



Module 17

Euthanasia and Emergency Killing

Lecture Notes

Slide 1:

This lecture was first developed for World Animal Protection by Dr Andrew Butterworth (University of Bristol) in 2003. It was revised by World Animal Protection scientific advisors in 2012 using updates provided by Dr Caroline Hewson.

Slide 2:

As veterinarians, most of you will be asked to euthanise animals during your clinical work, or you will make that recommendation to owners.

The objectives of this module are to teach you:

1. what we mean by euthanasia
2. why we euthanise animals
3. when we euthanise and who decides
4. how to kill animals humanely. Here, the most important factor in providing a humane death to animals is that you are knowledgeable, skilled and conscientious. This lecture cannot give you full training. However, it will give you preliminary knowledge
5. other relevant points, e.g. the euthanasia of foetuses.

[NB: We use the spelling 'euthanise' here. 'Euthanase' is also used, and is also correct.]

We will start with some definitions.

Slide 3:

Euthanasia is defined as “the humane killing of an animal for its own benefit” (Broom, 2007). Euthanasia literally means ‘good death’. This comes from the Greek ‘eu’ (good) + ‘thanatos’ (death). The term is best restricted to killing that is in the best interest of the animal whose life is being ended.

As vets, you will usually euthanise animals:

- to relieve suffering
- to prevent suffering in animals who cannot be treated or rescued (e.g. routine killing of dogs and cats at shelters).

Because the performance of euthanasia is motivated by compassion for the animal, and is not done primarily for human benefit, it is different from slaughter. Slaughter is “the killing of animals intended for human consumption” (EC, 2009). Slaughter should always be humane and then it provides a ‘good death’.

Large numbers of animals also sometimes have to be killed in an emergency due to disease outbreaks such as avian influenza and foot and mouth disease, by methods such as drawing blood, gassing or injection. This lecture includes some aspects of urgent on-farm slaughter of groups of animals to control disease, or when animals are unwanted.

The OIE have defined ‘humane killing’ as “killing by using a method that causes rapid and irreversible loss of consciousness with minimum pain and distress to the animal” (OIE, 2011). This is generally interpreted to mean:

1. Rendering an animal unconscious, in such a way that the animal does not anticipate it and so does not suffer fear or distress, and then
2. Killing the animal immediately, so that the animal does not regain consciousness before dying.

Slide 4:

Because euthanasia is typically performed to end an animal’s suffering, or to prevent unavoidable future suffering, it is sometimes known as ‘mercy killing’ (in English). However, a mercy killing describes the motive for killing, not the manner of death, and it is not always humane, e.g. an owner who cannot afford to pay for veterinary treatment decides to kill his/her animal but cannot afford euthanasia by a vet, so he or she drowns the animal.

For veterinarians, ‘euthanasia’ is a better term than ‘mercy killing’ because euthanasia implies and necessitates that the vet gives the animal a good death.

Before we look more closely at when you might be asked to euthanise an animal or group of animals, and who decides that, we will look briefly at different views on animal death.

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Cultural philosophies on animal death and on the value of euthanasia vary.

For example, stray dogs and cats are a big problem in much of the world. The authorities sometimes have programmes of mass killing and may use methods which would not be tolerated for individual pets. For example:

- until the introduction of the 1998 Animal Protection Bill in Taiwan, stray animals were killed by 'bulk drowning' (pictured)
- a number of countries use 'dog shooting days' as a means of eliminating unwanted or stray animals. On a dog shooting day, dog owners are warned to keep their animals inside or on a lead. All loose dogs are shot – animals without clearly identified owners are seen as having less value.

Slide 6:

In different religions and philosophies, there are differing teachings about the value of animal life and whether or not we should kill animals for any reason. For example, Buddhism and Hinduism caution against the killing of any species; Islam, Christianity and Judaism teach that we should always treat animals with concern.

Leaving aside religious and cultural traditions, and looking more closely at why we euthanise, some people argue that suffering is a feature of life and that prevention of suffering by shortening life is unnatural. However, in many parts of the world, the consensus is that suffering can become so severe and incurable that killing, if carried out in a humane way, is the only way to end the suffering. In that school of thought, humane killing is justified.

It is this 'justified end to suffering' by humane killing which is usually the reason for imposing a 'good death' on an animal. The interpretation of 'justified' and 'humane' is subjective. Personal, cultural and political influences can have a role here.

Veterinarians are obliged to achieve these goals, and we will look at how you do this later in this lecture. However, as scientific knowledge advances, methods and recommendations may change. The following slide shows you some online resources that you may find useful to refer to for updates when you are a practising veterinarian.

Slide 7:

Various veterinary and advisory bodies around the world provide guidelines for the humane killing of animals. Helpful resources are:

1. The American Veterinary Medical Association (AVMA)'s Guidelines on Euthanasia (2007). These provide detailed recommendations for all species, including amphibians, zoo animals, etc. The guidelines were being updated by AVMA in 2009/2010.
2. The World Organisation for Animal Health (OIE) has recommended standards for the humane killing of terrestrial farm animals for disease control purposes and routine slaughter (OIE, 2011).
3. The Humane Slaughter Association (HSA) provides detailed information on the humane slaughter of farm species including poultry, sheep, goats and fish.
4. An International Companion Animal Management (ICAM) Coalition publication on the euthanasia of dogs and cats.

Slide 8:

We have seen what we mean by euthanasia and that vets (and others) usually perform it to end suffering.

Next, we will look at typical situation when you would recommend euthanasia for an individual animal, or groups of animals, and who gives permission for euthanasia in those situations.

Slide 9:

We will start with the humane killing of individual animals. Commonly, these animals might be:

- severely injured animals – those with terminal conditions in which suffering is likely, or in which pain and distress are already apparent and cannot be prevented
- aggressive animals – where their interactions with humans and other animals are likely to cause unnecessary suffering, or where, because of their aggressive nature, they cannot be kept in conditions likely to provide for all their needs
- aged animals – where there are no resources to provide for their needs. This category can be difficult to justify. For example, the euthanasia of an elderly incontinent dog, or a lame horse, is often the result of increasing demands on the human carers. When the carers cannot 'cope', for logistical or financial reasons, then they are more likely to decide to have the animal humanely killed. Having a framework for ethical decision-making can help you to decide when to euthanise in such cases (Mullan & Main, 2001). This is covered in the lecture about the role of vets in animal welfare (Module 32).

Slide 10:

Emergency killing of very severely injured or debilitated farm animals and horses should ideally be done on-site. For more detailed information, see the chapter by Woods et al. in the book *Improving Animal Welfare: A Practical Approach*, edited by Temple Grandin (2010).

Farm animals should not be transported to the slaughterhouse if, for example, they have a broken leg. If they must be transported, they should not be forced to walk and they must be secured in the trailer with much soft bedding. The abattoir should kill them immediately on arrival.

Some countries have legislation to protect such animals, and require on-farm euthanasia. In other countries, the situation is different because owners lack the finances and vehicles, and abattoirs lack the knowledge, to provide a good death under those circumstances.

We will now look more closely at who decides that an animal should humanely killed or euthanised.

Slide 11:

When you are in practice and you find that an individual animal is suffering or is at risk of suffering, who decides that an animal requires euthanasia?

Module 32, on vets and animal welfare, deals with ethical decision-making in more detail, however, briefly, the decision to euthanise is normally taken by the owner, with advice from the vet. Many owners are very knowledgeable and have a good sense of their animal's 'fitness' or ability to cope with age, disability or injury; but some owners are not knowledgeable or are in denial that their animal is so ill. In that case, an owner's delay in deciding on euthanasia can result in unnecessary suffering for the animal, through prolonged distress, fear or pain.

There has been little research on how vets and clients reach decisions on when to euthanise. A study of companion animal vets and pet owners in Canada concluded that vets and clients both have important perspectives on an animal's quality of life (Morgan, 2007).

Many animal owners (pet owners and farmers) know what their animal needs and enjoys, and what they need from their animal. The pet owner has insights on whether the animal would be likely to enjoy his/her life under conditions of illness, if that meant he or she could no longer do the things he or she enjoys (e.g. chewing toys and chasing balls). The farmer needs the animal to grow quickly, produce milk, etc.

Veterinarians know how well animals generally respond to treatment, and tolerate treatment interventions. Usually, this combination of the client's knowledge and the vet's knowledge makes it relatively easy for clients to make an informed decision about whether to have their animal euthanised.

Legally, in most jurisdictions, animals are the owner's property and vets cannot decide what to do for the animal; only the owner can. Ethically, it is important that the vet respects the client's autonomy and does not use guilt or manipulation to bias the owner's decision about euthanasia. However, vets may sometimes have to override a client's autonomy for the

animal's sake, e.g. to strongly encourage euthanasia when there is no feasible treatment or prospect for recovery (Rollin, 2002; Morgan, 2007; Yeates, 2010).

Slide 12:

The picture on the left shows a mandibular tumour (fibrosarcoma) in a shih tzu. The prognosis for oral tumours such as fibrosarcoma is normally good if it is recognised and diagnosed early enough for a good resection margin. Without treatment the dog will experience pain, have difficulty eating, and bleeding may lead to maggot wounds which decreases the prognosis. In this case, the client brought the dog in for treatment late so the veterinarian suggested that a mandibulectomy be carried out. The client could not commit to caring for the dog after surgery so it was humanely killed.

The picture on the right is a male cat that presented with a blood-cavernous filled solid mass on its head (crown). The tumour was attached to the skull and was diagnosed as ossifying squamous cell carcinoma. The cat was a stray and the client who brought him in did not want to be responsible for the treatment charges if surgery was to be done, so the cat was euthanised to avoid further suffering.

The lesson we can take from these stories is that the prognosis of a cat or a dog with cancer depends on the nature of the tumour, the client's willingness to care for the animal after treatment, and the expertise of the veterinarian to correctly stage the cancer and perform or provide specific treatment. Failure to take decisive practical action could result in unnecessarily prolonged suffering for the animal. In countries with robust animal welfare legislation, many prosecutions are based on 'unnecessary' delay in the decision to end the suffering of diseased, neglected or injured animals. In such prosecutions, the court has to decide whether the animal suffered unnecessarily and, then, whether the defendant was responsible for the 'unnecessary' (prolonged, avoidable or untreated) aspect of the animal's condition. Vets may be called as expert witnesses in these cases.

Slide 13:

Euthanasia raises many ethical questions, detailed discussion of which is outside the scope of this lecture (which is concerned primarily with the welfare aspects of euthanasia).

However, briefly, one other example is 'convenience euthanasia': when you may be asked to humanely kill a healthy animal for the owner's convenience. Use of the term 'euthanasia' in these circumstances is dubious, but if an animal is killed with as little suffering as is possible, does the stage in life when the animal is killed matter, or the reason why it is killed, given that many farm species are killed very young and for our profit and use (food)?

A request to you for 'convenience euthanasia' is more likely to happen with a companion animal (e.g. because the owner is moving house, or the child who was given the pet has lost interest in it). Sometimes, this may indeed prevent future suffering if the owner would otherwise not take good care of the animal. Nevertheless, many vets and others find it distressing because the animal is being treated as a commodity, not as a sentient being with his/her own capacities and inherent longevity.

Veterinary ethicist Bernard Rollin (2002) argues that veterinarians should consider overriding an owner's decision to have his/her animal humanely killed for convenience. Many licensing bodies give professional guidance on this, and indicate that a vet is not obliged to comply with an owner's wishes in such a case. However, you may not be allowed, legally, to confiscate the animal. Alternatives include offering the owner a second opinion from another vet; asking the owner to sign over the animal to the vet so that the vet can re-home them or convey him/her to an animal shelter; or refer the owner to an animal rescue society, if possible. Anecdotally, many owners may choose the second option, perhaps because it is cheaper, quicker, more convenient and less distressing than the other two.

The British Veterinary Association also provides guidance on how to weigh up the benefits of such 'euthanasia' to the animal, and the harm that losing the animal may cause to the owner (Yeates, 2010).

Slide 14:

These last few slides have shown you the ethical and, potentially, legal difficulties that can arise when you do – or do not – recommend euthanasia. You will find it helpful when you are in practice to have a protocol for different the situations of euthanasia that you may encounter. This is because euthanasia will often be an unexpected task for you, and it can be very emotionally charged for the owner.

Having a professional protocol takes the pressure off you so that you can make good decisions that benefit the animal and focus on the process of carrying out the killing humanely and safely for all concerned. The protocol can cover ethical decisions for given situations, as well as important practical aspects, e.g.

- obtaining written consent: have a formal consent form with your practice's stamp on it
- agreement that a vet will not euthanise an animal that he or she does not know without examining it first
- your practice protocol on the euthanasia of large species with a captive bolt might be that you always service it after you use it, and on a certain day each week, so that you can be confident that it works when you have to perform euthanasia urgently or unexpectedly.

Slide 15:

We have seen that the decision to euthanise individual animals to end their suffering is usually made by the vet and the owner together. We will now look at when groups of healthy animals may have to be killed. In those cases, the decision is often made by the public or legal authority or body that you, as the individual veterinarian, may be asked to advise. Or, you may simply be required to implement it.

A common example around the world is that of stray animals: often they are killed by animal shelters when there are insufficient resources to provide a reasonable quality of life. (This is a short-term solution to the complex problem of over-population.)

Killing may also be carried out as part of planned population control – of stray dogs and cats, and of wildlife. However, such killing is not usually a long-term solution. Modules 14 and 26 examine population control of stray dogs and cats in detail, and modules 21 and 22 look at wildlife.

Slide 16:

Groups of animals are also killed by law if a very infectious and harmful disease is present, to remove infected or at-risk animals in order to protect the health of the greater population. That sometimes includes protecting the human population, in the case of zoonotic diseases such as avian flu.

Avian flu and other infectious diseases may also be an indirect threat to human wellbeing because when countries have an outbreak this prevents the export or even the local sale of animal products. When animals must be killed, by law, in order to protect the greater human economic good, this mass killing may be very unpopular at a local level.

Sometimes, market collapse may make it impossible for farmers to keep their young growing animals, and the law may then require the mass killing of these animals. This occurred in Canada in 2008/09, following the collapse of pig prices in North America (Whiting et al., 2011).

More routinely, on farms, very young animals may be killed because they have little or no market value within the system, e.g. day-old male chicks in the egg production system, or male calves born in dairy herds.

In research, the 'sacrifice' or killing of laboratory animals is often a fundamental part of their use. Killing is either a planned part of the experiment, or it is conducted where humane end-points are reached in the experiment (see Module 19).

It is very likely that some of you will find yourselves killing groups of animals during your professional life in one of these situations. Humane treatment of the animals is just as important here as in other situations.

Slide 17:

As shown on the previous slide, killing of groups of animals is often a legal requirement, or is the routine consequence of the human food system (as with day-old male chicks in the egg production system).

The picture on this slide shows cattle carcasses in the UK, following government-ordered killing after an outbreak of foot and mouth disease. This kind of radical action of mass killing and destruction of the carcasses may often appear draconian, and it rarely takes account of the needs and wishes of individuals and animals. However, local authorities may feel that the overriding importance of the issue permits direct and decisive action, and that 'across the board' directives prevent favourable or unfair treatment of particular groups or unfair attention to specific geographical areas.

In countries with governments that are unstable, poorly resourced or very corrupt, or where there are not enough veterinary personnel, serious infectious diseases such as foot and

mouth disease can decimate the nation's livestock population and pose a serious risk to the livestock in neighbouring countries. This is in part because affected and in-contact animals are not killed (and because of uncontrolled movement of animals). If such diseases spread, they can also cause suffering and death among local susceptible wildlife as well as the human population, e.g. avian influenza.

Because of the unplanned and large-scale nature of these situations, animals may suffer inhumane deaths if personnel are not trained. Your input as a veterinarian can be critical here.

Slide 18:

To recap, you now know what euthanasia is, why it is done, when it is typically chosen as a course of action and who decides that, and about other types of emergency killing.

The rest of the lecture will introduce you to how to carry out euthanasia of animals, including the advantages and disadvantages of different methods, which methods you must never use, and how to recognise that the animal has died and is not simply unconscious or in pain.

Slide 19:

Over the last fifty years, much scientific work has led to a better understanding of how best to provide a 'good death'.

A 'good death' is likely if the criteria listed on the slide can be achieved. Taking each one in turn:

- Rapid loss of consciousness is important because then the animal is no longer aware, and cannot feel pain. The method must also be irreversible and reliable: so, hitting an animal on the head is not enough because usually it does not kill, and it is impossible to know the thickness of his/her skull and deliver enough force every time. Similarly, the dose of drug used to kill an animal must be estimated carefully. Barbiturates are often used, but these drugs are fat-soluble and, in fat animals, not enough of the drug may be concentrated in the brain to kill them — instead it may be distributed in fat throughout the body and be released from there in waves, keeping the animals anaesthetised, but eventually he or she will wake up.
- Safety of personnel is important too, e.g. the risk of self-injection, injury by shooting, or inhalation of hazardous euthanasia drugs.
- Feasibility is also important; for example, intravenous injection of barbiturates is a very common and humane method of euthanasia for companion animals. However, if they are struggling, euthanasia should be delayed until they have been calmed down. This is important for two reasons. First, struggling and resistance indicates distress which is to be avoided in order to achieve a 'good death'. Second, when they are struggling it may prove difficult to raise a vein, especially without a skilled assistant. If the vein is missed and the barbiturates are injected perivascularly, the solution acts as an irritant. Sedating the animal first might help, but the better sedatives, which will not lower blood pressure so that you can subsequently access the vein, may be expensive.

- Although our main concern in this lecture is the animal's welfare, aesthetic considerations for the operator and others are important. For example, in horse-racing, if a horse falls and breaks a leg, often it has to be euthanised for humane reasons. This is normally done using a penetrating captive bolt and then 'pithing' the animal (destroying the nervous tissue in the head and spinal cord with a flexible rod). The method is entirely humane, but the sight of it can cause a lot of distress in racegoers who may be watching. Therefore, it is common to put up a temporary, high fence around the horse until the euthanasia is over.
- The final point is that the method of euthanasia should not make the animal's body a risk to other animals or humans, and the method of disposal should be able to take this into account. For example, animals killed by barbiturate should not be fed to dogs or left where dogs may eat them, as barbiturates in the flesh are likely to cause a degree of sedation or potentially anaesthesia in the dogs.

Slide 20:

The commonly used, acceptable methods of euthanasia are listed here. We will look briefly at each. It is not possible to review all the different uses and caveats of these methods in all the situations you may encounter, and there are many technical nuances that you will need to learn.

This lecture only gives an overview.

Slide 21:

Sodium pentobarbital is a barbiturate. At low doses it is an anaesthetic. However, at high doses depression of the respiratory and cardiac centres leads to death by anoxia. The dose for euthanasia should usually not be less than 150 mg/kg.

The picture shows a dog being injected with barbiturate, into the cephalic vein on the front leg.

Legal aspects:

Barbiturates are narcotics and they are controlled substances in the countries where they are used. In many countries their use for euthanasia is illegal. Where barbiturates are a legally accepted form of euthanasia of animals, the solution used is pentobarbital sodium 200 mg/ml. The solution often has blue colouring added, so that it cannot easily be mistaken. However, the solution being used in the picture has not been coloured.

The bodies of euthanised animals must be disposed of where other animals or people cannot consume them, because they contain barbiturates.

Advantages:

Evidence from human anaesthetic use suggests that induction of anaesthesia by barbiturate is not aversive.

Disadvantages:

The animal must be restrained to achieve access to a vein. In companion animals, typically

you use the cephalic vein; you can also use the saphenous vein (medial thigh). Generally, restraint can often cause fear and distress especially in animals unused to human contact, or where personnel have many animals to euthanise and may handle each one roughly.

Sodium pentobarbital is an irritant if it goes perivascularly, which can happen if the animal struggles or the vein is difficult to find. The person giving the injection must be competent, and must check that the animal has died, as deep anaesthesia will result if the animal is under-dosed.

Practicalities:

If you think the animal might struggle, especially larger animals who need a large dose and therefore a relatively long injection time, insert an intravenous catheter first so there is no risk of the needle coming out of the vein and injecting some perivascularly.

For nervous animals, the use of a sedative (subcutaneous injection or oral) given in time to act before euthanasia can reduce his/her distress at restraint. However, sedatives such as acepromazine and medetomidine lower blood pressure so you may not then be able to locate a vein.

Slide 22:

Where you cannot access a vein for whatever reason (e.g. because the animal is hypotensive, is frightened and is therefore struggling, or for anatomical reasons as in the case of piglets), intraperitoneal (IP) administration of sodium pentobarbital is recommended in AVMA guidelines and is used by many vets.

There are no clear data examining whether IP injection of concentrated sodium pentobarbital is painful or the solution irritant. Anecdotally, it does not seem to be distressing, but the AVMA recommends it is only done when the animal is sedated. Also, IP injection may be distressing if it is given into the liver or kidney by mistake, because those organs have a relatively inelastic capsule and the enlargement by the injected barbiturate may cause pain.

Another point to remember is that it takes longer for the animal to die than an intravenous injection of pentobarbital does, and larger doses are necessary to ensure that the animal dies and does not simply become unconscious.

Slide 23:

A manual from the Humane Society of the United States (HSUS) (Rhoades, 1999) advises you to avoid the left abdomen (stomach) and caudal abdomen (bladder). In both those situations, the drug would take a very long time to be absorbed and might only result in deep and reversible anaesthesia; in addition, injection into the stomach and possibly the bladder might be painful.

During the mass killing of newly weaned piglets in Canada in 2008–09, different methods were used including, IP injection of barbiturates as listed in OIE and AVMA guidelines. This was less satisfactory than other methods: out of 240 piglets, 7 per cent were still alive one hour after injection (Whiting et al., 2011). The use of barbiturates was more expensive than the other methods too. Those authors noted other reasons why IP injections were not satisfactory for killing animals in groups. These are shown on the slide and include the importance of weighing each animal, and of avoiding suffocation if they lie on top of each other as they die.

Slide 24:

This slide lists the signs of death following barbiturate overdose.

Note that deep anaesthesia can look similar, with no spinal reflexes, marked mydriasis, an inaudible (fibrillating) heart, and lack of respiratory movement.

Very fat animals, or geriatric or ill animals who have low blood pressure, may take longer to move from deep anaesthesia to death than other animals. You must therefore calculate the dose of pentobarbital accurately for the animal's body condition, and auscultate the chest for two or three minutes after the animal is apparently dead.

When the respiratory and cardiac centres have 'shut down' and the animal is dead, the mydriasis is total, leaving almost none of the pupil visible. Also, the cornea has a very glassy appearance, as it begins to dry out because the animal has stopped blinking and tear production has ceased.

Slide 25:

We have looked in some detail at the use of barbiturates. In countries where they are illegal, there are other ways to euthanise dogs and cats and we will look at these briefly at the end of the lecture.

First, however, we will look at other common methods of euthanasia, starting with stunning and exsanguination. This is commonly used in large animals, e.g. cattle and pigs, and it involves special stunning guns.

Once the animal is stunned, you would exsanguinate him/her by cutting the jugular vein, or another appropriate vessel. There is not time in this lecture to discuss methods of exsanguination, however key points to remember are:

- do not start exsanguination until you are sure the animal is stunned properly
- after stunning is verified, proceed quickly with exsanguination so that the animal does not recover from stunning during exsanguination.

Slide 26:

Captive-bolt stunning followed by pithing or exsanguination has the following advantages and disadvantages.

Advantages

Rapid insensibility can be brought about by captive-bolt stunning, used in large animals such as cattle, sheep and goats held in a pen. The animal may then be removed from the pen for killing by bleeding out or pithing. The site of application of the captive bolt is very important, to ensure that the bolt enters the correct part of the brain and does not go into the sinuses.

Disadvantages

Good training in the correct positioning and use of the stunning weapon is important. There should be only a short delay (seconds, not minutes) between stunning and killing, to ensure that there is no risk of the animal recovering consciousness.

Legal aspects

In some countries, routine use of captive bolt equipment is restricted to licensed slaughtermen, but mercy killing may be carried out by any person. Pithing is illegal in some countries in any ruminants that might enter the food chain due to concerns about zoonotic transmission of encephalopathies such as bovine spongiform encephalopathy (BSE).

Slide 27:

Another method of stunning involves a bolt that does not penetrate the brain. This is called 'non-penetrating percussive stunning', and you always follow it with exsanguination.

Advantages

Rapid insensibility can be brought about by the transfer of energy, through the bone of the skull, to nervous tissues in the head. Used in large animals such as cattle, sheep and goats held in a pen, the animal may then be removed from the pen for killing by bleeding out.

Disadvantages

Training in the correct positioning and use of the stunning weapon is important. There should be only a short delay (seconds, not minutes) between stunning and killing to ensure that there is no risk of the animal recovering consciousness. Because the non-penetrating captive bolt does not penetrate the brain, you cannot kill the animal by pithing and must do so by exsanguination. A general point about exsanguinations is that some infectious diseases are blood-borne, and death by exsanguination increases the risk of contamination of the premises and ongoing disease transmission. Therefore, overall, this method of slaughter may not be appropriate in the context of controlling certain infectious diseases.

Slide 28:

The stunned state is temporary, and killing must be carried out without delay to avoid any potential of return of sensibility. The animal must be killed by exsanguination (e.g. cutting the jugular vein, 'sticking' the heart, cutting foreleg off at chest (for piglets)). Before doing that, you must first check for the presence of certain signs and the absence of others to indicate that the animal has been stunned effectively, and that there is little possibility of brain function returning. These signs are listed on the slide.

Note that these signs are similar to those you might expect if the animal was dead. The difference is that breathing may return following stunning, even if the animal's body is otherwise still and pupils dilated. Immediate exsanguination is therefore essential to ensure death.

Slide 29:

Advantages

Electrical stunning can induce insensibility in a very short time (approximately 200 milliseconds). It is commonly used in sheep and pigs. The animal can then be killed by exsanguination or pithing. Electrical stunning is suitable for euthanasia of large numbers of animals on-farm in, for example, an outbreak of disease.

Disadvantages

Electrical stunning requires equipment which is usually only available in slaughterhouses. This equipment can be moved to carry out on-farm euthanasia. Training in using this equipment is essential.

Legal aspects

The use of electrical stunning for routine killing is restricted to licensed slaughtermen in many countries, and the use of trained personnel for this equipment in euthanasia of pigs or sheep in a disease outbreak would be required.

Successful electrical stunning of farm mammals has two phases: briefly, first the animal is stiff (tonic) and then the body relaxes (clonic) and there is kicking, defecation and downward movement of the eyeballs (HSA, 2011).

Slide 30:

Advantages

Small mammals (<1 kg), small reptiles (<500 g), small birds (<250 g) and fish may be effectively stunned/killed using a 'priest' (short, heavy rod). These animals can also be stunned/killed if their heads are banged very hard against a hard surface; however, this method is crude, not reliable, and can encourage a violent approach to animals, so it cannot be recommended.

In most of these animals, death occurs when the heart stops completely, and exsanguination may not be necessary. However, this must be confirmed. However, fish should be exsanguinated by gill-cutting following percussive stunning.

Disadvantages

Training in the use of percussion and effective restraint of the animal are important, to ensure an effective stun/kill at the first attempt.

Legal aspects

The use of percussive killing of laboratory animals is regulated.

Slide 31:

Summary: having covered the different methods of stunning, we will next look at shooting as a method of euthanasia.

Slide 32:

For information about the correct use of firearms for slaughter or euthanasia, see the Humane Slaughter Association's Guidance Notes, *Humane killing of livestock using firearms* (2nd ed.).

For horses and donkeys, when barbiturate overdose is not possible, the use of a free-bullet pistol provides an aesthetically acceptable and humane method of killing.

The bullet provides immediate insensibility, and causes irreversible damage to nervous tissue, resulting in death.

Many horse and donkeys are euthanised by this method, but the shooting must be carried out with an appropriate weapon, by a competent person, and the safety of people and other animals close by must be considered. In particular, the ammunition must be strong enough to kill the animal with one shot.

Slide 33:

Advantages

This is suitable only for wild species or for unrestrained and unrestrainable domestic species such as deer, bison, feral cattle and for zoo species. It permits euthanasia 'in the field' without transport or restraint. Repetitive rifles with silencers are used for killing farm animals in outbreaks of diseases.

Disadvantages

Training, accuracy and choice of weapon is critical. Head, heart or high-neck shots are likely to induce rapid unconsciousness and death, but wounding without killing has the potential to cause serious suffering. The use of free bullets presents real hazards to other animals and people in the vicinity. It is often appropriate to shoot from a raised place (such as a vehicle), downward at the animal, to reduce this hazard. The ammunition used must be powerful enough to kill the animal with one shot.

Legal aspects

In many countries, the ownership and use of firearms is regulated.

Slide 34:

Advantages

Large animals, particularly farm animals, may need humane killing in an emergency if, for example, they are severely injured in road traffic accidents, or become trapped. The cartridge is made of one large piece of lead, and is called a slug. Shotguns can be a good and reliable way of humane killing, especially of animals who are difficult to approach with a captive-bolt gun.

A shotgun, used from 30 cm (1 foot) away, can be an effective emergency killing method when aimed at a point in the centre of the forehead where two imaginary lines drawn from the base of the ear to the eye on the opposite side intersect. Ammunition must be powerful enough to kill the animal with one shot.

Disadvantages

The use of a shotgun is cruder than a rifle from a distance, and for other than emergency use is not recommended. A distance from the animal of 30 cm (1 foot) must be maintained for the safety of the operator.

Neither rifle or shotgun are appropriate in closed spaces.

Legal aspects

In many countries, the ownership and use of firearms is regulated.

Slide 35:

Signs of death from a free bullet are listed on the slide.

Slide 36:

The HSA's website, listed on the slide, gives detailed information about the killing of farm animals, e.g. diagrams of where to place the bullet or the captive bolt, as well as information about poultry and fish.

The World Organisation for Animal Health (OIE) also provides information on the slaughter and emergency killing of farm animals in its Terrestrial Code.

Slide 37:

If you humanely kill small birds in practice (e.g. an injured wild bird, or a pet bird), you would normally inject sodium pentobarbital into the vein on the back of the skull. You may also use a wing vein. Intraperitoneal injection may be difficult but, you may also inject the ulnar vein in the wing, if you can restrain the bird without distressing him/her. Sedation with medetomidine may help, but may lower blood pressure too much to easily access the vein.

Alternatively, you may use gaseous anaesthesia followed by an intracardiac injection of potassium chloride.

Slide 38:

Neck dislocation or 'neck-pulling' is widely used in killing birds, but is considered less than ideal. Recent work has clearly demonstrated that, while neck dislocation disrupts the nervous tissue in the spinal canal, the blood supply to the brain may continue for a significant period, causing suffering.

An alternative to neck dislocation for birds is percussive stunning with a specifically designed mechanical gun which both stuns and kills by irreversibly destroying brain function. For more information, see the Humane Slaughter Association's website at www.hsa.org.uk/

Slide 39:

We have just looked at how to euthanise animals. We will finish this lecture by looking at several related miscellaneous points, starting with the euthanasia of foetuses.

Slide 40:

During routine ovariohysterectomy of dogs and cats or at the emergency killing of any female mammal, you may find that she is pregnant.

This slide shows a pregnant uterus being removed during spaying. By virtue of being members of a sentient species, these young have the potential to suffer distress from hypoxia, pain or fear. However, to suffer these things, the young must have a sufficiently mature nervous system to enable them to be conscious and awake.

The foetuses in this picture are too young to be able to breathe, but recent research on foetuses of different species provides us with more guidance about the most humane treatment, as we shall see on the next slide.

Slide 41:

Puppies, kittens and other altricial young are neurologically immature at birth, and it is therefore unlikely that they would suffer if left to die *ex utero*, following the premature death or spaying of their mother.

In contrast, precocial species such as guinea pigs, piglets, lambs and other farm animals have a more mature neurological system at birth. They could suffer if left to die, if they had started to breathe.

However, studies with EEG in the precortical and cortical structures indicate that during gestation mammalian foetuses are unconscious. The reasons for this lack of EEG activity in areas of the brain related to consciousness include the effect of neuroinhibitors, such as adenosine. If the mother dies, the foetuses no longer receive oxygen and this makes their unconsciousness a permanent state while their brains approach death. However, in the case of neurologically mature foetuses who are close to the time of birth, it is important that they are left inside the uterus and not allowed to breathe. This is because their lungs may be sufficiently mature to enable them to oxygenate their tissues to the point where this reduces adenosine's inhibition of brain electrical activity resulting in consciousness and suffering confusion. (Mellor et al, 2009, pp 174-181; Mellor & Diesch, 2006).

Slide 42:

In light of this, the OIE's Terrestrial Code Section 7.5.5 (2011) states that for farm animals:

“Foetuses should not be removed from the uterus sooner than five minutes after the maternal neck or chest is cut, to ensure absence of consciousness. A foetal heartbeat will usually still be present and foetal movements may occur at this stage, but these are only a cause for concern if the exposed foetus successfully breathes air. If a live mature foetus is removed from the uterus, it should be prevented from inflating its lungs and breathing air (e.g. by clamping the trachea).”

In the case of puppies and kittens found in the womb during ovariohysterectomy, they are best left to die within the womb. If they are removed, although they may not be capable of

suffering, it may be aesthetically or ethically unacceptable to leave them to die. In that case, use intracardiac pentobarbital or potassium chloride or an overdose of inhalant anaesthetics. Using a blow to the head is not advisable because it is not a reliable form of humane killing.

Slide 43:

We have looked at the question of euthanising foetuses. In some farming sectors, such as dairy and egg production, young male animals are routinely killed because they have no value. One example is in the egg production industry: the male chicks do not grow quickly enough to be kept as broiler birds, and millions of them hatch every day. As a result, many of these male chicks are killed aged one day.

During a sorting process, workers separate male from female chicks and place the males on a conveyor belt. They are then killed using one of the following methods.

1. Macerator: the chicks are placed in a high-speed macerator that crushes them in under one second. This is more humane than suffocating or decapitating the chicks. The advantage of this is that it is safe for workers and large numbers can be killed quickly, unlike with (a) carbon dioxide which is heavy, so flow rates are critical yet the resultant high concentrations are aversive, or (b) cervical dislocation which is unreliable, slow and distressing to the operator. However, special equipment is needed, along with technical expertise to prevent blade revolutions that are too slow, which can lead to an inhumane death. Also care is needed in passing chicks along the conveyor system to the macerator, so that there no backlog of chicks crowded at the entrance.
2. Gas mixtures: the mixtures shown on the slide are legal in some countries, e.g. the UK. However, concentrations of CO₂ greater than 25 per cent are aversive. The HSA recommends one of the other two mixtures, i.e. with argon and with no more than 2 per cent oxygen. They stress that chicks must remain in the mixture until they are dead.

Slide 44:

We will now move back to the euthanasia of dogs and cats, and what to do in countries where barbiturates are expensive or illegal.

Alternative methods of euthanasia for dogs and cats are listed below.

- Injection of 1–2 mmol/kg (NB: not mg/kg, but mmol/kg) potassium chloride under general anaesthesia. This causes cardiac arrest and the associated hypoxia would be too distressing in a conscious animal. Therefore deep general anaesthesia is essential.
- Inhalant anaesthetics on their own may be used for the euthanasia of pets under 7 kg. However, they can be an irritant so the animals will be distressed as they lose consciousness; halothane is preferable to all the other fluorane gases for this purpose because it is the fastest and not associated with seizures (enflurane) or with apnoea during induction (isoflurane). Ether is not suitable because it is an irritant, and nitrous oxide is not suitable because it is not anaesthetic and causes death by hypoxemia, which is very distressing to the animal.

Slide 45:

Carbon monoxide may also be used – never from a car exhaust, but only pure carbon monoxide in a pressurised tank. In very large dogs, you could also use a penetrating captive bolt and then pith the dog (or exsanguinate it).

Slide 46:

For small stranded cetaceans (dolphins, porpoises), overdose with etorphine or barbiturates is possible. Head shooting with a rifle is also possible, but specialist knowledge should be sought (see the RSPCA Stranded Cetaceans – Guidelines for Veterinary Surgeons at <http://wildpro.twycrosszoo.org/S/00Ref/MiscellaneousContents/RSPCA-StrandedCetaceans/TitlePage.htm>).

Slide 47:

For larger stranded cetaceans, no reliable, humane method for killing is available. This poses a dilemma, because even if whales in particular are launched back to sea after stranding, they do not survive long because of the circulatory compromise that has occurred while they have been stranded. This is similar to the situation with downed cows.

Public pressure to preserve and rehabilitate sea mammals is great, and public expectation is that these animals will be protected from harm, including avoidance of humane killing, whatever the cost. However, as with all animals, a realistic assessment of the potential of the animal to suffer must be made to avoid prolonged, unrealistic efforts to re-float a dying, aged or severely injured animal, in which the most humane course of action would have been humane euthanasia without unnecessary delay.

Slide 48:

As vets, you must be experts on euthanasia and humane killing. So, we will end this lecture by summing up which methods of killing you should never use, because they are not humane, and which ones are acceptable.

This slide shows some of the many methods that are **not** recommended because they cause distress or pain, they are unreliable or take too long to work, prolonging suffering.

For example, methods which are inhumane when used alone include air embolisms, burning, chloral hydrate, chloroform, cyanide, decompression, formalin, household products and solvents, hypothermia, hanging, clubbing, strychnine and neuromuscular blocking agents (e.g. magnesium sulphate; curariform agents such as succinyl choline).

All of these methods have been used to kill animals, but developments in animal welfare science indicate that they have the potential to cause pain, distress or a prolonged death process. In particular, some veterinarians use succinyl choline or other neuromuscular blocking drugs as the sole agent of killing; this is inhumane because it causes a slow death by asphyxiation, due to paralysis of the respiratory muscles. They are listed in bold on the slide because vets should never use these drugs in an animal who has not been anaesthetised but,

historically, vets have done so.

Slide 49:

Which methods for killing are likely to provide a 'good death'? Within the acceptable methods, the most important factor is the person carrying out the killing, who must be knowledgeable, skilled and conscientious.

Whatever method is used, it is essential that the equipment is in full working order: if using an injection, the needle must be sharp and new; if using a gun, the gun, rifle or pistol must be well-oiled and maintained so that it will work perfectly. In addition, the person carrying out the euthanasia must be expert in the method being used.

- For the individual animal who can be adequately restrained, it is likely that intravenous barbiturate provides the best choice for a 'good death'. This method is recommended for stray dogs and cats.
- For horses and donkeys, barbiturate overdose or free-bullet pistol shooting is recommended.

Appendices 1 and 2 of the AVMA Guidelines provide detailed lists of all acceptable methods for the different species.

Slide 50:

For large animals on-farm, the use of a race or crush and captive-bolt stunning followed by bleeding or pithing offers rapid insensibility and reliable killing.

For large animals who are 'free', accurate head, heart or high-neck shooting offers a balance between efficiency and the distress of capture.

For large group situations in disease outbreaks (poultry, pigs), stunning followed by exsanguination should be considered (for larger birds such as turkeys), or stunning/killing by mechanical gun for smaller poultry (chickens, ducks).

Slide 51:

In practice, you will carry out many euthanasias, and you will need to communicate clearly with the client. A detailed account of how to counsel owners about euthanasia is beyond the scope of this lecture, but the main aspects are outlined on this slide and the next.

Deciding to end an animal's life can be a difficult decision for a client. It can also be a difficult decision for the vet, as the vet has a responsibility to the animal as well as the client (see Module 4).

Sometimes the cost of keeping an animal alive is a major factor in an owner's decision for euthanasia.

Whatever the circumstances, the quality of life for the animal is often the main focus, and it is

usually useful for the owner to have time to talk through the factors leading to the decision to euthanise. When concentrated pentobarbital sodium is used, the experience may be explained as 'analgesia, followed by anaesthesia, and then euthanasia'.

Slide 52:

The procedure should be scheduled so that there is time to talk and explain, and time to carry out the process without rushing. This includes obtaining the owner's informed consent – on a consent form that includes the owner's full name and address, describes their animal, and has a statement such as "I hereby consent to the euthanasia of the above animal" that the owner has signed and dated. In many countries, the veterinary body provides appropriate standardised wording and forms.

Some clients feel guilty after the euthanasia. They may feel selfish or unkind because they helped to make the decision. Guilt can occur on its own, but it is usually part of the grieving process, which also includes:

- anger
- denial
- bargaining
- depression
- acceptance.

The above are not distinct stages, but many people move through them in one order or another, before they can fully accept the death of their animal.

It may help if you explain that these feelings are normal, and you should remind the client of the reasons why you had to make this decision.

The client should feel that his/her animal's life (and death) was important, and that the euthanasia was not simply routine for the veterinarian.

Slide 53:

Finally, we have stressed your huge responsibility in killing animals humanely and we have focused on the animal's needs.

However, always remember that humanely killing animals can be very distressing for you, especially if you have to do it a lot in healthy animals (e.g. at a shelter, or as part of controlling disease outbreaks). Anecdotally, carrying out humane killing in those situations can contribute to distress and depression in the vet or other operators involved (Whiting & Marion, 2011). This is normal, not weakness: as a profession, we wish to save animals' lives if we can, and it is distressing to have to end them.

If you ever find that performing a lot of euthanasia or humane killing is affecting your mental and emotional wellbeing, it is very important that you seek support and help, for your own

sake. Some veterinary associations provide emotional support to members, or you may need to speak to a doctor, counsellor or supportive friend.