COMMENTARY

Rapid cardiac compression: An effective method of avian euthanasia

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ABSTRACT
Proper methods for euthanasia are critical for research with birds. Training in these methods is generally required by institutional animal care and use committees for any research that involves handling of birds, even if the intent is for birds to be released into the wild. Rapid cardiac compression (RCC) remains a preferred method for quick euthanasia in field settings but has not been described adequately in the literature. We describe proper application of RCC for euthanasia of small birds. We also provide external cues for a bird as it progresses toward death as well as other considerations when using RCC. Note that RCC is also known as “thoracic compression,” but that term is not biologically accurate and should be abandoned.

Keywords: bird, euthanasia, method, rapid cardiac compression, thoracic compression

Compresión cardiaca rápida: Un método efectivo para la eutanasia de aves

RESUMEN
Los métodos adecuados de eutanasia son críticos para la investigación con aves. Generalmente se requiere entrenamiento en estos métodos por parte de los comités institucionales de bienestar y uso animal para cualquier investigación que involucre la manipulación de aves, incluso si la intención es la liberación de todas las aves al medio silvestre. La compresión cardiaca rápida (CCR) sigue siendo un método recomendado para una rápida eutanasia en condiciones de campo pero no ha sido descripta adecuadamente en la literatura. Describimos una adecuada aplicación de la CCR para la eutanasia de aves pequeñas. También describimos los signos externos de un ave en el proceso de muerte así como otras consideraciones cuando se usa CCR. Se conoce también a la CCR como compresión torácica, pero este término no es biológicamente preciso y debería abandonarse.

Palabras clave: ave, compresión cardiaca rápida, compresión torácica, eutanasia, método

Ornithologists working in the field are faced with many challenges in ensuring that their research is conducted both safely and ethically. Proficiency in euthanasia is fundamental to all field studies in which birds are handled, regardless of whether death is an endpoint of the fieldwork (e.g., museum collections or specimen-based research) or the bird is to be released unharmed. The need for euthanasia in the former cases is self-evident, but euthanasia may also be required where death is not the endpoint (e.g., banding, tissue collection, attachment of devices) because accidents can happen. Various methods of euthanasia are suitable for birds, but only a few are practical in a field setting.

Two federal animal welfare laws regulate research involving animals in the United States. First, the Animal Welfare Act of 1966 (and corresponding regulations) dictates the treatment of animals in research, exhibition, and transport; it requires that methods of euthanasia be humane. Second, the Public Health Service Policy on Humane Care and Use of Laboratory Animals requires the use of euthanasia methods classified by the American Veterinary Medical Association (AVMA) as acceptable or acceptable with conditions. In practice, the AVMA guidelines are the standard upon which institutional animal care and use committees (IACUCs) rely when reviewing research protocol applications. The primary experience of IACUC members involves reviewing protocols where death is an endpoint, typically for captive small mammals. Fewer proposals are evaluated for research with wild birds. In addition, AVMA-approved methods superficially address the challenges faced by scientists and museum collectors working in remote areas or over extended periods. The availability, transport, shelf life, and use of euthanasia drugs or syringes are problematic in many field situations.

For the past century, thoracic compression (TC) has been the preferred method for euthanizing small birds in field
Rapid cardiac compression method

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The term should be abandoned and replaced with an accurate description of the cause of death. We suggest that cardiac compression (RCC) has not been adequately described, peer-reviewed, or illustrated (Winker 2000, Fair et al. 2010). The most recent AVMA Guidelines for the Euthanasia of Animals (AVMA 2013) reclassified TC from “acceptable with conditions” to “unacceptable until data could be produced in a clinical study clarifying the rapidity (time to loss of consciousness) and cause of death from TC.” The AVMA decision jeopardized specimen-based research for all disciplines that rely on TC in field studies. This decision led to a study assessing the efficacy of TC at the University of California at Davis, where clinicians at the School of Veterinary Medicine collaborated with museum specialists at the Museum of Wildlife and Fish Biology (Paul-Murphy et al. 2017).

TC was previously considered controversial because of concern that death was caused by suffocation (Bennett 2001, Ludder 2001, AVMA 2011). In fact, TC uses direct application of pressure over the heart, leading to obstruction of venous return and stoppage of cardiac output, and in many cases results in rapid rupture of the thin-walled regions of the vena cava or atrium and near-instantaneous cessation of brain and pulse activity (Paul-Murphy et al. 2017). Furthermore, when TC was compared to the interosseous injection of pentobarbital, which the AVMA (2013) states is the quickest and most reliable method, there was no significant difference in either time to loss of consciousness or time to death in small birds (Paul-Murphy et al. 2017). Because the term thoracic compression has been associated in the literature with suffocation, the method can be viewed unfavorably. More importantly, thoracic compression is not a biologically accurate description of the cause of death. We suggest that the term should be abandoned and replaced with rapid cardiac compression (RCC).

RCC has not been adequately described, peer-reviewed, or illustrated (Winker 2000, Fair et al. 2010). The Ornithological Council (2013) created a peer-reviewed position paper on the method, which many researchers have used for IACUC authorization. Our goal here is to follow the clinical study of Paul-Murphy et al. (2017), including details appropriate for practitioners and IACUCs. The authors’ (A.E. and I.E.E.) experience in the use of RCC is extensive, including more than 35 years using RCC in field studies.

In most field cases when RCC is used, the bird has been captured by mist net or wounded by firearms. In all cases, euthanization should be rapid and humane; this is particularly true for wounded birds. Many IACUCs currently require that a wounded bird be shot again to euthanize it quickly. Gunshot is an approved method of euthanasia (AVMA 2013), but a second shot from close range can be damaging to the carcass. RCC provides a better alternative to shooting a bird a second time. For example, a bird may be shot and dropped into heavy cover; if it is found alive and capable of escape, there is risk of losing the bird during the time necessary to establish proper distance for a second shot. This delay would also prolong the bird’s suffering. Therefore, quickly capturing the bird and applying RCC can minimize the bird’s pain and stress. Birds inadvertently injured during handling or found injured can also be euthanized most rapidly using RCC.

When a bird is captured in a mist net and death is the determined endpoint, it should be euthanized directly in the net to eliminate the additional stress of extraction from the net. In these cases RCC can be quickly applied to the bird while it remains in the net. Alternatively, when a bird is to be removed alive from the mist net for procedures prior to euthanasia, it should be placed in a cloth handling bag following bird-banding protocols. Extraction of birds from a mist net and a description of the bander’s grip are detailed in the North American Banders’ Study Guide (North American Banding Council 2001). The bander’s grip is appropriate prior to RCC because the bird can be easily manipulated into the three-point method described below, which minimizes stress.

There are several variants of RCC. The three-point method recommended here ensures proper euthanasia. RCC requires two hands. The dominant hand is used for the compression position while the nondominant hand supports the keel and prevents the bird from twisting out of position (Figure 1). The bird is rotated from the bander’s grip into position for RCC, and then the dominant hand is used to access the cardiothoracic area dorsally by placing the thumb under one wing and the index or middle finger under the other (Figure 1A, 1B). The heart is located under a “triangle” formed by the coracoid, ribs, and scapula. This triangle is marked by a soft, indented space between the first rib and the coracoid (Figure 2). The forefinger and thumb are placed over this triangle on both sides of the bird, with the tips of the fingers touching the coracoid (Figure 1C, 1D; Figure 3). Cardiac contractions can sometimes be felt when fingers are correctly placed. Once fingers are in position, the fingers of the nondominant hand are placed on the keel to stabilize the bird and keep it from twisting out of position (Figure 1E). It takes only a few seconds to place the fingers properly. With minimal practice on birds that will not be euthanized, a researcher can prepare to administer RCC. Once fingers are in proper position, the forefinger and thumb of the dominant hand are rapidly squeezed together with an anterior ventral motion that ensures the heart is between the fingertips. Pressure is applied rapidly, with fingertips nearly touching the heart.
FIGURE 1. Proper handling of a bird (here, a European Starling) during rapid cardiac compression (RCC). A dead bird was used for these photographs. Flank and downy feathers were removed to better show finger placement. (A) Bird in bander’s grip. (B) Maneuvering bird from bander’s grip to RCC position. (C) Correct position of thumb. (D) Correct position of forefinger. (E) Anterior view of correct position of both hands during RCC.
through the body cavity, compressing the heart between the fingertips. The continuous pressure immediately restricts the heart from beating, and the fingers of the nondominant hand are held steady, thus keeping the bird firmly in place. The pressed fingers are held together and not released until external cues indicate that the bird has expired. For a bird ranging in size from a House Sparrow (*Passer domesticus*) to a European Starling (*Sturnus vulgaris*), death occurs in 25–30 s (Paul-Murphy et al. 2017). However, clinical trials found variation within species to warrant application of RCC for an additional 30 s beyond perceived death.

**External Mortality Cues**

When applied correctly, compression over the heart stops contractions, thereby stopping the pulse instantaneously. Birds in the study were under light anesthesia, and EEG activity became flat (isoelectric) in approximately 19–88 s for sparrows and starlings, respectively (Paul-Murphy et al. 2017). Death from RCC is presumed to have a similar time course in a conscious bird of similar size (Paul-Murphy et al. 2017). External behavioral cues that indicate progression toward death include the following: (1) The bird will shudder and stiffen, can show an initial shaking of the head, and the eyes may close; (2) agonal gaping will sometimes occur at ~15 s; (3) feather erection, particularly on the head and dorsal neck region, will sometimes occur, followed by rapid relaxation and limp neck as the bird expires; (4) upon death, pupillary dilation (miosis) occurs. Continuing the cardic compression for an additional 20–30 s beyond the neck going limp will ensure the bird is dead. Almost all birds will defeate upon application of RCC; thus, we recommend holding the bird with the vent toward the ground, with the tail pulled back so that droppings do not soil feathers.

**Other Considerations**

The most common deviation from the method described above is a ventral approach to placing fingers in the coracoid triangle, thereby encircling the pectoral muscles. However, the ventral approach can be more challenging for correct finger placement, and thus the heart may not be properly compressed. Therefore, we do not recommend the ventral approach. Another technique is to approach the bird from the dorsum as described, but without using the second hand to stabilize the bird's sternum. In this position, a larger bird can twist out of position during RCC. Thus, using the second hand to prevent the bird from twisting out of position, working in unison with the hand applying compression, ensures the most reliable and repeatable results.

The size of the bird is an important consideration. If it is too large, then the heart cannot be compressed in a manner that ensures RCC. The body-mass limit for effective RCC is variable, based on the taxon and the experience of the researcher. Paul-Murphey et al. (2017) considered only two species, with average weights of 26 g (House Sparrow) and 71 g (European Starling). Studies have not been undertaken to assess the effectiveness of the method on larger or smaller birds. RCC is a standard technique for passerines, which rarely exceed 300 g, but the procedure has also been effectively used for birds up to 500 g such as gallinaceous birds, doves, and shorebirds.
(A.E. personal observation; K. Winker and B. K. Schmidt personal communication). The size and strength of the researcher’s hands may limit the application of the technique for birds exceeding 500 g.

The AVMA has approved guidelines for the use of RCC conditional upon the bird first being anesthetized (see “Adjunctive methods” in AVMA 2013:83). Anesthesia may be suitable for laboratory animals but is not practical in the field and frequently contaminates specimens. Moreover, if RCC is deemed humane (as argued here), there is no reason to require anesthesia. Euthanasia by RCC reduces the time a bird is handled, thus minimizing discomfort and stress during the time necessary to prepare and administer anesthesia. This advantage is directly supported by the AVMA (2013:84): “When properly used by skilled personnel with well-maintained equipment, physical methods of euthanasia may result in less fear and anxiety and be more rapid, painless, humane, and practical than other forms of euthanasia.”

Training, Institutional Support, and Approved Use Recommendations
Performing a physical method of euthanasia, whether it is RCC, cervical dislocation, or decapitation, requires proper training to ensure humane euthanasia. The AVMA Guidelines on Euthanasia require training for other physical methods, and this requirement should be expected for RCC. Training oversight is the responsibility of the IACUC and may come from another investigator, veterinarian, or technician with substantial RCC experience.

Advantages of Rapid Cardiac Compression
(1) RCC has been proven to result in rapid loss of consciousness and death (Paul-Murphy et al. 2017). (2) RCC yields carcasses in optimal condition for use as specimens for research collections and other purposes because the carcass remains intact and there is no chemical contamination. (3) RCC does not require drugs or chemicals, and it can be applied in any field setting.

Disadvantages of Rapid Cardiac Compression
(1) RCC may be discomforting to personnel performing or observing the method. (2) RCC requires mastering technical skills to ensure rapid loss of consciousness. (3) RCC is limited to smaller birds (although it is suitable for the overwhelming majority of bird species).

General Recommendations
Rapid cardiac compression is acceptable for euthanasia of smaller birds when performed by trained individuals. The applicant to the IACUC is responsible for ensuring that personnel performing RCC have been properly trained.

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