# Approved methods for small ruminant humane euthanasia

**Ryan M. Breuer,[1,2] DVM, DACVIM – LAIM; Joe S. Smith,[3] DVM, MPS, PhD, DACVIM, DACVCP**

[1]Clinical Assistant Professor, Department of Medical Sciences, University of Wisconsin – Madison, School of Veterinary Medicine, Madison, WI 53706
[2]Diagnostic Case and Outreach Coordinator, Wisconsin Veterinary Diagnostic Laboratory, Madison, WI 53706
[3]Assistant Professor of Farm Animal Medicine and Veterinary Clinical Pharmacology, Large Animal Clinical Sciences, University of Tennessee, Knoxville, TN 37996

## Abstract

Small ruminants continue to maintain their importance as both food and fiber animal species. Their role as companion animals has also increased in popularity. Keeping these purposes/utilities in mind, the discussion regarding humane euthanasia procedures can be a very difficult, albeit an educational decision for the client. As veterinarians, there is an ethical duty to ensure a safe and painless death for the patient, thus the value of being well trained and knowledgeable in the various available methods of humane euthanasia are critical in performing these procedures well. Humane euthanasia procedures also provide the opportunity to advise the client on relevant aspects of proper carcass disposal so that other scavenger species and/or environmental risks are avoided, depending on the method of euthanasia chosen.

**Key words**: sheep, goat, barbiturate, penetrating captive bolt

## Introduction

With the growing popularity of small ruminants in both food and fiber, as well as companion animal roles, euthanasia can be a very difficult decision for the client. As veterinarians we have an ethical duty to insure a rapid and painless death for our patients as well as to advise the client on relevant aspects of humane euthanasia and carcass disposal after a euthanasia procedure.

## Acceptable methods of euthanasia for sheep and goats

Acceptable methods of euthanasia for small ruminants include: barbiturate overdose or other anesthetic agent overdose, firearm, or penetrating captive bolt with an adjunctive follow-up method. For adjunctive methods after a deep plane of anesthesia or penetrating captive bolt usage, either exsanguination, pithing, or intravenous administration of a super-saturated salt solution can be used to ensure death. It is critical that before the usage of an adjunctive method the animal is confirmed to be unconscious.

## Pharmacological methods

### Barbiturate overdose

Barbiturates such as pentobarbital cause depression of the central nervous system, which in overdose situations will progress from a consciousness to unconsciousness state, anesthesia and then death.[1] This method of euthanasia will require restraint and placement of either a needle or an intravenous catheter, but aesthetically it is more appealing for companion small ruminants. As discussed later in this document, disposition of the drug in the carcass can provide a risk depending on disposal options available, so this may be a less achievable/desirable option for production small ruminants.

### Anesthetic overdosage followed by an adjunctive method

Animals rendered unconscious by an anesthetic overdose can be euthanized by an adjunctive method as long as there is a deep plane of anesthesia confirmed. Combinations of xylazine-ketamine, xylazine-ketamine-butorphanol, midazolam-ketamine, and tilletamine-zolazepam could all be used, in addition to inhalation anesthesia to induce a deep surgical anesthetic plane of unconsciousness. Once this is achieved, a super-saturated salt solution such as potassium chloride (340 g KCl per liter of water), magnesium sulfate (350 g $MgSO_4$ per liter of water), or magnesium chloride (546 g $MgCl_2$ per liter of water) could be rapidly administered intravenously to achieve euthanasia.[2] The authors have found that having multiple dedicated syringes ready of the super-saturated salt solution is useful for rapid administration. Due to environmental temperatures causing precipitation, it is recommended to use hot water to insure a saturated solution. Warming in an incubator may be necessary to keep stock solutions in suspension. Thirty to 60 mLs of saturated potassium chloride should be more than adequate for most small ruminant euthanasia procedures, but always have available stock solution if needed, and administer to effect, cardiac arrest. Compared to pentobarbital, the residue risks of an anesthetic overdose followed by administration of a super-saturated salt solution are low.

## Physical methods

Prior to the employment of a physical method of euthanasia, the practitioner should employ a sedation strategy to ensure proper placement of the gunshot or captive bolt discharge. Sedation can be provided with multiple agents (examples such as: xylazine, midazolam, or combinations of the previous two with ketamine and/or butorphanol). Before one of these methods are used, the veterinarian should ensure that there are no people or animals positioned such that they could be harmed from the discharge of a firearm or captive bolt device. The patient should be positioned to account for reflex movements after discharge.

### Firearms

The landmark for euthanasia by firearm is the intersection created from two lines, each originating from the lateral canthus of the eye and extending to the middle of the base of the

opposite ear,[3] as demonstrated in Figure 1. An alternative landmark uses the dorsal midline of the skull at the level of the external occipital protuberance with a downward aim toward the intermandibular space[4] ("B" in Figures II and III). For heavily horned animals in which the top of the skull may be too developed to access, a gunshot to the frontal region can be used, with a target being the foramen magnum. The goal of the trajectory of the bullet is the destruction of the brainstem, so the angle should be selected accordingly.

Calibers recommended for small ruminant euthanasia include .22 LR rifle, .38 Special, .357 Magnum, and 9mm.[1] Shotgun rounds with solid-point bullets can also be used, and may be more appropriate for large-horned adults. When utilizing a gunshot for euthanasia, safety is key, and there are several important considerations to remember. It is imperative that the muzzle of the firearm not be held directly on the skull, as this could lead to undesirable pressure buildup in the barrel. Instead it should be placed no closer than 6 to 12 inches from the target.

### Captive bolt

There are two styles of captive bolt devices: penetrating and non-penetrating. The impact of the captive bolt will induce unconsciousness immediately, and then this state of unconsciousness can be used to ensure death with an adjunctive method performed. A penetrating captive bolt is appropriate for adult small ruminants, and a non-penetrating captive bolt should only be considered for appropriate size neonates. The landmarks for captive bolt placement in small ruminants are identical to those for euthanasia by gunshot with the exception being the frontal shot as the large sinuses, which can make captive bolt shots inconsistent in sheep and goats. Figures 1, as well as "A" and "B" in Figures 2 and 3 all demonstrate landmarks and angles that could be used for penetrating captive bolt euthanasia of a small ruminant.

In addition to the three methods listed above, the AVMA Guidelines on Euthanasia also list electrocution as an acceptable method of euthanasia for small ruminants. However, this technique requires specific equipment for restraint and electrode placement, and is not recommended for routine use in the field.[1]

Regardless of method, confirmation of death should be assured at the end of every procedure. This can be accomplished by observing a cessation of heartbeat, lack of a corneal reflex, presence of rigor mortis, and prolonged cessation of rhythmic breathing. While utility for diagnostics is increasing,[5] point-of-care ECG monitors should not be utilized for confirmation of cessation of heartbeat due to their ability to record pulseless electrical activity, which can persist for several moments after death.

## Unacceptable methods of euthanasia for sheep and goats

The AVMA's Euthanasia Guidelines describe manually applied blunt trauma to the head, injection of chemical agents into conscious animals (examples: disinfectants and saturated salt solutions), xylazine or other alpha-2-adrenergic agonist followed by a salt solution, drowning, air embolism, electrocution with 120-volt system, or exsanguination while conscious, all are considered as unacceptable methods of euthanasia.[1] It should be noted that an alpha-2-adrenergic agonist could be implemented with another drug (ketamine for example) to guarantee unconsciousness, and then be followed by an intravenous administration of a saturated salt solution, but a deep anesthetic plane must be reached first. As a sole anesthetic agent, alpha-2-adrenergic agonists have proven unreliable for this purpose.[1]

## Considerations for Camelids and Farmed Cervids

Captive bolt and firearm landmarks for euthanasia in llamas and alpacas are similar to "A" in Figures II and III above. For farmed cervids the locations are similar to those described for cattle, with a target of the intersection of lines drawn from region of the base of the antler to the lateral canthus of the opposite eye.

## Additional considerations

Tissue and environmental persistence of barbiturates such as pentobarbital can be extensive, and the drug can be detected for extended periods of time in both the environment and after rendering carcass tissues. This has created problems with disposition of the carcass after euthanasia utilizing barbiturates, as environmental risks include the potential poisoning of protected species[6] or residues in rendered products leading to recalls in pet food stuffs.[7] Composting carcasses euthanized by barbiturate overdose may not degrade the pentobarbital molecule, as while no work has been conducted in sheep and goats with respect to environmental persistence of pentobarbital in animals euthanized by barbiturate overdose, a study in horses identified pentobarbital in the environment for 367 days after initiation of the composting process.[8] Clinicians should discuss the risks and liabilities of this method of euthanasia with clients prior to utilizing this method.

## Conclusion

In summary, veterinarians should be prepared to meet the needs of their clients for the euthanasia of small ruminants, whether they are companion or production animals. The use of an approved method, chemical vs. physical, in a safe manner will allow for rapid relief of animal suffering when necessary. Clients should be counseled on the safe disposition/disposal of carcasses where the animal was euthanized with pentobarbital, as there are health risks and potential liabilities due to the persistence of the compound in the environment for prolonged time periods afterwards.

## Acknowledgements and resources

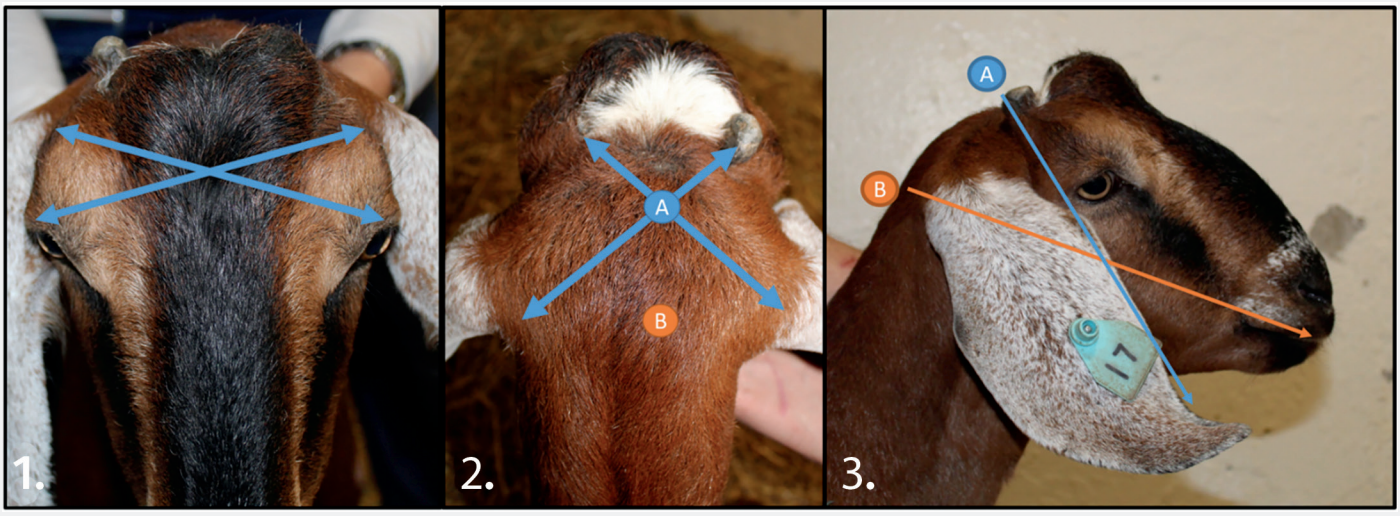
The authors would like to acknowledge Dr. Jan Shearer and Leslie Shearer who contributed materials for these proceedings and the presentation given at the 2024 AABP Annual Conference (Procedures for Humane Euthanasia, Dr. Jan Shearer and Leslie Shearer). (**https://vetmed.iastate.edu/vdpam/about/production-animal-medicine/dairy/dairy-extension/humane-euthanasia**)

– AVMA Guidelines for the Euthanasia of Animals: **https://www.avma.org/resources-tools/avma-policies/avma-guidelines-euthanasia-animals**

– WVDL Large Animal Humane Euthanasia Guidelines: **https://www.wvdl.wisc.edu/wp-content/uploads/2024/05/CL-Res-104-Large-Animal-Humane-Euthanasia-Guidelines.pdf**

**Figure 1-3:** Locations for gunshot or penetrating captive bolt placement in a goat. "A" corresponds with the landmarks described in reference 3 (Plummer et al., 2018) and "B" corresponds with the landmarks described in reference 4 (Collins et al., 2017). Images curtesy of Veterinary Research and Education Center, College of Veterinary Medicine University of Tennessee.




## References


1. Underwood W, Anthony R. AVMA guidelines for the euthanasia of animals: 2020 edition. Retrieved on March 2020;2013:2020-2021.

2. Shearer JK. Euthanasia of cattle: practical considerations and application. *Animals.* 2018;8:57.

3. Plummer PJ, Shearer JK, Kleinhenz KE, et al. Determination of anatomic landmarks for optimal placement in captive-bolt euthanasia of goats. *Am J Vet Res.* 2018;79:276-281.

4. Collins SL, Caldwell M, Hecht S, et al. Comparison of penetrating and nonpenetrating captive bolt methods in horned goats. *Am J Vet Res.* 2017;78:151-157.

5. Smith JS, Ward JL, Schneider BK, et al. Comparison of standard electrocardiography and smartphone-based electrocardiography recorded at two different anatomic locations in healthy meat and dairy breed does. *Front Vet Sci.* 2020;7.

6. Viner TC, Hamlin BC, McClure PJ, et al. Integrating the forensic sciences in wildlife case investigations: a case report of pentobarbital and phenytoin toxicosis in a bald eagle (*Haliaeetus leucocephalus*). *Vet Pathol.* 2016;53:1103-1106.

7. Buchweitz JP, Johnson M, Jones JL, et al. Development of a quantitative gas chromatography-tandem mass spectrometry method for the determination of pentobarbital in dog food. *J Agric Food Chem.* 2018;66:11166-11169.

8. Payne J, Farris R, Parker G, et al. Quantification of sodium pentobarbital residues from equine mortality compost piles. *J Anim Sci.* 2015;93:1824-1829.