Module 8
Disease and Production Measures of Animal Welfare

Lecture Notes

Slide 1:

This lecture was first developed for World Animal Protection by Dr David Main (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:

This module will show you

- How disease, production and welfare are related to each other
- What measures of disease and production you can use when assessing physical functioning and related feelings.

Slide 3:

As vets, our primary work concerns preventing or diagnosing and curing diseases in animals and, with farm animals, helping owners to maximise their animals' production.

By disease, we mean any physical or mental condition where the normal function of the local tissue or organ, or the body as a whole, is disturbed. Generally, most veterinary diseases primarily concern physical functioning, as mental diseases (e.g. schizophrenia) are not recognised in animals.

Intensive production techniques can result in similar disruption to the normal functioning of systems and are therefore discussed together with disease in this module.

Both disease and excessive production demands have a mental element because they provide sensory input to the brain which can result in negative feelings (e.g. pain, fatigue) and negative emotions (e.g. fear resulting from physical weakness and vulnerability).

You will recall that animal welfare includes three approaches, physical (including functioning), mental (including feelings) and aspects of naturalness (including behaviour), as illustrated on the next slide.

Slide 4:

This slide illustrates how the three areas of animal welfare overlap. Note that any significant compromise in physical functioning – because of disease or excessive production demands – can affect the mental state of the animal. However, it may also affect the third area of welfare, by thwarting the performance of natural behaviours that are important to the animal.

This third area may also be compromised by disease or by excessive production demands. For example, sheep are a social species that are highly motivated to avoid social isolation. When sheep become ill, they may not be able to keep up with their group. This may not only create feelings of fear because the sheep is now more vulnerable to predators but, in addition, they are no longer perform their natural behaviour of interacting within a group (grazing, resting, etc.), which may cause them frustration or some distress.

This review reminds us that while our professional focus will be primarily on animals' physical functioning and related feelings, we must always see our patients as a whole, including the behaviours that may be important to them. For example:

- we may recommend that a sheep farmer has a hospital pen where a sick sheep can rest and have easy access to food, protection from predators etc. Keeping in mind the 'natural behaviour' element of welfare, we can recommend that, where possible, the sheep in that pen has another sheep as a companion, or can see and hear other sheep.
- in that way, the behavioural component of the sick sheep's welfare is safeguarded, all as part of the primary clinical response to the sheep's illness.

We can apply similar approaches to our clinical care of other social species such as rabbits, horses and dogs.

Slide 5:

This slide shows that disease, production and welfare are closely related.

Disruption of physical function (pathology) by disease or excessive production (e.g. rapid growth, overcrowded housing, high demand for milk) results in altered behaviour (loss of appetite or reduced activity for example) and physiological changes (such as immunosuppression). These changes create sensory input which is evaluated by the brain, and this can give rise to negative feelings such as pain and weakness, and negative emotions such as fear secondary to the pain or weakness. All of these elements cause poor welfare, which in itself can lead to negative feelings and emotions, altered behaviour and physiological changes, resulting in increased susceptibility to disease and therefore entering a downward spiral that can lead to death of the individual in extreme circumstances.

When production demands are not excessive, the presence of disease can reduce an animal's production, e.g. slowing their growth rate.

Therefore, disease always means poor welfare, and poor welfare resulting from different causes may make disease more likely, often by immunosuppression.

However, good welfare can protect individuals against disease, either through social support by conspecifics or through better defence against pathogens as a result of pleasurable experiences (Broom & Fraser, 2007).

Slide 6:

Other courses will teach the details of different diseases in the different species. However, as a vet, this aspect of animal welfare is the one that animal owners will consult you about most. Many owners will also want you to tell them if the disease is causing their animal to suffer. So, we will look at an overview of diseases that may occur in animals.

Briefly, some diseases are caused by infectious agents, as listed on the slide.

Other diseases do not involve external infectious agents, but arise internally, sometimes because of external factors such as lack of adequate nutrition or excessive metabolic demand. Other non-infectious diseases do not have a clear external trigger; examples are many neoplastic (cancerous) diseases, autoimmune diseases and genetic diseases. For example, many breeds of dog are genetically predisposed to health problems such as heart disease, skin disease and joint disease, all of which can significantly reduce their welfare.

Slide 7:

Disease reduces welfare primarily because of the negative feelings that the animal experiences. These may be physical sensations such as pain and thirst, or they may be emotions that result from negative physical sensations, such as fear, which may arise because the animal cannot move.

Other problems that arise from disease are that immobility may put the animal at risk of pressure sores or circulatory problems, if they are lying down without adequate bedding. Animals may also feel fatigued from mounting an ongoing immune response to infection that their body is unable to eliminate.

Slide 8:

Pain is a particular concern with disease. Not all disease is painful. However, many diseases are – e.g. mastitis – and the various foot conditions that result in lameness (a sign of pain) in numerous farm species.

Pain occurs because the forebrain evaluates sensory input from particular neural pathways as noxious. Briefly:

- The relevant sensory input is either a mechanical, thermal or chemical stimulus that is detected by specialised receptors (nociceptors) at the end of particular types of myelinated and unmyelinated sensory nerve fibres. Note that the tissue damage which occurs when animals are diseased or injured causes the release of chemicals that can trigger the pain response. Those chemicals are part of the inflammatory response which also contributes to the pain because it causes local swelling which can put pressure on the sensory cells concerned.

- The noxious stimulus is transmitted to the dorsal horn of the spinal cord where it is 'processed'.
- The stimulus is then passed up the spinal cord to the cerebrum. There, the stimulus is consciously registered as pain. If the cerebrum is not functioning (e.g. because of anaesthesia or because the animal has been stunned), the animal does not feel pain, even though nociceptors are being stimulated and the rest of the pain pathway is functioning.

As vets, we have the knowledge and the professional license to use painkillers that prevent animals from experiencing pain. It is therefore important to understand the pain pathway. The next slide illustrates it.

Slide 9:

The pain pathway is similar in all veterinary species (Viñuela-Fernández et al., 2007). Looking at this diagram, and taking the dog's front left foot as an example, the pathway involves:

1. SIGNAL TRANSDUCTION: noxious chemical, mechanical or thermal stimulus. For example, local inflammatory substances are released because the dog has cut her foot. These inflammatory substances form a chemical 'signal' that is recognised by the peripheral nerves and generates a nervous impulse. The effect of this can be reduced by drugs in the aspirin class, known as non-steroidal anti-inflammatory drugs or NSAIDs. (Note: many human drugs in this class are toxic to domestic animals, including aspirin and paracetamol.) Research on farm animals indicates that using NSAIDs helps to reduce the pain caused by castration.
2. IMPULSE CONDUCTION: the nerve impulse is conducted to the spinal cord. Local anaesthetics (e.g. lidocaine) prevent this. Local anaesthetics are generally a very inexpensive way to manage the pain of routine procedures in farm animals, such as castration and disbudding.
3. TRANSMISSION and MODULATION: in the spinal cord, the signal is modified and transmitted to the brain. Several drugs interfere with this, as shown in the diagram; they include opioids (morphine-type drugs).
4. PAIN PERCEPTION: the signal is perceived in the brain. General anaesthesia prevents perception, but it does nothing to stop the other three levels of the pathway.

This diagram illustrates that, to control pain well, you need to use a combination of drugs that act at different points in the pain pathway. This is called multimodal analgesia.

Slide 10:

You now know the basic mechanism of pain. Farm animals and working animals are especially prone to painful conditions because of their husbandry.

As vets, we need to recognise these conditions and treat the pain if we possibly can. This is because painful conditions that are not treated can cause the pain pathway to become very sensitive. This can result in heightened perception of existing pain; this is known as 'hyperalgesia'.

Another problem that can occur when pain is not treated is that stimuli that normally would not cause any pain now become painful. For example, lightly touching the animal's skin may be extremely painful. This phenomenon is called 'allodynia'. Allodynia may persist even when the underlying source of the pain has been treated. This is shown on the next slide.

Slide 11:

This study examined the increase in central nervous system sensitivity following lameness in sheep. The results suggest that, even when you treat very lame sheep successfully, these animals may remain very sensitive to the pain caused by a mechanical nociceptive stimulus.

On the graph, the threshold for pain (measured as a force, in Newtons) three months after the lameness was cured (grey bar) is the same as or lower than the threshold for pain while the animals were lame (black bar), and much lower than the threshold in healthy animals (orange bar).

So we can see that, even though the sheep were no longer lame, they were more likely to suffer pain than other sheep if, for example, they banged their leg on the side of the race, or if they were walking on rocky ground.

Slide 12:

As vets, we need to recognise signs of pain in animals so that we can treat it. The earlier graphic outlined the drugs that you might use, and you will learn more about pain management in other classes.

The detection of pain takes practice, as some species do not demonstrate pain very obviously. For example, some herbivores tend to become still and passive when in pain, probably so as not to attract predators. The support materials of this course include references to some validated measures of pain that have been developed for dogs and cats. However, we lack validated tools for use in other species.

Generally, you can assess pain using behavioural indicators as outlined on this slide. For example, acute pain normally causes:

- altered posture e.g. hunched
- altered demeanour (animals may seem depressed and unresponsive to their surroundings)
- gait (lameness e.g. sheep with infected feet may graze while kneeling on their front legs)
- inappetence
- increased respiratory and heart rate
- grinding teeth (this is common in ruminants with visceral pain)

- response to palpation of the affected area
- vocalisations (these may be common in acute pain, e.g. during and immediately castration without analgesia)
- response to analgesia.

Chronic pain may be difficult to detect and, in older animals, is often mistaken for ageing. Chronic pain may be associated with signs such as irritability, social withdrawal, aggression and weight loss.

Slide 13:

We have been talking about how pain can result from disease. However, note that disease is not the only cause of pain. We saw that the pain pathway can be activated by noxious mechanical stimulation, and this can result when an animal is injured. Factors predisposing animals to injury are listed on the slide.

Parturition is another significant cause of pain, and some of it is the result of mechanical pressure on the pelvis during the birthing process.

Slide 14:

Returning to disease and welfare, pain is just one possible sign that disease is present.

As vets we are trained to recognise diseases by a range of clinical signs. Briefly, these include:

- changes in behaviours: sickness behaviours, pain behaviours, and
- physical changes: pale mucous membranes, blood in faeces, etc.

Disease can also affect the ability of animals to grow and produce milk, eggs, litters, etc. Therefore we may use measures of production as part of our assessment of their disease status. For example, we may measure body condition score, body weight, measures of fertility, etc.

We may also use laboratory tests and post-mortem examination to confirm whether disease is present, and so make a judgment about welfare.

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Having measured aspects of disease, we may want to use them to quantify welfare in a group of animals.

You can measure the level of disease in a group of animals by estimating the incidence and prevalence.

‘Incidence’ is the number of *new* cases in a fixed time period divided by the number of animals at risk. Usually the period of study is chosen to be one year, in which case we speak of the annual incidence.

There are different measures of incidence, which can be confusing, so we won't examine particular examples of disease incidence here. What we can say is that if a farm has a high incidence of a disease, welfare is poor in that regard and we can look at the possible risk factors and how we can help the farmer prevent more new cases from occurring.

A common example of how veterinary preventive measures can reduce the incidence of disease is the use of vaccinations: when animals have a primed immune system, they are able to mount a strong response to the infectious agent concerned and either not contract signs of the disease at all, or only develop a mild form of the disease which they recover from. Improved nutrition and hygiene are other aspects of husbandry that affect the extent to which farm animals will develop common infectious or metabolic diseases.

Slide 16:

Moving on to 'prevalence': this means the number of animals affected by the disease at any point in time. You calculate it by dividing the number of animals with the disease by the number of animals at risk.

When you inspect animals on a farm, you can assess prevalence directly. However, you would need the farm records in order to estimate incidence. Both are valuable in welfare assessment. However, prevalence alone gives you a 'snapshot' of the current state of affairs. For example:

- In a study of working equids in nine developing countries, the prevalence of different diseases varied between countries. Ectoparasite prevalence varied greatly between the countries, as you can see from the examples on the slides. The same was true of gait abnormalities, with relatively few equids in Afghanistan having that welfare problem.
- Note that those data were from non-random samples. So, although the samples from each country were relatively large, and a total of 5,481 donkeys, 4,504 horses, and 858 mules were assessed, we cannot know if those animals were representative of each country as a whole. Nevertheless, we can see from the slide there were significant welfare problems among the animals concerned.

Slide 17:

Now that we have looked at how disease can affect animal welfare, we shall consider how animal production relates to welfare.

Production is another area that farmers and the owners of working animals will consult you about, because their livelihood depends on the productivity of their animals. Those owners may be less likely than pet owners to ask you whether their animal is suffering. However, this does not mean that they do not care about suffering and, as the vet, you still need to keep that aspect of welfare in mind. You may find it easier to discuss if you present suffering in terms of the cost to the owner rather than talking only of the cost to the animal.

The measures of production that owners may consult you about include the animal's output of, e.g., milk, young, or physical work such as the speed or weight-bearing capacity of working animals.

The other common measure of production is the rate of production, e.g. the growth rate, the interval from calving to conception in cows, or the number of litters per year in sows or sheep.

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Production is a function of the animal's genetics, nutrition, metabolism and management, and it may be modified by the presence of stressors such as social instability, disease, chronic pain, fatigue, etc.

The influence of genetics on production and animal welfare is very significant. Briefly, pressure on farmers to produce cheap food has led to a focus on breeding animals for productivity alone, without full consideration of the consequences of high production on the animal as a whole. This has tended to produce genetic lines whereby the immense metabolic demands cause pathology. Examples are found in laying hens, and in some Holstein-Friesian lines of dairy cows.

- Laying hens can suffer from osteoporosis, which is a decrease in bone mineralisation that predisposes the birds to fractures. Osteoporosis is thought to result from the genetic selection of birds for high rates of lay, such that too much calcium has to be mobilised from the bones. If the birds are handled roughly during transport and slaughter, many of them may suffer broken legs and wings, which cause pain and distress.
- Dairy cows can suffer from metabolic exhaustion, which is partly caused by their genetic potential for high milk production. Their bodies naturally produce very large amounts of milk, because of their genetics; however, their conversion of dietary intake into milk components has not become more efficient. Therefore the high energy demand of their milk production tends to result in loss of body tissues and low condition score.
- In addition, there are negative genetic correlations between milk production, fertility and health in modern dairy cows. These are more apparent when cows are producing in a less intensive farm environment (with fewer high-energy feed supplements) because if you place a genetically high-yielding cow in a low-input–low-output system, she will continue to produce a lot of milk and she will suffer from hunger as a result. This suggests that, genetically, modern cows may be less adaptable than in the past.

Slide 19:

Another factor that can affect animals' production and their welfare is how they are handled.

This area of farm animal husbandry is covered more in Module 30. However, one of the earliest studies showed that hitting pigs reduced their growth rate, whereas stroking them increased their growth rate. This is illustrated by the graph on the slide.

Those pigs which had been hit (grey bar) on repeated occasions grew more slowly than those that had either no human interaction (black bar) or those that had been stroked (orange bar).

Slide 20:

Average daily gain in body weight, shown on the last slide, is just one of many markers of production that we can use as a measure of welfare. This slide shows more of them.

This is not to say that high production is an indicator of good welfare, as selection and management have often prioritised production over other aspects of biology relevant to welfare. However, a decrease in production below that expected, or below the average of the group, is often an indicator of a welfare problem.

As noted, because disease can reduce production, many markers of production are also used as markers of disease.

Slide 21:

We have now seen why disease reduces welfare, and why production can reduce welfare. We have also seen that genetics can promote production, but reduce welfare, and that gentle handling can promote welfare and increase production.

We have also reviewed some measures of disease and of production that we can use as measures of welfare.

We will finish by considering how we might put these measures together.

Slide 22:

You may remember from Module 2 that there are two broad measures of animal welfare that we can assess:

1. One is the events and resources that give rise to an animal's sensory input. These are known as 'welfare inputs' or 'resource-based measures'.

2. The other is their responses to this input. These animal-based measures are 'welfare outputs' or 'outcome-based measures'.

This slide illustrates welfare inputs and welfare outputs.

You see that measures of disease and production come under welfare outputs, at the bottom on the left. However, based on what we have discussed in this lecture, you can see that inputs such as how animals are handled (e.g. the use of pain relief before routine procedures such as castration), and the animal's genetics also affect our measures of disease and production. These are discussed in the next few slides.

Slide 23:

Therefore, when we assess the 'physical functioning' aspect of welfare, we not only need to measure the outputs of disease and production, we also have to include welfare inputs that affect disease and production. Some examples of these inputs are listed on the slide.

Slide 24:

Moving on to the welfare outputs that indicate production and disease levels with the group, this slide lists some examples. Note that for many of these, you may be reliant on your farm client to keep records. You may have to educate your client about how to recognise some of these welfare outputs because he/she may not be very good at that, and may therefore underestimate it.

One example of this is lameness in dairy cows, as we see on the next slide.

Slide 25:

The study showed that the average prevalence of lameness among dairy cattle in some UK dairy herds (22 per cent) was much higher than the farmers estimated it to be on that same day (6 per cent). We can see that farmers were not aware of the level of lameness on their own farm.

When this happens, your client is unlikely to undertake treatment or prevention of the condition concerned as he/she are unaware of the extent to which it might be affecting their animals' welfare and production. As their vet, it is important to show them how to monitor welfare outputs such as lameness in their animals if you are to help them to improve their animals' production and welfare.

Slide 26:

To sum up this lecture:

- Disease and production are related to each other, and can affect welfare by giving rise to feelings of pain, fatigue and nausea, as well as disrupted physical functioning.
- Pain is a particularly important aspect of disease, and you have seen how it is created via the pain pathway.
- Genetics play an important role in production and this can, in turn, result in reduced welfare.
- When you use disease and production to assess welfare, you need to consider relevant welfare inputs that affect disease and production, and welfare outputs such as body weight and signs of pain. It is important that the farmer recognises signs of disease, and you may need to train him or her to do so.