



University of Michigan Euthanasia Guidelines

METHOD ^{1, 18}	SPECIES											
	Amphibians	Birds	Cats, Woodchucks	Dogs	Fish	Ferrets, Bats	Monkeys	Rabbits	Reptiles	Rodents and Small Animals	Ruminants	Swine
Barbiturates ²	A	A	A	A	A	A	A	A	A	A	A	A
Injectable anesthetics ³	A	A	A	A	U	A	A	A	A	A	A	A
Inhalant anesthetics ⁴	U	AC	AC	U	U	AC	AC	ACJ	AC	AC	U	U
Carbon dioxide ⁵	U	AC	ACJ	U	U	ACJ	ACJ	ACJ	U	AC	U	U
Microwave irradiation ⁶	U	U	U	U	U	U	U	U	U	ACJ	U	U
Tricaine methanesulfonate ⁷	A	U	U	U	A	U	U	U	U	U	U	U
Benzocaine hydrochloride ⁸	A	U	U	U	A	U	U	U	U	U	U	U
Cervical dislocation ⁹	U	AC	U	U	U	ACJ	U	ACJ	U	ACJ	U	U
Decapitation ¹⁰	ACJ	ACJ	U	U	ACJ	ACJ	U	ACJ	ACJ	ACJ	U	U
Penetrating captive bolt ¹¹	ACJ	U	U	ACJ	U	U	U	ACJ	ACJ	U	ACJ	ACJ
Gunshot ¹²	U	ACJ	U	U	U	U	U	U	ACJ	U	ACJ	ACJ
Pithing ¹³	ACJ	U	U	U	U	U	U	U	ACJ	U	U	U
Stunning ¹⁴	ACJ	U	U	U	ACJ	U	U	U	ACJ	U	U	U
Rapid chilling/Hypothermia ¹⁵	U	U	U	U	A	U	U	U	U	ACJ	U	U

The methods listed below require that animals be anesthetized before euthanasia is performed

Electrocution	U	U	U	ACJ	U	U	U	U	U	U	ACJ	ACJ
Exsanguination under anesthesia	A	A	A	A	A	A	A	A	A	A	A	A
Potassium chloride under anesthesia ¹⁶	A	A	A	A	A	A	A	A	A	A	A	A
Terminal procedures (incl. removal of a vital organ and pneumothorax) ¹⁷	A	A	A	A	A	A	A	A	A	A	A	A
Rapid freezing under anesthesia	AC	U	U	U	U	U	U	U	AC	ACJ	U	U



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1. These guidelines are based on the AVMA Guidelines for the Euthanasia of Animals: 2013 Edition (<https://www.avma.org/KB/Policies/Documents/euthanasia.pdf>). Abbreviation codes are as follows: **A = Acceptable** - those which consistently produce a humane death when used as the sole means of euthanasia, **AC = Acceptable with Conditions**- those which consistently produce a humane death when specific conditions are met, **ACJ = Acceptable with Conditions requiring Justification**- may not consistently produce a humane death as sole means and requires IACUC approval, **U = Unacceptable**- deemed inhumane under any conditions, or found to pose substantial risk to human applying the technique
2. Intravenous (IV) injection is the preferred method for euthanasia. Intraperitoneal (IP) injection may be used in situations when IV injection would be distressful or dangerous. Intracardiac (IC) injection must only be used if the animal is unconscious, or anesthetized.
3. Chloral Hydrate is unacceptable for euthanasia alone but can be used as an anesthetic followed up with a 2nd method (e.g., removal of vital organ) to ensure death.
4. Either of equal preference: isoflurane, or sevoflurane, In rabbits and other species that show aversive reactions to inhaled anesthetics exposure to high concentrations resulting in rapid loss of consciousness is preferred.
5. Compressed gas in cylinders is the only recommended source of carbon dioxide because the inflow to the chamber can be regulated precisely. Flow rate should be 10-30% of chamber volume/minute. For neonates and immature animals, the time required for euthanasia may be prolonged. In small rodents, carbon dioxide exposure must be followed by an active method to ensure death (e.g., bilateral pneumothorax, exsanguination, decapitation, removal of a vital organ).
6. For use with small laboratory rodents only. Must be justified to ensure specially designed equipment is used.
7. Fish and amphibians may be euthanized by immersion in a tank containing tricaine methanesulfonate at a concentration of ≥ 250 mg/liter of water for 10-20 minutes. The solution should be buffered to a pH of 7.0- 7.5 with sodium bicarbonate.
8. Fish and amphibians may be euthanized by immersion in a tank or recirculation system containing benzocaine hydrochloride at a concentration of >250 mg/liter of water for 10-20 minutes.
9. Manual cervical dislocation is conditionally acceptable in mice, gerbils, hamsters and other small rodents, bats, rats weighing less than 200 gm, and rabbits or ferrets weighing less than 1 kg. Cervical dislocation may be performed on larger rats and rabbits manually by an individual with demonstrated proficiency or if a mechanical dislocator is utilized.
10. In amphibians, fish, and reptiles, decapitation should be followed by pithing of both the brain and spinal cord. Decapitation is also acceptable for neonates less than 10 days of age.
11. This method requires a secondary method to confirm euthanasia (e.g., exsanguination, etc.). For fish and reptiles, this should only be used in large species.
12. This method is only recommended for wild or free-ranging species. If animals can be restrained, penetrating captive bolt should be used instead. For fish and reptiles, this should only be used in large species.
13. May be used as only as secondary method of euthanasia in species with anatomic features that facilitate easy access to the central nervous system (e.g., frogs).
14. Stunning is unacceptable as a sole method of euthanasia. If performed properly, stunning will produce unconsciousness but must be followed by decapitation or pithing to ensure the animal's death.
15. Rapid chilling of zebrafish is acceptable as long as transfer to water at temperatures of 2° to 4°C occurs rapidly with as little transfer of warmer water as possible, Hypothermia is an acceptable method of anesthesia for neonatal rodents, however it requires a secondary method of euthanasia to ensure death and cannot be used as a sole means of euthanasia.
16. The only acceptable routes of administration are IC and IV.
17. Rapid freezing (e.g., liquid nitrogen) should only be used for reptiles, amphibians, and <5 -day-old altricial rodents. In all cases, animals must be anesthetized or rendered unconscious prior to freezing.
18. Unacceptable methods include: chloroform, carbon monoxide, thoracic decompression, formaldehyde, and non-penetrating captive bolt.