of the ear from a lateral viewpoint. This will effectively disrupt brain and brain stem, but the bullet may exit the other side of the head. Obviously, for safety reasons, this technique may only be used in limited circumstances. Shooting a horse in the neck or chest does not cause immediate loss of consciousness and is thus not acceptable (AVMA 2020).

This author has encountered a mustang whose previous interactions with people had resulted in extremely aggressive behavior. Whenever a person entered the corral with the horse, it would charge at them. Experienced trainers had evaluated the horse and determined that rehabilitation was unlikely, and that the horse presented a significant danger to people interacting with it. There was no possible means to handle the horse without ropes to catch and forcibly restrain it. Transport to a property with an equine restraint facility was also not possible. The most practical and humane method of euthanasia was a gunshot to the head as the horse approached.

4.5.2 Blunt Force Trauma

This technique is reserved for foals with smaller heads and softer bones. It is analogous to the captive bolt gun except with a sharp instrument like a miner's pick. The target is the same as with a gunshot; the confluence of an "X" is drawn from ear to opposite eye. This technique would only be appropriate in extreme situations on an adult horse. According to the 2020 AVMA Euthanasia Guidelines, this is only allowed for the horse under anesthesia.

4.5.3 Pithing

Pithing is the physical disruption of the brain stem and spinal cord. It is performed under general anesthesia. The pithing tool/rod is introduced through the AO space and manipulated to destroy the caudal brain stem and spinal cord (Turner 2018). The approach for this procedure is similar to the needle introduction for ITh administration of lidocaine described above. This technique would be easier to perform on foals or smaller horses.

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4.5.4 Helping Two or More Horses at the Same Time

There are times when multiple horses require euthanasia at the same time. Sedation of the second horse decreases their awareness of the procedures. The horse does not react and the owners can feel assured that the second horse is not fearful while observing the euthanasia. In this author's experience, a sedated horse will not react to another horse down on the ground or to the smell of blood.

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5

Livestock Euthanasia

Jan K. Shearer

5.1 Species-Specific Considerations

The Code of Federal Regulations considers the term "livestock" to include cattle, sheep, horses (discussed separately in Chapter 4), goats, and other domestic animals ordinarily raised or used on the farm. Turkeys and domesticated fowl are considered poultry and not livestock. People keep and raise livestock mainly for production purposes and/or companionship. Clients who want to raise and keep livestock may do so for small "hobby" farming rather than large-scale production. By caring for the animals, they learn about their unique behaviors and personalities and develop strong bonds of attachment best characterized as a pet relationship (Figure 5.1).

These more intimate connections make end-of-life (EOL) decisions naturally more difficult. Practitioners will be asked to euthanize companion livestock in a variety of settings including small farms, petting zoos, animal rescues, and sanctuaries. In most cases, the preferred location for conducting euthanasia is the farm of origin. In some cases, practitioners are equipped to handle animals presented for euthanasia in their clinic facilities. For animals that are nonambulatory, euthanasia must be conducted at the farm. Regardless of where the procedure is performed, practitioners need to be aware of carcass disposal options relative to burial, composting, or landfills based on local laws and ordinances.

Production livestock are raised in agricultural settings for the purpose of producing commodities such as food including milk and meat, and fiber, such as leather, wool, and mohair. Farms are businesses that must generate a profit, and like any enterprise that is not profitable, it will not last. Dairy farmers have dairy cows because they like dairy cows, but unless they are able to make enough milk to pay for the feed and a barn to house them, they won't be milking them very long. Therefore, the primary objectives in production settings are performance and profit. However, it's a love for the animals and a lifestyle that, no matter how meager, drives them forward.

Livestock producers understand from experience that disease can have catastrophic consequences ending in death or the need for euthanasia. As the saying goes, *"If you have livestock, you will have dead stock."* Ranchers see their cattle as individuals readily identifying their unique physical characteristics and personality traits (Irvine and Ellis 2010). They care about their animals and will do whatever is necessary to minimize their suffering in the face of illness or injury.

The key to preserving the welfare of livestock is the early detection of disease or injury, prompt treatment as necessary, and humane euthanasia for animals with serious or terminal diseases.

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Figure 5.1 Two boys presenting their livestock.

Options for an animal compromised by disease or injury include further treatment, slaughter, or euthanasia. The choice to euthanize an animal is based on:

- severity of pain and distress of the animal
- the likelihood that treatment will lead to a return to a healthy productive state
- disease or injury that results in a permanent nonambulatory state
- disease, injury, or disability that would make an animal unfit for transport
- disease or injury for which treatment is cost-prohibitive or where treatment would require an extraordinarily prolonged drug withdrawal time
- disease or treatment that would prohibit the slaughter of an animal for human use

Specific indications for euthanasia include the following:

- Fractured leg, where treatment is not considered a suitable option
- Severe trauma
- Progressive or nonresponsive infectious disease
- Inability to stand or walk
- Zoonotic disease with significant public health implications
- Unresponsive metabolic disease resulting in debilitation
- Progressive organ failure
- Persistent pain or discomfort that is not responsive to medical treatment

When a practitioner is presented with an animal in grave condition from injury or disease, further examination is needed to determine if additional treatment is warranted or if euthanasia may be necessary (Figure 5.2). If it is determined that euthanasia is best for the welfare of the animal, and the client agrees, the discussion turns to the method to be used. Some may be unfamiliar with methods of euthanasia acceptable in livestock. They may be uncomfortable with the use of a firearm and unfamiliar with captive bolts or be under the mistaken impression that these methods

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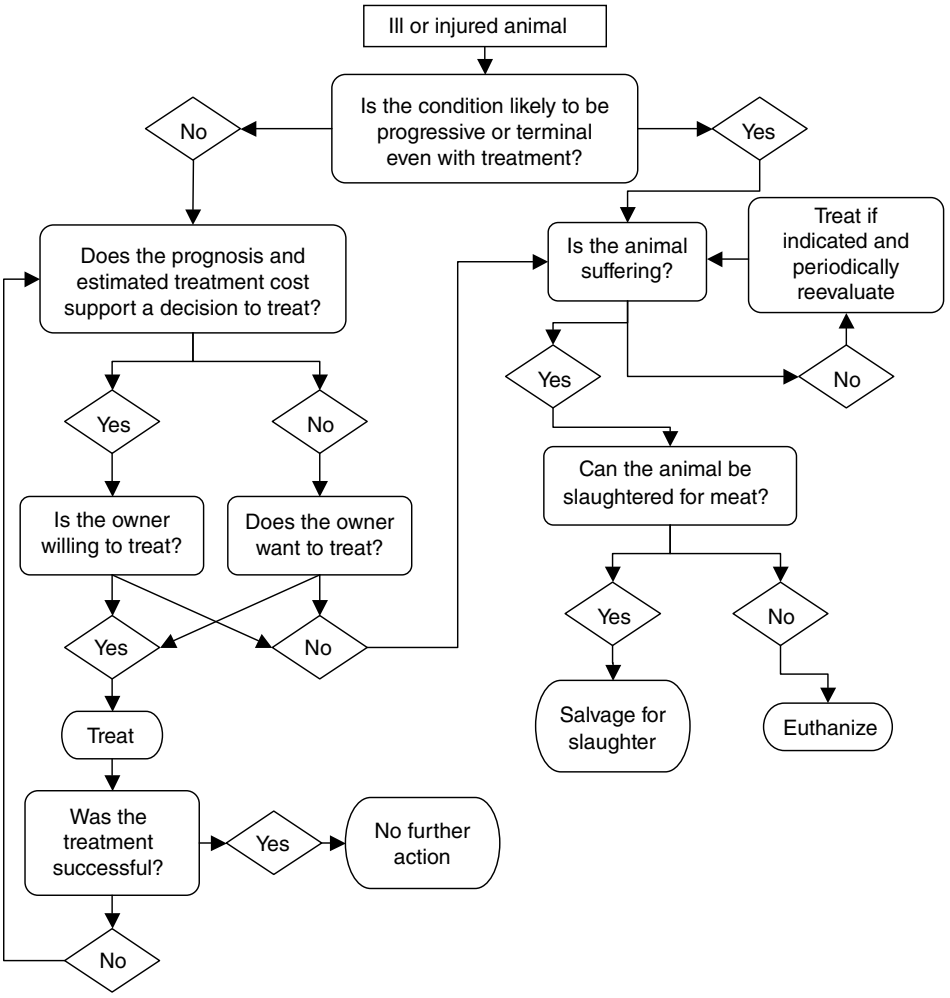


Figure 5.2 Determining factors for euthanasia of livestock. *Source:* Robert Callan, DVM.

are less humane than euthanasia by the intravenous (IV) administration of a barbiturate. This is a teaching opportunity for the practitioner; an opportunity to affirm perceptions that are accurate and correct those which are not.

5.1.1 Methods of Euthanasia

The methods of euthanasia acceptable for use in livestock are (1) the administration of a lethal drug overdose; (2) the use of a firearm; and (3) the use of penetrating or nonpenetrating captive bold with adjunctive methods to assure death. Each method has advantages and disadvantages and practitioners will have their preferred methods. Because specific conditions will differ, practitioners should be prepared to apply the euthanasia method that best fits the circumstances. One of the largest determining factors for method selection will be what happens with the carcass following death.

5.1.1.1 Euthanasia by Lethal Injection

Euthanasia by the IV administration of a lethal drug is common in livestock species, although some key considerations need to be made before proceeding (AVMA 2020). It's possible that a

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physical method may be the better choice. Large determining factors include drug cost and availability, the ability to handle the patients, and carcass disposal. The cost of euthanasia may be considerably more due to the price of drugs, particularly for larger livestock. There may also be additional costs associated with the placement of an IV indwelling catheter and the use of other technical aids. Some euthanasia drugs are registered as controlled substances (e.g. pentobarbital sodium), which may be harder to obtain and carry in large quantities. Livestock can also be difficult to handle at times making injections more challenging. However, perhaps the greatest complication encountered when euthanizing livestock using lethal injection is disposal of the carcass.

Carcasses that contain pentobarbital pose significant risks to wildlife and the environment (Wells et al. 2020). Regardless of the carcass disposal method chosen, rendering, burial, composting, or landfills, residues of pentobarbital will persist. See Chapter 7 for more information on carcass handling.

5.1.1.2 Physical Methods of Euthanasia

Euthanasia by gunshot and captive bolt are more common in livestock compared to smaller mammals and are highly effective, but they are aesthetically bothersome for some observers. This is particularly true for people unfamiliar with these methods, which includes clients of pet livestock, young people with 4H and FFA livestock projects, or in situations where these techniques are used on neonates and young stock. While this may be difficult to explain in terms that make sense to animal clients, practitioners have an obligation to be sure that people understand why the method is chosen.

For clients and others who choose to observe, it is important to share with them what observations they should expect to see and then describe the events as they occur in real-time. This will help reassure observers and instill confidence that the procedure is progressing as expected. A small to moderate amount of hemorrhage may be expected, and on occasion, brain matter may be extruded through the site of the bullet or captive bolt. Although unpleasant to see, the extrusion of brain tissue confirms a good shot.

To determine if the gunshot or captive bolt method was effective practitioners must know what constitutes unconsciousness. The physical observable parameters are: (1) an immediate collapse to the ground; (2) the body and muscles become rigid, with a gradual relaxation over a period of 15–20 seconds; (3) there is an immediate and sustained cessation of rhythmic breathing; (4) the animal makes no attempt to right itself or rise; (5) there is an absence of vocalization; and (6) there are no palpebral or corneal reflexes. These are important visual observations for practitioners because if these are not observed following the shot, it may indicate that the animal is regaining consciousness and should be shot again.

5.2 Equipment and Handling

Positioning and restraint of livestock are important for successful euthanasia procedures. For large livestock, one should also consider the animal's location at the time of euthanasia and how that relates to human safety and ease of removal or disposal of the carcass. For example, cattle should not be euthanized in a chute or narrow alleyway unless there is a way of opening the side to remove the carcass (Figure 5.3).

Good restraint is an important prerequisite for safe and efficient euthanasia of livestock. This may be accomplished with chemical restraint, physical restraint, or a combination of both. The guiding

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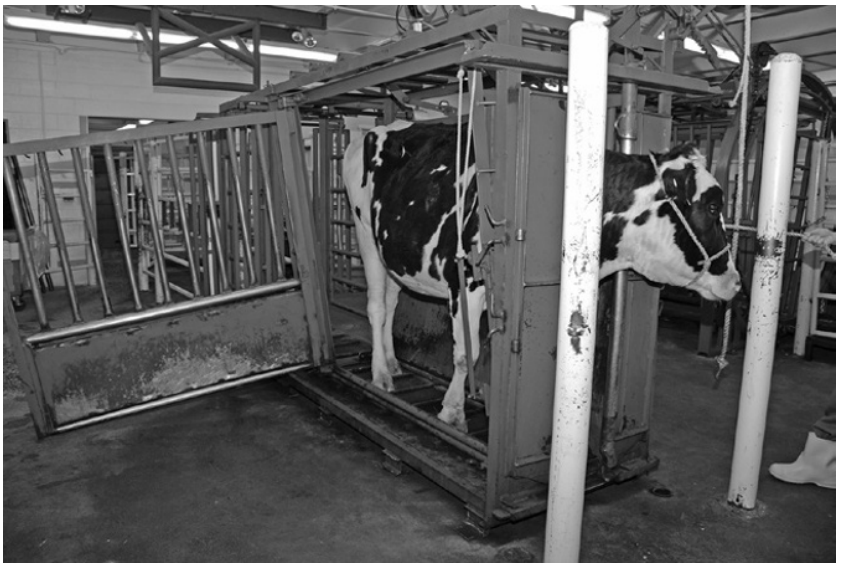


Figure 5.3 A chute with the side open prior to euthanasia. The head is restrained with a halter for safer euthanasia by IV injection, gunshot, or captive bolt stunning. The head is pulled slightly to the animal's left so that the animal will fall to the right side.

principle is to provide sufficient restraint to minimize stress, discomfort, or pain associated with the procedure. In practical terms, this implies sufficient restraint to either perform a competent venipuncture or sufficiently stabilize the head for an accurate gunshot or captive bolt stun.

Except for very docile or obtunded animals, some degree of physical restraint is likely to be necessary to stabilize an animal's head and neck. For manageable adult cattle and calves, a halter may be all that is needed. The halter can be secured to any convenient, sturdy object or, in some instances, held by an assistant. Sometimes, using two halters and cross-tying the animal will provide more restraint. In recumbent cattle, a single halter can be placed, pulling the head to the side and securing the lead around the rear leg and tied at the level of the stifle to provide stabilization of the head and neck. This will provide good restraint allowing for either lethal injection or euthanasia by physical method.

The mechanics of euthanasia for smaller ruminants and camelids is generally the same as in cattle except that the animals are smaller and more easily restrained without a chute. The goal is to position the animal so that the head and neck are accessible. For severely ill, obtunded, or recumbent animals, only minimal physical restraint may be necessary. Even in alert and active animals, gentle physical restraint is often sufficient. A halter can also be used. A head catch or chute is rarely needed to restrain a sheep or goat for euthanasia.

Euthanasia of swine can be more challenging than other livestock species due to the difficulty of proper restraint and positioning. In general, pigs do not accept physical restraint well. In severely debilitated or obtunded animals, this may not be an issue. While pig snares can be used, this often results in significant resistance and distress for the patient. Another alternative for smaller pigs is to suspend them in a sling. This may allow access to the cephalic vein for IV injection. However, because of the challenges with restraint and venipuncture, humane euthanasia performed by lethal injection may be best performed following heavy sedation or anesthesia to allow for a calm venipuncture or intracardiac (IC) injection. Otherwise, gunshot or captive bolt methods should be utilized.

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Sedation may be appropriate for all livestock species, particularly when simple physical restraint is not sufficient, or if the client specifically requests it. The primary reason for using sedation would be if the animal cannot be restrained sufficiently to allow for an effective euthanasia method. The practitioner will need to use their discretion and err on the side of caution.

5.2.1 Supply Needs for Lethal Injection

Even though many different species are considered livestock, most of the same supplies can be used among them. IV administration of drugs requires access to needles, syringes, catheters, extension lines, tape, and sometimes clippers to remove hair or fiber. A variety of syringe sizes are necessary to accommodate the size of animals, ranging from neonates to adults. As with all species, the bigger the animal, the bigger the syringe needed. Needle sizes range from 20 to 18 gauge × 1.5 in. for small ruminants or camelids, and up to 14 gauge × 2 in. for adult cattle. If an IV catheter must be placed, 18–16 gauge up to 3 in. is ideal for small ruminants or camelids. Larger livestock do well with 16–14 gauge × 3–5 in. catheters. Spinal needles or extra-long 6 in. needles may be needed for intrathecal (ITh) injections. Gloves should be on hand as well as ample amounts of the drugs themselves to ensure death is achieved. These will be described in greater detail in Section 5.4.

5.2.2 Firearm Selection

Considering the carcass disposal problems with lethal injection using pentobarbital, practitioners working with livestock must be able to euthanize animals using a firearm or penetrating captive bolts. For practitioners with ambulatory practices who plan to use a firearm for euthanasia, there are several things to consider. Some states require anyone traveling with a firearm to have a concealed carry permit. Assuming a practitioner carries a firearm on calls in their practice vehicle, is the firearm loaded or kept separately from the ammunition? Is the firearm secure at all times? Are the bullets or shotshells maintained in a moisture-proof container?

A .22-caliber rifle with a solid point bullet directed to the correct anatomic site will render most livestock immediately unconscious with a single shot. Soft or hollow point .22-caliber bullets may be used in calves, sheep, or goats and will reduce the risk of the bullet exiting the target. Soft or hollow point .22-caliber bullets may not penetrate the skull of adult cattle and are not recommended. A .22-caliber long rifle solid point (round nose) bullet is better suited for adult cattle and swine but may still lack the muzzle energy to penetrate some large cows, bulls, or boars.

A bullet's muzzle velocity and energy are greater when fired from a rifle compared to a handgun. The longer barrel of a rifle allows the propellant (gunpowder) to burn more completely, thus propelling the bullet through the barrel and maximizing its velocity as it leaves the muzzle. The shorter barrel of a handgun results in reduced muzzle velocity since some, if not much, of the pressure from the burning of propellants is dissipated into the air as the bullet exits the barrel. A .22 long rifle or .22 magnum cartridge is generally sufficient for cattle >24 months of age, but some practitioners still prefer higher caliber firearms. The problem with higher caliber firearms is that the higher muzzle velocity and energy risks perforation (bullet exits the skull) of the skull by the bullet. For the reasons of safety, a bullet that penetrates the target but does not exit is preferred.

For mature bulls and boars, a .357-caliber or larger firearm is recommended. Hollow or soft point bullets may be considered to minimize the risk of the projectile exiting the animal and possibly causing human injury or property damage. This is particularly a concern when using a large caliber firearm for small ruminants or calves. Shotguns ranging from 20 to 12 gauges are

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Table 5.1 Recommended firearm and cartridge for euthanasia of livestock.

Firearm	Animal type	Caliber	Bullet
Handgun or rifle	Calves, sheep, goats	.22 5.5 mm	Soft or hollow point
	Pigs <100 kg	.22 5.5 mm	Round nose
	Adult cattle (>24 months)	.22 magnum .357 9 mm	Round nose Soft or hollow point Soft or hollow point
	Horses	.357 9 mm	Soft or hollow point Soft or hollow point
	Adult bulls, pigs > 100 kg	.357 9 mm	Round nose Round nose
Shotgun	Calves, sheep, goats	20, 16, or 12 gauge	#4, 5, or 6 birdshot
	Pigs <100 kg	20, 16, or 12 gauge	#4, 5, or 6 birdshot
	Adult cattle	16 or 12 gauge	Slug or #4 or 5 birdshot
	Horses	16 or 12 gauge	Slug or #4 or 5 birdshot
	Adult bulls, pigs > 100 kg	12 gauge	Slug or #4 or 5 birdshot

Source: Adapted from Welfare aspects of animal stunning and killing methods (2004) *European Food Safety Authority* AHAW/04-027. Scientific report of the Scientific Panel for Animal Health and Welfare on a request from the commission related to welfare aspects of animal stunning and killing methods.

recommended for larger livestock such as bulls or boars. Recommended firearms and cartridges for the euthanasia of livestock are listed in Table 5.1.

5.2.3 Captive Bolt

Although restrictions or laws on carrying a captive bolt are unlikely to be as strict, the issues relative to protecting the captive bolt gun and charges from moisture are similar to firearms. The most common cause of captive bolt malfunction is the failure to clean the gun after each use. Powder residue quickly draws moisture when the gun is not regularly cleaned and stored in a moisture-free environment. The accumulation of powder residue and moisture leads to the development of rust, which, at worst, causes the pitting of the metal and malfunction of the captive bolt. Moisture also affects the powder charges used to drive the bolt; the result is soft shots (i.e. reduced bolt velocity).

Both penetrating and nonpenetrating captive bolt stunners are available for the euthanasia of livestock. The nonpenetrating captive bolt device has a mushroom head and stuns the animal solely by concussive force. In general, the nonpenetrating captive bolt stunner is not considered a reliable method for the field euthanasia of adult livestock. Along with concussive impact to the skull, when properly placed, penetrating captive bolt stunners cause irreversible physical trauma to the brain, including portions of the cerebrum, thalamus, midbrain, pons, cerebellum, and medulla oblongata. Penetration and physical trauma to these areas of the brain will cause irreversible loss of consciousness provided the appropriate areas are damaged. Captive bolt guns are a safer option for routine on-farm use. For this reason, the penetrating captive bolt stunner is generally preferred for veterinary euthanasia using physical methods.

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5.3 Pre-Euthanasia Sedation and Anesthesia

Pre-euthanasia sedation is typically used in livestock in order to aid in restraint and improve safety for the practitioner, client, and other bystanders. In some cases of pet livestock, the client may request sedation prior to euthanasia. In many cases, only mild sedation is needed to allow for successful venipuncture, catheter placement, or accurate gunshot or stunning. With more excitable animals, deep sedation may be required to ensure that the animal remains recumbent for the procedure in order to provide adequate restraint and safety.

Sedative drugs are relatively inexpensive and easy to obtain. Alpha-2 adrenergic receptor agonists like xylazine are probably the most common sedatives used for livestock. Xylazine provides potent sedation along with analgesia at very low doses in ruminants and camelids. Acepromazine can also be used but will not provide additional analgesia and will result in vasodilation and hypotension. Benzodiazepines such as diazepam or midazolam are also effective sedatives in ruminant and camelid species. Opioids such as morphine or butorphanol will also provide sedation and analgesia. Of all the livestock species, sedation of swine is probably the most unpredictable and may require high doses to obtain the desired effect. Combinations of sedatives are often used to provide more consistent and effective sedation and analgesia, particularly in pigs.

Anesthetic drugs vary in cost and are harder to obtain because many will be controlled substances. Pre-euthanasia anesthesia (unconsciousness) is necessary before performing certain euthanasia procedures like the IV administration of KCl or ITh lidocaine. Ketamine is the most common anesthetic used in livestock. The cardiovascular and respiratory depressant effects of sedatives or general anesthesia have the potential to prolong the duration of subsequent euthanasia when using the injection of pentobarbital-containing solutions. Clients who may be observing the procedure should be forewarned of this effect when using these drugs.

5.3.1 Cattle

In many instances, it may not be possible to safely restrain the animal simply with a halter or lariat or when an appropriate chute with a side opening is not available. In these cases, immobilization with sedation is required. A variety of drugs and drug combinations can be used for this, some of which are listed in Table 5.2. Xylazine is a common inexpensive sedative analgesic used in livestock. It provides reliable sedation and recumbency with relatively low doses and low cost. Detomidine is another α_2-adrenergic agonist sedative that could be used for sedation and restraint. However, Detomidine is more expensive and results in greater cardiorespiratory depression that may result in a prolonged response to lethal injection with barbiturates. Acepromazine is also an effective sedative in cattle but does not provide any significant analgesia. In addition, the hypotension resulting from inhibition of catecholamine-mediated vascular tone may result in prolonged response to lethal injection. Combinations of xylazine, butorphanol, and ketamine (Ket–Stun protocols) and tiletamine/zolazepam, ketamine, and xylazine (TKX protocols) can be used for reliable standing and recumbent restraint in cattle. Such combinations can provide profound anesthesia and analgesia.

In some instances, the animal may not be safely approached in order to administer sedation directly. Examples would be some range beef cattle, rodeo cattle, and bison. In these situations, the animals are generally excitable and may override simple sedation with just xylazine. A pole syringe or dart gun may be necessary for safe sedation in these animals. The drug chambers for pole syringes

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Table 5.2 Some suggested drugs and drug combinations for providing standing or recumbent sedation prior to euthanasia in cattle.

Drug or drug combination	Dose and route	Comments
Xylazine	0.01–0.05 mg/kg, IV 0.01–0.1 mg/kg, IM	Standing sedation. Dose-dependent on the excitability of the animal.
	0.1–0.2 mg/kg, IV or IM	Results in recumbency in most cattle. Higher doses can be used in anxious animals to assure recumbency prior to euthanasia.
Detomidine	0.002–0.02 mg/kg, IV or IM	Standing sedation. Dose-dependent on the excitability of the animal.
Acepromazine	0.05–0.1 mg/kg, IV or IM	Will provide sedation but no analgesia. Marked hypotension may prolong euthanasia by injectable barbiturates.
Standing Ket–Stun Butorphanol Xylazine Ketamine	Combine for SC or IM injection (1:2:4 ratio) 0.01–0.025 mg/kg 0.02–0.05 mg/kg 0.04–0.10 mg/kg	Provides effective standing sedation and chemical restraint for most cattle. Anxious cattle may need a higher dose. Increasing xylazine increases the likelihood of recumbency.
Recumbent Ket–Stun Butorphanol Xylazine Ketamine	Combine for SC or IM injection. 0.025 mg/kg 0.05 mg/kg 0.1 mg/kg	Routinely provides sedation and recumbency in most cattle. Onset in 3–10 min.
Xylazine–ketamine combination	Xylazine 0.05 mg/kg, IV Ketamine 4.5 mg/kg, IV	Produces rapid anesthesia that will last for 15–20 min.
TKX–ruminant Tiletamine Ketamine Xylazine	Reconstitute a 500 mg vial of tiletamine with 250 mg (2.5 mL) ketamine and 100 mg (1 mL) xylazine. Administer at 1–1.5 mL/110 kg, IM. This equates to a dose of tiletamine 0.53 mg/kg, ketamine 0.53 mg/kg, and xylazine 0.04 mg/kg.	Recumbency in 5–10 min. The low volume makes this combination ideal for immobilizing intractable ruminants. It may be administered by syringe, with a pole syringe, or dart gun if needed. Relatively expensive.

and dart guns are often limited in the volume that can be administered. The low volume required for TKX protocols is advantageous for anesthesia and recumbency in these excitable and potentially dangerous animals. Otherwise, euthanasia by gunshot at a longer range with a hunting rifle is appropriate. When using anesthesia drug combinations for the purpose of inducing unconsciousness, ensure the patient is ready before proceeding with a potentially painful euthanasia procedure.

5.3.2 Sheep and Goats

Sedation is rarely necessary for the euthanasia of sheep and goats that are comfortable with human contact and handling. They are accustomed to manual restraint or with the use of a nylon, leather, or rope halter. For excitable animals, such as wild sheep and goats, sedatives, as used in cattle, can be used in sheep and goats with similar considerations. A list of several options for small ruminants is listed in Table 5.3.

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Table 5.3 Some suggested drugs and drug combinations for providing standing or recumbent sedation prior to euthanasia in small ruminants.

Drug or drug combination	Dose and route	Comments
Xylazine	0.01–0.05 mg/kg, IV 0.01–0.1 mg/kg, IM	Standing sedation. Dose-dependent on the excitability of the animal.
	0.1–0.2 mg/kg, IV or IM	Results in recumbency in most cattle. Higher doses can be used in anxious animals to assure recumbency prior to euthanasia.
Detomidine	0.002–0.02 mg/kg, IV or IM	Standing sedation. Dose-dependent on the excitability of the animal.
Acepromazine	0.05–0.1 mg/kg, IV or IM	Will provide sedation but no analgesia. Marked hypotension may prolong euthanasia by injectable barbiturates.
Diazepam or midazolam	0.2–0.4 mg/kg, IV 0.3–0.5 mg/kg, IM	Provides moderate sedation in most sheep and goats.
Sheep Ket–Stun Butorphanol Xylazine Ketamine	Combine for SC or IM injection 0.025 mg/kg 0.05 mg/kg 1.0 mg/kg	Provides conscious sedation while significantly limiting movement in the animal. The animal will often become recumbent.
Small-ruminant cocktail	Combine ketamine (100 mg/mL), xylazine (100 mg/mL), and butorphanol (10 mg/mL) at a 10:1:1 ratio. Administer at 1 mL/80–100 lb BW IM. If giving IV, start with 2/3 dose.	Provides recumbency and good anesthesia in 5–10 min in most sheep and goats.
Xylazine–ketamine combination	Xylazine 0.05 mg/kg, IV Ketamine 4.5 mg/kg, IV	Produces rapid anesthesia that will last for 15–20 min.
TKX-ruminant Tiletamine Ketamine Xylazine	Reconstitute a 500 mg vial of tiletamine with 250 mg (2.5 mL) ketamine and 100 mg (1 mL) xylazine. Administer at 1–1.5 mL/110 kg, IM	Recumbency in 5–10 min. The low volume makes this combination ideal for immobilizing intractable ruminants. It may be administered by syringe, with a pole syringe, or dart gun if needed. Relatively expensive.

5.3.3 Swine

Consistent sedation in pigs can be challenging. Pigs tend to have erratic responses to most livestock sedatives. However, if it is necessary to sedate a pig for euthanasia, high doses can be used without harm. Alternatively, combinations of sedatives and anesthetics seem to provide more consistent results. Common injectable sedatives and anesthetics used in swine are presented in Table 5.4. IV injection can be challenging in pigs. Common sites include the ear vein, the anterior vena cava, brachiocephalic vein, jugular vein, coccygeal vein, cephalic vein, or lateral saphenous vein.

Vietnamese pot-bellied pigs or other pet pigs present additional challenges for euthanasia. They tend to resist physical restraint, and also to have poorly visible ear veins for venipuncture.

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Table 5.4 Some suggested drugs and drug combinations for providing sedation or anesthesia prior to euthanasia in pigs.

Drug or drug combination	Dose and route	Comments
Acepromazine	0.5–5 mg/kg, IM	Will provide sedation but no analgesia. Marked hypotension may prolong euthanasia by injectable barbiturates.
Diazepam or midazolam	0.2–1 mg/kg, IM	Provides moderate sedation and muscle relaxation in most pigs.
Xylazine	0.5–3.0 mg/kg, IM	Sedation, but unreliable when used alone.
Diazepam/midazolam plus butorphanol/morphine	0.2–0.5 mg/kg, IM 0.2–0.5 mg/kg, IM	This IM combination will generally provide smooth sedation. Good prior to masking with isoflurane.
Detomidine Midazolam Butorphanol	20–60 µg/kg, IM 0.3 mg/kg, IM 0.3 mg/kg, IM	This drug combination provides deep sedation.
Swine tiletamine cocktail	Suspend a 500 mg vial of tiletamine with 2.5 mL ketamine (100 mg/mL) and 2.5 mL xylazine (100 mg/mL). Administer at 1 mL/35 kg, IM	Smooth anesthesia. Apnea may occur.
Midazolam Tiletamine	5 mg/kg, IM 4 mg/kg, IM	This combination induces anesthesia in most pigs.

In addition, the family may want to be present and will expect the procedure to be performed with minimal distress for their pet. A very acceptable approach to euthanasia of pet pigs is to first induce general anesthesia followed by venipuncture or IC injection of pentobarbital or KCl. General anesthesia may be induced using various drug combinations administered IM behind the ear in the neck. Alternatively, many pigs accept being masked with isoflurane. This may be done with or without sedation administered by IM injection. Intramuscular or subcutaneous injections are most commonly administered in the neck just caudal to the ear in pigs.

5.3.4 Llamas and Alpacas

Because the jugular vein can be difficult to hit in llamas and alpacas, and because the carotid artery is positioned very close to the jugular vein, initial sedation is often given by the SC or IM route. Intracarotid injection of the sedatives will result in rapid excitement and possibly seizure activity. If giving the initial sedation in the jugular vein, it is recommended to initially give small portions of the dose slowly to check for an adverse response before the bulk of the drug is administered. Sites for IM injections are the triceps, the semimembranosus, and the semitendinosus muscles. SC injections can be given in the neck, just in front of the shoulder, over the triceps, or over the caudal thigh (see Table 5.5).

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Table 5.5 Some suggested drugs and drug combinations for providing standing or recumbent sedation prior to euthanasia in llamas and alpacas.

Drug or drug combination	Dose and route	Comments
Xylazine	0.05–0.1 mg/kg, IV 0.1–0.4 mg/kg, IM or SC	Standing or recumbent sedation. Dose-dependent on the excitability of the animal.
Butorphanol	0.05–0.2 mg/kg, IV or IM or SC	Produces sedation, and at higher doses may produce recumbency.
Diazepam or midazolam	0.2–0.4 mg/kg, IV 0.3–0.5 mg/kg, IM or SC	Provides moderate sedation in most sheep and goats.
Camelid Ket–Stun Butorphanol Xylazine Ketamine	Combine for SC or IM injection (1:2:4 ratio) 0.05–0.1 mg/kg 0.1–0.2 mg/kg 0.2–0.4 mg/kg	Provides conscious sedation. Animal may stay standing or become recumbent.
Small-ruminant cocktail	Combine ketamine (100 mg/mL), xylazine (100 mg/mL), and butorphanol (10 mg/mL) at a 10:1:1 ratio. Administer at 1 mL/50 lb BW in llamas and 1 mL/40 lb BW in alpacas IM. If giving IV, start with 2/3 dose.	This same mixture that is used in small ruminants is very effective in llamas and alpacas as well, just at a higher dose. Provides recumbency and good anesthesia in 5–10 min in most llamas and alpacas.
Diazepam–ketamine combination	Diazepam 0.1–0.2 mg/kg, IV Ketamine 3 mg/kg, IV	Produces rapid anesthesia that will last for 15–20 min.

5.4 Euthanasia Techniques

5.4.1 Noninhalant Pharmaceutical Agents – Intravenous Injections (Pentobarbital, KCl, Lidocaine)

5.4.1.1 Cattle

Euthanasia by lethal injection generally provides a very smooth transition from life to death. The primary stressors are the restraint required and the skin prick of the needle. There seems to be common concern over difficult euthanasia where excitability, excessive agonal response, or a prolonged time to death is observed. These occurrences are often attributed to either poor venipuncture with a portion of the drug administered perivascular, or severely compromised animals with compromised cardiovascular function. This is where the decision of whether or not to sedate an animal and whether or not to use a direct venipuncture or an IV catheter is critical. Above all, the most important aspect of smooth euthanasia by IV injection of pentobarbital is the rapid and complete injection of the drug. Using long (1.5–2 in.) large gauge (16–14 gauge) needles or catheters (3–5 in., 16–12 gauge) will aid in proper IV delivery.

Euthanasia solutions are most commonly administered in the jugular vein for cattle (Figure 5.4). The labeled dose for the drug is generally effective, although some individuals routinely increase this dose. For sodium-pentobarbital-based euthanasia solutions, the labeled dose is 100 mg/kg. Most current pentobarbital-based euthanasia solutions contain 390 mg/mL pentobarbital sodium, and the standard dose is approximately 1 mL per 4.5 kg (10 lb) body weight.

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Figure 5.4 Euthanasia of a calf by jugular IV injection. The extension set is not necessary but does allow some freedom if the animal moves its head and neck while giving the injection. Note that when the animal becomes recumbent, it lays down to the side opposite the direction the head is turned.

The jugular vein allows the best IV access for rapid administration of the euthanasia solution. Direct venipuncture or a jugular catheter may be used. It is recommended to use the largest gauge needle or catheter that is reasonable for the size of the animal (18–14 gauge for calves and 16–12 gauge for adult cattle). While the ear veins are an alternative, their size does not allow for as large a needle or catheter to administer the euthanasia solution as rapidly.

The animal should be restrained so that the jugular furrow is accessible for venipuncture or catheter placement (Figure 5.5). In both cases, the venipuncture is directed down the jugular vein with the blood flow. An extension set may be connected to the needle or the catheter to allow for easier administration of the euthanasia solution. Some prefer to draw back on the syringe plunger after every one-quarter dose to ensure the needle is still in the vein. If necessary, the needle should be redirected, or venipuncture should be attempted at another site. It is critical that the entire dose of euthanasia solution is administered rapidly in order to ensure a smooth euthanasia with minimal complications. Many euthanasia procedures that result in adverse behavior or reactions in the animal are due to perivascular administration of some or all of the euthanasia solutions.

To perform an IC injection, the location of the heart is identified either by auscultation or by palpation of the chest. The appropriate site for IC injection is generally in the 5th intercostal space (ICS) at the elbow level or just above the elbow. A 3-in. needle, inserted perpendicular to the chest wall, is required for calves, and a 5-in. needle is used in adult cattle.

Following completion of the injection, an animal lying on its sternum will become laterally recumbent. If the animal is standing, it will generally collapse gradually over several seconds. Some paddling of the limbs may be observed. Once recumbent, it is recommended that the

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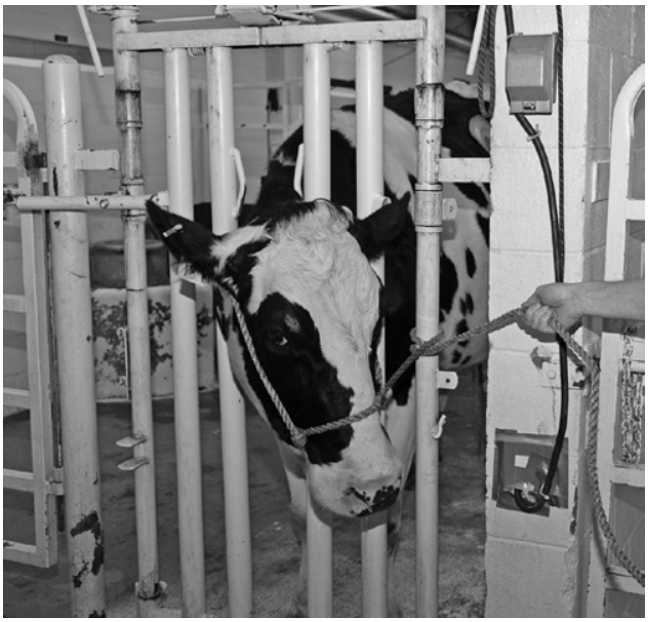


Figure 5.5 A head catch system with a solid wall and a swinging gate that can be used for physical restraint of cattle for euthanasia. Note how the head is restrained to the left of the animal. This will result in the animal most likely falling into right lateral recumbency upon euthanasia. This is important as it keeps the limbs toward the solid wall and allows safer access to the neck and jugular veins from the back or dorsum of the animal.

handlers and operator position themselves on the dorsal side of the animal to minimize the risk of being struck by the limbs. During this time, signs of unconsciousness can be assessed such as an absence of a righting reflex and corneal reflexes. After respiration has stopped, the heart is auscultated to verify cardiac arrest.

Cardiac arrest can also be induced by lethal injection of a saturated solution of KCl. This is considered an adjunctive euthanasia method and should never be used in a conscious animal. Once the animal is rendered unconscious, a saturated solution of KCl is given at a volume of 1 mL per 4.5 kg (10 lb) body weight (150 mg/kg, or 2 mEq/kg) and is sufficient to induce cardiac arrest. A saturated solution of KCl is created by combining 340 g of KCl salt in 1 L of water. If solid particles of salt are observed in the KCl solution, it means the solution is saturated at that temperature. The solution can be administered IV in the jugular vein. If the jugular vein is not accessible, KCl can be administered IC.

Consideration of the disposal of any livestock carcass is critical following euthanasia by lethal injection. The tissues of the carcass are potentially toxic to scavenging animals and the carcass must be disposed of properly. More details regarding this can be found in Chapter 7.

An alternative method of euthanasia is the injection of ITh lidocaine. This has become a method of interest for those who want to avoid the problems associated with carcass disposal issues in animals euthanized with pentobarbital. The procedure requires that the calf or adult cow first be anesthetized with ketamine HCl (or other suitable nonbarbiturate anesthetic agent) (Aleman et al. 2015; Rousseau et al. 2019). When the animal reaches an acceptable plane of anesthesia, a needle (4-in. in length) is inserted into the subarachnoid (thecal) space of the spinal canal through the atlanto-occipital joint. Once in proper position (i.e. between the spinal cord and dura mater), cerebrospinal fluid (CSF) will be seen flowing from the needle. Inject 60 mL of lidocaine (for an adult bovine) or a volume equivalent to 4 mg/kg lidocaine. Death should be expected within 10 minutes or less. If death is prolonged beyond 10 minutes, ensure that the animal is still under anesthesia and inject approximately 120 mL of KCl to cause cardiac arrest.

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The ITh method requires practice, which begs the question if the animal is anesthetized, why not just use IV KCl instead of going to the trouble of doing the ITh injection with lidocaine? Anecdotal comments suggest that there is more involuntary movement when KCl is administered IV. This author is not aware of other objectionable reasons for the ITh injection of lidocaine or KCl intravenously as long as there is assurance that the animal is fully anesthetized. Either method is effective. This procedure may be used in small ruminants and camelids and presumably swine, although it may require some practice to become proficient in placing the needle through the atlanto-occipital space and into the ITh space in all species.

5.4.1.2 Sheep and Goats

As with cattle, euthanasia by lethal injection is performed with pentobarbital-containing euthanasia solutions. The standard dose of 1 mL per 4.5 kg (10 lb) body weight is recommended. As with other species, it is critical that the euthanasia solution is injected rapidly and that it all enters the vascular space. Thus, performing a competent venipuncture or placing an IV catheter is critical for smooth euthanasia. Clipping the animal's neck will aid in venipuncture (Figures 5.6–5.8). Most problems with rough euthanasia are due to either perivascular administration of some or all of the euthanasia solutions or cardiovascular compromise in the animal. The use of sedatives prior to euthanasia may be associated with prolonged or rough euthanasia in small ruminants and may be due to slow drug distribution from hypotension caused by the animal's condition and the sedative.

Following administration of the euthanasia solution, the animal should calmly collapse into sternal, then lateral recumbency. The eyes generally remain open and fixed with dilated pupils. Corneal and palpebral reflexes are absent. Respiration becomes erratic and then ceases, followed by cardiac arrest. Once respiratory arrest has occurred, the animal should be assessed for cardiac arrest by auscultation of the heart.



Figure 5.6 Good visualization of the jugular vein in sheep. Shaving the neck is recommended for improved euthanasia by injection in sheep.

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Figure 5.7 Injecting the jugular vein in a sheep. Notice the gentle restraint and proper positioning used.



Figure 5.8 Placing an IV catheter in the ear vein of a sheep.

5.4.1.3 Swine

The challenge with performing euthanasia by lethal injection in swine is performing a successful venipuncture or IC injection. These procedures generally require suitable restraint. In debilitated or obtunded domestic pigs, successful venipuncture of an ear vein may allow for the administration of a euthanasia solution. Alternatively, venipuncture of the anterior vena cava, brachiocephalic vein, or jugular vein may be attempted in the neck. Because pigs generally resist physical restraint, this procedure will benefit from injectable sedation or anesthesia. Many pigs also tolerate being masked and anesthetized with isoflurane (Figure 5.9). Once the pig is sedated or anesthetized, venipuncture or IC injection can be done more successfully with little distress to the pig.

Clients of pet pigs often request euthanasia by lethal injection over gunshot or captive bolt stun. Understandably, a client will expect the procedure to be performed with minimal distress to their pet during the procedure. This can be successfully accomplished by first anesthetizing the pig with an injectable anesthetic combination or masking the pig with isoflurane, either with or without sedation, depending on the demeanor of the pig. Once the pig is anesthetized, a lethal injection of

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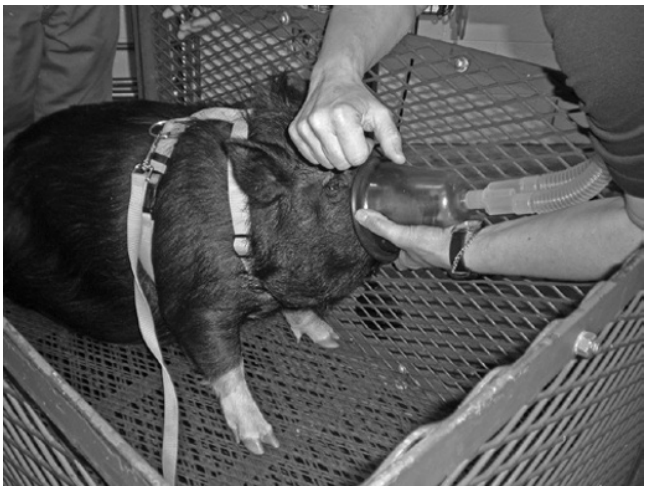


Figure 5.9 This pig is being given anesthetic gas to prepare for an intracardiac injection of a euthanasia agent.

a pentobarbital-containing euthanasia solution (1 mL per 4.5 kg [10 lb] body weight) can be administered. IC injection is often easier than venipuncture. This method is well-received by most pet pig clients. If this is a large domestic pig and the cost is a concern, then KCl (administered IC or IV) could be used instead of the pentobarbital euthanasia solution since the pig is already anesthetized at the time of euthanasia.

5.4.1.4 Llamas and Alpacas

Euthanasia by lethal injection is probably the most common method used for llamas and alpacas. This method is less aversive to most clients and often provides a very peaceful death. The animal should be restrained physically, with or without sedation, or anesthetized. Some clients may request or prefer sedation prior to euthanasia. Sedation should definitely be used if physical restraint is not adequate to allow for a proficient jugular venipuncture. However, sedation and anesthesia may prolong the time from administration of the euthanasia solution to cardiac and respiratory arrest. This should be communicated to the client prior to the procedure so that they are aware of this possible effect.

Jugular venipuncture can be challenging in llamas and alpacas, particularly in intact males. Male camelids have thicker skin overlying the jugular furrow making it more difficult to identify the jugular vein and to insert a needle. Clipping the neck will aid in the identification of the jugular vein (Figure 5.10). Initially clipping both left and right jugular furrows often makes it easier to appreciate the anatomy and gives more options should problems occur with the first attempt on one side.

Jugular venipuncture can be performed standing, recumbent in the cushed position (sternal recumbency), or in lateral recumbency (Figure 5.11). When standing or cushed, it is best to hold the head relatively relaxed and level with the head slightly turned away from the side used for the venipuncture (i.e. if performing venipuncture in the right jugular, turn the head slightly to the left). Jugular venipuncture can also be performed with the animal in lateral recumbency if they will allow physical restraint in that position or if heavily sedated or anesthetized. When attempting to localize the jugular vein, it is often easier to see the jugular vein recede when you stop holding it off in the neck rather than watching for distension when it is held off, particularly if the animal is not clipped. Jugular IV catheters can also be used for both sedation and the euthanasia procedure.

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Figure 5.10 Placing an IV catheter in the jugular of a standing alpaca. Note the obvious flow of blood. This should be minimized and contained whenever possible.



Figure 5.11 Euthanasia by injection using the medial saphenous vein in an alpaca.

If the animal is to be euthanized in a chute, then one must plan for extraction of the carcass. This is best accomplished if the side of the chute can be opened. Just prior to euthanasia, the latch for the side of the chute and for the head catch should be released to prevent these from jamming with the weight of the recumbent animal pressed against them.

The dose of currently available pentobarbital euthanasia solutions is 1 mL per 4.5 kg (10 lb) body weight. The full dose should be administered as rapidly as possible. This dose is typically sufficient in most animals. However, there are individual animals that may require a higher dose. Therefore, it is wise to always have extra euthanasia solutions on hand if needed.

IV injection by the jugular vein is preferred. This can be done either directly with a needle or from a catheter. The medial saphenous vein is an alternative site but requires that the animal is heavily sedated or anesthetized and is in lateral recumbency. If neither the jugular veins nor the lateral saphenous veins are accessible or suitable for IV injection, an IC injection can be performed. An IC injection using a 4–6-in., 16–18-gauge needle is most easily performed from the left side at the 5th ICS just behind the elbow.

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Following the injection of the euthanasia solution, the animal will gently collapse to lateral recumbency. The eyes will remain open and fixed, with dilated pupils. The corneal and palpebral reflexes will be absent. Respiratory arrest followed by cardiac arrest generally occurs within 2–5 minutes. Some regurgitation, defecation, or urination may be observed.

5.4.1.5 Technical Challenges (Sheep, Goats, Swine, and Camelids)

Vein visibility is one of the biggest challenges in sheep and camelids due to their thick layers of wool or hair. In swine, veins can be difficult to access due to their thick skin and fat content. When shears or clippers are unavailable, and the jugular vein cannot be seen, a leg vein must be used. Sedation or anesthesia will render the animal immobile and allow for safer handling while manipulating the legs. Typical leg veins to inject are the cephalic and lateral saphenous veins. If necessary, an IC injection may be attempted in the unconscious animal, or a physical method used instead.

5.4.2 Physical Methods

5.4.2.1 Gunshot in Cattle

The delivery of a bullet to the proper anatomic site produces an immediate loss of consciousness and damage to vital areas of the brain that assures a humane death, but there are significant safety considerations that must be understood. In most cases of euthanasia by gunshot, the shot is made at close range. When a handgun is used, the shot is usually within 3 ft of the target. For this reason, restraint is less important than in the case of the captive bolt. Restraint is essential when a captive bolt is used since it is necessary to hold the muzzle of the captive bolt gun flush with the skull. With a firearm, holding the muzzle flush with the skull risks an explosion of the barrel, a very dangerous situation.

Ricochet of a bullet is possible when conducting euthanasia, but unlikely since the trajectory of the bullet should enter the anatomic site approximately perpendicular to the skull. A bullet is more likely to ricochet off of hard surfaces such as a concrete floor or metal surface. When a bullet strikes the skull at a slight angle, it tends to penetrate into the softer tissue of the skin, soft tissues, and bone rather than glancing off of the skull as it would a harder surface.

The risk of personal injury and physical damage to property when using a firearm for euthanasia can be minimized by following these recommendations:

- Avoid euthanizing an animal by gunshot indoors or in an enclosed space.
- Use the appropriate firearm and cartridge based on the animal's size and age.
- Be familiar with the firearm that is being used.
- Assure adequate physical or chemical restraint of the animal. Even a debilitated or sedated animal can suddenly lunge forward or to the side and impact the operator with the firearm, potentially causing direct injury or a misfire.
- Be familiar with the surroundings and consider what is behind and to the sides of the target.
- Any handlers assisting with animal restraint should remain behind the shooter.

While a gunshot is more likely than a captive bolt to directly result in death, a secondary means of assuring death, such as pithing, exsanguination, or IV KCl injection, should always be available if needed.

For cattle that may be down or moribund, restraint is unnecessary. For animals that are down but alert, restraint may be necessary, particularly if a captive bolt is used. The type of restraint is

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dependent on both physical facilities and the size and temperament of the animal. Physical restraint is generally sufficient for dairy cattle, docile beef cattle, or markedly compromised cattle. In these cases, a halter tied to a post may be sufficient. If the animal is recumbent, a halter may be used to tie the head back to the rear leg. The halter lead can be held freely by an assistant as long as the length of the lead will allow the assistant to position themselves behind the shooter.

The choice of firearm and bullet has been discussed previously. For calves and cattle less than 24 months of age, a .22 caliber pistol or rifle with either hollow point (young calves) or round-nose bullets (juvenile and older cattle) is satisfactory. For adult cattle, a minimum of a .22 caliber magnum is recommended for consistent euthanasia. However, if a .22 LR (long rifle) bullet is used, it should be fired from a rifle rather than a handgun. A rifle is capable of higher muzzle velocity and energy by comparison with a handgun. Shotguns ranging from 12 to 20 gauge loaded with slugs or No. 4, 5, or 6 birdshots are also effective.

Humane euthanasia by gunshot requires proper positioning to ensure the projectile enters the proper anatomic site. The muzzle of the gun should be within 2–3 ft of the desired anatomic site for pistols and 1–2 m for rifles and shotguns. The preferred location for gunshots in cattle is at the intersection of two lines extending from the outside (lateral canthus) corner of the eyes to the base of the opposite horn or point where the horn would be located in a polled animal (Figure 5.12). The shot should be aimed so that the projectile enters perpendicular to the skull.

A common error made by practitioners with euthanasia by gunshot and captive bolt is placing the point of penetration too rostral or low on the forehead. In some cases, this can result in completely missing the cerebral cortex and only penetrating the frontal sinus. When this occurs, the animal may or may not lose consciousness immediately. If unconsciousness is achieved, they may regain consciousness if a secondary step to ensure death is not applied.

In cases where an animal must be shot from a distance, then a rifle or shotgun, loaded with a shotgun slug, should be used. The point of aim is the thorax just behind the elbow. Once the animal has fallen and it is safe to approach, the shooter should apply a headshot to ensure unconsciousness and death.

Following the gunshot, the animal should be assessed. If the animal is standing at the time of the shot, it will immediately collapse. The animal will be stiff and rigid for a period of 15–20 seconds before gradually becoming relaxed. The animal should make no attempt to right itself. There is an immediate and sustained cessation of rhythmic breathing. There should be no vocalization and no

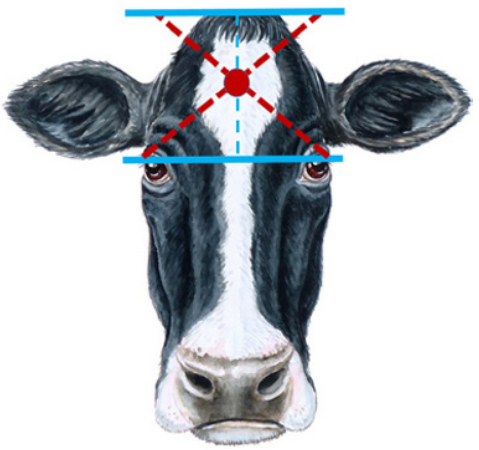


Figure 5.12 The point of penetration for gunshot or captive bolt in cattle is at the intersection of imaginary lines drawn from the lateral canthus to the horns, or where the horns would be if the animal had horns. The angle should be perpendicular to the skull which will direct the projectile toward the brainstem. Alternatively, in long-faced cattle or young stock (B), a point on the midline of the face that is halfway between the top of the poll and an imaginary horizontal line connecting the lateral canthus of each eye. *Source:* AVMA Guidelines for the Humane Slaughter of Animals: 2016 Edition.

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palpebral or corneal reflexes. Involuntary movement of the limbs may persist until after cardiac and respiratory arrest. These are not associated with pain or consciousness of the animal and the client or bystanders should be forewarned of this prior to euthanasia. These movements can sometimes be quite exaggerated, and it is recommended for personal safety that the operator stay on the dorsal side of the animal to assess corneal reflexes and cardiac and respiratory function. Anoxia from lack of respiration will cause cardiac arrest after approximately 7–10 minutes. The heartbeat is controlled by the sinoatrial node in the right atrium of the heart.

5.4.2.2 Captive Bolt in Cattle

Euthanasia with a captive bolt is similar to a gunshot but has several advantages. The main advantages are a decreased risk of injury to bystanders or damage to property from a free-flying projectile, and fewer regulatory considerations. The main disadvantage is the high upfront cost.

The choice of the type of captive bolt stunner was discussed in Section 5.2. Some captive bolt stunners have different strength charges and the option to choose an appropriate charge based upon the species and size of animal to be euthanized. In cattle, the landmarks for captive bolt stunning are the same as for gunshot. The frontal site is generally recommended in most field and veterinary situations. However, in some cases, due to positioning and facilities, it may be safer and easier to obtain accurate placement from above and behind the animal aiming just behind the pole and directing the bolt toward the muzzle of the animal. The barrel of the captive bolt stunner should be held directly against the skull over the intended site. In some models of captive bolt stunners, the bolt is actually recessed slightly into the muzzle to provide an automatic gap, increased bolt velocity, and higher muzzle energy on impact. This may improve penetration in adult livestock that have thick bone structures to the skull such as adult bulls and boars (Figure 5.13).

Because a penetrating captive bolt has a limited depth penetration, its primary objective is to induce immediate loss of consciousness. However, proper placement over the frontal site, as

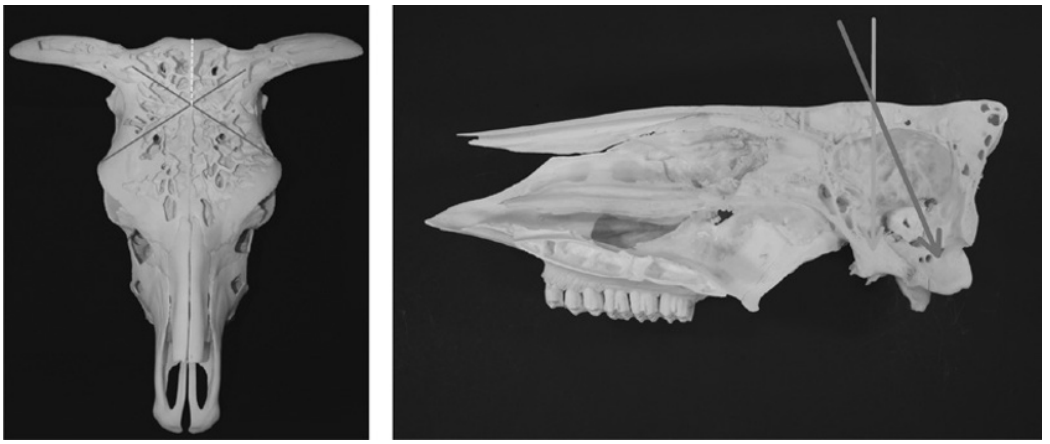


Figure 5.13 The bovine skull showing the point of penetration for euthanasia by gunshot or captive bolt. In the lateral view, the difference in penetration of a perpendicular (white arrow) versus a lightly angled (gray arrow) shot can be seen. The angled shot has an increased risk of ricochet, but it will also cause more damage to the brain stem. A perpendicular shot lower on the forehead may not even penetrate the cerebral cortex resulting in an ineffective euthanasia. *Source:* Dr. J.K. Shearer, Procedures for Humane Euthanasia, Iowa State University Extension.

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Figure 5.14 Restraint and placement of a captive bolt stunner on an adult cow. Note the light restraint with a halter and that the head is turned slightly to the animal's left so that it will fall in right lateral recumbency, allowing safe access from the dorsal side of the animal. The captive bolt stunner is placed directly against the animal's head. Note in this case that the stunner is angled slightly from perpendicular so that the penetrating bolt is directed more toward the foramen magnum and the brain stem.

described, will often lead to death (Figure 5.14). It does so by causing damage to the cerebral cortex, the reticular system in the brain stem, the ascending reticular activating system, and the thalamus, structures which, if sufficiently damaged, will lead to unconsciousness and death (Terlouw et al. 2016). There is an immediate and sustained cessation of rhythmic breathing, which leads to anoxia that in most cases will cause cardiac arrest and death in animals that do not receive a secondary step to ensure death. It is possible for animals to regain consciousness in a very small percentage of cases (most of these are inaccurate or misdirected bolts), and for that reason, a secondary adjunctive method of inducing cardiac arrest like IV KCl should always be employed. Other methods such as exsanguination, pithing, or creating a pneumothorax eventually cause death through anoxia.

5.4.2.3 Gunshot or Captive Bolt

5.4.2.3.1 Sheep and Goats Euthanasia by gunshot or captive bolt are acceptable methods in small ruminants. The equipment is essentially the same, with appropriate choices for the caliber of a firearm and specific power cartridge used for the captive bolt stunner. A .22 caliber pistol or rifle is adequate for small ruminants. A hollow or soft point bullet is appropriate for young animals and most adult small ruminants. The hollow or soft point bullet is less likely to penetrate all the way through the animal and thus has a decreased risk of human injury or property damage. However, a solid point round nose long rifle shell is more suitable for horned sheep or goats, particularly rams and bucks with thick skull bone structures. Almost all commercial penetrating captive bolt stunners are acceptable for the euthanasia of small ruminants.

Landmarks for conducting euthanasia with either gunshot or captive bolt are similar for sheep and goats. The optimal site is on the intersection of two lines, each drawn from the lateral canthus of one eye to the middle of the base of the opposite ear (Plummer et al., 2018). An alternative anatomic site is on the dorsal midline of the head at the level of the external occipital protuberance aiming toward the cranial-most portion of the intermandibular space (Collins et al. 2017) (Figure 5.15). The frontal site is generally not recommended. The forehead is shallow, and the brain is located in a more caudal position in the skull. The frontal site is reserved for use with firearm euthanasia of heavily horned sheep and goats where the preferred sites may be inaccessible.

Following a gunshot or captive bolt stun, the animal should become immediately unconscious. Tonic seizures may be observed and may progress to paddling of the limbs. The eyes remain open and fixed, with dilated pupils. Corneal and palpebral reflexes are absent. There is an immediate and sustained cessation of rhythmic breathing.

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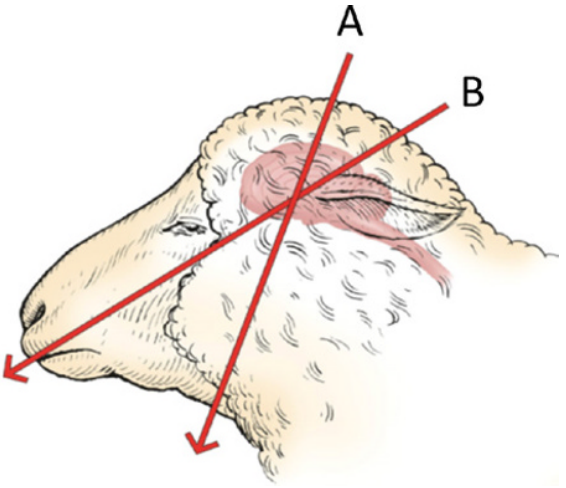


Figure 5.15 Directional aiming for a firearm or captive bolt in polled sheep or goats (A), place the PCB perpendicular to the skull over the anatomic site identified as slightly caudal to the poll (the crown or the highest point on the head) at the intersection of 2 lines drawn from the outside corner of each eye to the middle of the base of the opposite ear. Alternatively, a site located on the dorsal midline of the head (B), which corresponds with the external occipital protuberance of the skull (see figure that differentiates the poll from the external occipital protuberance). When using the site associated with the external occipital protuberance, place the PCB flush with the skull at the external occipital protuberance while angling or aiming the muzzle of the PCB toward the mouth (B). (Based on observations in goats by Collins et al. (2017) and Plummer et al. (2018).)

To ensure death, secondary methods of inducing cardiac arrest should always be performed following a gunshot or captive bolt stun. These include exsanguination, pithing, IV administration of KCl, or opening the chest to cause a pneumothorax. The methods for these procedures are the same as in cattle.

5.4.2.3.2 Swine Of all the livestock species, pigs are probably the most challenging animal to euthanize by gunshot or captive bolt. This is in part because of their cranial anatomy and also the difficulty of getting sufficient restraint to allow for accurate placement of the shot. Pigs have a much more developed skull structure with thick frontal bones and large sinuses covering the brain. In addition, the target area is very small.

As with all species, proper selection of firearm or captive bolt stunner is critical. While a .22 caliber pistol or rifle may be adequate for young or juvenile pigs, larger caliber firearms are necessary for adult pigs, particularly boars. A minimum of a .22 magnum should be used on adult sows and a minimum of a .357 should be used on adult boars. Because of the skull's heavy bone structure and sloped anatomy, solid point round nose bullets should be used to maximize penetration and minimize ricochet. An appropriate captive bolt stunner should have an elongated bolt to provide sufficient penetration through the frontal sinuses to the brain in adult swine.

Pigs, in general, are a difficult species to approach closely without confinement or restraint. This is necessary to allow for accurate placement of the firearm or captive bolt stunner. A nose snare may be used if necessary, but it will increase the distress in the animal. However, it may provide the opportunity for a more accurate shot and thus minimize the potential for pain and further distress in the animal. If a snare is used, the holder should stand behind the operator of the firearm or captive bolt. Alternatively, the animal may first be sedated to reduce movement and allow for a more accurate shot with less distress in the animal.

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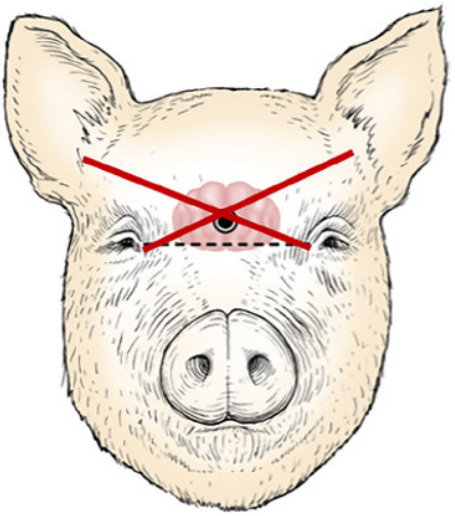


Figure 5.16 The anatomic site for proper placement of a bullet or penetrating captive bolt as in the center of the forehead at the intersection of 2 lines each drawn from the inner corner of each eye to the base of the opposite ear. This site is approximately, 1–2 cm above eye level (3–4 cm) in larger sows and boars. *Source:* With courtesy of Dr. J.K. Shearer.

The frontal site is recommended for gunshot or captive bolt stunning in pigs. The placement of the gun or captive bolt is in the center of the forehead at the intersection of two lines each drawn from the inner corner of each eye to the base of the opposite ear. This site is approximately 1–2 cm above eye level (3–4 cm in larger sows and boars), aiming toward the foramen magnum and spinal canal (Figure 5.16).

Following an appropriately placed shot, the pig will immediately collapse. They often show a period of violent tonic spasm followed by tonic-clonic seizure activity. If an animal does not demonstrate intense tonic spasm and instead has milder paddling or kicking movements, then it is likely that the stunning was ineffective, and it should be repeated immediately. During this time, the animal should have open, fixed eyes with dilated pupils. The corneal reflex should be absent.

A secondary method of assuring cardiac and respiratory arrest should be performed as quickly as possible, ideally during the tonic phase and before the clonic phase. If employing exsanguination, a chest stick should be performed in order to sever the common carotid arteries and other major blood vessels near the heart. Alternatively, one may use pithing, pneumothorax, or IV KCl to cause death.

5.4.2.3.3 Llamas and Alpacas Gunshot or captive bolt stun is most easily performed with the animal standing or cushed. This allows the best access to the poll of the head and an accurate shot. If necessary, the head can be restrained with a halter and lead, or a rope halter. A single lead can be used or if more restraint is necessary, two leads can be used to hold the head steady to the left and the right. The leads should be tied off to a post or other sturdy object. Alternatively, the handlers holding the leads should be positioned to the side and behind the person performing the euthanasia to minimize the risk of injury from a ricochet.

Euthanasia by gunshot or captive bolt is acceptable in llamas and alpacas, although not as commonly elected by clients. For gunshots, a .22 caliber hollow or soft point long rifle shell is adequate for alpacas and young llamas, and a .22 caliber round nose-long rifle shell is best for adult llamas. Most penetrating captive bolt stunners are adequate for both llamas and alpacas. If the captive bolt stunner has different-size blanks, the same charge recommended for sheep should be suitable for llamas and alpacas.

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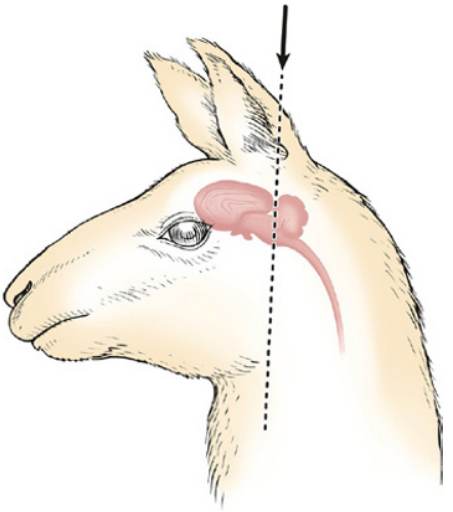


Figure 5.17 Anatomic site for placement of a captive bolt and desired path of the projectile in camelids. The device should be placed at the crown position (highest point on the head) aiming downwards to the base of the jaw. *Source:* AVMA Euthanasia Guidelines, 2020 Edition.

Two different sites for gunshot and captive bolt stun have been recommended in llamas and alpacas. The crown site is located at the top point of the head, directly between the ears on the midline, and aimed downward toward the base of the jaw, ideally in the neck (Figure 5.17). This is similar to that described for hornless sheep. The frontal site is located on the forehead at a point just above the intersection of two imaginary lines drawn from the eyes to the opposite ears. The shot is directed toward the foramen magnum. A bullet from the gunshot method would ideally stay within the neck and not exit the body. Whenever possible, the animal should be given time to lower its head and provide the practitioner with a perfectly positioned shot.

Following a gunshot or captive bolt stun, the animal will immediately collapse to lateral recumbency. The eyes will remain open but become fixed with dilated pupils. The corneal and palpebral reflexes will be absent. In all cases, a secondary means of assuring cardiac and respiratory arrest should be performed such as exsanguination, pithing, pneumothorax, or IV KCl. The methods for this are identical to those described for cattle.

5.4.2.3.4 Technical Challenges (Cattle, Sheep, Goats, Swine, and Camelids) Physical methods such as the use of gunshots and captive bolts create physical changes to the body similar to that of horses and other species. Because of the thickened craniums typical to these species, especially those with horns, there will be more bone to penetrate. This leads to a greater risk of improper penetration by both the bullet and the bolt. An immediate second firing may be required to avoid pain and distress in the animal. As mentioned previously, a secondary adjunctive method may be required and should be readily available.

5.4.2.4 Exsanguination

Exsanguination for all species covered thus far is considered an adjunctive method by the AVMA. It is performed by severing the major blood vessels of the neck. Once unconscious, a sturdy knife at least 6 in. in length is inserted behind the jaw and just below the vertebrae (Figure 5.18). The blade is then drawn forward, severing the trachea, carotid arteries, and jugular veins. An alternative method that is applicable to younger livestock is to sever the brachial vasculature. This is performed by lifting the forelimb and making a deep cut beneath the elbow to the shoulder. This is considered an adjunctive

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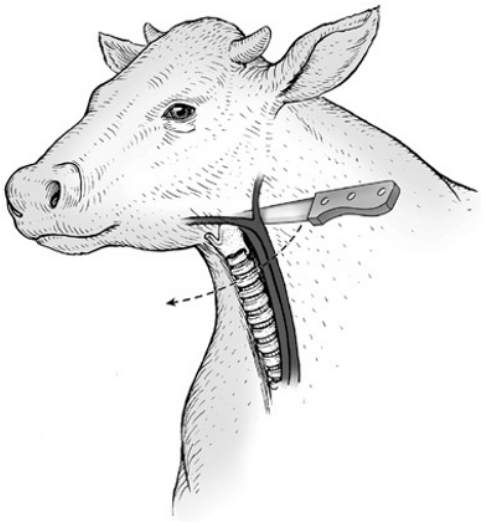


Figure 5.18 Diagram showing the method for exsanguination by severing the blood vessels of the neck. A rigid knife at least 6 in. in length is inserted behind the jaw and just below the vertebrae. The cut is extended outward in order to sever the trachea, carotid arteries, and jugular veins. *Source:* With courtesy of Dr. J.K. Shearer.

acceptable method only when the animal is already unconscious. If the animal were awake and aware of the procedure, this would be considered a slaughter procedure, not euthanasia.

If the neck is not easily cut, more force will need to be applied to the blade and deeper cutting movements performed. This can be emotionally troubling for those performing it and any onlookers. Practitioners are encouraged to practice this technique on deceased animals before attempting it with a client present.

5.4.2.5 Pithing

Pithing is another adjunctive method in unconscious animals. It is used to destroy brain tissue (particularly the brain stem) and cause death following techniques that may only render the animal unconscious, such as with a nonpenetrating captive bolt. Pithing is accomplished by inserting a rigid or semiflexible rod through the hole in the skull left by the penetrating bolt or bullet. The rod is directed toward the brain stem and moved in a vertical, horizontal, or circular motion to cause extensive physical damage. The rod should be at least 6 in. long and can be made from a screwdriver or a Buhner needle. Disposable pithing rods are also available (www.pithingrods.com). It should be noted that pithing can contribute to the dissemination of brain particles to other tissues. Persons using pithing to ensure death should be aware that this procedure will cause an increase in involuntary movement of the limbs, which may be disturbing for onlookers and dangerous for persons near the feet and legs.

5.5 Special Circumstances

Over the last decade, further consideration has been given to the euthanasia of the pregnant dam and the potential for conscious distress perceived by the fetus. Current research suggests that although the fetus is sentient, it remains in an unconscious state until after birth when it has taken a breath (Mellor and Diesch 2006; Mellor 2010). While the fetus will show reflex responses to stimuli in utero, there is no conscious perception of pain or discomfort. This has implications regarding euthanasia. First, in circumstances where a pregnant dam is euthanized, the fetus does not have recognition of pain or distress as long as it stays within the uterus until the time of death

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(cardiac and respiratory arrest). If the euthanized dam is to be prepared for custom slaughter, the fetus should remain within the uterus for a period of 15–20 minutes, or until dead.

These concepts also pertain to the ethical and moral considerations in dystocias where the fetus is alive but cannot be delivered vaginally and a cesarean section is not considered an option for medical reasons or by client request. These are very rare and difficult situations, the answer to which is very personal. However, the research indicates that the fetus will not consciously feel pain or distress if a fetotomy is performed on a live fetus that has not taken a breath (Mellor and Diesch 2006). If this alternative is selected, the first cut should be made rapidly and result in severing major blood vessels (i.e. removal of the head for anterior presentation or a hind limb at the pelvis for a posterior presentation) allowing for exsanguination in utero. This method of euthanasia by fetotomy, while not a pleasant choice to have to make, should at least be considered physiologically humane based on current research.

Mass euthanasia in situations of contagious disease outbreaks also poses unique considerations for livestock (Baker and Scrimgeour 1995). Human resources responding to a widespread disease outbreak such as foot and mouth disease (FMD) may be limited. Also, the logistics of depopulating large numbers of animals on a premise with insufficient animal handling facilities must be considered (de Klerk 2002; Scudamore et al. 2002). Further consideration must be made for how the remains of the animals will be collected and disposed of. Euthanasia in situations of mass eradication of a contagious disease will be managed and monitored by federal and state regulatory health officials who will designate appropriate methods for euthanasia. If large numbers of animals must be euthanized expediently on the original premise, the most likely method will be a gunshot. It should be noted that in the case of mass euthanasia, it is preferable to use a firearm that has sufficient muzzle energy to reliably result in death of the animal and not simply stunning the animal where adjunct methods are required.

This section on livestock euthanasia techniques has focused on the four primary methods of euthanasia in livestock that are accepted by the AVMA: (1) euthanasia by lethal injection of a pentobarbital-containing euthanasia solution, (2) gunshot, (3) captive bolt stunning, and (4) ITh injection of lidocaine. It must be acknowledged that unique circumstances can occur where the equipment required to perform one of these methods of euthanasia is not immediately available. Such situations challenge our ethical responsibility to follow established guidelines and our moral responsibility to relieve suffering. Morally, we face the consideration of whether prolonged suffering and natural death are preferable to a rapid death with the potential of additional acute pain and distress.

Methods of causing death in such situations should try to emulate the principles of euthanasia by rapidly rendering the animal unconscious, followed by inducing cardiac and respiratory arrest. Small livestock can be rendered unconscious by a very forceful blow to the head. This requires the use of a heavy, solid object that is forcefully propelled into the frontal area of the skull resulting in skull fracture and both concussive and physical damage to the brain. This procedure requires a high degree of force and accuracy to result in unconsciousness. The procedure is controversial, as it may not result in immediate unconsciousness when inappropriately applied. Blunt force trauma should only be used as a last resort in euthanasia.

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6

Zoo Species Euthanasia Considerations and Techniques

David S. Miller and Grey Stafford

6.1 Sociocultural Considerations

As with all species, a "good death" is the bar for which veterinarians should strive when euthanasia of zoo and aquarium species is required. However, euthanasia of zoo and aquarium vertebrate animals presents many practical challenges, given the diversity of anatomy, physiology, behavior, size range, and other characteristics associated with over 8500 different species managed in these facilities (Marcy 2021). Many of the euthanasia methods used for domestic animals can be directly used for zoo animals or modified to meet a species' characteristics.

Nevertheless, substantive challenges for appropriately selecting and applying euthanasia methods include:

- taxon-specific and individual-specific
- zoo and aquarium community "culture"
- societal expectations including segments of society that are opposed to animals under human control
- those who don't accept that zoo and aquarium animals are biological beings that can become sick and/or die, just as occurs with humans and domestic animals. Philosophical opposition to any justifications for ending an animal's life.

Therefore, the inherent biological complexity of animal species in zoos and aquariums, coupled with the diversity of societal perspectives, must be accounted for before, during, and after euthanasia of these animals (Figure 6.1).

The current standard-bearers among the zoo and aquarium background reflect an evolution from centuries of wildlife being valued solely for exhibition to the inclusion of broader scientific objectives. Therefore, in addition to exhibitions, many zoological institutions have embraced education, conservation, and research as a part of their mission. These scientific missions influence care and management decisions for animals throughout their life, including the institution's management system (traditional, semi-free ranging, use of ambassador animals, applied behavioral management, and other management systems). The scientific missions can affect when and how euthanasia is conducted as well as postmortem disposition of the body (AVMA 2020).

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Figure 6.1 A zoo habitat with polar bear resident. Careful consideration must be given to the time and place for the procedure. *Source:* Barb Wolfe, DVM, PhD, DACZM.

It is also important to recognize that some animals in zoos and aquariums become recognized by the public and become a part of the local, national, or international human community's focus and interest. This can have an impact on facility's financial security via paid attendance, donations, and other sources of income and goodwill. There can also be tensions caused by responsible population management objectives and where there is limited space and resources for meeting animal welfare needs.

The preceding reflects the perspectives of North American authors, but these perspectives are not necessarily shared globally; cultural, religious, local, or regional conventions, and other concerns may influence when and how animals' lives are ended. The potential for adverse publicity is highlighted by the international controversy over the decision to end a young giraffe's life and the subsequent feeding of the giraffe's carcass to the zoo's carnivores, even though the postmortem handling of the giraffe, by definition, did not pose animal welfare concerns for a deceased individual (Parker 2017).

There is the need to recognize that society's perspectives on zoos and aquariums, and humans' relationship with animals and wildlife are evolving over time. North America is a reflection of society's shift to more urban environments and fewer opportunities to interact with animals. This evolution may also overlay differing values among generations. Each of the above sociological factors has the potential to influence or cloud the decision whether to euthanize an animal and guide which methods are used.

6.2 Institutional and Professional Community Considerations

Zoos and aquariums differ from client-owned animals in that multiple personnel with differing roles have a stake in animal husbandry and management. Zoo directors, oversight boards, trustees, curators, animal care staff, and other personnel have varying levels of animal care and high-level perspectives and may have differing tolerances for the involvement of external interest in

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high-profile or routine euthanasia events. While facilities staff, concession workers, and others may not appear to have a stake in animal euthanasia events, there is value in considering their contact with the public as a part of euthanasia-related communications.

Veterinarians conducting euthanasia within zoological institutions must be cognizant of their personal biases and potentially adapt their approach according to the institution's exhibition and scientific missions, as well as staff needs. Accommodation of the human-animal bond, aesthetics, and opportunity to grieve, must be addressed for zoo and aquarium personnel while balancing the investment that staff make in caring for their animals with intra-institutional dynamics, and external audiences.

At least half of staff's waking hours are devoted to their animals. Therefore, a great deal of staff's pride, as well as their personal and professional identity, are a part of caring for and bonding with their animals. This must shape discussions regarding when and how to euthanize, as well as the adjustment and emotional processing after an animal's life is ended when daily staff's participation is required for optimal euthanasia events. There is an inherent tension between the investment that staff must make to provide optimal care for their animals and the need to "let go" when euthanasia is required. This tension can be further complicated by population management, economic, and other considerations external to animal health and staff's personal value systems. Therefore, end-of-life considerations for zoo and aquarium staff are similar to and often of greater magnitude than for companion animals and humans (Figure 6.2).

While quality of life concerns for individual animals are a common justification for euthanasia of nondomestic animals, population management euthanasia can be a justification for euthanasia



Figure 6.2 Zoo staff gathering to work with a giraffe. Animals of this size require many people to keep the animal and staff safe. *Source:* David Hamilton.

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of zoo and aquarium animals (Browning 2018). Population management euthanasia is the euthanasia of otherwise healthy animals due to limited resources such as space, social interruptions affecting the previously mentioned institutional goals, and/or welfare of other animals, and/or the individuals' limited genetic value to the population. The philosophical perspective supporting population management euthanasia includes:

- mitigation of harm when breeding is prevented, such as loss of parental and social skills
- failure to successfully reproduce following extended use of contraceptives
- reduced expression of normal behaviors
- disruption of natural animal life cycles
- reproductive pathologies associated with failure to breed
- suboptimal demographic population structure
- inadvertent requirements to maintain abnormal social groupings based on single-sex, demographically geriatric, and other groups (Ardaiolo and Powell 2013).

Counterarguments to population management euthanasia include concerns for ethical responsibility to the animals, public perceptions, alternative population management strategies, and staff resistance (Powell and Ardaiolo 2015; Browning 2018). This does not eliminate other options for population management that will vary by species and circumstances. However, this does require effective communications with internal and external audiences about the justification for population management euthanasia and how animal welfare concerns are addressed.

Intra-unit, intra-institutional, and professional community dynamics and public relationships have the potential to be particularly strained where community, national, or international attention is focused on the fate of high-profile animals, particularly where institutional norms are not strong and supportive. A notable challenge is where the inevitability of animal death clashes with philosophical perspectives that animals should not be under human care. In these instances, the circumstances surrounding the animal's death may be perceived and communicated differently according to the agenda of differing interests and thereby complicate decisions such as when to end an animal's life, selection of euthanasia method, and the caretakers' grieving process. While end-of-life considerations for zoo and aquarium animals that do not have a high profile may be less complicated or emotionally charged, caretakers still face difficult decision-making challenges and grieving similar to those associated with companion animals within institutional context. External resources such as GRAZE (www.zoomentalhealthsupport.com) may be of value for proactive and crisis responses that can assist with addressing the social concerns associated with euthanasia of zoo and aquarium animals.

There is a need to recognize the means by which information is shared external to the institution. Currently, there is a shift from conventional media and journalism to internet and social media technology and this prolongs news cycles that permit revisiting of videos. This increases the potential for perceptions of euthanasia and other zoo and aquarium activities to be skewed according to the interests of the media holder and this can impact legislative and regulatory actions that can limit options for optimizing animal welfare. Addressing this requires institutional and professional community clarity on birth-to-death management plans that address animal welfare, population management, research, and other scientific missions. Based on this, there is a need to develop advanced communication plans and a comprehensive euthanasia protocol that clarifies the decision process and methods of euthanasia while not losing sight of the need to address animal welfare as effectively as possible (Figure 6.3).

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Figure 6.3 Bonded animals make any euthanasia more complicated. *Source:* Barb Wolfe DVM, PhD, DACZM.

6.3 End-of-Life Considerations

Euthanasia complications in non-domestic species can occur and this topic has been incompletely discussed at this time (Hepps-Keeney and Harrison 2022). Measures to minimize the occurrence of undesirable euthanasia outcomes should be carefully considered and planned for. The following section will operate under the thesis that planning for prevention of undesirable outcomes is an obligation for veterinary professionals, and that there are three stages where end-of-life considerations are relevant (Figure 6.4). These three stages are:

A) During an animal's life where caretaking can optimize an animal's quality of life, and length of life, and serve as a baseline for comparison to evaluate an animal's future quality of life. Training animals for species and individual appropriate handling is a key part of addressing an animal's quality of life and can lay the foundation for euthanasia procedures that minimize or eliminate animal distress (Heidenreich 2019).
B) During the decision-making process for whether, when, and how euthanasia is to be conducted. This is where the institution's collection plan and animal welfare guidance serve to structure deliberation about the animal(s) to be euthanized, the animal's social group, staff welfare, conservation and science objectives, external audiences, and other considerations.
C) After the animal's death where staff grieving, animal disposition (use for research, curation, preservation, and/or disposal), application of management changes that benefit surviving animals, and outreach occur.

6.3.1 Lifetime Considerations

There is a need to proactively plan for optimizing animal welfare during all stages of an animal's life, including a plan for end-of-life concerns. Optimal animal welfare must consider basics such as provision of a balanced diet and water, meeting the animal's environmental, health, behavioral

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Figure 6.4 A dying primate is euthanized after zoo personnel consider all other options. *Source:* Dakota Zoo.

and social needs, and basic management to include monitoring of weight, training for voluntary behaviors (Table 6.1), and other animal management. These measures serve as preparation for euthanasia by providing baselines for future comparisons, delaying the occurrence of euthanasia by improving animal's quality and duration of life, and by providing a husbandry and training foundation for low-distress handling that will improve the quality of euthanasia procedures. Regular quality of life and daily assessments throughout an animal's life as a routine part of work culture will serve to determine how management and animal welfare can be improved and serve as a reference for assessments of geriatric-aged animals (Campbell-Ward 2023). Simple tools such

Table 6.1 Routine positive reinforcement training procedures throughout a zoo and aquarium animal's life that can maximize the odds that euthanasia procedures will be optimal for animal and staff welfare.

Handling procedures	Voluntary medical procedures
• Squeeze acclimation	• Venipuncture
• Manual restraint	• Body weight
• Separation	• Manual palpation
• Stationing	• Ultrasound
• Transport	• Hand injection
	• Radiographs
	• Foot work
	• Blood pressure, EKG (e.g. gorillas)
	• Gas anesthesia (e.g. face in a mask)

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as videos and lameness assessments can minimize subjectivity and reinforce an animal welfare-centric work culture (Hunter-Ishikawa et al. 2023).

6.3.2 Euthanasia Decision-making Considerations

The decision-making process for euthanasia including decisions whether, when, and how to conduct euthanasia must be transparent and open to the greatest extent possible. While there are many details to consider, the optimal decision will ideally mesh the ideals of each stage of the process (Table 6.2).

There are three euthanasia decision-making stages: whether, when, and how euthanasia should be conducted (Figure 6.5). Whether euthanasia should be conducted will always be the first stage. When euthanasia should be conducted will generally be driven primarily by animal welfare concerns. However, in some difficult situations, such as very large animals, how euthanasia will be conducted will be the second stage, and this will drive when euthanasia can be conducted.

6.3.2.1 Whether to Conduct Euthanasia

Decisions regarding whether to conduct euthanasia should be made within the framework of collection plans and institutional animal welfare structure, with modifications for the specifics of a situation. A lifetime history of quality-of-life assessments can assist with determining what is best for an animal by serving as a record for tracking subtle and overt changes that represent significant

Table 6.2 Elements of whether, when, and how to conduct euthanasia of zoo and aquarium animals to maximize the odds of a successful outcome.

Elements of whether to conduct euthanasia	Elements of when to conduct euthanasia	Elements of how to conduct euthanasia
• Animal quality of life (disease, lameness, other) • Staff safety • Conservation/science needs • Social group needs (including offspring) • Emergency (e.g. natural disaster, disease outbreak, food supply chain disruption)	• Animal quality of life (disease, lameness, other) • Staff safety • Conservation/science needs • Social group needs (including offspring) • Emergency (e.g. natural disaster, disease outbreak, food supply chain disruption) • Staff availability • Staff communications • Optimal conditions for the animal • Media/external audience concerns	• Animal quality of life (disease, lameness, other) • Animal handling • Minimization of adverse stimuli • Staff safety • Social conspecifics' needs • Aesthetics • Animal's trained behaviors • Ready availability of drugs, equipment, and supplies specific to the procedure • Animal-handling options • Tissue collection needs • Minimization of postmortem gross and histopathology artifacts • Use for research (e.g. museum or specific project requests) and conservation (e.g. reproduction and gamete banking needs) • Carcass disposal options • Regulatory guidance

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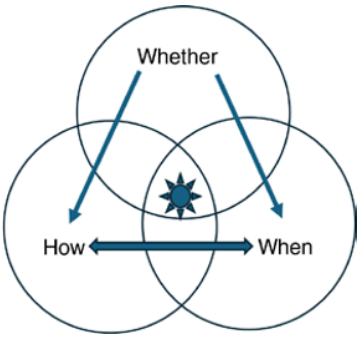


Figure 6.5 Euthanasia decision-making stages.
Source: David Miller DVM, PhD, DACZM, DACAW.

health, and other concerns in animals that often hide their illnesses. In instances where urgent decisions are not required, scientific considerations may enter the discussion. For instance, germplasm collection and the fate of *in utero* or juvenile animals may be important for endangered species population management. Population management and other scientific concerns have the potential to delay or accelerate the timeline for euthanasia. Also of concern are social groups, such as disruptions in hierarchy when dominant animals are removed from a group.

The decision process can present a substantive challenge to staff that have been devoted to optimizing an animal's welfare throughout its life. In many instances, an animal's caretaker will be a part of the decision process. However, the transition to "letting go" can be difficult to incorporate into objective decisions to terminate an animal's life, much as with companion animals and some other settings. Additional concerns for surviving members of the animal's social group can also complicate the decision to euthanize, such as when there are not "good" options for caring for the surviving member of a pair. Another circumstance that can present challenges for euthanasia decision-making is when the need for a resolution is immediate (e.g. due to severe traumatic injury) or imminent due to animal welfare concerns or disasters such as where an animal's basic needs cannot be met. Regardless of the factors involved, it is important to strive for consensus and anticipate sources of objections and potential responses.

6.3.2.2 When to Conduct Euthanasia

When to conduct euthanasia is dependent upon animal welfare concerns including how severe a condition might be and the condition's timeline for progression. There is also a need to consider: conservation/science needs, social conspecifics' needs, emergency constraints, public health, euthanasia method, and staff involvement and availability, as previously addressed as part of the decision process for whether to euthanize. Above all, an effective communication plan with all internal staff and external audiences is essential. Consider whether advance communications about a euthanasia procedure will be beneficial or result in disruption by excess or external participants.

Safety is paramount for considering when to conduct euthanasia. Human safety is the first priority, with an emphasis on the physical safety of the staff (particularly with potentially dangerous species), as well as concern for transmission of zoonotic agents, staff emotional safety, and other considerations. Animal physical safety must also be considered, such as for animals that are situated arboreally, for large animals where falls to hard surfaces during initial immobilization are a risk, animals in aquatic environments at risk of drowning, and other factors that will vary across settings. Decreasing the impact on socially housed conspecifics, minimizing the transmission of zoonotic agents, minimization of sensory impact (such as alarm odors emitted by euthanized animals), and other factors must be identified and managed to the best extent possible. Broad

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consideration of the various negative impacts on all potentially affected humans and people will maximize the odds of having a successful euthanasia procedure.

6.3.2.3 How to Conduct Euthanasia

6.3.2.3.1 Animal Handling

The most impactful part of euthanizing zoo and aquarium animals is appropriate handling. Appropriate handling can be the difference between a "good" and a "bad" end-of-life procedure. This is where lifetime training for voluntary shifting (Heidenreich 2019), manual restraint, and medical procedures, as well as trust in their caretakers and comfort in their environment, are directly relevant to euthanasia. Lifetime training for routine husbandry and veterinary procedures maximizes the odds of a calm animal that will accept administration of medications or physical euthanasia methods with little or no distress. Lifetime training may also increase the ability to adapt handling and euthanasia procedures according to the animal's quality of life and current condition or limitations. Lifetime training can be modified prior to euthanasia, when needed, to account for the specifics of a pending procedure, such as within enclosure "furniture," drug volume, and delivery method (e.g. intramuscular [IM] injection, oral [PO] administration). Unlike survival anesthesia or sedation, food rewards are acceptable for euthanasia.

There is a need to anticipate from the animal's perspective responses to potential adverse or novel stimuli such as extraneous personnel, sound, touch, visual and emotional stimuli in environment, including due to other animals. Staff proficiency and efficiency in animal handling are also important during procedures for minimizing distress. Emotions from the humans in attendance and unneeded noise also have the potential to stimulate a sense of arousal in the animal and this arousal may counter immobilizing and sedative drugs, as well as confound physical restraint. A culture of routine open dialogue and documented protocols will help ensure that the best choices are made.

Voluntary behavior, manual restraint, and chemical restraint in isolation or in combination with zoo and aquarium animals are based on routine practices that can be modified as needed for euthanasia. Staff skill sets and experience (particularly with a given species and setting), references devoted to restraint, familiarity with the literature, and informal communications are resources that can be applied to optimize specific animal euthanasia events. Restraint that minimizes the activation of the sympathetic nervous system minimizes the odds of animal alarm or distress that will confound the euthanasia procedure. Ensuring that all supplies are readily accessible, and that staff roles of each staff member are defined in advance reduces the potential for harm or distress in the animal (Figure 6.6).

6.3.2.3.1.1 Voluntary Behaviors Training animals for voluntary medical procedures can enable staff to access animals for injections or other forms of restraint with minimal to no alarm response or other distress. Also important are routine husbandry behaviors such as shifting so that an animal can be isolated from conspecifics or into enclosures that permit close proximity for subsequent euthanasia-related procedures. Facilities that are well-designed and based on animal behavior and natural history can support shifting into safe areas as can the ability to modify lighting (e.g. dimming for animal calmness). There is a need to temper expectations for voluntary behaviors when animals are physically disabled, in pain, senescent, ill, distressed due to a loss of place in social hierarchy due to end-of-life conditions, or other reasons. Regardless, these challenges illustrate the importance of conducting training early and often throughout animals' lives.

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Figure 6.6 Some animals will be euthanized during medical procedures when a significant illness is found. *Source:* Dakota Zoo.

6.3.2.3.1.2 Restraint Devices A variety of mobile and fixed restraint devices can be used to restrain or limit the movement of zoo and aquarium animals as a part of routine husbandry and euthanasia procedures. These devices can serve to restrain an animal while humans are at a distance and outside of the animal's flight zone, or at a minimum, distant from immediate proximity to the animal. The value of these devices for restraint as a part of euthanasia procedures is a function of the species, individual, the individual's restraint history, setting, skill of staff, intact functionality of the device, and potentially other factors as a part of planning for a specific procedure. Regardless of the device used, the goal is for restraint to result in little to no distress or alarm for the animal to achieve a "good death." Ideally, these devices will be the least alarming to the animal if they are familiar with it on a daily or routine basis.

Squeezes A variety of designs for different species can be used to "squeeze" an animal with a moveable part of an enclosure that can press an animal against an opposing cage side or solid surface, much as with cattle squeeze chutes. Depending on the design, open bars or solid sides with access ports can permit staff to physically contact the animal. This can assure staff safety for large and/or dangerous species and can minimize animal distress when the animal is acclimated to the device and procedures in advance. Incorporation of a squeeze (and scale) into a chute or passageway that an animal uses daily is an ideal strategy for acclimating an animal to a squeeze when the squeeze is applied often enough for the animal to become acclimated to being squeezed (Figure 6.7). Some squeezes will have a dropped floor for species which will become passive when their feet are not contacting the ground. Some squeezes can be rotated to a horizontal position, such as for large-bodied species where procedures such as foot care can be performed more easily on a laterally recumbent animal. Squeezes can also be incorporated into movable cages that can be attached to

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Figure 6.7 A sable antelope retrained in a squeeze chute to minimize injury. *Source:* Barb Wolfe DVM, PhD, DACZM.

the enclosure side for the animal's voluntary shift followed by closing the entry door and the cage being moved away from the enclosure.

Protected Contact Protected contact is a commonly used term for enclosures that limit contact between staff and large and/or dangerous species when there is the intent for staff to be able to physically contact the animal via ports that can be opened according to what part of the body needs to be accessed. Protected contact is generally designed for animals to voluntarily present themselves for physical contact, injections, and other medical procedures. However, this concept can be extended to restraint when animals are trained to enter crates with access ports, as has occurred for mammal and reptile species. In contrast to openness of squeezes, the solid sides of such crates may provide animals with security due to the absence or reduction of visual contact, particularly for species that are calmed by darkness. Clear tubes used for snakes, particularly poisonous species, are an alternate protected contact approach that permits staff to visualize the animal and potentially access the tail without the animal being able to turn around and strike personnel.

Push Boards Push boards are solid sheets of wood, metal, or other material with handles that permit staff to guide an animal into a location where euthanasia is to be performed and/or pushed against a wall or fence for restraint. Push boards are a moveable and improvised version of protected contact that can be useful for species that cannot climb or jump over the board. As with other procedures, it is ideal for animals to be acclimated to the procedure. Regardless, slow and patient movements that minimize the alarm response of the animal will decrease alarm responses and distress and enable hand injection of drugs or other methods associated with euthanasia.

6.3.2.3.1.3 Manual Restraint For species and individuals where skilled staff can capture and restrain the animals, or after animals are restrained by other methods, manual restraint may be

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useful. The direct proximity of humans and physical control of the animal increases the odds that an animal will experience distress or alarm, or that the animal or staff will experience an injury. Therefore, skilled staff with good hand-eye coordination and experience with the capture method is important, as is having the animal in a setting where objects that can interfere with restraint are eliminated or reduced. Be aware that removal of hide boxes and other objects can potentially increase distress prior to the capture event. This requires balancing the tradeoffs for a specific situation. Manual restraint includes:

- Hand "grabs" for tractable animals and for those that are sufficiently slow or immobile to permit use of this method. Jesses on birds and tethers on some tractable animals can serve as an initial method of manual restraint, and this requires an animal to acclimate to the device.
- Tools for pinning animals, such as snake tongs or snake hooks, can be used to restrain an animal for an injection or until hand restraint can be applied.
- Nets are used for each of the major animal taxa, whether in aquatic or terrestrial environments. This method generally requires skill and permits the animal to be transferred to hand restraint, injected through the net, or other strategies.
- Towels, blankets, and similar materials can be used to hood an animal (such as for raptors or ratites) or thrown over an animal for initial restraint followed by transition to hand restraint. This method can be useful for calming animals by eliminating visual stimulation and allowing staff to safely restrain limbs, such as for preventing raptor talons from impaling staff.

6.3.2.3.1.4 Chemical Restraint; Pre-euthanasia Sedatives and Anesthetics Many zoo and aquarium animal euthanasia events use chemical agents as the primary method of restraint or in combination with other methods. Past records, experience with conspecifics, and references can be used to identify appropriate dosages and drug combinations for balanced anesthesia (West, et al. 2014; Kreeger et al. 2023). Training of animals for voluntary IM injection or intravenous (IV) injection of immobilizing drugs is preferable as a means of reducing discomfort compared to the impact trauma of remote injection via darts. Commonly used drugs include cyclohexanes, alpha-adrenergics, benzodiazepines, butyrophenones, opioids, propofol, inhalants, and tricaine methanesulfonate (MS-222 for fish and other poikilotherms). These agents can be administered via hand injection, darts, orally, enclosures for inhalants, or immersion in baths (MS-222). Overdoses of immobilizing drugs as a part of immobilization can be euthanasia method options. Importantly, the use of drugs can influence methods of carcass disposal, and this may be a particular concern for large-bodied animals where incineration or deep burial would be required.

6.3.2.4 Selection of Euthanasia Methods

The American Veterinary Medical Association (AVMA) criteria for evaluating methods of euthanasia provides a useful structure for evaluating what euthanasia methods to use for zoo and aquarium animals (see Chapter 1). These criteria can be condensed to considering the impacts on the animal, impacts on staff, availability of drugs and equipment, legal concerns, and postmortem use of the animals. While many euthanasia procedures for zoo and aquarium animals may use a routine approach (e.g. IV administration of a barbiturate such as pentobarbital), there is value in using the AVMA criteria to ensure that the "best" option or the best balance of competing interests is used for each euthanasia procedure. There is a need to retain an open, observational, and analytical mind to ensure that each animal's specific needs are addressed. This will vary by animal, staff, public, logistics, and other considerations. This is also a dynamic target, as changes in any of the

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precedings and others, such as extreme weather conditions (whether from the animal or human perspective), may require modification of "routine" procedures.

The three basic mechanisms by which an animal's life can be ended (depression of cortical neurons required for life; hypoxia; and destruction of central nervous system [CNS] tissues) are addressed in Chapter 1. All euthanasia methods that are used for domestic animals and applied to wildlife species are based on these mechanisms. However, for zoo and aquarium species, knowledge of an animal's physiology, anatomy, behavior, and life stage is essential for considering how conventional euthanasia methods may or may not be useful for a given situation (Figure 6.8). For instance, animals with a tolerance for hypoxia (e.g. many poikilotherms, diving species, fossorial species, neonates of some species, hibernating, bruminating, or estivating species, and other characteristics) may be resistant to euthanasia methods based on hypoxia. The animal's behavior is relevant in that animals with strong innate fight or flight responses that are activated by rough handling may be resistant to the effects of immobilizing and/or euthanasia drugs due to activation of the sympathetic nervous system. Therefore, handling based on strong training for voluntary behaviors can minimize the impact of fight or flight responses, diving out of reach of staff, and other species characteristics that can require modification of conventional euthanasia methods.

Euthanasia methods must cause death while inducing minimal to no pain, distress, or anxiety, be appropriate for the size and characteristics of the animal, safe for the operator and nontarget animals, and must result in irreversible cardiac and respiratory failure. Euthanasia procedures for zoo and aquarium animals should be based on existing medicine and husbandry practices, as indicated in previous sections. Most zoo and aquarium euthanasia events use pentobarbital, with modifications as needed for a given procedure. Contemporary references (Table 6.3) can provide some reference to standard medical practices for chemical immobilization, venous access, and other basic procedures that can serve as a foundation for euthanasia events. Less conventional methods may be of value in some instances, such as slow intraosseous (IO) administration of chemical agents in debilitated animals that have an IO catheter in place due to medical reasons. Conventional approaches will be of varying value for a given euthanasia procedure depending upon the species, setting, staff experience and skills, available resources and limitations, and the individual animal's characteristics, history, and current condition. Training and husbandry references are also key to ensuring that zoo and aquarium animal euthanasia events are truly "good deaths," and these references are continually being updated and refined (Figure 6.9). As with medical references, the husbandry procedures that support "good deaths" will be modified



Figure 6.8 Euthanasia of a mussel via injection. *Source:* Barb Wolfe DVM, PhD, DACZM.

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Table 6.3 Selected general zoological medicine references for methods upon which euthanasia procedures can be based.

Reference	Reference topic
West et al. (2014)	Comprehensive reference on chemical immobilization
Kreeger et al. (2023)	Comprehensive reference on chemical immobilization
Fowler's Zoo and Wild Animal Medicine series (note that back editions may need to be consulted for some topics). Latest edition: (Miller et al. 2023)	Series of veterinary medical texts for zoological species
Divers and Stahl (2019)	Veterinary medical text for herptiles
Samour (2016)	Veterinary medical text for birds
Smith (2019)	Veterinary medical text for fish
Consult with the facility holding the animal to be euthanized.	Resources for contemporary taxon-based husbandry guides. These are continually evolving and often require access to password-protected websites.
Ramirez (2019) Chance and Furlong (2022) Stafford (2007)	References for positive reinforcement training



Figure 6.9 Operant conditioning improves an animal's comfort with handling and can make euthanasia protocols safer. *Source:* Dakota Zoo.

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according to the species, setting, staff experience and skills, available resources and limitations, and the individual animal's characteristics, history, and current condition.

Regardless of the degree to which animals are trained, chemical immobilization may be used for restraint or as part of euthanasia procedures. Comprehensive consideration of chemical immobilization methods is available in multiple references (West et al. 2014; Kreeger et al. 2023). Selected comments for zoo and aquarium animals are as follows:

- Complementary pre-euthanasia drug combinations for sedation and anesthesia can minimize the odds of stage 2 activity (see Chapter 1). As with companion animals, stage 2-associated occurrences warrant advance communication to staff to ensure their awareness prior to administering euthanasia agents.
- Administration of barbiturates most commonly occurs via IV routes, although lymphatic vessels may be inadvertently injected in some species, particularly poikilotherms. Species-specific anatomical challenges may require the use of less conventional blood vessels such as sublingual vessels, or identification of suitable blood vessels using ultrasound.
- Methods based on hypoxia are uncommonly used for zoo and aquarium animals. However, in the event of an emergency requiring mass depopulation (as opposed to euthanasia) (AVMA 2019), these methods (CO_2, CO, nitrogen) may be of value for reducing distress due to the reduced need for handling and absence of manipulation for venipuncture.
- Physical destruction of brain tissue requires a well-working firearm, a euthanasia location where firearms are legal, accurate knowledge of the animal's skull anatomy, a firearm and ballistic that can penetrate the skull, skilled marksmanship, accurate targeting of the ballistic, a location where human and other animal's safety can be assured, consideration of the auditory impacts of firearms on staff and animals, and the appropriate human and animal social environment.
- Except in the case of a dangerous escaped animal or an emergency due to a disaster (hurricane, tornado, flooding, etc.), in which case it may not be possible to prioritize euthanasia (a good death), it would be unusual for a firearm to be the preferred means of ending a zoo and aquarium animal's life. This would also require having appropriate backstops and other safety measures in place.
- Destruction of brain tissue also eliminates postmortem assessment of this tissue and is a particular concern when zoonotic agents such as rabies are of concern.
- A potential benefit of euthanasia with a firearm is the opportunity to feed the carcass to other animals as enrichment or for other reasons, particularly where lead shot fragments can be avoided.
- The need for physical contact between the captive bolt and the animal's skull requires a stationary animal and could be disturbing or unsafe for the captive bolt operator.
- Pithing is best used as a secondary method of destroying brain tissue that is most useful for animals that are unconscious due to other methods and is particularly useful for poikilotherms because of the difficulty of confirming death in these species.
- Exsanguination is also most appropriate as a secondary method of euthanasia for assuring death in poikilotherms as well as homeotherms, although prevention of blood-borne agent transmission is required.
- Blunt trauma, cervical dislocation, decapitation, and thoracic compression are also most appropriately used as secondary methods of euthanizing zoo and aquarium species but may be considered for primary euthanasia of "feeder" animals (e.g. rats, mice, fish, and other species) that are fed to permanent collection animals. These methods must only be used by professional staff or veterinarians who are fully trained and proficient in these methods.

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- Hypothermia can be a confirmatory method of euthanasia in insentient animals. A full discussion of the concerns of feeder animals is beyond the scope of this chapter.
- Kill traps can result in instant death and are most appropriately used for pest-rodent species removal.
- Electrocution is unlikely to be relevant for euthanasia of zoo and aquarium animals.

In addition to pre-mortem considerations, selection of euthanasia methods should include post-mortem expectations that reflect the zoo and aquarium community's best practices, as well as the needs of the facility and real or potential collaborators. For instance, methods of euthanasia that destroy the brain eliminate or minimize the opportunity for gross and histopathological assessments of this tissue, which thereby limits diagnosis of CNS disease, including zoonotic agents such as rabies. Similarly, some injectable agents such as pentobarbital can induce histological artifacts. While secondary intoxication after consumption of an animal euthanized by drugs is a concern that warrants prohibition of feeding zoo animal carcasses containing drug residues to other zoo animals (Wolfe and Miller 2005), risks associated with contact toxicity (such as for museum specimens) may be considered in some instances, even though this risk is likely minimal. Since renderers may not accept a carcass that is contaminated with drugs, incineration, deep burial, or other methods may be required for animals for which drugs are used for euthanasia and should influence what euthanasia method will be used.

In contrast to domestic animals, the research needs for zoo and aquarium animals may warrant postmortem procedures that benefit veterinary medicine or general research needs. For instance, postmortem radiographs of intact carcasses can be of value for subsequent clinical reference, particularly where there is the opportunity for gross visual comparison. Likewise, use of the carcass for practicing endoscopic procedures can serve to benefit future antemortem diagnostic procedures. Basic medicine and specific research projects may benefit from postmortem tissue collection and collection of eggs and sperm can support cryogenic banks intended for later conservation needs. Research can also benefit from carcasses or parts of carcasses that are donated to museum collections. Education programs may benefit from horns, integument, and other parts that are donated so members of the public can have direct contact. Necropsy findings can also be used as the basis for improvements in surviving animals' care and therefore should be a part of debriefing discussions.

6.3.2.4.1 Special Considerations

Refinements to euthanasia methods must consider many zoo and aquarium animal characteristics that differ from those of domestic animals (Figure 6.10). Life stage characteristics include the degree of ontogenetic development, physiology, and torpid life history stages. Ontogenetic characteristics include shelled or leathery (birds and reptiles) and unshelled eggs (amphibians and fish), as well as intermediate developmental stages such as marsupials in obligate pouch development stages. While rigorous information regarding egg euthanasia is limited, shelled or leathery eggs may be euthanized via anoxia (e.g. application of oil that prevents respiration through the shell), addling (termination of embryo development by shaking, puncturing, or oiling the egg), maceration, prolonged exposure to carbon dioxide (CO_2), cooling or freezing, and potentially other methods. Unshelled eggs may be euthanized via freezing, maceration, and placement in tissue fixatives, among other options. Pouch-bound young must be looked for when a marsupial female is euthanized. If found, the juvenile must be euthanized using methods that are likely applicable to adults of the species. As indicated previously, some juvenile animals and species have a tolerance for hypoxia that warrants additional attention to verifying death. Similarly, euthanasia of animals in

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Figure 6.10 Working with aquatic animals poses a unique set of challenges. *Source:* Grey Stafford.

torpid life history stages (hibernation, estivation, brumation) requires attentive confirmation of euthanasia and may require higher doses of barbiturates (Hepps-Keeney and Harrison 2022). In such instances, secondary euthanasia methods such as physical destruction of the brain or decapitation are recommended.

Arboreal animals may be difficult to get in hand without darting with chemical immobilization drugs and care must be taken in these instances to ensure that trauma does not result from contact with branches or other objects when falling, and that uncushioned falls to the ground are avoided. Padding or nets that prevent partially immobilized animals from hitting the ground are needed to ensure animal welfare, and placement of such padding warrants careful consideration of potential animal trajectories and unanticipated movements. Similarly, padding or other low-distress approaches (e.g. use of a squeeze) should be employed to prevent large-bodied animals from sustaining uncushioned falls to the ground. Planning and positioning are key to ensuring that large-bodied animals fall into hay, shavings, mattresses, or other materials that will cushion falls to the ground as immobilizing agents take effect, and ropes or other means of controlling the fall and/or guiding the animal may be warranted.

Large-bodied animals also pose challenges for administration of sufficient volumes of barbiturate based on similar domestic animal species' dose, and in such instances, coadministration of magnesium sulfate (2 mL/kg of saturated solution) or potassium chloride (75–150 mg/kg) to unconscious animals may be warranted and may be combined in the same syringe with the barbiturate if the magnesium sulfate or potassium chloride are in solution and no crystals are in the syringe.

Special circumstances that warrant otherwise unplanned animal death include emergencies. For dangerous animals that have escaped or otherwise pose a threat to human or other animals' safety, immediate responses may require use of firearms that do not result in euthanasia, although accurate remote targeting of the brain can result in euthanasia (DeNicola et al. 2019). Natural disasters and similar emergencies can also pose situations where animal lives must be ended for reasons other than the animal's current health and welfare status. While euthanasia methods may be employed under some natural or other disaster scenarios, depopulation standards may be required under other scenarios (AVMA 2019). Depopulation methods recognize that under some pressing

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circumstances, euthanasia methods may not be practical and good faith efforts to use the most humane methods available to end life may be required.

Zoological Disaster Response, Rescue, and Recovery (ZDR3) is an industry-led effort that can assist with advance planning for emergencies and emergency responses, including euthanasia under emergency conditions (www.zdr3.org). Advance planning is an essential part of emergency responses and ZAHP (Zoo and Aquarium All Hazards Partnership (www.zahp.org)) is a second industry-specific organization that provides resources that are complementary to ZDR3. Preparation for catastrophic events also warrants attention to staff mental health, and as discussed previously, GRAZE offers support for the zoo and aquarium community.

6.4 Taxon-Based Euthanasia Overview

The diversity of species, individuals, and situations where euthanasia is conducted in zoos and aquariums is extensive. The following provide general, broad-based comments that will assist practitioners with euthanasia in zoo and aquarium species but are not comprehensive. Refer to Chapters 2–5 for specific technique training that may be applicable to zoo species.

6.4.1 Fish

The major fish taxa in zoos and aquariums are Teleosts (bony fish) and cartilaginous species (sharks, rays, and eels). These major groups of aquatic animals have a wide range of body sizes and can respond differently to chemical immobilization and euthanasia agents. These differences are magnified by the diversity of water chemistry, diets, and other characteristics associated with over 3000 species of fish cared for in zoos and aquariums. Fish can be trained for behaviors that can facilitate basic husbandry, restraint, and euthanasia behaviors, such as sharks trained to accept restraint in slings. However, nets and other manual restraint methods are most commonly used for fish. Caution is warranted for large and dangerous species, including those with venomous natural defenses. Chemical agents can be administered to fish via baths (e.g. MS-222), IM, intracoelomic, and IV routes. Captive bolts may be effective for large-bodied fish when the location of the brain is established (Figure 6.11). While ultrasound and ECGs may be useful for evaluating fishes' physiological functions, the potential for incomplete depression due to chemical agents and spontaneous recovery indicate that secondary methods of euthanasia such as pithing and exsanguination are warranted.

6.4.2 Amphibians

The major amphibian taxa are Anurans (frogs), Urodela (salamanders), and Gymnophiona (Caecilian). These species generally have an aquatic lifestage and often have moist integuments that are permeable to some chemical agents. Amphibians have jumping, four-legged gait, and swimming locomotion strategies that influence restraint strategies. As with fish, amphibians have a variety of life histories that may influence euthanasia procedures, and some species have integuments that can be irritating to the unprotected skin of staff. Most amphibian species are small-bodied and are conventionally restrained using manual methods. Chemical agents can be administered via the topical, bath, IM, intracoelomic, and IV routes. Common IV routes include tail, jugular, and ventral abdominal (lizard) veins. As with fish, secondary methods of euthanasia such as pithing and exsanguination are warranted to ensure that death has occurred.

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Figure 6.11 Captive bolt use in large white sturgeon. *Source:* Jackson Gross, PhD.

6.4.3 Reptiles

Reptiles are composed of five anatomically and physiologically diverse groups: lizards, snakes, chelonians (turtles and tortoises), crocodilians, and tuataras. Over 400 species of reptiles with a wide variation in body sizes and diverse life histories are cared for in zoos and aquariums. Reptiles employ a variety of locomotion methods that pose varying degrees of challenge for personnel responsible for restraining animals for euthanasia. As with other poikilotherms, behavioral assessments of reptiles based on many mammalian criteria (facial expression, ear position, piloerection) are of limited value and can present personnel safety challenges from species that are venomous, aggressive, or large-bodied. Reptiles in all five major groups can be trained for husbandry and medical procedures, and voluntary entry into containers that enable protected contact is possible. Since training for many species is limited for most institutions, various restraint devices or manual restraints are commonly used for euthanasia. For some species, minimizing visual stimulation and application of ocular pressure to reduce vagal tone, dorsal recumbency, or other methods appear to reduce distress associated with manual restraint. Placement of venomous snake species in clear plastic tubes and use of multiple personnel to restrain large-bodied dangerous species are examples of restraint methods that can be used to maximize personnel safety. Chemical agents can be administered via IM, IO, intracoelomic, and IV routes. Common IV routes include tail, jugular, brachial, subcarapacial (chelonian), and ventral abdominal (lizard) veins, as well as the dorsal cervical sinus (sea turtle). In snakes, cardiac venipuncture is regarded as a safe procedure because of the ability to stabilize the heart (unlike other taxa) and the absence of apparent complications with routine venipuncture (Figure 6.12). Firearms and captive bolts may be effective for large-bodied reptiles such as crocodilians when the location of the brain is established. While ultrasound and ECGs may be useful for evaluating a reptile's physiological function, the potential for incomplete depression due to chemical agents and spontaneous recovery indicate that secondary methods of euthanasia such as pithing and exsanguination are warranted.

6.4.4 Birds

Over 1000 species of birds among 41 orders are cared for in zoos and aquariums. The sizes of birds under managed care range from small hummingbird species to large-bodied ratites (ostrich, emu, cassowary) with a corresponding diversity of physiology, anatomy, behavior, and life history

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Figure 6.12 An anesthetized carpet python receiving an intracardiac euthanasia injection. *Source:* Gregory A. Lewbart.

strategies. While flight is the most common method of locomotion for birds, aquatic species and some ground-dwelling species are flightless. Birds can be trained for voluntary medical and husbandry procedures, although manual restraint is common with the use of nets, push boards (ratites), hand grabs, and other methods as options to consider for a particular species and individuals. Large-bodied species can inflict severe injury on staff, some species can cause injury via feet (raptors, ratites), and caution is warranted for most species' beaks due to injuries caused by crushing (psittacines), penetration, or other means (Figure 6.13). Staff eye protection is warranted for many species. Inhalant agents can be administered to birds via face masks or closed containers. Chemical agents can be administered via IM, IO (most species), intracoelomic, and IV routes. Common IV routes for birds include the jugular, ulnar, and metatarsal veins. Captive bolts are available for birds with the size and anatomy of commercial poultry and may be useful for large-bodied species such as ratites. Auscultation, electrocardiogram (ECG), prolonged fixed eye position, and other methods of confirming death in mammals are more reliable in birds than in poikilotherms but secondary methods of euthanasia can be valuable.

6.4.5 Mammals

Zoos and aquariums care for 29 orders of mammals, ranging in size from shrews to elephants and whales. The taxonomy, physiology, anatomy, behavior, and life history range include features that differ from domestic animals such as egg-laying (monotremes), pouch young, heavily keratinized dermis (pangolins), spines (porcupines), deep diving physiology (marine mammals), and other characteristics. The range of locomotion methods that staff must be aware of includes arboreal, high jumping, swimming, and other strategies that can complicate restraint for euthanasia and other procedures. Large-bodied, predatory, and other species can pose a threat to human safety. Mammals are commonly trained for voluntary and medical procedures, although some taxa are more likely to be trained for a variety of reasons. Many restraint devices and techniques were originally developed for specific mammalian taxa. Chemical injection methods of euthanasia are most common for mammals with administration via jugular, femoral, cephalic, saphenous, tail vein, or intraabdominal routes, although inhalants may be administered in some instances. Atypical IV

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Figure 6.13 A large bird being assessed before euthanasia. Safety will be a top priority for everyone. *Source:* Dakota Zoo.

access includes extradural intervertebral venous sinus (pinnipeds) and fluke or flipper veins (cetaceans). Even using tools that are common for domestic mammals for assessing death, inconsistent responses warrant use of secondary methods of euthanasia.

Many of the mammalian euthanasia techniques described in other chapters are relevant to zoo and aquarium mammals. However, large-bodied hoofstock, large marine mammals, and megavertebrates can present unique challenges (Figure 6.14). Intraspecies social dynamics must be considered for the animal being euthanized, surviving members of the group, and cohorts that may be present for part or all of the euthanasia event. For the latter, the presence of a trusted companion can be comforting to the animal that is to be euthanized, but potentially traumatic to the companion. In addition, the proximity of companion animals can pose a safety risk to personnel during euthanasia events.

A practical concern for large-bodied mammals is having sufficient drug supplies on hand to conduct euthanasia. Potential supply disruptions and urgent euthanasia procedures may favor keeping large drug supplies on hand. However, while drug therapeutic efficiency can extend well beyond listed expiration dates (Prem Swaroop and Varun 2011), retaining drugs beyond their expiration dates is not compliant with some regulatory requirements and risks unsatisfactory drug performance that can compromise the quality of the euthanasia procedures. As drug expenses for large-bodied animals can be substantial, arrangements, where drugs can be replaced prior to expiration with updated products by pharmacies, shared or borrowed drug resources among facilities, or other solutions, may need to be considered in advance for euthanasia or immobilization events.

Special postmortem concerns for large-bodied mammals include necropsies and disposal. Necropsies may require the participation of staff to address the physical challenges of the necropsy. This can be emotionally challenging for staff who cared for the animals during life if these individuals are asked or required to assist with the necropsy. Disposal can present logistic challenges whether the animal is incinerated, buried, composted, or other methods are used. Prevention of scavenging of the carcass is critical where secondary toxicosis is possible due to the presence of immobilizing drugs in tissues. Use of potassium chloride, magnesium sulfate, or secondary mechanical methods of euthanasia can minimize the level of immobilizing drugs in the tissues of immobilized animals (Harms et al. 2014).

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Figure 6.14 A large hoof stock species being moved inside for the procedure. *Source:* Dakota Zoo.

6.5 Postmortem Considerations

6.5.1 Confirmation of Death

As with domestic animals, confirmation of death is an important part of zoo and aquarium animal euthanasia procedures. However, unique anatomical structures and physiology can present challenges for establishing death in some species and individuals, particularly for poikilotherms. In such instances, ultrasound to assess heart contractions, electroencephalogram (EEG) or ECG to assess brain or heart activity, and other methods may be useful to confirm death. As these methods are not foolproof, a secondary method of euthanasia and/or monitoring for at least 30 minutes is advised.

6.5.2 Grieving and Postmortem Handling

As with companion animals, zoo and aquarium staff should be provided the opportunity to grieve in the presence of the animal's carcass following confirmation of death (Figure 6.15). Similarly, members of the public and other external entities should be offered opportunities to grieve such as with pre-communications that an animal is in decline, onsite memorials, opportunities for the public to share memories online, and providing links to zoo or conservation projects that benefit surviving and future members of the species or the zoo in general. There is also the obligation to meet the zoo and aquarium community's need for postmortem data and opportunities for research and archiving of carcasses or parts of carcasses.

Expectations for appropriate handling of animal's remains will vary by culture, religious traditions, historical context, individual animal, and other concerns. This may involve societies physically

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Figure 6.15 Zoo personnel often become very connected with animals in their care and can grieve the loss in profound ways. *Source:* Courtesy of Grey Stafford.

distant from North America and Europe with "loaner" animals in American or European zoos, as well as societies within America or Europe. An example of the latter is the death of the orca Lolita (Tokitae) in 2023. In this instance, conventional United States zoological postmortem carcass handling was modified for transport of Lolita's ashes to the Lummi Nation (Native American nation) for private ceremonial mourning because of Lolita's birth within the Lummi Nation's waters and this society's cultural identification with orcas.

There is a need to recognize that after death occurs, the animal's welfare is no longer a concern, as the animal is unable to experience either "good" or "bad" welfare. This biological reality is distinct from some societal perceptions, such as where the euthanasia of a young giraffe due to population management concerns and subsequent feeding of the carcass to the zoo's carnivores caused international objections (Parker 2017). In contrast, acceptance of the giraffe's death and predator feeding on the carcass created little or no consternation in the country where the giraffe lived. In addition, respectful handling of the carcass can also be a concern for some staff in some instances, particularly where pathologists who are not a part of the institution conduct necropsies and are feared as uncaring strangers. In this instance, there can be challenges in meeting expectations for carcass handling if routine necropsy disarticulation procedures are witnessed by staff. Alternatively, staff participation may be required for large-bodied animals because of the physical labor demands associated with necropsies of a large animal. Another possible scenario is where staff may voluntarily witness or participate in a necropsy as a means of closure and/or observing and understanding pathology that was not evident in life and with the objective of improved future animal care.

Biosafety protocols must be considered a part of an animal's postmortem handling, particularly where exsanguination, pithing, or other euthanasia procedures are used that can increase staff exposure to zoonotic agents. A variety of infectious agents can potentially infect personnel attending a necropsy. This warrants use of personal protective equipment (PPE), appropriate ventilation,

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and care for exposure to the carcass and bodily fluids postmortem, and where practical, premortem. The risk of aerosolization and other routes of transmission can be present even when zoonotic agents are not suspected prior to conducting the necropsy. Nevertheless, the potential for a necropsy to provide staff with closure, contribute to the medical database for the species, and for banked samples or museum donations to contribute to basic research indicates that all euthanized zoo and aquarium animals and natural deaths should be necropsied by a knowledgeable veterinary professional unless precluded due to autolysis or other compelling reasons. Postmortem research requests and biobanking needs should be used to modify routine necropsy protocols as needed for a specific animal. In many instances, requests for specific germplasm or other tissues are requested within the zoo and aquarium prior to animals' deaths and these requests should be associated with an animal or species' record prior to death and used to modify standardized necropsy forms. Ideally, pathologists and laboratories that are a part of a zoo and aquarium animal's necropsy will have the specialized knowledge needed to evaluate these species.

As indicated previously, the euthanasia event should include opportunities for closure. Information from necropsies can provide information about an animal's condition that will help staff refine their understanding of the animal's health and welfare and will contribute to medical and biological research that will benefit surviving and future individual *in situ* and *ex situ* animals and/or their populations. Germplasm that contributes to the species' conservation goals can also serve as a source of comfort for those who are grieving. Also important are opportunities to debrief after euthanasia. This can address the grieving process and also serve as a reference point for what went well with the euthanasia procedure and how future events could potentially be improved upon.

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7

Post-Death Considerations and Closing Thoughts

Kathleen A. Cooney

7.1 The Evolving Landscape of Deceased Pet Aftercare

Since the first edition of this book in 2012, more research has come forth to tell us what clients want for their deceased animal, and the different ways that bodies can be managed. The act of euthanasia will generate a body that must be cared for, and for some practitioners with a large number of appointments, this may mean multiple bodies per day. According to the Companion Animal Euthanasia Training Academy (CAETA), part of the 14 Essential Components of Good Euthanasia includes "Assistance with body care." Veterinary teams aren't expected to know every detail that an aftercare company knows. However, they should have a basic understanding of what's available in their community and how to formulate and execute an aftercare plan.

7.1.1 Client Expectations

Practitioners knowledgeable in deceased pet aftercare options, including familiarity with local regulations, will be very valuable to their clients. There are more options than ever before, and clients will have questions about the choices available to them. Companion animal clients have a growing desire to be more involved with their pet's aftercare arrangements, including wanting to know more information about body handling, ways to memorialize, and the full scope of body transformation methods, e.g. cremation. It's rare for veterinary companies to include aftercare information on their websites. However, doing so is helpful for clients and reduces confusion during an already overwhelming time for many (Kogan 2021). Animals in the zoo setting have very bonded caretakers, and many will want to see respect given to the deceased body in much the same way. Owners of farm animals euthanized on premises will expect the veterinary team to guide the fastest and safest removal of the animal without causing distress to other animals.

7.1.1.1 Spending Time with the Body

Following euthanasia, grieving clients may request to remain with the body for a period of time. This is acceptable and encouraged, especially for those who need time to come to terms with the permanency of death. Clients may need just a few minutes or much longer including overnight or even a few days. Veterinary teams can assist in the hospital by quieting the area and keeping the room undisturbed until the client is finished saying goodbye (Figure 7.1). A doorbell feature has gained popularity as a way to allow the client to sit alone with their pet and alert the veterinary

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Figure 7.1 A pet owner spending time with their deceased cat. *Source:* CAETA (2025).

team to return to the room when the client is ready to depart (Gardner and McVety 2017). These wireless doorbell systems can be used in hospitals and mobile settings like homes or farms.

When clients spend time with the body, especially soon after death, they may notice body movements such as small whisker twitches, mild leg kicks, reflexive breaths, and urination or defecation. If they are left alone with the animal's body, they should be told what to expect and how normal such movements are as the body releases energy. If they are uncomfortable being alone with the body, a member of the veterinary team can remain in the area. Some families may request to keep the body for an extended period of time. The body should be protected from heat, insects, and predators until the client is ready to proceed with final aftercare.

Other animals may show interest in being close to a deceased companion (Figure 7.2). As long as the body does not harbor a contagion or spreadable disease, curious conspecifics or other species can be invited to investigate the body and vicinity. In this author's experience, clients often ask if other animals should be allowed to see and smell the body. Informing them of the possibility is advised. If having other animals present both during and after euthanasia is important to the client, veterinary teams should try to accommodate them.

7.1.1.2 Reviewing Aftercare Choices and Memorialization

When an animal has been euthanized, whether it has been done in the hospital or external setting, preparations need to be made to ensure that the animal is handled according to the client's wishes. Whenever possible, details should be discussed prior to the euthanasia procedure to expedite arrangements, ensuring the body can be safely and adequately managed within a reasonable time frame. Aftercare choices can be verbally described to clients or information can be provided in written form either online or through handouts.

In a 2021 study, pet owners shared that when asked about making aftercare arrangements, most want input from their veterinary team, but are capable of determining what is best for their family. Around 19% stated they typically know exactly what they want and need little input from their vet (Cooney et al. 2021). While clients may ask veterinary teams for guidance, they do not expect them

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Figure 7.2 Horses gather around to inspect a deceased pasture mate. *Source:* Colleague of Kathleen Cooney.

to be funeral directors, knowing every option the aftercare company provides. There is an expectation however for veterinary teams to inform clients about aftercare options such as cremation type, urns, etc. Practitioners will want to tour all local facilities so they can give accurate information (see Table 7.1).

Clients may choose to keep a physical reminder of their animal, such as a clipping of hair, a feather collection, or a clay paw print, all of which are common and expected in modern times (Desmond 2016). Physical impressions and body tissue/materials need to be collected before post-mortem decay sets in or a permanent change is made, e.g. the body is burned or buried. Memorial keepsakes can be created during the euthanasia appointment by veterinary staff, or afterward by the staff at the aftercare company's facility (Figure 7.3). It is quite common for aftercare companies to make and send memorial items back to clients. If the veterinary team arranges this, they will want to make sure items are returned according to client wishes.

7.1.1.3 Respectful Body Handling

Bodies should always be treated with the utmost respect, whether the client is present or not. Treating an animal's body kindly helps lessen professional compassion fatigue (Figley and Roop 2006), and signifies that even in death, respect is the right thing to do. Bodies should be moved in such a way as to convey this respect. Using a stretcher to carry the body rather than dragging is a clear example (Figure 7.4).

If the animal's body will be moved to an aftercare facility, it will first need to be prepared by the veterinary staff. Following confirmation of death and privacy for the family (if requested), the body

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Table 7.1 What veterinary teams should know about pet cemeteries and crematoriums.

- What kind of records does the facility keep?
- How long are the records retained?
- What type of system does the facility use to identify the body bags animals are received in?
- How will the facility handle multiple transfers from veterinary clinics to prevent loss of an individual body's identification tag?
- Are the bodies provided with toe tags or identification collars so that they can be identified even if they become displaced from the bags in which they are transported?
- Where and how are the bodies stored after receipt by the facility and before disposal?
- Does the facility have refrigeration and freezer capacity to accommodate the volume?
- What method is used to identify, store, and transport a patient's individual ashes after cremation?
- If the facility provides for burials, what size plot is allocated for each animal?
- How many animals can be buried in a plot or grave?
- What is the daily capacity of crematorium furnaces?
- What is the breakdown between the number of communal cremations versus private cremations?
- How does the facility ensure that ashes of individually cremated pets are only those of the pet being cremated?
- What is the largest-sized body that can be cremated on site?
- Can the facility handle large breed dogs or small farm animals?
- If communal cremations are provided, how many animals are cremated at one time?
- Are owners or veterinarians permitted to observe the cremation or burial?
- What is the standard turnaround time for receipt of a body from the veterinary practice to return the ashes to the family?
- What kind of packaging is used for the ashes, and can owners open the containers and view the ashes?
- What type of fuel is used in the cremation?
- Do ashes contain chunks of bone or teeth, or are they sifted to remove those fragments before they are returned to the owners?
- Has the facility been inspected by the state, and if so, when was the last inspection done?
- Are there any fenced-off portions of land in the cemetery area?
- What is the number of pets handled annually?
- Can the facility sustain its growth over the next 5–20 years?
- Does the facility engage in any business other than pet disposal? For instance, does it burn medical waste?
- Do the furnaces meet the EPA requirements for the location?

Source: Hofmann, M. E. & Wilson, J. F / with permision of American Veterinary Medical Association.

should be placed in a container for easier handling and to minimize area contamination from bodily fluids, (Figure 7.5). Ice and other cooling systems can be used to keep small bodies cold until the client is ready for final aftercare. While many veterinary services still use plastic refuse bags to transport remains of small animals, clients prefer caskets, designated body bags, and even

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Figure 7.3 Clay memorial print made from an euthanized exotic pet. *Source:* Angela Lennox, DVM.



Figure 7.4 Carrying a large dog down the stairs on a rigid stretcher.

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Figure 7.5 A dog placed in a respectful body transport bag that owners can decorate with messages. Bags like this are leakproof and hold bodily fluids. *Source:* CAETA (2025).



Figure 7.6 A deceased horse pulled onto a trailer for transport to a local crematory that can accommodate large animals. A cover is respectfully placed over the horse, and it is moved via a large sled rather than being dragged over hard surfaces. *Source:* David Shuey, LMSW, DMA, RVT (ret.).

blankets/shrouds instead of trash bags (Cooney et al. 2021). Larger animals will require blankets or tarps to wrap or cover the body and are typically moved to facilities using trailers (Figure 7.6).

Small animals are much easier to manage than larger animals. If small enough, they can be carried by one to two people and transported in passenger vehicles or small trucks. Larger animals

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need equipment to move. While this author was able to fit a 175 kg llama in the back of a minivan, flatbed trailers are more common. Aftercare facility staff will commonly arrive to pick up deceased animals and transport them for services on request. Clients are not usually present for this transition time. However, they certainly can be, especially if they want to be part of every part of the process. Arrangements can be made to have the animal picked up and taken immediately to the crematory or cemetery for burial. This minimizes the holding time and helps ensure that the client's wishes are carried out as quickly as possible. Some veterinary hospitals, or even the family, will bring the companion animal's body to the aftercare location themselves, to make sure it arrives in a timely fashion. Zoos, production farms, and high volume-euthanasia small animal practices may have aftercare facilities on site to expedite aftercare, reducing the need to transport to another location.

7.1.2 Aftercare Ordering Models

Euthanasia produces a deceased body which veterinary teams typically manage on their clients' behalf, in an effort to ensure proper body handling and because, traditionally, it has been challenging for pet owners to access pet aftercare facilities on their own. This help, and the preplanning support clients receive, has been shown to reduce owner anxiety around death/loss and death decisions (Kogan and Erdman, 2019). As of 2025, veterinary teams routinely manage a client's pet aftercare needs.

Aftercare companies may form business partnerships with veterinary teams as the responsible party to ask the client (the pet owner) what they want for aftercare, and relay these wishes to the pet aftercare company. The veterinary team collects money on behalf of the client for said services and pays the aftercare company directly. This arrangement is known as a Veterinary Aftercare Ordering Model (VAOM).

An alternative model to the VAOM is the Client Aftercare Ordering Model (CAOM). In this model, pet owners interact directly with an aftercare company, selecting the type of cremation and memorial items they want without the need to convey detailed information to the veterinary team. The veterinary team's responsibility is merely to direct the client to the aftercare company before or just after the death of the pet and safely hold the deceased pet until the aftercare company picks up the body. The veterinary team may collect payment if that's the CAOM arrangement they use, or the client pays for services to the aftercare company directly. In a 2025 study looking at the differences between these two models, veterinarians shared that they feel comfortable speaking with clients about basic aftercare options, but that overall, they want clients to have their needs met, and that working through a CAOM may be the best way to do that (Cooney and Kogan 2025).

7.1.3 Reducing Risk and Improving Accuracy

Practitioners will want to gather consent for any aftercare arrangements they or their team make on behalf of the client. When the client indicates what they want, the details are written down and the staff reviews the information for accuracy. This is an important step, and if rushed, mistakes can happen. The client gives consent by signing the agreement and paying for services. If the veterinary team is recommending an aftercare company's services or obligating a client to work with one company over another, there is a professional call to action to ensure the aftercare company is reputable and reliable (see Table 7.2). A veterinary company may want to elect a staff member or two to be in charge of knowing the ins and outs of the aftercare services they work with, and guarantee aftercare requests are properly managed.

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Table 7.2 Ethical Aftercare Recommendations for Veterinary Teams.

1) Dissemination of Information
   a) Take the time needed to address client aftercare concerns and options (typically 5–20 minutes)
   b) Ask clients if they have a preferred crematory/cemetery and respect their decisions
   c) Present a choice of local pet aftercare options
   d) Provide written explanations of aftercare services/offerings including cost considerations (e.g. aftercare company brochures, website links)
   e) Utilize proper forms (e.g. crematory authorization, burial forms, etc.) to reduce liability risk and increase transparency

1) Procedures
   a) Follow pet owners' choices closely
   b) Use respectful, designated cadaver bags or containers (e.g. caskets, shrouds) in line with state mandates
   c) Perform procedures with due diligence (e.g. procedural checklist, use technology to track the body) to prevent mistakes
      i. Properly label bodies immediately (i.e. within 30 minutes of appointment completion)
      ii. Submit pet information to aftercare companies as soon as possible (i.e. within 1 hour)
      iii. Ensure pet bodies leave the hospital with proper labeling and instructions

1) Partnering with aftercare companies
   a) Visit local pet aftercare facilities annually to familiarize yourself with their offerings and policies and ensure they meet industry standards
   b) Encourage aftercare companies to:
      iv. Provide emotional assistance to pet owners (i.e. grief support facilities for visitations/services, etc.)
      v. Obtain bodies as quickly as possible (e.g. within 24 hours)
      vi. Demonstrate high-quality body handling standards (i.e. proper containment and cleanliness, respectful conduct with or without owners' presence)

Source: Cooney, K. A. et al / with permission of Elsevier.

Aftercare details are often part of the euthanasia consent form. However, it may be better to have a separate one. Euthanasia is a medical procedure whereas aftercare is not, and the information between the two is very different. Due to the level of options related to aftercare, and that veterinary teams are hiring aftercare companies to perform a service on their behalf unrelated to euthanasia, a separate consent form for aftercare makes sense. If using a CAOM, the veterinary team is usually just confirming wishes. Aftercare agreements are formed between the pet owner and aftercare company, thus protecting the veterinary team from any liability or misconduct after the body leaves their care.

Additional services like a necropsy, tissue collection, or rabies testing will need to be well documented. Following testing, the body will need to be handled in accordance with the owner's wishes or whatever might be mandated by the state. When the body is altered, e.g. head removal for brain tissue sampling, the owner should understand what is taking place and why. Imagine their fright when receiving the body back for burial and the head has been removed.

7.2 Types of Aftercare: Current options

7.2.1 Overview of Aftercare Goals

There are numerous goals when preparing for, and carrying out, the aftercare of deceased animals. As was already mentioned, practitioners will strive to meet client expectations and handle the body with respect. A few more key considerations must be met. They include the certification that the

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animal is indeed dead before proceeding with aftercare, and also the protection of the environment, people and living animals from any harmful chemicals.

Body care options following the death of animals continue to grow in the United States. Depending a bit on geography, most owners have the choice of burial, cremation, rendering, or even body donation for their animal to a scientific institution. More unusual uses of the body, especially with livestock and horses, include donation to zoos as carnivore food and enrichment. Freeze drying and taxidermy are also options for owners wishing to keep their pets looking in death the way they looked in life. The cost and options available are often determined by size and species.

7.2.1.1 Verifying Death

Before any form of aftercare is conducted, the body needs to be confirmed dead. Signs of death are generally considered similar between species of the same dwelling space, i.e. those that live on land versus those that live in water. It is important that practitioners recognize all signs of death and prepare onlookers for what to expect (see Tables 7.3 and 7.4).

The animal should always be evaluated fully to assure that death has occurred (Figure 7.7). Death is characterized by permanent unconsciousness, and irreversible respiratory and cardiac arrest. The animal should be evaluated for absence of respiration for a period of at least 5 minutes.

Table 7.3 Possible physical indicators of death in animals.

• Opisthotonus
• Pupil dilation
• Urination and defecation
• Corneal glazing
• Third eye relaxation
• Myoclonic twitches
• Agonal breaths
• Borborygmi
• Thoracic air release
• Nasal and oral fluid release
• Fly strike

Table 7.4 Verification of death is done by assessing for the following.

• Lack of pulse
• Absence of audible heart sounds
• Complete cessation of breathing (apnea)
• Lack of reflexes
• Graying of mucous membranes (pallor mortis)
• Internal blood pooling and discoloration (livor mortis)
• Body temperature reduction (algor mortis)
• Body rigidity (rigor mortis)

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Figure 7.7 Listening for a heartbeat in a dairy cow. Assessing for physical changes helps practitioners verify death.

If the respiration is very shallow, it can be difficult to evaluate. Identifying a peripheral pulse can be difficult in large animals. Thoracic auscultation should be performed to confirm cardiac arrest. Alternatively, this could be assessed by electrocardiogram (ECG) or a doplar unit. Following death, the pupils will remain dilated, and the eyes develop a glazed or glossy appearance. Rigor mortis, the stiffening of the body following death, will develop and may be appreciated as early as 10 minutes but may take up to several hours. It is critical that death is accurately confirmed following euthanasia, which is especially important for those species that can dramatically slow their metabolism and breathing, e.g. reptiles, amphibians, and fish.

Of all of these signs, only rigor mortis indicates that irreversible death has occurred. Other signs can be seen during various stages of life, anesthesia, and near-death events with possible revival. A cardiac puncture test is commonly performed in shelter settings as another verification of death in small animals (HSUS 2013). A needle and syringe are inserted within the heart to check for movement by cardiac muscle contractions. If blood is aspirated, and the syringe remains still, death is confirmed.

Urination and defecation should be expected with death in most animals. When appropriate, towels or plastic liners should be placed under the hind end of small animals to contain any fluids. This is especially important if the animal is on a loved one's lap, within a family's home, or on any surface that will be difficult to clean. Urine can quickly saturate a towel, so another one should be within reach if needed. If heart or upper respiratory disease was present, something should be placed under the head to absorb nasal discharge such as blood and mucus.

Animals may exhibit very different signs of death depending on the method of euthanasia. The use of inhalants, injectable pharmaceutical agents, or physical methods all demonstrate fairly consistent physical changes depending on the species. The presence of pre-euthanasia sedation or anesthesia may also alter signs of death. It is commonly reported that animals in stage three of anesthesia prior to euthanasia with a barbiturate exhibit less agonal breathing and body stretching (Cooney 2011). Animals given simple sedation prior to barbiturate euthanasia may move slower through all five stages of anesthesia and exhibit more involuntary signs.

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Gunshot or captive bolt gun usage generally sets the animal up for a period of tetanic spasm that lasts for several seconds. The limbs initially flex and then gradually extend. This may be followed by hind limb movements that increase in frequency. In some cases, these may increase in force as well and can present a danger to the operator, handler, or bystanders. These movements are in part due to simple motor reflex responses of the extremities and are exaggerated due to the loss of inhibitory control by the brain. It is important to be aware that exaggerated limb paddling may occur and practitioners can explain to the client or bystanders that this is not an indication of consciousness. Immediately following gunshot or stunning, the corneal reflex will be absent, and the pupil should become dilated with an absent pupillary light reflex. The respiration pattern will be slow and become erratic.

7.2.1.2 Destruction of Drugs and Safe Transport

Because of the variety of species and animal sizes, aftercare considerations in livestock encompass many of the same issues as small companion pets and horses. It is always important to discuss aftercare of the carcass with the client prior to euthanasia, as that may affect the choice of euthanasia method and location. Specifically, one must consider the location of euthanasia for large livestock to facilitate movement of the carcass if needed. This could be to load the carcass onto a trailer or truck for transport, move to a site for burial, or move to a site for composting.

Scavenging by predators is a major concern when euthanasia is performed with an injectable agent like pentobarbital. Known as relay toxicosis, ingested drug-laden tissue poses a serious health risk, including death, for predators. Even small carcasses from dogs, cats, and exotics can pose a risk, which is why veterinarians should use the minimum recommended pentobarbital dose to achieve death (Kollias et al. 2023). A famous case of wildlife death occurred in 1999 in Colorado. Seven eagles were killed after ingesting pentobarbital-infused tissues from two mule carcasses. The rancher and veterinarian were fined $10,000 each (O'Rourke 2002). Many accidental pentobarbital poisonings of bald and golden eagles as well as other species have been reported (Krueger and Krueger 2000; O'Rourke 2002; Meeker 2008). Unfortunately, this is not an uncommon situation. It is also possible for domestic animals to become exposed to pentobarbital in buried bodies. This was dramatically demonstrated when several dogs were poisoned after exposure to a horse carcass that had been euthanized with pentobarbital more than 2 years prior (Kaiser et al. 2010).

If a practitioner is found responsible for the accidental death of endangered species, such as one protected by the Endangered Species Act or the Environmental Protection Agency (EPA), the US government can issue fines up to as high as $250,000 per individual and $500,000 per organization, as well as imprisonment for up to 2 years. Because of this, it is imperative that veterinarians and the entire veterinary team educate themselves and clients on proper burial guidelines, even having clients sign a legal document stating they understand the risks, laws, and regulations. Specific information can often be obtained from local or regional public health department offices, the county commissioner's office, or the state department of agriculture, depending on the office jurisdiction in a given state.

In 2023, the American Veterinary Medical Association (AVMA) surveyed veterinarians to gain an understanding of their comprehension of pentobarbital use and body disposal requirements. The results showed that veterinarians from varying industries had gaps in their understanding of pentobarbital risks and that more education about proper disposal is needed (Hess et al. 2023). Small animal practitioners are less likely to inform clients of pentobarbital contamination risk compared with large animal practitioners. The AVMA is now looking at ways to help increase veterinary awareness and client education regarding risks. CAETA recommends veterinarians obtain signatures from clients indicating they understand the importance of proper burial depth,

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Table 7.5 A ranking of deceased animal disposal methods to mitigate pentobarbital contamination risks.

Least risk/most acceptable
Cremation
Alkaline hydrolysis
Composting
Greater risk/less acceptable
Burial
Landfill
Body preservation
Body donation
Unacceptable
Rendering
Carcasses as a food source

proving that the risks were discussed. Table 7.5 provides a list of animal disposal methods ranked by contamination risks.

Lead from lead bullets has also been shown to poison wildlife. Elevated lead concentrations in predatory and scavenging birds are usually caused by primary lead poisoning, most frequently by direct ingestion of lead fragments from ammunition (Slabe et al. 2022). When euthanasia by gunshot is chosen, practitioners must determine whether nonlead ammunition is a viable option for their patient, especially if adequate burial depth for the body will be hard to obtain. If the body will be left above ground or placed in a landfill with questionable protective cover from predatory birds, another euthanasia method should be considered, e.g. intrathecal lidocaine. The goal is to protect all wildlife, regardless of the level of governmental protection. If incidents of wildlife death continue to be reported, it is possible that burial may not be allowed at all following the use of barbiturates or lead ammunition.

It can be challenging to tell a client that their animal's body now poses a risk to the environment. These conversations are best before euthanasia begins so that strategic aftercare plans can be made. This author recommends supportive phrases like:

- "Let's talk for a moment about the euthanasia method I'm choosing for your pet (animal), and the importance of safe body handling afterwards."
- "We are using a euthanasia method that is highly effective at achieving permanent death, but it can be dangerous to the wildlife and the environment."
- "We want to keep your pet's body protected from harm, as well as protect any wildlife that may come in contact with it."
- "We will need to choose an aftercare plan that meets government regulations."

If a client dislikes the proposed plan, an alternative euthanasia method may be chosen that eliminates toxins in the body. Most people will understand and follow the veterinary practitioner's direction, especially with the formation of the veterinarian-client-patient-relationship (VCPR).

Aftercare and disposal of the body are a major concern for the livestock and horse owner. These details should be in place before the euthanasia is performed if possible. Many states have laws requiring equine carcass disposition within 24–72 hours after euthanasia (Haskell and Ormond 2003). The equipment necessary to move the carcass would ideally be on-site at the time of euthanasia. The body can be covered with tarps or plastic if there is a significant interval between

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euthanasia and body disposal. Even a short time between euthanasia and disposition of the body may provide an opportunity for scavengers and insect infestation.

In most deaths involving large bodies, some form of equipment will be necessary. A tractor with a loader is most commonly used to lift the body. Forklift teeth may be used to slide under the body or chains may be wrapped around the legs and attached to the loader bucket to move the body. Sometimes owners will transport the body to the disposal site themselves, or a professional hauling service is called out. Most hauling trucks have a winch system to load the body. If the body needs to be transported on an open trailer, some form of cover will make the trip more esthetically acceptable.

7.2.2 Cremation

Cremation is the burning process that removes soft tissue and leaves the skeleton in the form of ash and bone fragments. Intense heat, up to 2000 degrees, is generated by burning natural gas. Depending on the size of the animal, cremation takes 30 minutes to a few hours. There are three types of cremation categories which veterinary teams need to understand so they can accurately describe them to clients.

According to "Aftercare," in *Hospice and Palliative Care for Companion Animals* by Ellis (2017), the following definitions explain the differing types of cremation.

1) Private cremation: A cremation procedure during which only one animal's body is present in the cremation unit during the cremation process.
2) Individual (partitioned) cremation: A cremation procedure during which more than one pet's body is present in the cremation unit, separated by space, and the cremated remains of specific pets are returned to the owner. Some commingling of ashes will occur.
3) Communal cremation: A cremation procedure where multiple animals are cremated together without any form of separation. These commingled remains are not returned to the owner.

As of 2025, there are no statistics indicating how many animals are cremated in the United States each year. Based on the increasing number of crematory businesses started annually, it is evident that clients are opting more and more for cremation over burial. It is generally less expensive than cemetery burial and offers more options such as scattering the remains, carrying portions within jewelry, or saving them until the time when they can be buried along with the client themselves. Cremation also ensures that any diseases or euthanasia solution within the deceased pet's body will not contaminate soil or another living being.

Cremation is appropriate for any size or type of animal as long as the retort is large enough (Figure 7.8). The cost of cremation is based on the weight of the animal. Owners may elect a partial cremation, meaning only part of the body is cremated for sentimental reasons so ash may be returned, e.g. head, heart, and hoofs. This is an economical option as well as more practical when a large retort is unable to accommodate the full body, e.g. horse or elephant. The remainder of the body will be disposed of according to owner wishes.

7.2.3 Alkaline Hydrolysis

Alkaline hydrolysis (AH) is the process of using alkali salts and water to reduce an animal's soft tissue down to skeletal remains. An animal's deceased body is placed inside the AH machine for an average of 14–24 hours while the chemical digestion takes place (Figure 7.9). When complete,

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Figure 7.8 Inside a crematory oven, also known as a retort. The chamber may be small or large enough to accommodate various-sized animals.



Figure 7.9 A standard alkaline hydrolysis machine for large animal carcasses or high-volume small animal operations. *Source:* BioLiquidator.

the bones are removed, dried, and ground into ash similar to the more standard cremation process (Figure 7.10). Ash may be returned to clients or spread in accordance with the AH company's policies. It is touted as a more eco-friendly option compared to cremation or burial.

The process goes by such names as aquamation, flameless cremation, water cremation, and more, and has been gaining popularity since 2010 in the United States. The ash that is created is fine like talcum powder, and there is usually a higher amount of ash remaining since none is

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Figure 7.10 A completed alkaline hydrolysis cycle showing carcass bones. *Source:* BioLiquidator

burned away during the process (Desmond et al. 2022). One of the unique differences between cremation and AH is the preference to keep bodies cold but not frozen. Frozen bodies make placement within the AH machine more challenging and slow down the processing time. Veterinary teams may be asked by AH operators to avoid freezing bodies.

7.2.4 Burial

Burial is the placement of the deceased animal's body underground, beneath soil. Burial can occur on private property, at a pet cemetery, or in a landfill (Figure 7.11). Animals can be buried in boxes of various materials, in blankets, bags, or laid naturally in the earth with no wrapping at all. Pet cemeteries will have specific regulations for burials on their grounds.

Veterinary practitioners and their staff can help prepare animals for burial, regardless of size. Any medical waste, such as catheters, tape, and feeding tubes, can be removed to return the animal to a natural state. Companion pets can be wrapped in special blankets or anything the family feels appropriate, including placing memorable articles such as toys, photos, and collars/leashes/halters with the body. When possible, the animal's body should be tucked into a position appropriate for burial before rigor mortis sets in. Adding one cup of lime above and below the deceased animal has long been thought to speed the decomposition process. However, this may not always be the case. It may increase decomposition at first but then slows at around 6 months (Schotsmans et al. 2014).

If a client is considering burying their animal on their property, they must first contact local authorities to learn the rules and regulations of doing so. Every state, even country, will have specific guidelines that need to be followed to protect the environment and public at large. It can be difficult to get a concise, uniform answer as to how a burial should be conducted. All practitioners should be educated on regulations within their state/country of practice to protect themselves from legal backlash should a client perform an improper burial. Clients should also be warned to avoid burying animals near trees with large root systems and be cognizant of utility lines that may

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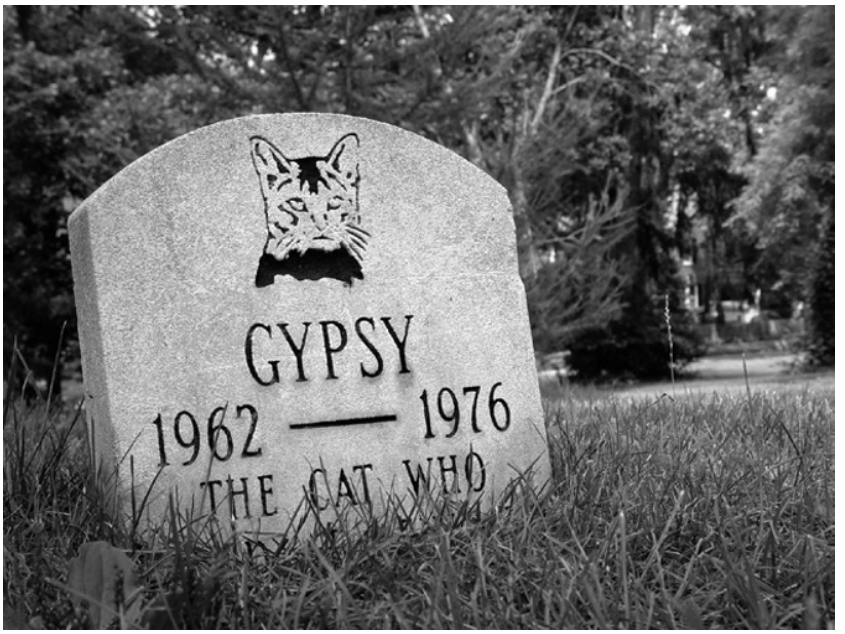


Figure 7.11 An example of a pet cemetery grave marker.

be underground. Burial in the winter may not be possible in cold climates due to the difficulty of digging a hole in the frozen ground.

Common animal burial guidelines often recommended throughout the United States:

- Avoid placing the body close to wells, waterways, and flood plains.
- Bury the body with a minimum of 3 ft. of soil cover.
- Ensure permission to bury on the land or at the landfill.
- Be careful of buried power lines, water lines, and tree roots.

It would be rare for livestock owners to consider burial at a pet cemetery except in some instances for pet livestock. Burial on the premises is more common. Owners may have the machinery to do this, or they may contract with a local excavator (Figure 7.12). While this is safer than leaving carcasses for surface scavengers and decomposition, there are still biosecurity and environmental risks. Local ordinances must be followed to protect against contamination of streams, lakes, ponds, or groundwater and wells. Animals euthanized with pentobarbital will contaminate groundwater and adjacent soils (Bagsby et al. 2018).

Burial at local landfills is often acceptable, as long as procedures are in place to prevent groundwater contamination or scavenger poisoning. Landfill use is uncommon for family-owned pets, but is still available in parts of the country, especially for larger stock and is an important option to have. Landfills are designed to protect the environment, offering not only containment of carcass materials but also a barrier to prevent wildlife access. A Florida landfill that had received wastes in 1968 and 1969 was determined to be the source of contamination for nearby groundwater. Samples of groundwater were taken from a well approximately 300 m from the landfill in 1984 and again in 1991. Both samples were positive for pentobarbital (Eckel et al. 1993). These observations demonstrate pentobarbital's remarkable stability and highlight the need to handle carcasses properly.

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Figure 7.12 Mechanical equipment is used to prepare a horse burial site and lower the horse safely into the ground. *Source:* Colleague of Kathleen Cooney.

Regardless of the species, if the practitioner knows the body is going to the landfill, they will want to use extra caution with the type of euthanasia method they choose. It is best to contact the local landfill to determine if there are any specific restrictions and what fees may be charged. Using the landfill generally has the benefit of a low-cost alternative if available but does require extra time, labor, and a means to transport the carcass.

There are certain situations, such as on large ranches or in open country, where the owner may choose to leave the body to natural disposition by scavengers. This can be purposeful or necessary due to an emergency situation, e.g. horse with a broken leg on a backcountry trail ride. If moving the body to an aftercare facility is impossible, the practitioner should choose a euthanasia method that reduces poison in the tissue. The attraction of scavengers and flies, as well as the odor produced, are important considerations as well. When a human body is intentionally left above ground, this is called a "sky burial." Sky burial is a traditional funeral of the Mongolian and Tibetan ethnic minorities, and it has a long history over thousands of years in China (MaMing et al. 2016). While the term sky burial is not classically used when referring to animals, it may be useful to distinguish the difference between animals placed underground and those left above.

7.2.5 Composting and Rendering

Composting is an aboveground burial specifically designed to recycle organic waste. It is a simple and easy procedure for the backyard gardener but is much more challenging when the objective is to hasten decomposition of animal carcasses, especially large ones. Approximately, 6 months is required to completely compost a carcass (Berge et al. 2009). The actual compost pile must be constructed and managed appropriately to be effective and to minimize contamination of the environment. A recognized problem with this means of carcass disposal is that pentobarbital used to

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euthanize animals may not be completely degraded by the composting process (Cottle et al. 2009; Payne et al. 2015). However, with proper attention to the composting process, residual pentobarbital may be reduced by as much as 94% (Lochner et al. 2022).

Composting is probably utilized more for disposal of livestock remains than for any other species. The composting process has the benefits that it can decrease the pathogen load of the carcass, decrease odors associated with decay, can be performed any time of the year, is relatively inexpensive, and requires only a small amount of labor. The basic procedure is to first establish a 24-in. bed, of course, absorbent, organic material such as rough wood chips. This should contain pieces as large as 4–6 in. to improve aeration and drainage. The carcass is then placed on this bed and the rumen is punctured to allow for gas release. Next, the carcass is covered with high-carbon material such as sawdust, dry stall bedding, old dry silage, or other coarse organic material (Figure 7.13). Including some semisolid manure will improve carcass degradation. There should be a perimeter of at least 24 in. of high-carbon organic material surrounding the bottom, sides, and top of the carcass. The composting pile is allowed to sit for 4–6 months, with the temperature of the pile checked at regular intervals. Optimal temperature should be between 104 and 140°F. Overall, composting is an efficient and effective method of carcass disposal but does require some labor, resources, and a commitment to do it right.

Rendering is another option for body disposition and is considered animal tissue recycling. This option is relatively inexpensive but is not an acceptable option for some clients. Practitioners need to tell rendering truck operators if the animal was euthanized with drugs like barbiturates that are not inactivated by the rendering process. Barbiturates associated with euthanasia of horses and other species have been found as contaminants in pet foods (Bischoff and Rumbeiha 2018). Most, if not all, renderers will avoid carcasses that were euthanized with pentobarbital for this reason.

Rendering is a common method of livestock carcass disposal, but over the last decade, this has become more expensive and is less available due to limitations and regulations placed on the rendering industry. The benefit of rendering is that the remains can be removed from the premises quickly and no further equipment or labor is required. The cost for rendering livestock varies by



Figure 7.13 Composting pile for livestock.

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area from about $40 to $200 depending on the species and size of the animal. If a necropsy is performed on the animal prior to pickup by the renderer, it is important to replace the viscera back into the carcass and suture the carcass closed with string or twine.

7.2.6 Body Preservation

Veterinary teams may be asked to help arrange the body preservation of a deceased patient. The most common types are freeze drying, complete or partial body taxidermy, and skeleton preservation (Figure 7.14). A list of local and national services should be kept on hand for easy referencing. Bodies will need to be held in cold storage or by whatever means the service requires. The sooner the body gets to the preservation company, the better to reduce physical change through decomposition. The cost of these services depends on what is being asked for, but generally far exceeds the cost of standard cremation or burial. In this author's experience, payment for body preservation is handled between the pet owner and the company, not the veterinary service. If the body is being preserved for public display, e.g. a rhino on exhibit at the museum, practitioners should avoid euthanizing it with harmful chemicals that will linger in the body.

7.2.7 Educational Memorial Donation

Animal cadavers for use at teaching institutions or within research are becoming more difficult to source. Pet owners may be interested in donating their animal's body as an educational memorial. If they know it's an option, dog owners would be interested in donating their pet's body to help veterinarians learn about disease and anatomy (Tracey and Aktan 2023). Few people know body



Figure 7.14 Image of a freeze-dried dog, preserved in a life-like position at the owner's request. *Source:* Good Shepherd Pet Services, Inc.

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donation is an option and teaching institutions may be reluctant to ask for fear of retaliation. Of the 63% of pet owners who said they would be interested, they did share that they want their pet's body respected and would like the option to have the ashes returned following the body's use (Tracey and Aktan 2023). This is rarely an option. However, owners will need to be ok with relinquishing control of where the body ends up as well as what was learned.

Example details and language to include on an educational memorial donation form:

- Date
- Pet's name and signalment
- Owner's name, contact information, signature
- Attending staff's name and signature

> "I hereby authorize this veterinary hospital to donate my deceased pet's body for teaching purposes. I understand they will be using my pet as an educational resource for veterinary education and have my permission to use the body in whatever means necessary to deliver said education. To my knowledge, my pet is free of agents/diseases that could harm others. I understand following the educational memorial, my pet will be disposed of according to company policy. I have entered freely into this agreement and feel it is the best choice for me, my family, and anyone who can learn from my pet."

7.2.8 Consuming the Body as a Purposeful Food Source

Already mentioned was the idea of a sky burial, wherein the animal is left out in the open for scavengers to feed on. There may also be instances when the euthanized animal will be purposefully fed to animals in captivity, such as at the zoo or a wild animal sanctuary. Practitioners will need to know the aftercare plan of their patient before selecting the euthanasia method so they may avoid toxic chemicals like barbiturates and bullets containing lead. The carcass should be quickly fed to carnivores or placed in cold storage to minimize decomposition before ingestion (Figure 7.15). Chapter 6 has more information on the feeding of euthanized bodies in the zoo setting.

7.3 Closing Thoughts on the Future of Euthanasia

One of the most important ways to ensure a smart maturation of euthanasia is for veterinary professionals to pay attention to it. With so many advancements in life-sustaining therapies and treatments, giving focus to euthanasia can feel less and less necessary. Death, however, is one constant we must embrace to ensure it is performed ethically and skillfully. It's important for veterinary personnel to recognize that advances are regularly being made to improve the euthanasia experience from beginning to end. New euthanasia drugs are being developed, new safer and faster techniques are being applied, and pet loss support is expanding. All it takes to remain current is a little professional attention to euthanasia on a regular basis.

Like many procedures in veterinary medicine, the cost of euthanasia is rising. Because death is a necessary part of life for all animals, and euthanasia is a common way to achieve it, it will need to remain affordable for clients. If euthanasia is priced beyond what the average client can afford, they will either avoid it or seek out the least expensive option, which may not be in their animal's best interest or theirs. Veterinary professionals may find themselves in challenging moral waters more and more as they navigate what is best for their patient and client. The goal will be to find the

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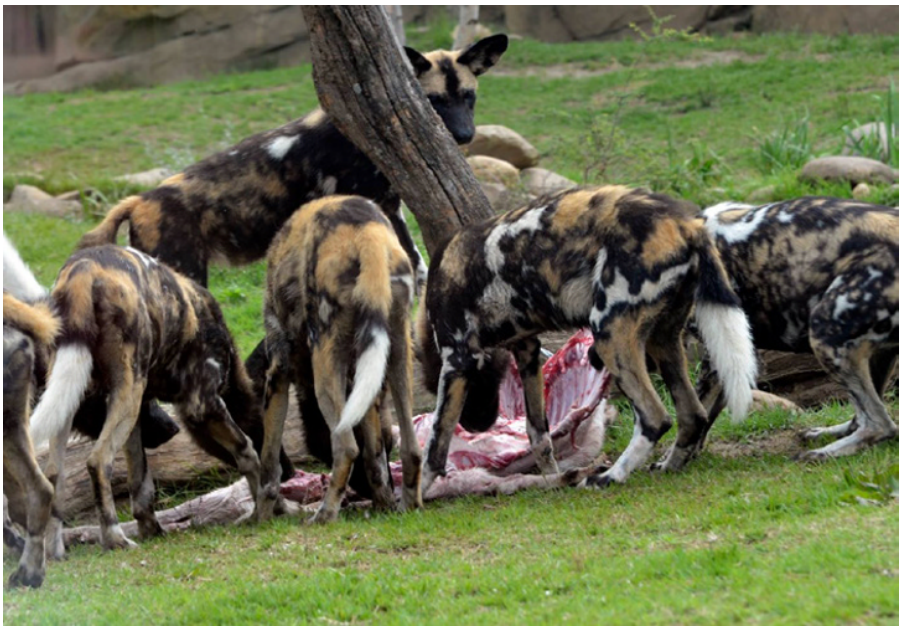


Figure 7.15 African painted dogs at the Cincinnati Zoo feeding on a deceased animal carcass as part of the enrichment program. *Source:* Cincinnati Zoo & Botanical Garden/https://cincinnatizoo.org/special-painted-dog-enrichment/ (last accessed on April 18 2025)

win-win-win for everyone that keeps euthanasia affordable, dependable, compassionate, and for the veterinary team, meaningful and rewarding.

With a dedication to this line of work, these authors are certain that new techniques and business models will emerge to make the euthanasia of animals smoother, harboring fewer complications, and ultimately minimizing animal suffering and the ever-present concern of compassion fatigue. Euthanasia practitioners should be reaching for existing methods that match well to the 14 criteria proposed by the AVMA in their euthanasia guidelines and developing new methods that are even better. Euthanasia research is needed within all animal industries to get us there. A third edition of this book has the potential to include drugs and methods unthought of today that could forever change the euthanasia landscape.

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