

# Vaccines and animal welfare

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## Summary

Vaccination promotes animal welfare by protecting animal health, but it also has other welfare benefits, e.g. recent investigations have looked at the potential of vaccines in immunoneutering such as immunocastration – a humane alternative to the painful traditional methods. Similarly, vaccination can be used during disease outbreaks as a viable alternative to stamping-out, thus avoiding the welfare problems that on-farm mass slaughter can cause. Protecting animal health through vaccination leads to improved animal welfare, and maintaining good welfare ensures that animals can respond successfully to vaccination (as poor welfare can lead to immunosuppression, which can affect the response to vaccination). It is clear that vaccination has tremendous advantages for animal welfare and although the possible side effects of vaccination can have a negative effect on the welfare of some individual animals, the harm caused by these unwanted effects must be weighed against the undoubted benefits for groups of animals.

## Keywords

Animal health – Animal welfare – Animal well-being – Immunocastration – Pest control – Vaccination – Vaccination side effects.

## Introduction

Vaccination of animals is relatively simple and the welfare of large numbers of animals can easily be protected as a matter of routine (see other chapters in this issue of the *Review*). Vaccination is used primarily to promote animal health by preventing disease outbreaks that can have a devastating effect on animal production, as well as on human and animal health. Animal health is a crucially important factor in modern-day farming, but two other related aspects are often not appreciated. First, poor health in itself is a welfare problem for the animals concerned. And secondly, poor animal welfare (or well-being, the words are used interchangeably here) in the absence of any disease is also important because it too can impact on farm productivity. Most farmers, therefore, want to promote good animal health and good animal welfare to help ensure good productivity and food safety. Furthermore, society demands that animals be treated humanely and stock-keepers themselves want to do the right thing for their animals, i.e. they recognise that they have a duty of care.

Vaccination, therefore, is an extremely effective way in which to promote both good animal health and good animal welfare. This may be especially true in some types

of farming, such as organic livestock production (17), where the use of traditional therapies is restricted in order to minimise residues and prevent the development of resistant strains of micro-organisms or parasites (23). Vaccination helps provide for sustainable and economic stability for farmers and the communities they serve (16). However, vaccines have to be affordable and animal stock-keepers have to have the knowledge, ability and inclination to use them (5).

In addition to farm animal productivity and food safety, vaccination plays an important role in human health through the control of some zoonotic diseases in wildlife, such as rabies, where the wild animal reservoirs of infection can be reduced through the use of vaccine baits (19). Other areas where vaccination is being used, or is being developed, is for use in the control of pest populations (2), and in the immunoneutering of farm animals to replace painful routine procedures such as castration.

This article examines some of the disadvantages of vaccination and also its potential role in various areas of husbandry. Other aspects of animal welfare, such as public acceptance of animal research, immunocontraceptives and

immunoneutering, and application of the Three Rs in the development and production of vaccines are dealt with in volume II of this issue (see Audonnet *et al.*, Cussler, and Hardy and Braid), and several articles deal with the unwanted side effects of vaccines that may have welfare implications for the animals.

## Animal welfare

Animals that have the ability to experience pain, as well as pleasurable states such as happiness, are known as 'sentient', i.e. they are able to experience negative (poor) and positive (good) physical and psychological well-being. It is generally considered that all vertebrates, and even some invertebrates, are able to experience negative well-being, i.e. to suffer in some way. The neurological capacities of animal species to suffer will vary between different classes of animals (mammals, birds, reptiles, amphibia and fish), and even between individuals according to their stage of development (neonates may suffer more pain than adults as their nervous system is immature [13]), their experiences in life, their ability to remember those experiences, and their capacity to respond (e.g. some individuals may be brain-damaged). Animal welfare is about animals' feelings and emotions, which encompass adverse states such as pain, distress, anxiety, discomfort, grief, fear, boredom, frustration, etc., and, at the other end of the scale, happiness and contentment (8).

A deeper question is whether animals can 'suffer' pain as well as 'feel' pain and there is considerable debate about this issue (7). To put it another way, animals may not suffer (pain and any other adverse state) in the sense that they may not mentally reflect very deeply on their feelings and in this way animals may be different from humans. However, it is also possible that animals do suffer like humans but perhaps not in quite the same way or to the same degree, because they are not as self-aware as humans. This is not surprising as, after all, vertebrates have a similar evolutionary history, and feelings such as pain and fear are protective sensations that enable animals to survive in their respective environments.

Feelings of pain and distress are adverse states that can result in animals having a poor quality of life, especially if these feelings persist for any length of time. Consequently, it is important to develop welfare assessment measures that indicate how an animal is feeling, and to what degree its likes, wants and needs are being met in the husbandry system in which it lives. It is also important to develop indicators of how the welfare of diseased animals is compromised (4). When animals become infected (this can be thought of as being exposed to a stressor) they may then experience mental effects due to fever (feeling hot), malaise (feeling tired), lethargy (feeling of having no energy) and

nausea (feeling sick). In addition they may suffer from adverse clinical states such as hyperthermia, vomiting, diarrhoea, salivation, retching, coughing, lameness, ulceration, colic, etc. All these are matters of welfare concern and avoiding contracting the disease through vaccination is extremely beneficial for the welfare of animals.

The well-being of each member of a group of animals (herd, flock, etc.) contributes to the overall assessment of the welfare of the group, as well as the health status of the group. Animal 'groupings' may be at an 'on-farm' level, but may also be at national and international levels. An international approach to the conservation of animal health is particularly important as most nations have common borders with other countries, and disease transmission is not limited by such notional geographical separations. Vaccination is a major method by which national herds/flocks are protected from disease.

However, vaccination is not without its disadvantages as sometimes, the welfare of individual animals may be reduced (often temporarily). For example, vaccinating a group of animals may cause side effects in some, but the overall immunity of the group is raised, thus protecting the large majority of animals while harming a few. Some vaccines commonly cause side effects and so the consequential anticipated benefit (deduced from a risk assessment) has to be substantial and sufficient to outweigh the harms caused.

### The relationship between animal health and welfare

In general terms 'animal health' is interpreted as involving disease and forms of physical ill health, whereas 'animal welfare' is seen to be about psychological well-being (4). The two are independent of each other in the sense that one can have healthy animals whose psychological well-being is poor, and unhealthy animals whose well-being may be good, although most of the time poor health leads to poor welfare. For example, some healthy captive or confined animals show stereotypic behaviour – a sign of poor welfare. A good example of this would be primates kept in impoverished conditions in zoos, such as in small cages where they constantly pace. On farms it could include tethered animals, such as veal calves, and sows kept in crates. All these animals have poor mental health and through their stereotypic behaviours or self-mutilation they may even damage their own tissues. In contrast to the poor welfare of these healthy animals, the psychological well-being of some 'unhealthy' animals may remain relatively high if the health problem is of low impact, or has no impact at all, e.g. a benign tumour. However, the welfare of animals will usually be negatively affected if their health is poor. These animals will be suffering in different

ways from the tethered farm animals, with feelings related to the animals' immune responses such as fever, malaise, nausea, vomiting, etc. (3).

Many of the notifiable diseases, such as foot and mouth disease (FMD) and classical swine fever, affect productivity and that is why they are so listed. This lack of productivity is due to the negative impact that the disease has on the animals' health and welfare. For example, cattle with FMD show salivation, as they are unable to eat, drink or swallow due to ulcerated tongues, and are lame as they cannot bear weight on their feet. These conditions are all associated with painful lesions and vaccination can help reduce such adverse effects. Overall, poor health, particularly with infectious diseases, leads to poor animal welfare, and this can be prevented through an effective vaccination programme.

## Recognising and measuring welfare

Indicators of poor mental health or poor psychological well-being are more difficult to identify than indicators of poor health or poor productivity. Productivity indices such as weight gain, body temperature, milk yield, normal reproductive behaviour patterns, egg yield, etc., are indicators in a general sense of both good health and good welfare. However, there are many instances in which health and welfare are poor but productivity is not affected, so such indicators are often only affected when the health and welfare is compromised to a substantial degree. Thus, productivity may remain unaffected, or be only marginally affected, even when animals are kept so confined that they cannot carry out many of their normal behaviours (e.g. veal calves tethered in small crates, laying hens in small battery cages, cows stalled in cubicles). Under these conditions productivity may even increase, as animals do not expend energy in moving around and some diseases may be reduced. However, other diseases may increase. Similarly, animals may be subjected to acute severe pain early on in life, e.g. through castration or docking, or having their beak trimmed with a hot blade, but productivity in the long term is unlikely to be affected. Nevertheless, it is now being realised that after these 'minor' operations animals may have prolonged pain for several days or even weeks afterwards (14, 20, 21, 22).

Other more extreme indicators of poor welfare are mortality and morbidity, however, one has to be careful in their interpretation. Mortality as an indicator is likely to reflect considerable suffering before death. But a farmer who kills sick animals for humane reasons rather than let them struggle on in the hope that they will live long enough to get better and be sold to make a profit, may have a higher on-farm mortality but cause less animal suffering.

More subtle indicators of welfare include behavioural diversity, stereotypic behaviours, and corticosteroid and catecholamine levels, but such scientific measures of animal health and welfare need to be carefully defined and recorded in such a way that they give meaningful information about the state of the animals concerned. At present they are really only appropriate in a research setting, but it may be possible to link them with on-farm animal welfare (25). A growing area of animal welfare research is 'asking the animals' what they prefer in terms of their environment, i.e. observing how hard they will work to access or avoid a particular environment. This area of research, known as 'preference testing', provides extra information, from the animals' viewpoint, in addition to the more traditional measures of welfare.

Measures of welfare have to be seen in the context of the farming practices being used, the productivity of the animals and other environmental factors. The overall aim for the stockman is to cause only the minimum amount of animal suffering to meet the farming objectives. It is generally seen as being unethical to cause more suffering than is necessary to achieve those objectives. This 'extra' suffering has been termed 'avoidable' suffering. The levels of on-farm measures of welfare can be benchmarked (used as performance indicators), as is happening in some of the farm and food assurance schemes. These benchmarks form a valuable guide for farmers as they will show how much avoidable suffering is being caused.

## Poor welfare and response to vaccination

It is important to appreciate that there is a connection between animal welfare and health, and that a healthy mental state can increase resistance to infectious disease, whereas a state of poor welfare can reduce immune resistance and so predispose animals to disease. A reduced resistance may lead to the development of clinical disease from carrier states, and it may mean that the disease is never completely eliminated and that the animal then remains a carrier. Poor welfare at a critical time may also affect the response to vaccination, e.g. castration without anaesthesia or analgesia. Lessard *et al.* (18) found a decreased antibody response to bovine serum albumen challenge (on day of castration and 14 days later) in 10 to 17 day-old castrated piglets compared with sham-operated controls ( $P < 0.0001$ ). They also found reduced lymphocyte blastogenic responses to concanavalin A, phytohaemagglutinin, and pokeweed mitogen. This immunosuppressive effect of castration is probably due to a stress reaction and the secretion of cortisol, potentially reducing vaccine effectiveness.

In conclusion, it is important that animals are in a state of good welfare throughout their lives to ensure that they are in a fit state to respond successfully to vaccination.

## Side effects of vaccination

Many vaccines have side effects, but normally they are trivial and of short duration and are usually associated with live vaccines. Sometimes adjuvants in a vaccine can cause an adverse reaction, sometimes latent infections can be caused (e.g. Herpes virus infections), and sometimes an animal may fail to respond (seen as an unwanted side effect). Some other common side effects include:

- transient swelling at the site of injection and a reaction that may change coat colour in the area
- coughing after nasal administration
- transient pyrexia (fever)
- respiratory distress, salivation, vomiting, diarrhoea, urticaria
- reduced fertility, foetal deformities and abortion
- excretion of vaccine virus, which may affect other animals in the herd that are susceptible, e.g. spread of vaccine virus in pigs from fatteners to breeders.

These are relatively uncommon as clear warnings are given by the manufacturers, and safety testing of vaccines helps prevent their occurrence. Of recent note however, has been the development of fibrosarcomata in cats at the site of injection, and the development of peritonitis in fish that are immunised by the intraperitoneal route, quite likely a response to the adjuvant.

## Animal welfare in safety testing of vaccines

The welfare of laboratory animals has not always been well protected in the past, particularly due to the requirement that animals should be allowed to die of infection in the control group, and also in the vaccinated but unprotected groups (e.g. Leptospirosis challenge tests). The development of humane endpoints where surrogate markers, i.e. early clinical signs, are used as predictors of death provides a real humane alternative to death as an endpoint when there are no other testing strategies that will achieve the same scientific objective (e.g. assessment of safety and potency) (see article by Cussler in volume II of this issue).

## Other uses of vaccination

### Immunocontraception and immunocastration

Immunoneutralising vaccines against sperm, egg antigens and the hormones of pregnancy have been developed and may form the basis of immunological contraceptives in the future (studies are being carried out in humans [1, 15]). Immunisation through the use of baited vaccines has already been used as a strategy for the control of rabies in

the wild animal reservoir (10) and, potentially, a similar strategy could be used for controlling the population of so-called 'pest' species (see below).

Castration is a common procedure in the farming of pigs, sheep and cattle and it is normally carried out on farms with no anaesthetic and no post-operative analgesia, something that is unlikely to happen for companion animals or for humans! Whether castration is done surgically or with a rubber ring there is good scientific evidence that animals are in serious pain at the time of castration and that this persists for varying periods of time afterwards (21, 24). The best alternative to this routine farming intervention is not to do it at all, and in some farming systems that is a practical solution. Another approach is the local destruction of testicular tissue by various chemicals. However, more recently, the possibility of preventing testis development through vaccination has been investigated. This can be done either by treating males with exogenous hormones that down-regulate the hypothalamic/pituitary/gonadal axis or by neutralising these hormones with specific antibodies (see paper on immunocastration by Hardy and Braid in volume II of this issue of the *Review*). Very few measurements of the welfare of treated animals have been carried out, but the behaviour of immunised male pigs was found to be similar to that of surgically castrated ones (6), who show reduced aggressive and mounting behaviours and increased feeding behaviour, compared with entire males. While there has been little reaction on the site of injection using this vaccine (9) – because vaccines are directed against hormones (e.g. GnRH) produced by tissues of the animal – it may induce cellular damage away from the injection site, e.g. in the hypothalamus; but whether this causes pain or discomfort is unknown (24).

As well as on farms, vaccination can be used to manipulate the sexual activities of animals, and thus control populations, in other animal facilities such as animal sanctuaries, zoos and wildlife parks (see the article by Plumb in this issue) and such interventions should improve the welfare of the animals. Vaccination can also be used to control pests in the wild (e.g. foxes, possums); controlling numbers will improve the welfare of the group by avoiding food shortages (starvation) and excessive competition for mates and territory, thus leading to better conservation of competitor species.

### Prevention of mass slaughter for disease control

For some diseases it has been policy to stamp out an infection on farms through the mass killing of animals. Vaccination of animals with appropriate measures to differentiate vaccinated animals from infected animals, is a useful adjunct, even a viable alternative to mass killing.

With a stamping-out policy, it is a major welfare problem to kill large numbers of animals humanely on farms, unlike in abattoirs where systems can be easily put in place to ensure a humane death. Several reports have been made on some of the problems involving poor welfare that have occurred during a disease outbreak (12) and various reports have addressed the issue of humane killing of animals for disease control (11).

such as castration. It is relatively inexpensive, highly effective, and while there are side effects the benefits of vaccination outweigh the harms caused through these unwanted effects.

## Conclusion

Vaccination can play an extremely important role in the promotion of the psychological well-being of animals through disease prevention, disease control, population control and the replacement of routine painful procedures



## Les vaccins et le bien-être des animaux

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### Résumé

La vaccination assure aux animaux un meilleur bien-être en protégeant leur santé. Elle a également d'autres effets positifs sur le bien-être : des recherches récentes ont ainsi révélé les possibilités offertes par les vaccins de supprimer les fonctions de reproduction chez les animaux par des méthodes immunologiques telles que l'immunocastration – une alternative décente aux douloureuses méthodes traditionnelles. De même, en cas de foyer de maladie, la vaccination peut remplacer les stratégies d'abattage sanitaire, évitant ainsi les problèmes de bien-être que peut susciter l'abattage massif d'animaux dans les exploitations. La protection conférée par la vaccination améliore le bien-être des animaux et, inversement, des animaux bénéficiant de bonnes conditions de bien-être réagissent mieux à la vaccination (par opposition à l'immunosuppression observée chez les animaux en mauvaises conditions, qui altère leur capacité de réagir à la vaccination). Il est évident que la vaccination présente un intérêt considérable du point de vue du bien-être animal, et les effets indésirables parfois constatés au niveau individuel ne doivent pas cacher les bénéfices incontestables au niveau des troupeaux.

### Mots-clés

Bien-être des animaux – Contrôle des nuisibles – Effet secondaire du vaccin – Immunocastration – Protection animale – Santé animale – Vaccination.



## Vacunas y bienestar animal

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### Resumen

La vacunación, que favorece el bienestar de los animales porque protege su salud, trae también consigo otros beneficios en ese terreno. En fechas recientes, por ejemplo, se han estudiado las posibilidades de uso de métodos inmunológicos para obtener animales asexuados, con técnicas como la inmunocastración (alternativa clemente a los dolorosos métodos tradicionales). Asimismo, ante un brote zoonosario existe la posibilidad de utilizar la vacunación como alternativa viable al sacrificio sanitario total, soslayando con ello los problemas de bienestar que pueden derivarse de la práctica de sacrificios masivos en las explotaciones. El hecho de proteger la salud de los animales mediante vacunación propicia un mayor grado de bienestar, lo que a su vez garantiza que los animales respondan adecuadamente a la vacunación (pues un animal que viva en condiciones deficientes puede sufrir inmunodepresión, y ello podría restar eficacia a una vacuna). Está claro que la vacunación presenta enormes ventajas desde el punto de vista del bienestar animal y, aunque sus posibles efectos secundarios puedan influir negativamente en el estado de algunos ejemplares concretos, conviene comparar esos eventuales efectos dañinos con los indudables beneficios que la vacunación reporta a grupos enteros de animales.

### Palabras clave

Bienestar animal – Castración inmunológica – Control de plagas – Efecto secundario de la vacunación – Sanidad animal – Vacunación.



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