# Euthanasia Guidelines for Cattle

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The newest version of the AVMA Guidelines on Euthanasia is "*in press*" at the time of the preparation of these proceedings. Among numerous updates, one will notice that the revised version is more comprehensive than previous editions. Another change with this newest edition is that it will be a "living document"; that is, it will be on-line and in a format that will permit updating as new information becomes available. Other changes relative to the 2012 Guidelines include the development of separate documents for Mass Depopulation and Humane Slaughter. The Panel determined that it was necessary to develop separate documents for these topics since the techniques applicable to mass depopulation and humane slaughter do not always fit the definition of euthanasia.

In the following we have attempted to summarize the salient features of the AVMA Guidelines for euthanasia of cattle, including recent studies that did not make the deadline for inclusion in the revised version. One of these, by Dr. JN Gilliam et al,. is particularly noteworthy since the information presented in this paper represents a major shift in current thinking on anatomical site selection for conducting euthanasia in cattle. A second study is that reported Dr. B. Wileman, et al. on firearm and munitions selection which supports observations from an earlier Canadian study indicating that the .22 LR loaded with a hollow point bullet lacks sufficient muzzle energy and physical characteristics to provide consistent results when used for the euthanasia of cattle.

In addition to proper application of euthanasia techniques, persons conducting euthanasia procedures need to understand the visual indicators of unconsciousness and the physical parameters that confirm death. Careful observation of these responses helps provide clues to the effectiveness of the euthanasia procedure and the possibility or likelihood of a return to sensibility. Proper interpretation of these responses is essential to assuring the welfare of animals that must undergo euthanasia.

There are many ways to induce death, but not all are humane nor would they fit the definition of euthanasia. Sometimes people resort to unapproved or unacceptable methods out of convenience and/or a failure to understand that the particular method applied does not induce a humane death. It is imperative upon all who work with livestock to be prepared for situations that might require euthanasia of an animal. But, having the right equipment and a thorough understanding of the technique does not assure humane euthanasia. Too many animals still experience horrible deaths simply because of inertia and indecision. We discuss just a few of the causes of euthanasia delays. Once the decision is made, euthanasia should be conducted with as little stress to the animal as

possible. This can be challenging as well as dangerous in some venues requiring tranquilization of some animals.

We conclude with a brief discussion of options for carcass disposal. This is no small concern as options for the disposal of carcasses have decreased markedly in many areas.

## AVMA Guidelines on Euthanasia

Euthanasia means a "good death" whereby the methods applied to cause death induce an immediate loss of consciousness followed by cardiac and respiratory arrest and death without a return to consciousness. In the updated version of the AVMA Guidelines, euthanasia techniques are classified as 1) Acceptable, 2) Acceptable with Conditions, 3) Adjunctive, and 4) Unacceptable. Methods deemed "Acceptable" are those that consistently produce a humane death when used as the sole means of euthanasia. Those methods classified as "Acceptable with Conditions" are those that require certain conditions to be met in order to consistently produce a humane death. For example, techniques in this latter category might have greater potential for human error or injury and/or may require a secondary (adjunctive) step to ensure death. Although the "with conditions" qualifier suggests that these methods are less humane or not as suitable as those listed as "Acceptable", in fact they are considered to be equivalent to those listed under the "Acceptable" category.

Methods classified as "Adjunctive" are those that should not be used as the sole method of euthanasia; rather they are to be used in conjunction with others to ensure death in animals previously rendered unconscious. And finally, methods classified as "Unacceptable" are those that are considered to be inhumane under any conditions.

## Methods of Euthanasia in Adult Cattle

Methods recognized as appropriate for euthanasia of cattle are: 1) barbiturates and barbituric acid derivatives ("Acceptable"), gunshot and penetrating captive bolt ("Acceptable with Conditions"). Penetrating and non-penetrating captive bolt are suitable for euthanasia of calves. Whether used in mature animals or in calves penetrating captive bolt requires an "Adjunctive" method to assure death. These are described in greater detail below.

## "Acceptable" Methods

**Barbiturates and barbituric acid derivatives**—Barbiturates are preferred by some because of their rapid action and ability to induce a smooth transition from consciousness to unconsciousness and death. Drawbacks to the use of these agents for euthanasia include: cost, the need for restraint to deliver the drug, necessity to maintain a careful accounting of amounts used, requirements that these agents be administered only by a veterinarian or personnel who are registered with the US Drug Enforcement Administration and finally, residues that limit carcass disposal options.

**A question that frequently arises is: *"What happens to the fetus in pregnant animals euthanized by an overdose of pentobarbital"*?** Research and clinical observation shows that barbiturates readily cross the placenta resulting in fetal depression; however death of the dam precedes death of the fetus by as much as 20-25 minutes. Fetal welfare is preserved by the fact that while *in utero*, the fetus is maintained in sleep-like state of unconscious. On the other hand, if removed from the uterus prior to

20-25 minutes post death of the dam, the fetus may regain consciousness. In cases involving euthanasia, any fetus removed from uterus prior to the amount of time required to cause death should be carefully observed for evidence of life and immediately euthanized if there is any doubt.

## "Conditionally Acceptable" Methods

**"Free Bullet" from Gunshot.** A 2008 study by Fulwider found that gunshot is the most common method used for on-farm euthanasia of cattle. Death by means of a "free bullet" is caused by massive destruction of brain tissue. Despite its popularity and effectiveness for the purpose of euthanasia, those who are less familiar with firearms often find gunshot violent and objectionable. However, as stated in a previous edition of the Guidelines:

*"Properly applied, "euthanasia by either gunshot or penetrating captive bolt, causes less fear and anxiety and induces a more rapid, painless, and humane death than can be achieved by most other methods."*

Penetrating captive bolt is also used for euthanasia of mature cattle in field situations. Unlike euthanasia with firearms, once the animal is rendered unconscious, an adjunctive method to insure death must be applied. Styles of penetrating captive bolt include an in-line (cylindrical) and pistol grip (resembling a handgun) versions. Pneumatic captive bolt guns (air powered) are limited to use in slaughter plant environments. Models using gunpowder charges are more often used in farm environments. Depending upon model, the bolt may automatically retract or require manual placement back into the barrel through the muzzle. Accurate placement of the captive bolt over the ideal anatomical site, energy (i.e. bolt velocity) and depth of penetration of the bolt determine effectiveness of the device to cause a loss of consciousness and death. Bolt velocity is dependent on maintenance, in particular cleaning and storage of the cartridge charges. Captive bolt guns should be cleaned regularly using the same or similar solvents used in the cleaning of firearms. Powder charges for the captive bolt should be stored in air tight containers to prevent damage from moisture in hot and humid conditions.

Non-penetrating captive bolt is not recommended for euthanasia of adult cattle. On the other hand, non-penetrating captive bolt is appropriate for euthanasia of calves when followed by the use of an adjunctive (secondary step) method to assure death.

## Research on Firearm Use for Euthanasia of Cattle

Although the .22 LR is a popular caliber of firearm, results of a Canadian study suggest that it may not be the best choice for euthanasia of adult cattle because of poor penetration, deflection and fragmentation of the bullet. Standard and high velocity bullets fired from a .22 caliber rifle at a range of 25 meters (82 feet) failed to penetrate skulls of steers and heifers studied. These observations are corroborated by the results of a Kansas State University study by Wileman et al, designed to evaluate the characteristics of bullet penetration and brain tissue destruction using different calibers of firearms. In this study, researchers assigned disembodied heads of feedlot cattle to one of seven treatments: **1) *.22 LR with a solid point bullet*** (160 ft. lbs. or 217 Joules), **2) *.22 LR with a hollow point bullet*** (160 ft. lbs. or 217 Joules), **3) *.223 rifle*** (1183 ft. lbs. or 1604 Joules), **4) *9 mm handgun*** (316 ft. lbs. or 428 Joules), **5) *.45 caliber handgun*** (551 ft. lbs. or 747 Joules), **6) *12 gauge shotgun with # 4 shot*** (1769 ft. lbs. or 2398 Joules) and **7) *12 gauge loaded with a 1 oz. slug***

(4095 ft. lbs. or 5552 Joules). Cadaver skulls were shot from a fixed distance of 3 meters (approximately 10 feet). The anatomical site used was on the intersection of two lines each drawn from the medial canthus of the eye to the base of the opposite ear with the firearm directed toward the foramen magnum. Damage to the brain was determined by computed tomography (CT) using serial coronal scans at 3 mm intervals which were reconstructed at 1.5 mm intervals.

Results demonstrated that the .22 LR hollow point bullet had the poorest depth of penetration (107.5 mm) compared with other treatment groups which had a penetration depths of 150 mm. Only 33% of the 9 mm bullets caused damage to brain tissues sufficient to cause death. Greatest destruction of brain tissue occurred with the 12 gauge shotgun with #4 shot and the 1 oz. slug. Researchers concluded that the .22 LR with a hollow point bullet and the 9mm pistol could not be recommended based on this study.

A couple of points worthy of mention in regard to the above studies; first, when gunshot is used for the purposes of euthanasia, whenever possible the firearm should be held perpendicular to the skull and at a distance of no more than 2 to 3 feet away from the intended target. Reasons for these recommendations are to avoid ricochet and to take full advantage of the bullet's maximum muzzle energy. Obviously, this is not possible for an animal that is standing or mobile which is frequently the circumstance in feedlot conditions. In the studies cited above the distance of the shooters from their targets were 25 and 3 meters for the Canadian and US studies, respectively. As the distance away from the target increases so do the challenges for accurate shot placement, potential for ricochet and ability to maintain sufficient muzzle energy particularly when lower caliber firearms are used.

## Recommendations on Firearms for Euthanasia

**Handguns**. Handguns or pistols are short-barreled firearms that may be fired with one hand. For the purposes of euthanasia, handguns are limited to close-range shooting (within 1 to 2 feet or 30 to 60 cm) of the intended target. Calibers ranging from .32 to .45 are recommended for euthanasia of cattle. Solid-point lead bullets are recommended over hollow points because they are more likely traverse the skull. Hollow point bullets are designed to expand and fragment on impact with their targets which reduces the depth of penetration. The .22 caliber handgun is not recommended for routine euthanasia of adult cattle regardless of the type of bullet used, because of the inability to consistently achieve desirable muzzle energies with standard commercial loads.

**Rifles**. A rifle is a long barreled firearm that is usually fired from the shoulder. Unlike the barrel of a shotgun which has a smooth bore for shot shells, the bore of a rifle barrel contains a series of helical grooves (called rifling) that cause the bullet to spin as it travels through the barrel. Rifling imparts stability to the bullet and improves accuracy. For this reason, rifles are the preferred firearm for euthanasia when it is necessary to shoot from a distance. Rifles are capable of delivering bullets at much higher muzzle velocities and energies and are therefore not the ideal choice for euthanasia of animals in indoor or short range conditions. General recommendations on rifle selection for use in euthanasia of cattle include; .22 magnum, .223, .243, .270 and .308 and others.

**Shotguns**. Shotguns loaded with birdshot (lead or steel BBs) or slugs (solid lead projectiles specifically designed for shotguns) are appropriate from a distance of 1 to 2 yards (.9 to 1.8 meters). Although all shotguns are lethal at close range, the preferred gauges for euthanasia of mature cattle

are 20, 16, or 12. Number 6 or larger birdshot or shotgun slugs are the best choices for euthanasia of cattle. Birdshot begins to disperse as it leaves the end of the gun barrel; however, if the operator stays within short range of the intended anatomic site, the birdshot will strike the skull as a compact bolus or mass of BBs with ballistic characteristics on impact and entry that are similar to a solid lead bullet. At close range, penetration of the skull is assured with massive destruction of brain tissue from the dispersion of birdshot into the brain that results in immediate loss of consciousness and rapid death.

One advantage of euthanasia using a shotgun is that within close range and when properly directed, birdshot has sufficient energy to penetrate the skull, but is unlikely to exit the skull. In the case of a free bullet or shotgun slug there is always the possibility of the bullet or slug exiting the skull creating an injury risk for the operator or by-standers. For safety reasons it is important that the muzzle of a shotgun (or any other firearm) never be held directly against the animal's head. Discharge of the firearm results in the development of enormous pressure within the barrel that can result in explosion of the barrel and potential for injury of the operator and by-standers if the muzzle end is obstructed or blocked.

## Captive Bolt

**Penetrating captive bolt.** In general, captive bolt guns, whether penetrating or non-penetrating, induce immediate loss of consciousness, but death is not always assured with the use of this device alone. Therefore, an adjunctive method such as a second shot, exsanguination, pithing or the intravenous injection of a saturated solution of potassium chloride (KCl) is recommended to ensure death when penetrating captive bolt is used. A newer version of penetrating captive bolt has emerged in recent years. This device is equipped with an extended bolt with sufficient length and cartridge power to increase damage to the brain including the brainstem. If studies prove this to be an effective 1-step euthanasia method, it will eliminate the need for an adjunctive method.

Unlike techniques described for gunshot, the animal must be restrained for accurate placement of the captive bolt. And, unlike use of a firearm, proper use of the captive bolt requires that the muzzle of the device be held firmly against the animal's head. Once the animal is restrained, discharge of the captive bolt should occur with little or no delay so that animal distress is minimized. Adjunctive methods should be implemented as soon as the animal is rendered unconscious to avoid a possible return to sensibility. Thus, when conducting euthanasia by captive bolt, pre-planning and preparation is necessary to achieve the desired results.

Visual indicators that an animal has been rendered unconscious from captive bolt or gunshot include the following: immediate collapse; brief tetanic spasms followed by uncoordinated hind limb movements; immediate and sustained cessation of rhythmic breathing; lack of coordinated attempts to rise; absence of vocalization; glazed or glassy appearance to the eyes; centralized eye position with a dilated pupil; and absence of eye reflexes. Nervous system control of the blink or corneal reflex is located in the brain stem; therefore, the presence of a corneal reflex is highly suggestive that an animal is still conscious.

## Anatomical Landmarks for Euthanasia of Cattle

The objective in euthanasia is to cause sufficient damage to the brain to result in immediate loss of consciousness and death. Accomplishment of this objective requires the accurate delivery of a bullet or captive bolt at an anatomical site that is most likely to cause damage to the brainstem. In the past, most recommendations suggested that the ideal site was on the intersection of two lines each drawn from the medial canthus of the eye to the base of the opposite horn or top of the ear in polled cattle.

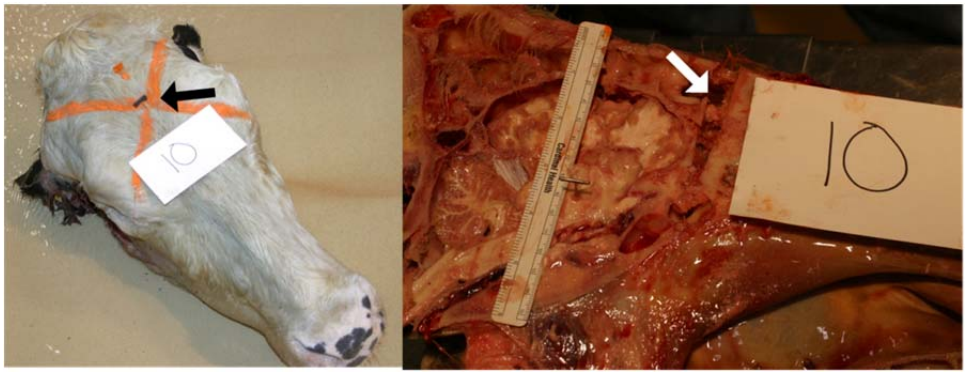



Figure 1. Cadaver skull form an adult Holstein cow shot with a penetrating captive bolt. The shot was placed on the intersection of 2 lines each from the medial canthus (inside corner) of the eye to the opposite horn or top of the opposite ear (black arrow). Note that the bolt failed to enter the cranial vault (white arrow). Path of the bolt is rostral to the brain (Gilliam et al., 2012).

As early as 2008, Gilliam and others suggested that this site was in fact too rostral (i.e. toward the nasal region or muzzle) and unlikely to damage the brainstem (See Figure 1). In order to confirm this observation, Gilliam instituted a study to evaluate the likelihood of brainstem damage using penetrating captive bolt at two anatomical locations. Cadaver skulls from 15 cattle were divided into one of two groups. Group 1 was shot with the penetrating captive bolt on the intersection of two lines each drawn from the medial canthus of the eye to the opposite horn or top of the opposite ear. Group 2 was shot at the intersection of two lines each drawn from the lateral canthus of the eye to the opposite horn or top of the opposite ear. The actual tract (or path) of the bolt for each respective location was determined by computed tomography and physical observation of the brain and brainstem. Evaluation of the skulls from Group 1 demonstrated that the bolt failed to make contact with the brainstem in all skulls studied (See Figure 2). In Group 2, the bolt was observed to cause significant damage to the brainstem in 6 of 8 skulls studied (See Figure 3). These results, although preliminary, indicate that the higher anatomical site improves the likelihood of causing damage to the brainstem. However, these data also suggest that some adjustment of this site is still necessary to achieve consistent results. This study is continuing with plans to assess age and

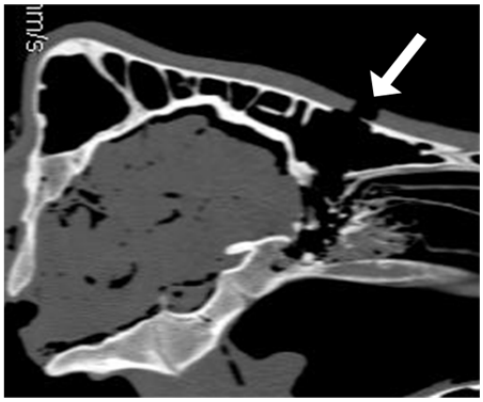


Figure 3. Computed tomography image of a bovine skull shot with a penetrating captive bolt showing the bolt path (white arrow) too far rostral to disrupt the brainstem (Gilliam et al. 2012).

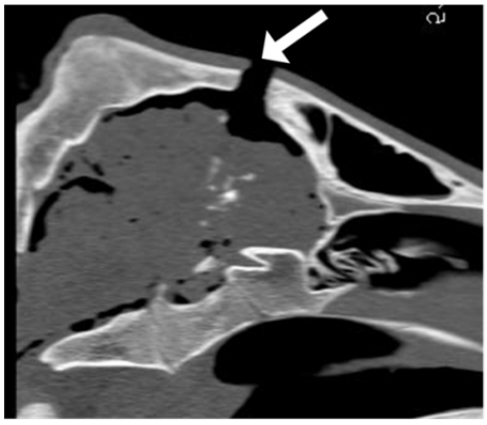


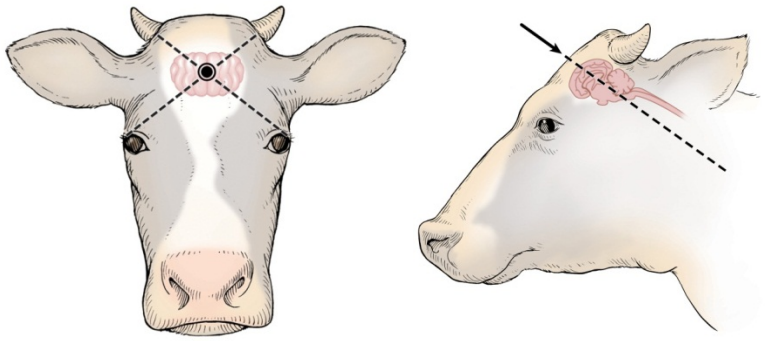
Figure 2. Computed tomography image of a bovine skull shot with a penetrating captive bolt showing the bolt path (white arrow) disrupting both the cerebral cortex and brainstem (i.e. bolt path is indicated by bone fragments pushed into the brain, Gilliam et al 2012).

breed differences for determination of the best anatomical site for conducting euthanasia in cattle.

**Anatomic landmarks for use of the penetrating captive bolt and gunshot**. Based upon current information in cattle, we suggest that the point of entry of the projectile should be at (or slightly above) the intersection of two imaginary lines, each drawn from the outside corner (lateral canthus) of the eye to the center of the base of the opposite horn. If a firearm is used it should be used within 3 feet of the target when possible and positioned so that the muzzle is perpendicular to the skull to avoid ricochet. When using penetrating captive bolt, operators are advised to restrain the head so that the captive bolt may be held flush with the skull.

In all cases, proper positioning of the firearm or penetrating captive bolt is necessary to achieve the desired results. As suggested earlier, persons using captive bolt are advised to prepare for the application of adjunctive methods to assure death as soon as possible following confirmation that the animal is unconscious. It is also important to consider positioning of the captive bolt device. Directing the bolt toward the foramen magnum will likely improve results particularly when placement of the device is slightly rostral.

Figure 4—Anatomic site for gunshot or placement of a captive bolt and desired path of the projectile in bovids.



**Poll Stunning**

Many people assume the poll (the highest point on the skull) is a proper site for conducting euthanasia procedures with either gunshot or penetrating captive bolt. In fact, this site is not advised since studies indicate that the depth of concussion in this region is less than that observed with frontal sites. Furthermore, research indicates that the use of penetrating captive bolt at the poll is more prone to operator error and misdirection of the bolt into the spinal cord instead of the brain. Conversely, for large bulls and water buffalo use of the frontal site is not always effective because of the thickness of the hide and skull in this region. Use of the poll position can be effective if the appropriate captive bolt gun is used and when the muzzle is directed so that the discharged bolt will enter the brain; but this site is not recommended for routine use.

**Unacceptable Methods**

The methods of euthanasia deemed unacceptable include: 1) manually applied blunt force trauma (as with a large hammer), 2) injection of chemical agents or other substances not specifically designed

or labeled for euthanasia (i.e. disinfectants, cleaning solutions, etc.), 3) air injection into the vein, 4) electrocution as with a 120 volt electrical cord, 5) drowning, 6) exsanguination of conscious animals, and 7) deep tranquilization as with xylazine or other alpha-2 agonist followed by potassium chloride or magnesium sulfate. While some have been forced out of desperation to resort to one or more of these methods, readers are strongly advised against their use. Several of these methods are known to result in a less than humane death and for others the level of pain or distress associated with these methods is unknown. For example, use of xylazine to create a deep state of tranquilization followed by the rapid administration of KCl is used by some veterinarians. The position of the AVMA is as that stated in Goodman and Gilman's Pharmacological Basis of Therapeutics, 11th Edition: "Although large doses of alpha-2 agonists can produce a state resembling general anesthesia, they are recognized as being unreliable for that purpose." Therefore, until such time as we have better information on this method in terms of its ability to cause a humane death, it is best to utilize alternate techniques.

## Confirmation of Death

Regardless of method used for conducting euthanasia procedures, it is important to confirm death. It is sometimes more easily said than done. However, the most reliable criteria include lack of pulse, breathing, corneal reflex and response to firm toe pinch, inability to hear respiratory sounds and heart beat by use of a stethoscope, graying of the mucous membranes, and rigor mortis. None of these signs alone, with exception of rigor mortis, confirms death.

## The Impediments to Timely Euthanasia

No one enjoys the task of euthanasia or really wants to do it. This is especially so for a livestock owner faced with the task of euthanizing his/her own animal. Employees face similar problems in conducting these procedures and for the same reasons. Some develop close attachments for the animals within their care. The physical methods of gunshot and penetrating captive bolt are inherently violent. While this is a significant deterrent in itself; in addition, many people are unfamiliar with the proper use of firearms, let alone captive bolt. Sometimes the question that prevents moving forward with timely euthanasia is related to an uncertain prognosis. Diseased and/or injured animals often exhibit conflicting signs; it's not always a black or white decision as to whether or not euthanasia is indicated. The opportunity to error on the side of waiting too long looms large.

The consequence of early euthanasia is largely economic and delaying it prolongs animal suffering. Veterinarians play a key role in assisting folks with these decisions and should be consulted whenever there are doubts as to whether euthanasia is warranted. When necessary or desired, veterinarians can intervene and relieve their clients of the burden of conducting the task on an animal to which they are emotionally attached. Euthanasia decisions can be complicated and some will undoubtedly be haunted by those lingering questions for which some might find consolation in the words of Dr. Bernard Rollin, Professor of Philosophy and Bioethics at Colorado State University, *"Better a week too early than a day too late"*.

## Considerations for Conducting the Procedure

Persons conducting euthanasia procedures should attempt to minimize animal distress. If animals are accustomed to human contact the presence of a familiar person may be reassuring and reduce anxiety. For animals that are not accustomed to human contact, gunshot may be the best option for euthanasia simply because it can be delivered with the least amount of human contact. In some cases tranquilization may be necessary to quiet a frightened or anxious animal.

Cattle should be approached quietly and restrained only as necessary to properly conduct the procedure. If the animal is ambulatory and able to be moved without causing distress, discomfort or pain, it may be relocated to an area where the carcass may be more easily reached by removal equipment. Dragging of non-ambulatory animals is unacceptable. In cases where movement of a down animal would increase distress or animal suffering, the animal should be euthanized first, and then moved following confirmation of death.

## Euthanasia of Injured or Recumbent Cattle on Enclosed Trailers

Not all cattle requiring euthanasia are found in the farm or ranch setting. Some are the consequence of livestock truck roll-over accidents or cattle injured in the process of hauling to a market or packing plant. Whenever an animal is down and unable to voluntarily walk off of a trailer, it may become necessary to euthanize the animal prior to removal. Since entering the trailer with a fractious animal (dairy bull or beef animal) might put a person at considerable risk, and gunshot is unsafe and possibly restricted by local ordinances, tranquilization of the animal is necessary. This can be accomplished by a veterinarian with a medicated dart from either a pistol or rifle, or by use of a "pole syringe" of sufficient length to deliver the tranquilizer from across a barrier between the operator and the agitated animal. Xylazine dosed at 0.3 to 0.5 mg/lb. (3 to 5 CC of 100mg/Ml /1000 lbs.) is usually sufficient to render the animal safe to approach.

Readers are cautioned that although this is a larger dose than that one would normally use, the combination of administering the drug to an anxious animal plus delivery via a dart or pole syringe makes the end result less predictable. Following administration of the xylazine, leave the animal undisturbed for the 15 to 20 minutes required for the xylazine to take full effect. Once the animal is sufficiently tranquilized it may be approached for application of the penetrating captive bolt with adjunctive procedures to ensure death. The primary concerns in these situations are human, animal and food safety.

## Carcass Disposal

Euthanasia presents another issue that people frequently fail to consider – disposal of the carcass. In North America, there are plenty of coyotes, buzzards and other scavenging animals willing to assist with carcass removal. This seems a natural way to dispose of an animal carcass; it serves the purpose of disposing of the carcass and provides food for the scavengers. This practice may be acceptable on large acreages, especially those without nearby neighbors and areas containing upland woods and brush. However, this natural method isn't permitted in most areas, and some scavengers become predators when carcasses are less available. This places newborn calves and other animals weakened by disease or other maladies at risk of predation. Most cattle producers are well aware that coyotes can take a significant toll on newborns. In dairy operations, calves may be attacked at

birth or later when confined to a small pen or hutch. In either situation, they are easy prey for a coyote. Furthermore, a proper method of carcass disposal is needed to prevent the spread of infectious and/or contagious disease. Finally, as described earlier, when barbiturates are used for euthanasia wildlife may be at risk from the consumption of carcasses with drug residue that may be deadly. Penalties for the accidental killing of endangered animals are severe and include incarceration as well as huge fines for persons convicted of the offense.

The problem is that socially, economically and environmentally acceptable methods of carcass disposal have become increasingly difficult to find. In the United States the disposal of animal carcasses is regulated by state and local laws that vary widely according to animal species. The most common methods for disposal of animal carcasses are burial, composting, incineration and rendering. Less common methods would include landfills and tissue digestion.

Advances in analytical chemistry have led to increasingly sensitive assays for multiple drugs and antimicrobials. The ability of these technologies to identify residue at extremely low levels has also continued to increase the scrutiny of rendered product end users. Today, acceptable levels are no longer acceptable, for many if not most, only zero tolerance will do. The result is a rendering industry that is much less accepting of the carcasses of animals euthanized by barbiturates. Therefore, the first choice recommendation for carcass disposal of animals euthanized by pentobarbital overdose is incineration or cremation; but cost precludes this from being an economically viable consideration for carcass disposal in most of today's commercial farm operations. The next best option is burial of the animal sufficiently deep to avoid being exhumed by scavengers. This must be conducted in accordance with State and local laws to assure no contamination of ground water sources. When the ground is frozen, carcasses must be carefully covered and stored until such time as burial may be possible.

Composting is another means of carcass disposal that is becoming increasingly more common. Although studies are few, most report the persistence of barbiturate residues in composted material. For these reasons, the physical methods of gunshot and captive bolt are far more attractive for euthanasia of livestock. Even when adjunctive methods such as the rapid intravenous administration of potassium chloride are used to assure death there are no worries for rendering or composting. In short, while there are many within the veterinary profession that find gunshot and penetrating captive bolt violent methods and therefore less desirable, when they are properly conducted they are very humane, cost-effective and do not pose residue risks.

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