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## Management of Exotic Disease Outbreaks : Learning by Example

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The expansion of international trade brought about by the perception that freer trade will generally improve the world economy, and the emergence of international terrorism as a credible economic threat, have together increased the awareness of the vulnerability of agriculture to the consequences of the introduction of an exotic disease. The accidental introduction of foot-and-mouth disease (FMD) into the United Kingdom in 2001 showed what could happen to an intensive livestock industry in which the FMD virus had spread undetected for over three weeks before a control program was put in place. As far as is known, this was a single introduction, but the total cost of the outbreak was \$20 billion; however, what would have been the result of intentional release of FMD virus at 20 sites across the country ?

This paper summarizes some of the major exotic disease outbreaks that have occurred predominantly in Europe and North America during the last eight years, and describes some of the details of the natural history of the causal organism. Fundamental to any attempt to control an outbreak is an understanding of how the disease survives; by knowing the rules which constrain its transmission and persistence in an environment, it is possible to develop a rational control program. Although this meeting concentrates on cattle disease, value can be derived by consideration of strategies employed to eradicate other highly infectious diseases of animals. When, in the case of avian influenza, the disease is also potentially zoonotic, there is an additional urgency to bring it under control. The reader is referred to the proceedings of the 2002 World Buiatrics Congress for details of FMD and the other exotic diseases of cattle (Kitching, 2002).

### Foot-and-Mouth Disease

During the 2001 outbreak on mainland Great Britain, 4 million FMD susceptible animals on 10,157 premises were slaughtered, made up of 2026 premises reported as infected, 4762 premises which were considered dangerous contacts to infected premises and 3369 premises contiguous to infected premises. A further 2.5 million animals were slaughtered for reasons relating to welfare. The origin of the outbreak was most likely to have been untreated waste food fed to pigs, but the disease was not reported by the farmer, and it remained unrecognized for almost a month, by which time it spread extensively in the sheep population. In the Netherlands, to where the FMD spread from UK through France, 60,000 predominantly cattle were slaughtered, together with a further 200,000 cattle sheep, goats and pigs that had been vaccinated against FMD to help prevent further spread. The vaccinated animals were slaughtered to allow the Netherlands to quickly re-establish its international trading status.

Control of outbreaks of FMD within Europe is by slaughter of all infected and susceptible in-contact animals, movement controls and disinfection. The use of vaccine was always retained as an option if the slaughter policy was not proving effective. However, if vaccine was used, it was anticipated that the vaccinated animals would be slaughtered, in order to quickly re-establish intra-Community and international trade. During the outbreaks of 2001 vaccine was used in The Netherlands to surround the infected focus with protected animals, and these were then slaughtered. In the UK, vaccination was considered, but because of the extent of the spread was rejected as being logistically not practical. There was also some concern that the public would not want milk from vaccinated animals, and the farmers themselves expressed the view that if their animals were going to be slaughtered because they were vaccinated, they would prefer not wait for their compensation payments, but have their animals slaughtered immediately. Since the outbreak, and the recognition of the number of animals killed in the control program, it is no longer considered politically acceptable to adopt a similar policy in any future outbreak (even though it could be argued that a far greater number of animals were slaughtered in the UK than was actually necessary). The politicians have made it clear that vaccination would be used, and it is up to the scientists to resolve the problem of carriers, and their effect on trade.

### **Avian Influenza**

Avian influenza (AI) is an orthomyxovirus infection of wild and domestic birds characterised by oedema of the head, diarrhoea, reduced egg production, respiratory signs and death within 48 hours. However, there are many strains of AI virus, all of which belong to type A influenza, but which may be identified by different combinations of the haemagglutinin and neuraminidase surface antigens. Traditionally strains containing H7 were considered virulent, causing fowl plague, but virulence has also been associated with other H antigens, in particular H5, and some strains containing H7 are of low pathogenicity. Strains of AI virus may be pathogenic in one species of bird, but not in others. 20 % of wild migratory ducks in North America are asymptotically infected with strains of AI virus, but some of these are highly pathogenic when transmitted to domestic poultry. Pathogenicity of AI virus strains is defined by testing in laboratory chickens or by nucleotide sequencing. Strains of AI virus may also infect other domestic animals such as pigs and horses and also humans.

### ***Distribution***

Because of their association with migratory birds, AI virus strains are distributed worldwide, but may only occasionally appear in domestic poultry. In 1997, an H5N1 strain appeared in Hong Kong and spread to humans, infecting 18 and killing 6, and resulted in the almost total depopulation of poultry in the Territory. Since then, genomic variants with the H5N1 antigens have re-appeared on regular occasions, resulting in further slaughter of affected poultry and the introduction of vaccination, and two further human cases and one death. During 2003, the presence of a low pathogenic H7N2 strain was detected in Connecticut, USA, similar to a strain previously detected in the live poultry markets in New York. Almost 3 million poultry were quarantined and vaccinated.

An outbreak of highly pathogenic AI due to a H7N7 strain affected poultry flocks in the Netherlands, Belgium and Germany during 2003, and also spread to humans. In the

Netherlands almost 30 million chickens on 255 premises were slaughtered, in Belgium 3 million poultry on 8 premises were culled, and in Germany there was a single outbreak. The origin was thought to be a Dutch farm with free ranging poultry, close to water where wild ducks were common. Although the birds on the farm were sero-positive for a low pathogenic strain of AI, high pathogenic H7N7 had previously been isolated from the migratory ducks and waterfowl. H7N1 and H7N3 strains had also been found in chicken and turkey flocks in Italy during the previous four years.

### ***Transmission***

Transmission of AI virus between wild and domestic birds is often through shared and contaminated drinking water. There are large quantities of virus in the faeces and respiratory exudates and in eggs produced during early infection - although the embryos will usually die. Spread between poultry premises is commonly by contaminated fomites, litter and vehicles, and on the clothing and hands of people, although with the Dutch strain, probably also by infected individuals. Pigs have been infected with some strains, and may provide an environment for a more human specific mutation. Experiments to infect pigs with the Dutch strain were successful, although the virus failed to transmit between pigs, or maintain itself in pigs without frequent re-introductions from poultry. The ability of one strain of virus to recombine with another within a single host, as could have occurred during the Hong Kong and Dutch outbreaks if one of the infected people had already been infected with a human influenza strain, raised the possibility on each occasion of a new strain with the virulence of the poultry strain and the ability to easily transmit between humans, leading to a world wide pandemic.

What particularly characterised the Dutch outbreak strain was the apparent ease with which it spread directly to humans. Although the Hong Kong outbreak of 1997 had shown that avian strains could directly affect humans, there had been no human to human transmission, and opinion was that the virus would first have to adapt to transmission between humans by passage in pigs, whose cells shared receptor characteristics with both humans and birds. However, in the Netherlands there were 83 confirmed cases of human H7N7. 79 of these showed conjunctivitis, and 13 mild influenza like illness, and there was one death. Three family members of two poultry workers developed respiratory disease, suggesting that with this strain, human to human transmission was in fact possible. Extreme precautions were taken to reduce the infection of people involved in the depopulation, including vaccination, administration of viricidal drugs, face masks and goggles.

### **Newcastle Disease**

Velogenic Newcastle disease (ND) is a Type 1 avian paramyxovirus infection of poultry characterised by neurologic signs, oedema of the head, respiratory distress, loss of egg production, diarrhoea and high mortality in affected flocks. Wild species of birds are also infected but many fail to show clinical signs, and psittacine species and some other wild species can develop persistent infection. Severe disease has been seen in cormorants and fancy pigeons.

### ***Distribution***

The presence of velogenic strains of ND in wild and pet birds potentially allows the virus a worldwide distribution, although only when the virus becomes established in the domestic poultry population is it considered a problem. On the 1<sup>st</sup> October 2002, an exotic strain of ND virus was confirmed in the state of California, USA. It was originally identified in the backyard flocks from which were derived fighting cocks, but because the practice of cock fighting was illegal in California, it became very difficult to trace infection between flocks. The disease spread to Arizona and Nevada, and during the eradication programme, which took approximately eight months, almost 19000 premises were quarantined, 931, including 17 commercial flocks were confirmed positive, and 3.5 million birds were slaughtered. Sequence analysis of the strain indicated it was identical to a strain present in Mexico. A single outbreak also occurred in a backyard flock in Texas, but the sequence of the virus causing the outbreak was different from the California strain, indicating a second introduction.

### ***Transmission***

Introduction of ND virus into a commercial premise is usually by contaminated fomites such as egg trays, vehicles or people, although inadvertent contact with wild birds can be responsible. The legal or illegal movement of persistently and subclinically infected psittacine birds from South America has been a frequent cause of its introduction into Europe and North America, although the movement of fighting cocks into USA from Mexico was probably the cause of the California and Texas outbreaks.

### **Classical Swine Fever (Hog Cholera)**

Classical swine fever (CSF) is a highly contagious virus disease of pigs caused by a strain of pestivirus, closely related to bovine virus diarrhoea virus and border disease virus of sheep. Some strains can spread between species and cause disease. CSF can be acute, characterised by high fever, depression, multiple internal and superficial haemorrhages and death, subacute or chronic, characterised by general poor health, susceptibility to other infections and low mortality. The virus can cross the placenta and cause persistent infection without an antibody response.

### ***Distribution***

CSF has been eradicated in Australia, USA and Canada, but is present in European wild pig populations, particularly in Germany, Italy and Sardinia, from where it occasionally spreads into the domestic pigs. In 1997/98 it caused an outbreak in the Netherlands in which over 10 million pigs were slaughtered to bring it under control and eradicate the virus. In 2000 it spread into the UK for the first time since 1986. 16 herds became infected, on which 41,500 were slaughtered, and a further 31,900 pigs were slaughtered on 40 contiguous farms. The initial outbreak was missed because the disease was not acute, and clinically resembled porcine dermatitis and nephropathy syndrome which was also known to be on the farm (Paton, 2002).

Strains of CSF virus can be divided into three groups and several subgroups by comparing an approximately 190 nucleotide sequence from the E2 region of the genome. The UK outbreak was caused by a strain within the 2.1 subgroup, which is not present in Europe, but found in south east Asia.

### ***Transmission***

CSF is transmitted between infected and susceptible pigs, particularly by persistently infected animals. However, meat and other products from infected animals can contain large amounts of virus, and excretions can contaminate fomites and food material which might later be fed to pigs. The two outbreaks of CSF in the UK prior to 2000, in 1971 and 1986 had been caused by feeding untreated waste food to pigs - similar to the cause of the 2001 FMD outbreak - but it was not clear how the 2000 outbreak had started. The first pigs affected were being kept outdoors, a practice becoming more common in the UK as animal welfare lobbies become more influential, and it was speculated that a passer by had thrown infected meat, perhaps present in a sandwich, into the field in which the pigs were kept. A second possibility was the spraying of virus contaminated water onto nearby fields from a neighbouring abattoir. Although the disease had been present within the UK from mid June, it was not detected until early August. The strain caused only mild disease in the adult sows which were first infected, and it did not appear clinically obvious until it had spread to weaned pigs on a grow out operation linked to the same company. In all, the pig company controlled about 140 farms, and the outbreak was predominantly confined to within this organization, although there was some spread to neighbouring farms. In view of the highly infectious nature of CSF virus, and that it had remained undetected for almost 3 months, it was fortunate that the structure of pig farming within the UK had kept it restricted in its distribution.

### **Conclusion**

The usual reaction to an outbreak of an exotic disease is to slaughter all affected and in-contact susceptible animals. But unless control is achieved within a relatively short time, public reaction, depending on the species involved can start to transform into political pressure to use an alternative strategy. This might also manifest itself in the form of scientists from other disciplines wanting a piece of the action as it was evident during the 2001 FMD outbreak in the UK, when the politically well connected modelling groups took over the control policy. Although large scale slaughter appears morally indefensible, when controlling highly infectious animal disease it may be the most efficient method in the long term. However, if alternative, as effective methods of control are available they should be employed, and historical dogma should not stand in the way. But if suitable alternatives are not available, then strenuous efforts to develop them must be a priority for any national research program, as it is clear that no country can rely on remaining free of exotic disease.

### **Abstract**

No country can afford to be complacent about the threat of exotic disease threatening the stability of its livestock industry. Increased global trade and the potential for bio-terrorist attack has exposed countries which previously have never experienced major epizootics to the spectre of funeral pyres and mass graves. It is essential to up-date contingency plans to respond to outbreaks of unlikely pathogens, and if control strategies, such as mass slaughter, are not acceptable to the public, alternatives must be developed which are as effective in eliminating the disease.

### **Résumé**

Aucun pays ne peut se permettre de relâcher sa vigilance en ce qui concerne les maladies exotiques qui menacent la stabilité du secteur de l'élevage. En raison de l'intensification du

commerce mondial et de la possibilité d'attaques bioterroristes, des pays qui n'avaient jamais connu auparavant d'épizooties graves doivent envisager le spectre des bûchers et des charniers. Il est essentiel de mettre à jour les plans d'urgence pour pouvoir intervenir en cas de détection d'agents pathogènes inattendus, et, si le public n'est pas prêt à accepter des mesures de lutte comme l'abattage en masse, de trouver des mesures de substitution pour éliminer la maladie.

## References

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