

Humane killing of animals for disease control purposes

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Summary

Killing for disease control purposes is an emotional issue for everyone concerned. Large-scale euthanasia or depopulation of animals may be necessary for the emergency control or eradication of animal diseases, to remove animals from a compromised situation (e.g. following flood, storm, fire, drought or a feed contamination event), to effect welfare depopulation when there is an oversupply due to a dysfunctional or closed marketing channel, or to depopulate and dispose of animals with minimal handling to decrease the risk of a zoonotic disease infecting humans. The World Organisation for Animal Health (OIE) developed international standards to provide advice on humane killing for various species and situations. Some fundamental issues are defined, such as competency of animal handling and implementation of humane killing techniques. Some of these methods have been used for many years, but novel approaches for the mass killing of particular species are being explored. Novel vaccines and new diagnostic techniques that differentiate between vaccinated and infected animals will save many animals from being killed as part of biosecurity response measures. Unfortunately, the destruction of affected livestock will still be required to control diseases whilst vaccination programmes are activated or where effective vaccines are not available. This paper reviews the principles of humane destruction and depopulation and explores available techniques with their associated advantages and disadvantages. It also identifies some current issues that merit consideration, such as legislative conflicts (emergency disease legislation versus animal welfare legislation, occupational health and safety), media issues, opinions on the future approaches to killing for disease control, and animal welfare.

Keywords

Animal welfare – Depopulation – Disease control – Euthanasia – Killing – Novel technique.

Introduction

Large-scale euthanasia or depopulation of animals may be necessary for the emergency control or eradication of animal diseases, to remove animals from a compromised situation (e.g. following a flood, storm, fire, drought or a feed contamination event), to effect welfare depopulation when there is an oversupply due to a dysfunctional or closed marketing channel, or to depopulate and dispose of animals with minimal handling to decrease the risk of a zoonotic disease infecting humans (1, 2).

Operators must be mindful of the emotional aspects of the task for the owners of the animals, the other emergency

response staff, and the community at large (3). When it has been concluded that killing must be undertaken for disease control, the technique employed should be effective for the species, age, and breed (4). The World Organisation for Animal Health (OIE) *Terrestrial Animal Health Code (Terrestrial Code)* provides guidance on this in a chapter on killing for disease control purposes (5). Depending on the method, animals may have to be handled and restrained during the killing process, and so measures should be taken to minimise distress and suffering prior to loss of consciousness.

Whilst recent advances in diagnostic and vaccination technologies will likely reduce the need to kill animals for

disease control purposes, it should be noted that in many cases killing will still be required while vaccines are sourced and deployed. In a disease outbreak emergency, it may be necessary to destroy a large number of animals quickly. Because live animals will continue to produce and possibly disseminate the pathogen, it is essential that these animals be speedily slaughtered with as much consideration given to the humane treatment of the animal as is practicable under such extenuating circumstances.

Euthanasia is the term usually used to describe ending the life of an individual animal in a way that minimises or eliminates pain and distress (6). It is synonymous with a rapid loss of consciousness and a loss of brain function. By contrast, depopulation is defined as destroying animals as quickly and efficiently as possible, with as much consideration given to the welfare of the animals as practicable. When animals are killed in an emergency situation, the circumstances facing those carrying out the depopulation are understood to be extenuating, but operators must still aim to destroy animals humanely. Death may result from cardiac or respiratory arrest or from destruction of the brain. For an animal to experience pain, its cerebral cortex and subcortical structures must be functional (7). If the cerebral cortex is non-functional because of hypoxia, depression by drugs, electric shock or concussion, the animal does not experience pain (8, 9, 10). From an animal welfare perspective, the process of causing unconsciousness with minimal stress to the animal is the key to euthanasia. The choice of a terminal procedure to cause death after anaesthesia is less important, provided that the animal does not regain consciousness.

It is important that the death of the animal be confirmed at an appropriate interval after killing and before moving the carcass for disposal (11).

Whilst in an emergency situation certain laws and regulations may be 'suspended', it is important that every effort be made to ensure that animals to be killed are treated in a humane manner prior to and at the time of their destruction. Depopulation may employ euthanasia techniques, but not all depopulation methods meet the criteria for euthanasia (6).

It is also important to note that the means used to kill the animals may reduce the options for subsequent carcass disposal; for example, if animals are killed using barbiturates their carcasses cannot be disposed of by feeding them to other species.

General principles

The aim should be the implementation of the most appropriate killing method to ensure that animals are killed without avoidable pain and distress. This includes the use

of pre-killing treatments such as sedation and appropriate animal handling techniques.

The scientific assessment of animal welfare involves consideration of diverse elements. Selecting and weighing these elements often involves value-based assumptions which should be made as explicit as possible. This is especially the case when considering the various aspects of the emergency killing of large numbers of animals. Professional judgement and ethics must be used.

The general principles for the welfare of animals in livestock production systems are included in Chapter 7.1. of the OIE *Terrestrial Code* (12) and the principles for humane destruction for disease control purposes are outlined in Chapter 7.6. (5). These principles are:

- all personnel involved in the humane killing of animals should have the relevant skills and competencies; competence may be gained through formal training and/or practical experience
- as necessary, operational procedures should be adapted to the specific circumstances pertaining on the premises and should address, apart from animal welfare, the aesthetics of the method of euthanasia, the cost of the method, operator safety, biosecurity and environmental aspects
- following the decision to kill the animals, killing should be carried out as quickly as possible, and normal husbandry should be maintained until the animals are killed
- the handling and movement of animals should be minimised and, when done, it should be carried out in accordance with the recommendations described below
- animal restraint should be sufficient to facilitate effective killing, and in accordance with animal welfare and operator safety requirements; when restraint is required, killing should follow with minimal delay
- when animals are killed for disease control purposes, methods used should result in immediate death or immediate loss of consciousness lasting until death; when loss of consciousness is not immediate, induction of unconsciousness should be non-aversive or the least aversive possible and should not cause avoidable anxiety, pain, distress or suffering in animals
- with regard to animal welfare, young animals should be killed before older animals; with regard to biosecurity, infected animals should be killed first, followed by in-contact animals, and then the remaining animals
- there should be continuous monitoring of the procedures by the Competent Authorities to ensure they are consistently effective with regard to animal welfare, operator safety and biosecurity.

Disease control/disaster contingency plans should be in place at a national level and should contain details of management structure, disease control strategies and operational procedures. Animal welfare considerations should be addressed within these contingency plans. The plans should also include arrangements to ensure that an adequate number of personnel who are competent in the humane killing of particular animals are available to implement the approved procedures. Local plans should be based on national plans and be informed by local knowledge.

For instance, the Australian Veterinary Emergency Plan (13) outlines an approach to managing animals during emergency disease responses which includes the following components:

- destruction of the minimum number of non-infected animals or suspect animals during the disease response emergency
- maintenance of acceptable animal welfare standards for all livestock species, without compromising disease control or eradication efforts
- effective management of animals within restricted areas and elsewhere, based on sound risk assessment, to avoid later welfare problems
- best use of available resources (personnel, infrastructure, feed and water).

The operational activities should be led by an official veterinarian who has the authority to appoint the personnel with the required competencies and ensure that they adhere to the required animal welfare and biosecurity standards. Personnel are organised into specialist teams that are then deployed to work on each affected site. Each team should contain a veterinarian or have access to veterinary advice at all times.

A plan should be devised for each affected site that covers animal welfare considerations, operator safety, biosecurity, available resources, and normal animal husbandry practices. It also needs to identify potential environmental impacts and psychological impacts on the owners and their families, team members and the community. Team leaders must be aware of the potential impact that animal destruction will have on all people involved. Consideration needs to be given to how farmers and veterinarians can work with the media to ensure balanced reporting of depopulation. Photographs and television images of mass slaughter are distressing, so it is important that they are accompanied by clear information on the reasons for the destruction and on the welfare-protection measures in place. Transparent media coverage of the way in which animal welfare is safeguarded as a result of a well-executed plan will boost staff morale and increase community support for the campaign.

By definition, euthanasia involves a painless and stress-free death. Emergency killing may not achieve this ideal, but should involve transitioning an animal to death by methods that cause as little pain and stress as possible under the prevailing circumstances. Acceptable methods for euthanasia that are currently in use in various parts of the world and are recognised by the OIE include (5):

- poultry: cervical dislocation, decapitation, gassing
- cattle: captive bolt, gunshot, injectable agents
- swine: captive bolt, gunshot, injectable agents, gassing, electrocution.

These situations are often complex and in many cases facilities are inadequate and do not enable disease response teams to conduct efficient operations. Another critical consideration is occupational health and safety for animal handlers when dealing with zoonoses such as avian influenza.

In recent years in North America and Europe the practicality of portable technologies has been investigated with the aim of enabling on-farm destruction rather than moving animals to processing facilities.

The United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service has funded the development of a Modified Atmosphere Killing (MAK) trailer for the mass gassing of poultry (Figs 1 and 2) (14). It is a portable gassing system for small flocks that is constructed of stainless steel and can be transported by a half-ton vehicle. It has a dynamic top-loading arrangement, a capacity for approximately 300 broilers (age ~40 days) or 440 caged layer hens, and a dumping capability for easy removal of dead birds. Its construction and materials allow for disinfection. It delivers a steady-state gas concentration

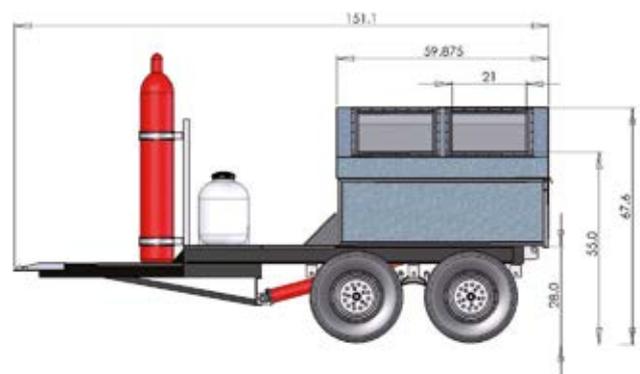


Fig. 1
American Modified Atmosphere Killing (MAK) trailer for the mass gassing of poultry

Dimensions in inches



Fig. 2
American Modified Atmosphere Killing (MAK) trailer

Photo courtesy of B. Webster, University of Georgia

of carbon dioxide (CO₂) (40% to 50%) and nitrogen gas can also be added in combination. Trials with the MAK trailer have achieved loss of consciousness in birds at 20 seconds and death in four minutes.

Many countries already employ whole-house CO₂ gassing for poultry as a means of depopulation (15, 16). This method works well for those husbandry situations in which the poultry houses can be adequately sealed to ensure an effective and constant concentration of gas.

A mobile electrocution unit for the mass depopulation of swine is commercially available in Europe (Meat Processing Systems Inc.) and is contained in the veterinary stockpiles of several European nations (Fig. 3). This equipment has been used for several disease outbreaks in the European Union and is currently being adapted for operation in North American swine facilities through a project funded by USDA. While this equipment offers new efficiencies in the humane killing of animals, it is important that it be



Fig. 3
Swine mobile electrocution unit for the mass depopulation of swine (Meat Processing Systems, Inc.)

Photo courtesy of Meat Processing Systems Inc.

operated by trained personnel. A welfare officer should be present to oversee operations.

Further work is currently ongoing to identify novel or modify existing methods for depopulation. A study has just concluded examining practical methods of on-farm depopulation of swine using CO₂ gas and publications are in progress or have been released (17, 18). Studies examining the placement and utility of captive bolts for the depopulation of cattle are also under way, looking at both pneumatic auto-pithing devices and standard extended solid bolt devices.

Case study – a novel approach to mass depopulation of poultry

Since 1997, when highly pathogenic avian influenza H5N1 in poultry and humans was first reported, studies on mass depopulation, including the use of water-based fire-suppression foam in high-density poultry sheds, have been undertaken in Europe, North America and other countries (4, 19).

Key parameters to consider if using foam-based depopulation methods to manage animal welfare risks are bubble size and the depth, persistence and fluidity of the foam. Only purpose-built and validated equipment should be used. It is important to have a local and appropriately trained animal welfare officer on site when water-based foam depopulation is used.

The benefits of using water-based foam include:

- operators have minimal contact with birds (worker health and safety considerations)
- birds are treated *in situ*, which reduces handling stress
- minimal personnel are required for operations (three to five workers)
- rapid depopulation is achieved
- the technique can be used in a variety of poultry housing facilities, including collapsed housing
- dust and aerosols are reduced (important for potential zoonotic diseases).

Studies have been done using water-based foam generated with ambient air as well as with CO₂. American studies (19) have been undertaken to compare the delivery and impact of these two foam technologies under field conditions. Foam concentrate is either pumped into fan-driven generators or pumped under pressure through specialised nozzles.



Fig. 4
Application of medium-expansion foam, generated by a North Carolina Department of Agriculture unit, into a broiler shed in a North American trial

Photo courtesy of M. Farnell, Mississippi State University

This foam can be used for the depopulation of poultry sheds for emergency destruction where birds are confined to the floor (Figs 4 and 5). It cannot be used directly if floors are slatted or if the birds are in cages. However, work is under way in the United States to adapt the technology for cage-reared birds. A blanket of foam is generated to cover the birds and kill them mechanically by occluding their airways (19).

The technique would be particularly applicable in an outbreak of a potentially zoonotic disease such as avian influenza because it minimises exposure of humans to live birds. Other situations where foam use may be applicable would be where there is an outbreak of a rapidly spreading infectious disease that cannot be easily contained, or where birds are housed in structurally unsound buildings posing a hazard to operators.

Birds die from anoxia and the time to death delivered by these foam types is similar to that of CO₂ gassing (20, 21). CO₂-generated foam causes chemically induced intoxication whereas the foam generated with ambient air produces mechanically induced anoxia in birds. In both cases, similar behavioural responses were seen in the birds, with cortisol blood levels as an indirect stress measurement being comparable for both methods (20). A report evaluating depopulation of poultry with an argon/CO₂ gas mixture, CO₂ gas, foam generated with CO₂ gas, and foam generated with ambient air, compared the time to death measured by electroencephalogram (EEG) (20). This study found no significant differences in the mean time to EEG silence between CO₂ gas (~134 sec); foam generated with ambient air (~134 sec); and foam generated with



Fig. 5
Application of high-expansion foam, generated by a KifCo Aviguard unit, into a poultry shed in a North American trial

Photo courtesy of M. Farnell, Mississippi State University

CO₂ gas (~120 sec). The argon/CO₂ gas mixture had the longest time to EEG silence at ~195 sec (20).

Conclusions

Killing for disease control is usually carried out in an emergency situation and necessarily involves consideration of a multitude of factors, including animal welfare. Large-scale destruction of animals is not part of any normal husbandry situation. People are strongly connected to their animals and many generations of hard work and genetic selection can often be wiped out by the need to destroy their animals, and this takes a heavy toll on all of those people affected. Therefore, authorities must be mindful that, when they are conducting killing and mass destruction procedures on herds and flocks, these operations were not anticipated by the owners and managers of the livestock. So, consideration of the human element of livestock disease control should be paramount to any procedure carried out to control the disease if the effort is to move forward relatively unimpeded. New technologies and effective biosecurity measures can greatly reduce the number of healthy in-contact animals that need to be killed. New equipment for mass destruction of other species has been developed in recent years, as have a number of new technologies such as foam for the mass killing of poultry flocks. These innovations have the potential to greatly improve the efficiency and effectiveness of the process, but further work to improve the humane performance of these approaches is required.



Mise à mort dans des conditions décentes d'animaux à des fins de contrôle sanitaire

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Résumé

La question de la mise à mort d'animaux à des fins de contrôle sanitaire est un sujet sensible pour toutes les personnes concernées. Plusieurs situations imposent de recourir à l'euthanasie à grande échelle, ou dépopulation d'animaux : urgence sanitaire ou nécessité d'éradiquer une maladie animale qui ne peut être maîtrisée autrement ; élimination d'animaux pris dans une situation dangereuse (par exemple en cas d'inondation, de tempête, d'incendie, de sécheresse ou de contamination des aliments) ; dépopulation pour des raisons humanitaires en cas de sureffectifs dus à des dysfonctionnements ou à la fermeture des filières commerciales ; nécessité de limiter au maximum les manipulations d'animaux lors des opérations de dépopulation et d'élimination des animaux afin de réduire les risques de transmission de maladies zoonotiques à l'homme. L'Organisation mondiale de la santé animale (OIE) a élaboré des normes internationales qui fournissent des orientations pour la mise à mort dans des conditions décentes de plusieurs espèces dans diverses configurations. Certaines questions fondamentales y sont définies, par exemple les compétences des personnels chargés de manipuler les animaux et le recours à des techniques d'abattage exemptes de cruauté. Certaines des méthodes décrites sont utilisées depuis longtemps ; d'autres approches, plus innovantes, sont explorées pour l'abattage massif d'espèces particulières. D'autre part, grâce aux innovations dans le domaine de la vaccination et des techniques de diagnostic qui permettent désormais de distinguer les animaux vaccinés des animaux infectés, un grand nombre d'animaux ne sera plus abattu dans le cadre de l'application des mesures de biosécurité. Néanmoins, l'élimination des animaux d'élevage atteints reste un impératif de contrôle sanitaire en attendant le démarrage des programmes de vaccination ou dans les situations où il n'y a pas de vaccins efficaces disponibles. Les auteurs font le point sur les principes d'abattage et de dépopulation respectueux du bien-être animal et décrivent les techniques disponibles, en indiquant leurs avantages et inconvénients respectifs. Ils soulignent également les problèmes qui méritent d'être examinés avec attention, par exemple des incohérences au plan législatif (contradictions entre les réglementations applicables respectivement aux urgences sanitaires et au bien-être animal ; législation sur la santé et la sécurité au travail), le rôle des médias, l'acceptabilité future des méthodes d'abattage à des fins de contrôle sanitaire, et le bien-être animal.

Mots-clés

Abattage sanitaire – Bien-être animal – Contrôle des maladies animales – Euthanasie – Mise à mort – Technique innovante.



Sacrificio humanitario de animales con fines de lucha zoonosanitaria

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Resumen

Para cuantos interviene en él, el sacrificio de animales con fines de lucha zoonosanitaria es un asunto cargado de afectividad. La eutanasia o el sacrificio sanitario a gran escala de animales puede ser un expediente ineludible para erradicar enfermedades animales o controlarlas en casos de emergencia, para eliminar la presencia animal en situaciones comprometidas (como después de inundaciones, tormentas, incendios, sequías o episodios de contaminación de alimentos), para efectuar sacrificios con fines de bienestar cuando haya excedente por cierre o disfuncionamiento de un canal de comercialización o para sacrificar y eliminar a los animales con un mínimo de manipulaciones a fin de reducir el riesgo de infección humana por alguna enfermedad zoonótica. La Organización Mundial de Sanidad Animal (OIE) tiene formuladas normas internacionales para prestar asesoramiento sobre el sacrificio humanitario de diversas especies en situaciones varias. En ellas se definen una serie de aspectos fundamentales, como la competencia en la manipulación de animales o la aplicación de técnicas de sacrificio compasivo. Aunque algunos de estos métodos llevan muchos años en aplicación, ahora se están estudiando nuevas soluciones para proceder a sacrificios masivos en determinadas especies. Las nuevas vacunas y técnicas de diagnóstico que permiten discriminar entre animales vacunados e infectados salvarán a muchos animales de ser sacrificados como parte de medidas de seguridad biológica. Lamentablemente, la destrucción de ganado enfermo seguirá siendo un paso inevitable para luchar contra una enfermedad en espera de que se activen los programas de vacunación o cuando no se disponga de vacunas eficaces. Tras repasar los principios que rigen la destrucción y el sacrificio sanitario compasivos, los autores pasan revista a las técnicas existentes y a sus ventajas e inconvenientes. Asimismo, señalan una serie de temas de actualidad dignos de ser tenidos en cuenta, por ejemplo conflictos legislativos (leyes sobre emergencias sanitarias frente a leyes de bienestar animal o de salud y seguridad laborales), cuestiones ligadas a los medios de comunicación, opiniones sobre futuros métodos de sacrificio con fines de lucha zoonosanitaria y la cuestión del bienestar animal.

Palabras clave

Bienestar animal – Control de enfermedades – Despoblación – Eutanasia – Nueva técnica – Sacrificio.



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