Aquatic Mammals 2012, *38*(3), 317-321, DOI 10.1578/AM.38.3.2012.317

Short Note

Euthanasia of an Adult Southern Right Whale (*Eubalaena australis*) in Brazil

Cristiane K. M. Kolesnikovas,[1] Kátia R. Groch,[2] Karina R. Groch,[3] Aury Nunes de Moraes,[4] Paulo A. C. Flores,[5] Dan J. Pretto,[5] Rodrigo R. Freitas,[6] Morgana C. Gaidzinski,[6] Luciana M. de P. Moreira,[7] and Maria E. C. da Rocha[7]

[1]*Associação R3 Animal, Rua dos Coroas, 469 Florianópolis, SC, 88061-600, Brazil*
E-mail: criskolesnikovas@gmail.com
[2]*Departamento de Patologia Experimental e Comparada, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo, Avenida Orlando Marques Paiva, 87, São Paulo, SP, 05508-270, Brazil*
[3]*Projeto Baleia Franca, Avenida Atlantica, s/no., Praia de Itapirubá, CP 201, Imbituba, SC, 88780-000, Brazil*
[4]*Universidade do Estado de Santa Catarina (UDESC), Centro de Ciências Agroveterinárias (CAV), Hospital de Clínica Veterinária (HCV), Avenida Luiz de Camões, 2090, Lages, SC, 88523-000 Brazil*
[5]*Centro Nacional de Pesquisa & Conservação de Mamíferos Aquáticos, ICMBio, MMA, CMA-SC, Rod. Maurício Sirotsky Sobrinho, s/n, km02, Jurerê, Florianópolis, SC, 88053-700 Brazil*
[6]*Unidade de Zoologia "Profª Morgana Cirimbelli Gaidzinski" – Muesc/UNESC, Avenida Universitária, 1105, Bairro Universitário, Criciúma, SC, 88806-000 Brazil*
[7]*Área de Proteção Ambiental da Baleia Franca, ICMBio, MMA, Avenida Santa Catarina, 1465, Bairro Paes Leme, Imbituba, SC, 88780-000 Brazil*

Rescue of stranded large whales is always challenging, especially in the case of adult animals. Euthanasia may be an option when the animal presents with disabling injuries, its size or local conditions prevent rescue attempts, or actions to save the animal would only prolong pain and suffering (Geraci & Lounsbury, 2005). Euthanasia is the act of humane induction of death for an animal that is suffering. Ideally, the act must minimize any pain, distress, or anxiety experienced by the animal prior to its death. The euthanasia technique should induce a very rapid loss of consciousness in the animal, followed by cardiac and respiratory arrest and the loss of brain function (American Veterinary Medical Association [AVMA], 2007). Intravenous (IV) injection of barbiturates to promote anesthesia and unconsciousness followed by cardiotoxic or muscular blocking drugs is the most accepted protocol for small cetaceans; however, difficulties in the administration of large volumes of drugs, and the associated elevated cost, sometimes prevents successful euthanasia via this method in large whales.

The primary IV routes for drug administration during euthanasia in cetaceans are the ventral fluke or peduncle veins. In the case of large whales, venous access is often hindered by one or more of the following conditions: (1) the position of the animal (often in ventral recumbency) hinders access to vessels in the ventral peduncle or fluke; (2) sudden vertical and lateral fluke movements can cause serious injury to individuals close to or holding the fluke; and (3) if the animal is at a beach with rough surf, waves constantly break over the whale resulting in dangerous working conditions. Intra-cardiac (IC) administration of drugs would be an option if a needle of appropriate size and rigidity is available.

Given the difficulties of approaching large baleen whales to administer drugs for euthanasia and the uncertainty in terms of doses and effects, reports on successful and failed attempts may be useful for future cases in which rescue is not possible. This note describes the euthanasia methods carried out on an adult southern right whale (SRW) (*Eubalaena australis*) stranded in Brazil. Prior rescue attempts, necessary logistics, approaches dealing with public and media who expected a good and rapid solution for the case, and detailed clinical conditions of the animal during the 7 d it remained stranded will be discussed in a separate article that is under preparation.

On the morning of 7 September 2010, an adult female SRW, 14 m long, stranded in ventral recumbency at Itapirubá Sul Beach (Figure 1) in the city of Laguna on Santa Catarina State (28° 21'51.08" S, 48° 43'32.95" W; Figure 2), Brazil. Rescue was the first choice option and was attempted the day

following the stranding. Because of the large (about 2 m) breaking waves (with a surf zone ~300 m across), the low tide, and the animal's size, a major concern of the rescue attempt was that this action would put the whale, people, and boat safety at risk. As part of the stranding protocol of the Área de Proteção Ambiental da Baleia Franca (Southern Right Whale Governmental Protection Area) and southern branch of the Brazilian Network of Stranding and Information of Aquatic Mammals (REMASUL-REMAB), biologists, veterinarians, and institutional representatives convened and decided that euthanasia was the best option based on the animal's welfare, but also considering (1) the advice of the local Navy's authority to not proceed with the rescue because of safety concerns on site; (2) the logistic difficulties; (3) that it was the 4th stranding day with the animal presenting declining responsiveness to human approach and showing pendullar nystagmus (a sign of neurologic compromise according to Rucker [2010]); and (4) the fact that large whales (> 10 m) have been known to take as long as 4 to 5 d to die once stranded (Daoust & Ortenburger, 2001). Euthanasia was conducted with the consent of the Brazilian Environmental

Figure 1. Southern right whale in the second day of stranding (8 September 2010)

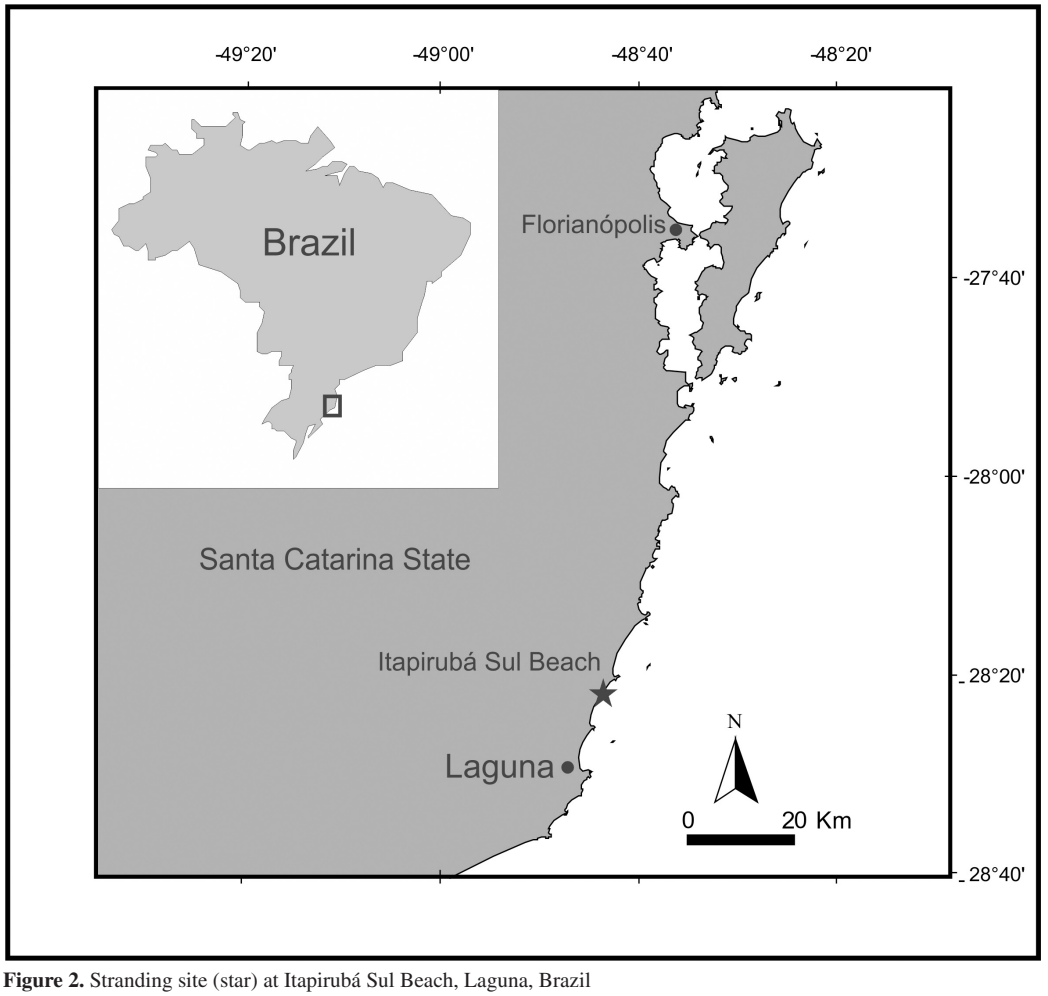

Figure 2. Stranding site (star) at Itapirubá Sul Beach, Laguna, Brazil

Agency responsible for aquatic mammals (Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos [CMA], Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio], Ministry of the Environment).

Because the animal was partially submerged, with waves striking its body and the flukes moving, venipuncture for an IV injection at the ventral fluke was considered dangerous and was ruled out. Other vessels in the pectoral and dorsal appendages have been proven to be inaccessible in large whales (Dunn, 2006). Thus, procedures that include intramuscular (IM) pre-medication for animal sedation and the protocol described by Dunn (2006) for administration of a barbiturate directly into the respiratory tract via the blowhole were chosen as most feasible. Dunn describes blowhole administration of pentobarbital followed by IV injection of T-61® for euthanasia in a fin whale (*Balaenoptera physalus*) of 13.5 m total length. At this time, the staff faced difficulties in acquiring the necessary amount of pentobarbital because it is limited for human use, and the local human hospital did not have the permits for use in animals.

The estimated whale's weight for drug calculation was 40 tons. The protocol for drug administration was modified according to the availability of the drugs. For pre-medication, 0.2mg/Kg xylazine (8,000 mg) and 0.021mg/Kg midazolan (840 mg) were prepared in separated syringes and administered IM into the tongue. Usually in cetaceans, IM administration of drugs is preferred to be into the epaxial muscles (Tarpley, 1987); however, because of the thickness of the blubber layer estimated to be 20 to 30 cm in this adult SRW, an extended manufactured needle would be necessary and was not available. The tongue was accessible because the whale was partially buried in the sand and its mouth was kept open, held up by the baleen plates. The whale could not move its jaws but showed contractions in the tongue in response to the injections.

Thirty minutes after the last injection, 113 g of thiopental sodium diluted in 2,000 mL of saline solution were administered into the blowhole using a 30.0 × 2.5 cm tube. In order to minimize reflux during expiration, the drug was administered between breath movements; however, an unknown amount of the drug was still expelled in the subsequent expiration. Palpebral reflexes and breathing rate were monitored before and after drug administration, and no changes were observed. After 30 min of the thiopental sodium administration, 500 g of chloral hydrate was administered into the blowhole. Chloral hydrate is a sedative and hypnotic drug expected to enhance anesthetic effects in association to thiopental (Booth & McDonald, 1988). After 60 min from the last administration of drugs, no changes in clinical parameters were observed. Because the animal did not show adequate sedation, the tentative plan to access the ventral fluke vessels to give a lethal IV injection was canceled.

The next morning, the whale's respiration rate was unchanged, and the palpebral reflex appeared to be faster; however, the animal kept demonstrating unawareness of human presence and constant ocular nystagmus. Evaluating pre-existing large whale euthanasia protocols and the impossibility of gaining access to the fluke vessels because of wave and tail movements, the best procedure seemed to be an IC injection based on the procedure described by Daoust & Ortenburger (2001). The authors euthanized a 10.5-m fin whale with IC administration of 5,000 mg of xylazine, followed by 100 mL of T-61® and 1,200 mmol of potassium chloride (KCI) diluted in 600 mL of sterile water through a manufactured needle of 100 cm inserted into the thoracic wall after local anesthesia.

Drugs and equipment were not available until the seventh day of stranding when the procedure was undertaken. A 150 × 1.0 cm steel needle with a bevel point and a small, 8 cm hole behind the point was locally manufactured for the IC injection. A steel bar of 160 cm with sharp point was inserted inside the needle to give more resistance and prevent obstruction of the needle during insertion through the tissues.

The whale was first anesthetized with a mixture of 0.5 mg/Kg xylazine (19,800 mg) and 2.47 mg/Kg ketamine (99,000 mg) administered IM into the tongue. After 40 min of the xylazine and ketamine injections, an incision was made into the blubber layer, and the needle was inserted intercostally into the right side of the animal's body approximately 20 cm behind the pectoral flipper, pointed to the left pectoral flipper aiming to reach the heart. When about 120 cm of the needle was inserted, the steel bar was removed from the needle and a copious amount of blood started to flow in a low pressure, suggesting that a vessel or the heart had been reached. A volume of 750 mL of T-61® (Intervet, Germany) was administered. One minute after drug delivery, the animal stopped presenting any blowhole or eye movements, and the palpebral reflex was absent. Immediately, 10,000 mL of a 1 mmol solution of KCl was delivered as a final euthanasia drug. The whale was monitored up to 1 h after the last breath, and no vital signs were observed.

A necropsy was performed the next day (11 September 2010), and no gross lesions were found that could explain why the animal stranded. The only observed lesions were extensive necrotic ulcerations in the skin under the head and symmetrically on the base of the lower jaws. Despite

effort to perform the necropsy as fast as possible, removal of the whale carcass from the water and dissection procedures took a long time (approximately 11 h); thus, microbial culture and histopathological analysis were impaired due to autolysis. Selected organ fragments were frozen for future molecular studies of pathogenic organisms.

It is known that species and even individuals can respond differently to drug administration and effects. For large whales, dosages of drugs are even more difficult to calculate because the animal's weight is not precise, and there are few publications on right whale sedation (Moore et al., 2010). Xylazine has been successfully used IM to sedate a 10.5-m long emaciated fin whale with a total amount of 5,000 mg (Daoust & Ortenburger, 2001). Midazolam has been used in gray whales (*Eschrichtius robustus*) at a dosage of 0.02 to 0.03 mg/kg or 15 mg/1m in body length (Greer et al., 2001). Dosages of 0.01 to 0.025 mg/kg of midazolam were administered IM in North Atlantic right whales (*E. glacialis*) at sea to sedate entangled animals and enhance gear removal (Moore et al., 2010). In the present case, the dosage of 0.2 mg/kg of xylazine combined with 0.021 mg/kg of midazolam administered IM into the tongue was not enough to sedate the 40 tons of estimated body weight of this SRW. In the second tentative procedure, the dosage of xylazine was increased to 0.5 mg/kg, and the drug was adjusted to 2.47 mg/kg of ketamine to induce anesthesia. Considering that deep sedation parameters for cetaceans are cessation of tail-fluke movements, loss of strong corneal and eyelid reflexes, swallowing in response to tactile stimulation of the pharynx, retraction of tongue, tail movements, movements of pectoral flippers in response to surface stimulation, and movement of the blowhole after stimulation of the nares or vestibular sacs (Brunson, 2007), it was assumed that the whale was sedated.

The upper respiratory tract has been used as a route for systemic delivery of substances such as anesthetics, emergency drugs, and a number of illicit drugs (Chernow et al., 1984; Gonda, 2006). In whales, sedation with pentobarbital via the upper respiratory tract prior to IV injection of lethal drugs for euthanasia has already been reported (Dunn, 2006). Thiopental has been used to euthanize humpback whales (*Megaptera novaeangliae*) in doses of 0.3 to 0.4 mg/kg IV (Kátia R. Groch, pers. comm., September 2010). In the present case, the dose of 2.8 mg/kg of thiopental administered via blowhole during the first procedure was not effective; however, exhalation of an uncertain amount of the administered drug may have contributed to underdosage and lack of sedative effect. One of the factors that may have contributed to facilitating the exhalation of the drug was the length of the tube (30 cm), which may have been too short. Dunn (2006) reported the use of a tube 76.5 cm long with minimal loss of the drug administered.

The IC protocol was similar to that used by Daoust & Ortenburger (2001), except for a higher dose of xylazine and the addition of ketamine to induce analgesia before making the incision into the thorax. It is uncertain whether the needle reached a vessel or the heart. No pulsation was felt through the needle; however, the rigid blubber layer of 21 cm at the point of insertion (measured during necropsy) could have attenuated the vibrations. The distance from external skin surface to internal thoracic wall at this point was 41 cm. The heart measured approximately 80 cm in width and 80 cm in length; and because of its relatively large size, we believe that there is a good chance that the needle did reach the heart. Nevertheless, blood flew when the needle was 120 cm inserted, and the successful euthanasia indicates that the needle gained access to the central circulation.

T-61® is a mixture of a local anesthetic, a hypnotic agent, and a curariform drug in aqueous solution with formamide (Greer et al., 2001). The dose of 0.06 mL/kg administered IV in a fin whale led to cardiac arrest after 20 to 25 min. The dose of 0.01 mL/kg administered IC followed by administration of KCl was effective in a fin whale, which lost vital signs after 1 h (Daoust & Ortenburger, 2001). In both cases, the whales presented fasciculation in the epaxial muscles, and movements of the upper jaw opened the mouth before death. In the present case, the T-61® volume (0.018 mL/kg) used seemed to be adequate and promoted a humane euthanasia given that respiration stopped almost immediately after drug administration. No fasciculation, tail flurrying, or upper jaw movements were observed. Even though cardiac movements could not be monitored, the whale seemed to have lost vital signs almost immediately after the injection of T-61®. The rapid loss of reflexes and respiration paralysis are characteristic of T-61® action, and euthanasia results from central nervous system depression, hypoxia, and circulatory collapse (Caffrey et al., 2011). The whale also showed no additional palpebral reflexes or breathing movement when KCl was administered, so perhaps its injection was not necessary. The overall doses used in the second procedure were probably higher than necessary, but as the doses in the first procedure did not produce the expected effects, and there is little information about dosages and effects in right whales, we decided to use a protocol with higher dosages. Therefore, this protocol was successfully used and can serve as an extreme example from

which drug dosages can be diminished according to the condition of the animal.

Some authors suggest that natural death for larger stranded whales may be the most practical option (Geraci & Lounsbury, 2005). In the present case, the animal had been stranded for several days, and it was not known how many more days it would or could survive. The euthanasia procedure was chosen in order to end the animal's suffering. It was the first time that an adult SRW had been euthanized in Brazil, and it provided the involved professionals with the experience to be prepared for future events (i.e., have prepared access and permits for drug usage, legal permits for the procedure, trained personnel, euthanasia protocols, and appropriate equipment). It was important that all options to rescue the animal were exhausted before the decision for euthanasia was made. Further, the collaborative action was also a result of the stranding network and its protocol. We hope that this communication also helps other professionals to choose the best euthanasia protocol in cases where rescue is not possible.

Acknowledgments

We thank staff members of Projeto Baleia Franca, Área de Proteção Ambiental da Baleia Franca/ICMBio, CMA/ICMBio, Associação R3 Animal, Unidade de Zoologia "Profª Morgana Cirimbelli Gaidzinski" – Muesc/UNESC–Criciúma, and volunteers who strongly assisted with logistics, equipment, and help in the management of the whale during the stranding. Thanks to the Southern Marine Mammal Stranding and Information Network (REMASUL), the National Network (REMAB), and CMA/ICMBio for personal and technical support. We gratefully acknowledge Andrade Gutierrez and Santos Brasil for their help in the manufacture the needles and financial costs of the drugs utilized. Laguna and Imbituba City Halls helped with equipment during necropsy. The Exército Brasileiro (Brazilian Army), Environmental Police of Santa Catarina State, and Capitania dos Portos-Delegacia de Laguna (Brazilian Navy) provided on-site logistic conditions and safety for the staff. Special thanks to Dr. Michael Moore who kindly reviewed early drafts of this paper.

Literature Cited

American Veterinary Medical Association (AVMA). (2007). *AVMA guidelines on euthanasia*. Schaumburg, IL: AVMA. 36 pp.

Booth, N. H., & McDonald, L. E. (1988). *Veterinary pharmacology and therapeutics* (6th ed., p. 243). Ames: Iowa State University Press.

Brunson, D. B. (2007). Aquatic mammals. In W. J. Tranquilli, J. C. Thurmon, & K. A. Grimm (Eds.), *Lumb & Jones' veterinary anesthesia* (4th ed., pp. 833-840). Ames, IA: Blackwell Publishing.

Caffrey, Y. N., Mounchili, A., McConkey, S., & Cockram, M. S. (2011). Survey of euthanasia practices in animal shelters in Canada. *The Canadian Veterinary Journal*, *52*, 55-61.

Chernow, B., Holbrook, P., D'Angona, D., Zaritsky, A., Casey, L. C., Fletcher, J. R., & Lake, C. R. (1984). Epinephrine absorption after intracheal administration. *Anesthesia and Analgesia*, *63*, 829-832. http://dx.doi.org/10.1213/00000539-198409000-00008

Daoust, P. Y., & Ortenburger, A. I. (2001). Successful euthanasia of a juvenile fin whale. *The Canadian Veterinary Journal*, *42*, 127-129.

Dunn, J. L. (2006). Multiple-agent euthanasia of a juvenile fin whale, *Balaenoptera physalus*. *Marine Mammal Science*, *22*, 1004-1007. http://dx.doi.org/10.1111/j.1748-7692.2006.00073.x

Geraci, J. R., & Lounsbury, V. J. (2005). *Marine mammals ashore: A field guide for strandings*. Baltimore, MD: National Aquarium in Baltimore.

Gonda, I. (2006). Systemic delivery of drugs to humans via inhalation. *Journal of Aerosol Medicine*, *19*, 47-53. http://dx.doi.org/10.1089/jam.2006.19.47

Greer, L. L., Whaley, J., & Rowles, T. K. (2001). Euthanasia. In L. A. Dierauf & F. M. D. Gulland (Eds.), *CRC handbook of marine mammal medicine* (2nd ed., pp. 729-738). Boca Raton, FL: CRC Press. http://dx.doi.org/10.1201/9781420041637

Moore, M., Walsh, M., Bailey, J., Brunson, D., Gulland, F. M. D., Landry, S., . . . Rowles, T. (2010). Sedation at sea of entangled North Atlantic right whales (*Eubalaena glacialis*) to enhance disentanglement. *Plos One*, *5*(3), e9597. http://dx.doi.org/10.1371/journal.pone.0009597

Rucker, J. C. (2010). Pearls: Nystagmus. *Seminars in Neurology*, *30*, 51-53. http://dx.doi.org/10.1055/s-0029-1244994

Tarpley, R. J. (1987). Whales and dolphins in veterinary medicine. *The Southwestern Veterinarian*, *38*, 59-84.