# The use of vaccination in emergency animal disease responses

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**Summary**

The author discusses the potential of vaccination to assist in the management and eradication of emergency animal diseases (EADs), as a complementary measure to either minimise the scale of, or to avoid, stamping out. Vaccination is only one of many tools available for disease control, especially for EADs. The decision on whether to use a vaccine in the face of an outbreak can be controversial, as policy-makers in the United Kingdom found during the foot and mouth disease outbreak in 2001. The advantages, disadvantages and limitations of using vaccination are discussed, as are strategies for EAD vaccination and the importance of contingency planning. The author identifies the potential for vaccines to lead to various problems, including encouraging genetic drift in field strains of pathogens, the risk of reassortment with naturally occurring pathogens, or the creation of a carrier state in an infected animal.

**Keywords**

Animal diseases, Animal disposal, Control, Disease response, Emergency, Planning, Vaccination.

## La pratica della vaccinazione in risposta alle emergenze sanitarie animali

**Riassunto**

*L'autore discute le potenzialità della vaccinazione nell'aiutare la gestione e l'eradicazione delle emergenze sanitarie animali come misura complementare per ridurre, o evitare, l'eliminazione degli animali stessi. La vaccinazione è solo uno dei molti strumenti disponibili per il controllo delle zoonosi, specialmente per le emergenze. La decisione se utilizzare o meno un vaccino per fronteggiare un'epidemia può essere controversa, come si verificò nel Regno Unito durante l'esplosione di afta nel 2001. Si discutono vantaggi, svantaggi e limiti dell'impiego della vaccinazione, così come le strategie di vaccinazione per le emergenze sanitarie animali e l'importanza della pianificazione.L'autore sottolinea le potenziali capacità dei vaccini di essere causa di vari problemi, compresi il promuovere la deriva genetica in ceppi di campo di patogeni , il rischio della ricombin-azione con patogeni naturalmente esistenti o l'induzione di uno stato di carrier in un animale infetto.*

**Parole chiave**

Controllo, Eliminazione animale, Emergenza, Malattie animali, Pianificazione, Risposta alla malattia, Vaccinazione.

## Introduction

Vaccination to assist in the management and eradication of emergency animal diseases (EADs) is gaining acceptance as an alternative or adjunct to the more traditional 'stamping-out' approach. Vaccination has the potential, in some circumstances, to minimise the need for the rapid destruction and disposal of large numbers of animals that stamping out entails. For the purposes of this paper, an emergency animal disease (EAD) is defined as a disease

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that requires an urgent response to contain an outbreak to avoid disruption to the community (possibly including public health concerns) or trade. It may be a disease that is exotic to a country or be an unusual occurrence of an endemic disease.

Vaccination is only one tool that can be utilised amongst a range of disease control options. It can be a powerful tool when used in conjunction with other emergency management procedures and, for this reason, it is important to understand its benefits and limitations (2).

Fundamental principles of safety, efficacy and appropriate manufacturing practice should be considered in a risk analysis (12) before vaccine use is included as part of an EAD response. Ideally, these concerns should be addressed before an EAD event, as part of contingency planning.

The foot and mouth disease (FMD) outbreak in the United Kingdom (UK) in 2001 highlighted how contentious the decision of whether or not to vaccinate animals in the face of an EAD can be (16). The case highlights the need to explore the potential role of vaccines in the control of socially and economically important diseases.

The context in which a vaccine is being used must be considered when discussing the role of vaccination. The success of vaccination is dependent on the properties of the vaccine, such as its efficacy, and the appropriate handling and delivery of the vaccine (14). However, vaccination is not a substitute for good animal health policy based on robust epidemiology and technical knowledge. Vaccination must be seen as just one tool that can be used in the effective management of a disease outbreak.

## Options for the use of vaccination

The major motivation for recourse to vaccination in disease control is to assist in containing, controlling or eradicating a disease outbreak. Effective disease control cannot be ensured with vaccination alone, but requires the support of basic principles of biosecurity, movement restrictions and risk-based trading of animals and animal products.

Vaccination may also be used to alleviate a disease outbreak, as in control of clostridial disease, or to protect public health (e.g. where vaccination of dairy cattle against leptospirosis is used to protect humans). Vaccination may help to limit adverse animal welfare effects of an EAD outbreak, especially in intensively farmed animals.

Vaccination has been used successfully to reduce the prevalence of endemic disease to a level where stamping out can then be used for final eradication. This approach was used in the eradication of bovine brucellosis from Australia (10).

Vaccination without stamping out has been used to eradicate disease, most notably in human populations, as with smallpox (5) and polio. However, these events are few and require intense effort to achieve adequate vaccination coverage across a population, as well as long time lines before achieving eradication (usually measured in decades). In such programmes, reliance upon vaccination uptake is a major factor in the suppression of outbreaks. The recent rise in cases of pertussis and measles in developed countries (7), despite available vaccines, is an indicator of the risk of relying solely upon vaccination to control disease, without use of other strategic control measures.

During outbreaks of EADs, vaccination takes on a different context from routine disease control. Firstly, the timeframe within which animal health authorities are acting is generally short. Secondly, human and other resources can be limited so that even if vaccine is available, animal health authorities may not be able to respond rapidly enough to meet the demand. Traditional methods of disease control in livestock, such as stamping-out and movement restrictions, are still the most effective way to control an EAD outbreak, especially if an outbreak is small or in a geographically or demographically isolated area. Using vaccination may be a last resort to achieving eradication and may be an indicator that other control measures have failed.

 

Whatever the circumstances surrounding a decision to use vaccination during an EAD, the role of other disease control measures should always be considered.

## Policy for vaccination during an outbreak of an emergency animal disease

The Australian Veterinary Emergency Plan (1) envisages vaccination being used under four different policy frameworks, as follows:

- as a primary element where vaccination will be used with or without stamping out
- as a secondary element where vaccination may be used to assist an eradication campaign based on stamping-out and other traditional methods of disease control
- as a tertiary element where vaccination is unlikely to be used unless the disease becomes well established and a long-term campaign is required to eradicate the EAD
- not used in a response; reasons for not using vaccination include unavailability of vaccine or, if vaccine is available, it does not meet the manufacturing and safety standards of the country; other reasons not to use vaccine are complex and may involve trade, marketing, resourcing and operator safety issues.

The policy for vaccine use must be considered as a dynamic medium in which shifts can occur between primary, secondary or tertiary elements depending on the circumstances. The use of vaccines for a particular disease may differ according to the type of vaccine available and the circumstances in which the EAD occurs. For example, in the case of classical swine fever (hog cholera), Australia's current policy is not to vaccinate, but to stamp-out (1), yet vaccination may be used as a primary response strategy in countries where epidemics occur on a regular basis and stamping out is not feasible.

The critical issue with vaccination for EAD decision-makers is to decide in advance what the policy on vaccine use will be, given the available knowledge on appropriate sources of vaccine, and the predictions of the type of disease outbreak that could be encountered. Scenario planning approaches can be effective tools but are best used in advance of an outbreak where critical analysis can take place beyond the 'heat of battle'. It is important for decision-makers to understand at least the basic epidemiology of an EAD, as this will determine to some extent resource allocation, the choice of antigen and the contribution it might make.

## Vaccine types

Vaccine types can be categorised in different ways. The two categorisation methods described here can assist animal health decision-makers to understand what types of vaccine may be used in an EAD.

Vaccines can be classified on the basis of the method of production (4) as follows:

- live – usually an attenuated or naturally avirulent strain of the relevant organism; live vaccines can pose a risk in the sense of reversion to virulence or their ability to reassort with field strains of the pathogen
- inactivated – where the organism has been altered by a chemical or physical procedure so it can no longer cause infection; there is usually less risk involved with this type of vaccine except when they are not adequately inactivated (for example, FMD outbreaks have been reported in Italy due to an inadequately inactivated vaccine) (17)
- novel vaccines – generally vaccines that rely on advanced technologies such as DNA vaccines (11), minigenes (21), viral vectors, 'trojan horse' vaccines or genetically modified organism vaccines; this type of vaccine offers considerable opportunities for use and potential benefits but so far have had limited use in animal health; there are, however, some notable examples amongst EAD vaccines, such as Aujezsky's disease, Newcastle disease and avian influenza (18).

Vaccines may also be classified on the basis of the immune response they elicit, namely:

- non-marker – these are the more traditional vaccines that elicit primarily antibody response that is indistinguishable from natural infection by the pathogen related to the vaccine strain

- marker – most of these are newer generation vaccines that elicit an immune response that can be differentiated from natural infection; when a gene that codes for a glycoprotein in a pathogen is deleted, the vaccine strain will not induce specific antibodies to that glycoprotein and this allows a serological test to differentiate between true infection and vaccination (18); however, these vaccines can be based on traditional methods of vaccine manufacture and are often a different strain of the pathogen under examination (e.g. avian influenza) or are a highly purified vaccine from which some protein components that exist in the structure of the natural pathogen have been removed (e.g. FMD vaccines); the marker vaccine presents animal health decision-makers with one of the most promising alternatives to stamping out and disposal of animals in that it is possible to distinguish vaccinated animals from naturally infected animals and thereby enable presentation of a case for the absence of the infective agent at the herd or flock level.

## Strategies for using vaccination

A number of strategies for vaccinating susceptible animals can be utilised during an EAD. These strategies can be classified in a number of ways, two of which are described below.

One approach to classification is based on the purpose of vaccination (6, 15, 16). The terminology applicable to this classification system describes vaccination as suppressive or preventive, as outlined below.

### Suppressive vaccination

Suppressive vaccination is applied to animals that are immediately at risk or are exposed in an infected area. The UK government in its 2004 FMD contingency plan has simply defined suppressive vaccination as 'vaccination to kill' (15, 16). Here, vaccination is used to reduce the viral load or shedding of virus to assist other control measures being employed. Suppressive vaccination is often used because of response resource constraints in more intensive farming situations, or to buy time because of a 'bottleneck', such as constraints in carcass disposal.

### Preventive vaccination

Preventive – may also be termed 'pre-emptive' vaccination: this is applied to high-risk animals or to enterprises that are not in an infected area but could be exposed to infection in the near future. The UK government in its 2004 FMD contingency plan has simply defined protective vaccination as 'vaccination to live' (15, 16) which can be used for the control of those diseases where it is usual to employ a stamping-out policy. However, a number of factors should be considered, including the quality and efficacy of the vaccine and the accepted international standards for disease control. This strategy may be employed where the risk of infection is low, but this is not usual in an EAD response, except for rare or endangered animals.

A second approach for considering vaccination use is based on the spatial pattern of how vaccination is applied, as described below.

### Barrier vaccination

This involves the creation of a barrier outside the infected zone to slow down the transmission rate of the disease by vaccinating all susceptible animals. The location and shape of the barrier may be influenced by natural geographical features, such as a valley, or by the demographics of the animal population at risk. Other terms used to describe barrier vaccination include buffer and 'firebreak' (Fig. 1). Ring vaccination (Fig. 2) involves creating a circular barrier or an annulus around an infected area, the diameter of the ring will depend on a number of factors including the epidemiology of the pathogen involved, livestock density and available resources.

This method is more often associated with preventive vaccination but this is not always the case. When ring vaccination is employed, premises both within and outside the infected zone may undergo vaccination to both reduce viral shedding and provide a ring of protection around the infected area, especially with a highly contagious disease such as FMD.

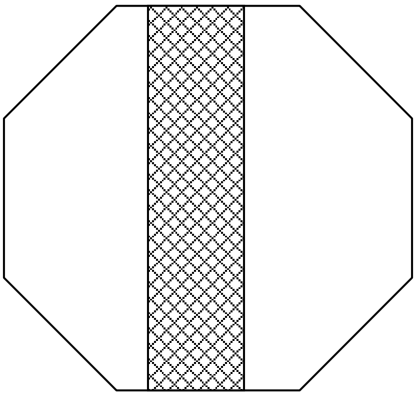

Figure 1
Barrier (firebreak) vaccination

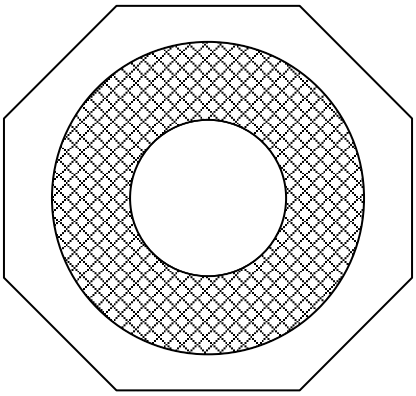

Figure 2
Barrier (ring) vaccination

## Targeted vaccination

In some circumstances it may be necessary to target high-value animals or animals in highly intensive situations, such as large piggeries or feedlots which, if infected, can greatly amplify the pathogen (Fig. 3). This vaccination strategy would generally be used pre-emptively and would target high-risk enterprises within the vicinity of an infected area to reduce the risk of an outbreak escalating. One aim is to reduce the chances of high-risk operations becoming infected and subsequently requiring allocation of significant resources. Targeted vaccination can also be used to protect rare and endangered species or valuable genetic material.

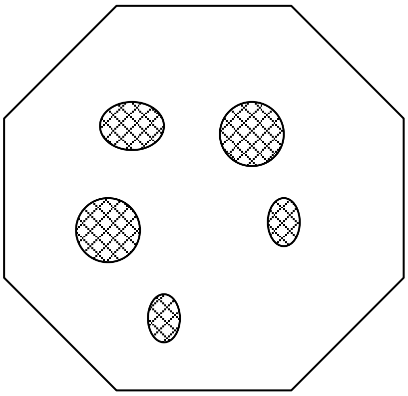

Figure 3
Targeted vaccination

## Area or blanket vaccination

Area or blanket vaccination involves the vaccination of livestock in a geographic area which may be a discrete area, an entire region, state or even country (Fig. 4). Implicit in blanket vaccination is the requirement that all susceptible animals within the area are vaccinated, except wildlife in many circumstances. The usual approach would be to vaccinate an area extending around an infected zone. The shape of the vaccinated area is likely to be determined by fixed boundaries or geographic landmarks. Sometimes the phrase 'mass vaccination' is used for large-scale blanket vaccination and if this method is employed it may indicate that some disease control strategies, such as stamping out, have not succeeded, and that longer-term management of the disease is required. Mass vaccination may be used as a primary EAD response and its use will be influenced by the immediate disease control objectives and international standards.

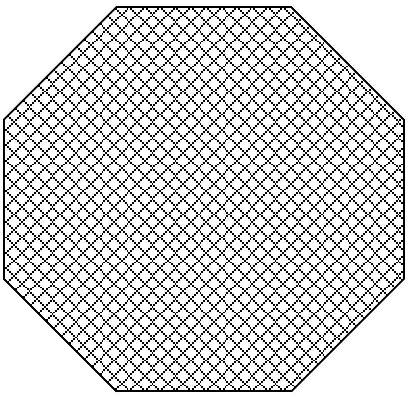

Figure 4
Blanket (mass) vaccination

Aspects that are important to consider when selecting a strategy for vaccinating are the geography of the outbreak, the density of stock in the region and other factors that may affect pathogen distribution, for example climatic conditions. Host factors such as the delay in developing an immune response should also be considered.

## Advantages of vaccination

Vaccination provides a powerful disease control option to animal health decision-makers when combined with other disease control strategies. With developments in technology, vaccination will predictably play an even greater role in disease control in the future. Some specific advantages of vaccination include the following:

- potential reduction in numbers of animals infected – vaccination used appropriately should slow down the transmission of the disease in the vaccinated population and virtually eliminate the occurrence of new cases in the wider population, if used in conjunction with other risk reduction measures, particularly movement restrictions
- potential reduction in numbers of animals slaughtered – this is an increasingly important advantage for the use of vaccine in the face of heightened public and political pressure to reduce the number of uninfected animals slaughtered during an EAD response
- containment of outbreaks where resources are limited – vaccination has the potential to reduce resource demands by two major means:
  - reducing the number of animals requiring slaughter and subsequent disposal
  - increasing the amount of time animal health authorities have available to implement other control measures, including slaughter and subsequent disposal of infected animals, by reducing pathogen shedding and transmission
- maximum utilisation of animal protein for its intended purpose – this is related to the reduction in animals destroyed for disease control purposes; vaccinated animals may pass through the normal production cycle as long as any food safety and trade concerns have been addressed; this also has implications for management of animals at the farm level, as it allows primary producers to continue with their breeding and rearing operations with minimal disruption
- protection of public health – even if an EAD is not highly contagious and can be well contained with the available resources, human health authorities may consider vaccination of susceptible animals important to reduce the risk of transmission of zoonoses to humans; for example, it could be argued that a highly pathogenic strain of avian influenza, such as H5N1, may pose a significant risk to humans, especially those working with infected animals; if an appropriate human vaccine is not available, then an alternative that may be considered is the vaccination of the susceptible animal population to suppress virus production and thus the level of challenge to humans (8)
- protection of high-value animals and rare or endangered species – vaccination has a specific niche for protecting high-value livestock, whether it is to preserve genetics or for economic benefits; vaccination may be employed to protect rare or endangered animals, even if it is not used for other susceptible species.

A risk-based approach to vaccination is essential. The advantages can be significant in leading to an EAD response that minimally disrupts the normal routines of an affected region but they require careful consideration in any response where an appropriate vaccine is available.

## Limitations and disadvantages of vaccination

Despite the fact that vaccine technology is continuously progressing and offers great potential benefits for the future, there are still a number of key disadvantages with current vaccines that limit the utility of vaccination, especially during an EAD response. A common misconception is that vaccines offer total protection for individuals and a population against a particular pathogen. The limitations of vaccines must be included in any consideration of vaccination as part of a disease control programme. If used inappropriately, a vaccine may 'fail' when it was the strategy for use that was at fault. Limitations and disadvantages are given below.

## Effectiveness of vaccines

The vaccine under consideration may not be particularly effective in terms of efficacy, vaccination regime or in terms of time for an animal to produce an appropriate immune response. An appropriate vaccine antigen must be selected. Use of vaccines that are inadequate or have not been appropriately tested may lead to failure of a vaccination programme, and consequent disease transmission.

## Reversion to virulence or inadequately inactivated vaccines

Live vaccine agents present a risk of reverting to a previously virulent state. Inactivated vaccines are a risk if the pathogen that forms the active component is not adequately treated to inactivate it. For example, outbreaks of FMD in the 1970s and 1980s in Europe were attributed to inadequately inactivated vaccines (17). For adequately assessed vaccines that pass through the appropriate regulatory assessments, the risk for either reversion to virulence or inadequate inactivation should be negligible but in the middle of an EAD response, there is a risk that vaccines not fully assessed by regulatory authorities are used.

## Effect on the evolution of pathogens

Live vaccine strains have the potential to cause selection pressure on naturally occurring pathogens resulting in the evolution of more pathogenic strains of an organism. This is especially relevant in the context of viral evolution and the quasispecies theory (9), which is a model that assists in understanding how pathogens evolve. According to this theory, aspects such as adaptation and robustness in a finite population are based on competitiveness and a dynamic fitness that can see, for example, more virulent pathogens emerge from a population previously identified as avirulent.

## Potential for re-assortment

Live or genetically modified vaccines may present a problem when confronted with the naturally occurring organism. This differs from evolution of the pathogen as it represents a change from one strain of an organism to another in a short period due to the molecular reassortment between an iatrogenic and a natural strain. For example, live bluetongue vaccines have been considered suboptimal in the past due to their potential to reassort with field strains and formulate a 'new' strain of the pathogen with unknown effects (19).

## Potential for contaminated vaccines to cause other disease

In a worst-case scenario, a contaminated vaccine could lead to a disease that is more costly than the disease it is intended to control. For example, spread of scrapie in Italy (20) was attributed to a contaminated ovine and caprine agalactia vaccine. Contamination in vaccines is not an uncommon phenomenon even in developed countries with strong regulatory systems, the most common contaminant being bovine pestivirus.

## Potential for contaminated vaccines to interfere with interpretation of serological tests

Bovine pestivirus contamination in a porcine vaccine may lead to a serological reaction that may be confused with classical swine fever. This may have trade implications for a country free of the disease, yet experiencing a serological cross-reaction that requires further investigation and interpretation.

## Carrier and subclinical animals

This is especially important in cases where vaccines are not highly efficacious or where vaccination is employed as a suppressive strategy. Although during a suppressive vaccination campaign, animals will eventually be slaughtered, vaccination may result in a false sense of security leading to compromises in movement controls or biosecurity and ultimately breakdowns in disease control. Vaccines may fail to promote a full immune response resulting in subclinically infected animals in which the pathogen can continue to multiply (usually at reduced levels) and be shed.

## Vaccination may initially require more resources

Vaccination may require a marked and immediate increase in resources, especially human resources, but it may reduce the long-term disease control resource requirement. The other major resource requirement may be the supply of the vaccine to be used, especially if a country has not included vaccination in its contingency plans. There may be a premium charged by a vaccine manufacturer to supply a certain number of vaccine doses, beyond the usual production runs, or there may be a delay in the supply chain for the requested number of vaccine doses.

## Risk of vaccination teams transmitting disease

If there are breakdowns in personal biosecurity during the vaccination programme, disease can be spread by fomites or members of the team. In the face of an EAD outbreak, the vaccination team operating in or near infected areas may unknowingly come into contact with subclinically infected animals and then transmit the infection.

## Difficulties with handling vaccines

Many vaccines have specific handling requirements, such as maintenance of a cold chain, to ensure the efficacy of the vaccine. Live vaccines are sensitive to environmental temperature, both excessive heat and freezing conditions. Many inactivated vaccines are also sensitive to temperature change. The provision of cold chain facilities may present difficulties in remote areas.

## Difficulties with follow-up surveillance when the disease has been brought under control

Many vaccines do not permit differentiation of vaccinated from infected animals using standard serological tests. This may compromise follow-up surveillance and the ability to declare country freedom even in the absence of clinical disease.

## Pressure from industry or government to eradicate disease rapidly

This pressure may lead to poor decision-making regarding the use of vaccine. Inappropriate use of vaccination may have severe consequences on both disease control and trade.

## International trade implications of using vaccine

While a good quality, highly efficacious vaccine may be available, there are still diseases for which the use of the vaccine has negative effects on international trade. It may be a valid concern that vaccinated animals or animal products from vaccinated animals cannot be distinguished from truly infected animals or products thereof.

## Consumer resistance to vaccinated products

There may be marketing concerns that vaccinated animals are not fit for human consumption, even though their animal products may be perfectly safe to consume when appropriate withholding periods are observed. Retailers may avoid sourcing products from vaccinated animals to reduce the risk of consumer reaction.

## Public health and occupational safety

Maladministration of a vaccine may represent an occupational health and safety risk to animal health workers, e.g. *Brucella abortus* RB51 strain vaccine is used in cattle, however accidental inoculation with this live, attenuated vaccine strain is a cause of illness in humans (3).

## Environmental issues

Although vaccines are unlikely to cause environmental problems, regulatory authorities take potential environmental issues into consideration when assessing applications to register veterinary vaccines. Vaccine waste, including needles and syringes, should also be considered an environmental problem, especially in the face of a large-scale outbreak. Genetically modified organisms may present an additional environmental risk.

 

### Caution

Care must be taken when vaccinating animals in the face of a disease outbreak, as commercially manufactured vaccines are formulated for use in healthy animals. In an outbreak, undetected disease and the extra stress of handling animals may be factors that contribute to suboptimal vaccine performance (14). EAD vaccines may need to be formulated using significantly higher antigen levels in order to elicit a rapid immune response and be protective against infection at an earlier stage than otherwise would be the case.

## Critical factors for deciding to use vaccine in an emergency animal disease situation

Some of the most important factors to consider before deciding on the applicability of vaccination in an EAD response are listed below.

### Rate of transmission of the disease

This will determine to a great extent whether vaccination is an appropriate response to the outbreak and which vaccination strategy should be implemented. For highly contagious diseases, the decision to vaccinate will need to be made rapidly to achieve the maximum benefit from the vaccination campaign.

### Differentiation between infected and vaccinated animals

Consideration should be given to the potential for vaccination to mask clinical disease or create carrier animals and the ability to differentiate between infected and vaccinated animals (18).

### Performance of vaccine in the field

The issues that must be considered include safety and efficacy, regulatory approval and ability to stimulate an appropriate immune response within the targeted population. During an EAD, there may be a need to use a vaccine that has not been field-tested and where data have only been collected on animals under laboratory conditions.

### Population density

The density of livestock is a major consideration when using vaccines, especially with highly infectious diseases (1). Vaccination in high-density populations can reduce disease spread, allowing time for other control measures to be implemented, and can protect high-value enterprises. Population density is a relevant consideration on many levels, from farm to region to state, and even at a national level.

### Availability of appropriate vaccine

Reasons for unavailability of an appropriate vaccine include failure of available vaccines to meet the regulatory standards for that country, lack of a master seed formulated for a particular outbreak strain and total unavailability of a vaccine for that disease-causing organism. Regulatory approval is dependent upon good manufacturing practice and adequate safety and efficacy data. Appropriate distribution systems are required, often including the ability to maintain a cold chain. Contingency planning should include consideration of the establishment and maintenance of vaccine or antigen banks, either in the country or with a reputable overseas supplier, ready for an EAD response.

### Trade requirements

The standards of the World Organisation for Animal Health (OIE: Office International des Épizooties) will govern to a great extent the use of vaccine for particular diseases, especially in exporting countries. For example, FMD freedom can be pronounced with or without vaccination (13). When vaccination is used to control FMD and vaccinates are not slaughtered, there are more rigorous requirements for proof of freedom and international recognition may be delayed. Trading partners may place more stringent restrictions on imports of animals and animal products than required by OIE standards. This may act as a disincentive to vaccinate.

### High-value animals and rare or endangered species

Vaccine use may be considered when populations of rare or very valuable animals are faced with potential infection. Even if vaccines are not employed in livestock in an EAD response, they may be used for certain categories of animals, especially if these animals are kept isolated or under quarantine conditions. The most obvious example is zoo animals that are of high value because of their rarity. Domestic animals may also be considered as high value if they are genetically important or belong to a rare breed. Contingency planning should include consideration of vaccination of these animals and the conditions to apply.

### Public health

Vaccination can provide a very effective tool for protecting public health where the EAD is a potential zoonotic disease. Rabies vaccine is an obvious case where vaccination of domestic and wild animals that exist in close quarters with humans is a recognised tool for the control of this disease. There are particular difficulties associated with vaccinating wildlife, not the least being accessing the target population.

### Resource implications

Other disease control measures, such as stamping out, are very resource intensive. Vaccination may be considered as a more effective use of available resources. Conversely, vaccination when faced with an EAD may be resource intensive due to the need for appropriate biosecurity measures, animal identification and subsequent monitoring of vaccinates.

### Costs involved with vaccination and proof of freedom

Costs are not limited to implementation of the vaccination programme but must also include the cost and time for follow-up surveillance activities, as dictated by international animal health standards. A cost/benefit analysis therefore needs to be undertaken when considering vaccination.

### Food security

Vaccine may assist or be detrimental to the ability of a country to guarantee food supply. In countries where animal protein is in limited supply, vaccination may offer animal health decision-makers an option for safely distributing animal products sourced from at-risk susceptible animals. Food safety issues, whether real or perceived, must be taken into consideration in the decision to vaccinate.

### Exit strategy

If a decision is made to vaccinate, then an exit strategy which includes timing and the conditions to apply, needs to be considered.

## Conclusion

Vaccination is a valuable strategy in the control of EADs. When used in isolation, it is unlikely to eradicate an EAD but is best used in combination with strategies such as quarantine of infected properties, appropriate biosecurity and movement controls. However, many factors need to be taken into consideration before implementation of a vaccination programme. Consideration of these factors will ideally occur during contingency planning prior to an EAD outbreak.

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