

AVIAN INFLUENZA IN SMALLHOLDER CHICKEN FLOCKS

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Avian influenza virus occurs in a number of forms, some of which produce severe disease in chickens and turkeys. A recent outbreak in Asia is caused by a type of the virus that also affects other birds and humans. This virus has become endemic in some countries and smallholder chickens and ducks may be hiding the virus and spreading it to commercial poultry and humans. With cases reported in a number of Asian countries there is a risk that it may spread to other regions. A major danger for smallholder farmers is that low pathogenic forms may spread unnoticed and then mutate to highly pathogenic forms causing serious disease. Many cases of the disease have occurred in smallholder units in Asia and could well be a problem in other countries as it spreads.

The tools used to prevent and control avian influenza are:

- Education - Awareness raising and disease recognition.
- Biosecurity - Isolation from infected and recovered poultry; wild birds; live poultry markets; fomites (especially manure).
- Early recognition - Monitoring and diagnosis.
- Unofficial measures - Voluntary quarantine.
- Official measures - Diagnosis and stamping out (quarantine, slaughter, disposal and clean-up)
- Vaccination - Inactivated, recombinant, molecular and sub-unit vaccines.

The significance of these approaches for smallholder farmers is discussed

INTRODUCTION

Avian influenza (AI) is caused by the avian influenza virus (AIV). This virus has long been known as the cause of severe disease (formerly called fowl plague) in chickens and turkeys. The virus also infects other domestic and wild birds, usually without producing symptoms. Wild birds, particularly waterfowl, including ducks, may become infected and carry the virus. (Gilchrist 2005). The virus is usually considered to be non-pathogenic to ducks (Selleck *et al* 1994). The most commonly infected free-flying wild birds are waterbirds (ducks and geese) and waders. The recent outbreak in Asia has also caused disease and deaths in ducks, free-flying wild birds and humans (Li *et al* 2004) and a severe outbreak has been identified in migratory waterfowl in western China (Liu *et al* 2005).

Avian influenza viruses isolated from chickens vary in pathogenicity and have, in the past, been grouped into mild pathogenicity (MPAI) and highly pathogenic (HPAI) types (Swayne and Halvorson 2003). More recently, however, the practice has been to

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describe all viruses that are not HPAI as low pathogenicity (LPAI) viruses (Alexander 2003).

The history of disease and its control are well summarised in a review article by OIE (Swayne and Suarez 2000). The Asian outbreak is described by a more recent article (Anon. 2004).

The avian influenza viruses are classified into H and N groups based on their surface antigen structure with haemagglutinin (H) and neuraminidase (N) being the defining components of the groups. There are 15 H groups and 9 N groups. Most combinations of these groups have been found in domestic and wild birds, but only H5 and H7 types have been found in cases of severe avian disease. All the other H types (H1-4, H6 and H8-15) are of low pathogenicity for birds.

Within the H5 and H7 groups most isolates are of low pathogenicity but adaptation to chickens can lead to mutation from low to high leading to some concern that spread of mild forms may be relevant to eradication methods (Alexander 2003). In addition mutation to a form infective to humans has occurred in the H5 type in Asia where H5N1 is the cause of the Asian influenza outbreak. This virus has become endemic in some countries and smallholder chickens and ducks may be hiding the virus and spreading it to commercial poultry and humans.

There is a particular danger of genetic change in AI viruses from passage through pigs. If pigs are kept in close contact with infected poultry the virus may infect pigs and undergo recombination with AI viruses in the pigs. The chance of such viruses being a cause of serious disease in humans is increased (Horimoto and Kawaoka 2001).

Low pathogenicity viruses occur in wild birds (Mackenzie 1988; Easterday *et al* 1997) and are maintained in wild aquatic bird reservoirs, occasionally crossing over to domestic poultry and causing outbreaks of mild disease (Halvorson 2002). High pathogenicity viruses do not have a recognised wild bird reservoir, but can occasionally be isolated from wild birds during outbreaks in domestic poultry.

Prevention of exposure to the virus and eradication are the accepted methods for dealing with HPAI viruses. Control programs that allow a low incidence of infection are not an acceptable method for managing outbreaks of severe disease but have been used during some outbreaks of mild disease. Vaccination has been used in control and eradication programs for some LPAI viruses (Swayne and Suarez 2000).

The H5N1 Asian avian influenza outbreak appears to have different characteristics from earlier outbreaks and has involved some wild and domesticated waterbirds (Li *et al* 2004)

A global strategy has been developed by FAO/OIE/WHO (Anon. 2005a). This strategy includes recognition of the exposure of smallholder farmers to the ravages of the disease and their lack of resources to counter it. The strategy will include:

- Improving animal health services at village level by means of organising community-based early warning networks, utilising the existing pool of para-veterinary village workers.
- Increasing farmers' general awareness through simple biosecurity guidelines on avian influenza control using publications in local language.
- Providing access to credit or microfinance as a tool for rehabilitation as an alternative to direct compensation, which some countries may not be able to afford.
- Developing farmers' groups and/or associations to help improve awareness and dissemination of information.

The involvement of private sector organisations in assisting smallholders should not be overlooked as the control of the disease in smallholder situations may be essential to protection of commercial poultry organisations.

Large populations of birds make a big target for viruses. Small farms offer a lesser target but can still become infected. Small farms may hide the virus between outbreaks or spread it between commercial farms during an outbreak. Live-bird markets, semi-feral poultry and fighting cocks may all be involved in virus spread. Placing susceptible birds in contact with other birds, that may be infected, and then returning them to the home unit increases the risk of infection being introduced. Many countries with smallholder chicken flocks held in villages have become, in effect, covered by a thin carpet of semi-feral village chickens

Fighting cocks are of particular concern in causing human infection because of the intimate level of contact that may occur between humans and these valuable birds. There are anecdotal accounts of fighting cocks, appearing to be injured in a fight, being treated by the owner sucking on the bird's nasal passages to remove sinus secretions. If such a bird were infected with HPAI it is obvious that the risk of human infection is high.

The prevention and control of avian influenza can be achieved by the following methods.

- Education - Awareness raising and disease recognition.
- Biosecurity - Isolation from infected and recovered poultry; wild birds; live poultry markets; fomites (especially manure).
- Early recognition - Monitoring and diagnosis.
- Unofficial measures - Voluntary quarantine.
- Official measures - Diagnosis and stamping out (quarantine, slaughter, disposal and clean up).
- Vaccination - Inactivated, recombinant, molecular and sub-unit vaccines.

These methods are discussed separately in the following sections.

EDUCATION - Awareness raising and disease recognition.

Avian influenza has been a rare occurrence until the recent Asian epidemic and may not be either recognised or considered important in many countries. Awareness raising and disease recognition may be issues in such areas. The severity of symptoms

may vary and the implications for the owner of affected or even merely exposed birds are serious and many producers may be fearful of the consequences of admitting that the disease may have occurred. Attempts at hiding the disease may facilitate its spread.

Education strategies should include awareness raising through mass media, school and community programs (in youth and women's organisations) and involving local technical people in surveillance and training activities.

Educational strategies are discussed by OIE/FAO/WHO (Anon. 2005b).

BIOSECURITY - Isolation from infected and recovered poultry; wild birds; live poultry markets; fomites (especially manure).

Poultry farming systems may be classified into four levels of biosecurity along the lines of the sectors proposed by FAO (Anon. 2004).

Sector 1. High biosecurity industrial integrated systems.

Sector 2. Moderate to high biosecurity commercial systems.

Sector 3. Low to minimal biosecurity commercial systems.

Sector 4. Minimal biosecurity village or backyard systems.

It is the fourth sector type that is the subject of this paper. The relevance of the comparison between these systems is to emphasise the high level of exposure to the virus that may occur in smallholder poultry systems. The impact of an incursion of the virus on Sector 1 or 2 may be much worse because of the high number of birds involved and because the opportunity for a large number of virus multiplications in a short time is much higher. This high number of rapid multiplications favours the development of genetic change including the possible change from low to high pathogenicity.

While smallholder chicken farming operations have lower numbers of susceptible birds exposed to the virus they still offer an opportunity for LPAI viruses to mutate to HPAI forms by passage through chickens. This is especially a concern because LPAI forms may not cause sufficient disease signs to allow them to be recognised.

The smallholder operations may be physically more exposed to domestic or wild birds carrying the virus. Spread to or from neighbouring smallholder units may occur easily.

They also are more likely to be associated with live bird markets where newly bought or unsold birds that have been exposed to the virus are taken home to an operation where susceptible birds are present. The lower number of birds involved however imposes a limit on the number of multiplications that may occur thus reducing the chance of genetic change occurring leading to further spread of LPAI.

Equipment used for transporting eggs or birds to or from the market may also be contaminated on return to the unit. People moving between infected and susceptible birds are also possible carriers of virus.

EARLY RECOGNITION - Monitoring and diagnosis.

If official eradication procedures are applied as a result of an outbreak in commercial poultry it is likely that birds on smallholder farms may also be killed off to stop virus spread. The cost of such slaughter may be very serious for a smallholder farmer.

The H5 type may spread from poultry to humans so it is important for all poultry farmers to avoid close contact with infected birds. If the virus becomes established in people there is a very real danger that it could adapt and become a serious human disease.

Signs of disease vary a lot and are not typical of the disease. The clinical and autopsy signs of the disease vary with the pathogenicity of the virus, the species affected, sex, age, concurrent infections, acquired immunity and environmental factors. LPAI causes a low mortality rate but clinical signs may be common. They may cause depression, loss of production; oedema, necrosis and haemorrhage of the comb and wattles and respiratory signs including pneumonia, rales, coughing and sneezing.

In chickens and turkeys HPAI may cause sudden death with no clinical signs. Less severely affected birds may show nervous signs with tremors of the head and neck, weakness or unusual positioning of the head, wings and legs. There may also be some lesions of the comb and wattles. Birds may be depressed, quiet, and stop laying.

Diagnosis can only be confirmed by laboratory tests including antibody, antigen or virus detection. In such a critical disease it is important to have diagnostic facilities available in advance. Recognition of the earliest cases is most important if there is to be any hope of successful eradication. As early cases may be caused by LPAI the significance of diagnostic facilities becomes even more important. Monitoring by sampling flocks over a wide area is important in establishing a baseline of information to allow evaluation of isolations made in a suspected outbreak.

Differential diagnosis may be important. A number of other diseases may show signs that can be confused with AI. Fowl cholera and Newcastle disease are prominent among these. Other causes of respiratory signs with or without sudden death must also be considered including laryngotracheitis, coryza and mycoplasmosis. Diseases such as infectious bursal disease or coccidiosis may cause sudden deaths in young birds and if some respiratory disease is also present there may be confusion.

The OIE has developed a Manual of diagnostic tests and vaccines for terrestrial animals (Anon. 2005d).

UNOFFICIAL MEASURES - Voluntary quarantine.

The risk for individual smallholders is that the identification of the disease in their flock may lead to loss of face in the community or to slaughter of their poultry by authorities. With H5N1 HPAI there is the additional danger of human infection to consider. Covering up the infection adds to the likelihood of spread to humans.

To protect susceptible birds smallholders may benefit from the voluntary imposition of quarantine with complete restriction of the entry of virus from outside the area. There is some point in improving the isolation of their flock by preventing movement of live birds, people, equipment and poultry products into the area.

Once an outbreak occurs in a smallholder flock or area it seems unlikely for eradication to be successful without the persuasive effect of incentives and disincentives at an official level. An exceptionally altruistic and well-educated community of smallholders would be needed to expect successful eradication. Smallholder operations normally depend upon the movement of live birds, people, equipment and poultry products. A complete standstill is unlikely to be effective. The spread of disease is unlikely to be controlled unless an all-in, all-out, system including a single age of birds in all units in a neighbourhood is applied.

If compensation is not provided there is a strong incentive to dispose of affected birds as profitably as possible. In many cases rapid sale of suspect birds would appear attractive and thus further spread of virus could occur. The downside of a compensation scheme is that some producers are encouraged to spread the disease to their flock in order to get access to funds that may not otherwise be available during an outbreak.

Unofficial measures to control an outbreak are likely to be counterproductive. Vaccination is probably the only thing a smallholder can do. The risk of using unauthorised vaccines must be understood and discouraged.

Pigs that are housed with poultry are a particular danger as recombination of AI viruses from poultry and pigs is likely to result in the emergence of a human pathogen. Smallholders could well improve reduce their exposure to such a virus by separating pig and poultry production and limiting access of smallholder poultry to wild birds (Horimoto and Kawaoka 2001).

Biosecurity can be improved for a smallholder farmer by housing chickens in small flocks in bird-proofed colony cages with a raised floor. There should be no scavenging (semi-feral) poultry having access to the area in the vicinity of the cage. This type of housing has the added advantage of controlling other endemic diseases and thus improving productivity of the flock. Further improvement in biosecurity is made possible by purchasing started chickens (16 weeks of age) from a reliable disease-free source, and keeping them in a single age-group and replacing all of them at the end of their productive life with a new group.

The establishment of an industry sector based on the application of such biosecurity principles and other appropriate technology practices is a feasible way of improving poultry productivity. Improved housing, nutrition, biosecurity (isolation, clean drinking water etc.) and disease control (such as Newcastle disease vaccination) are the basis of another paper by this author at this conference.

OFFICIAL MEASURES - Diagnosis and stamping out (quarantine, slaughter, disposal and clean-up)

In most cases of an initial incursion of HPAI into an area that has been free of the virus the authorities will respond by attempting to stamp it out. This involves having an agreed eradication plan including a legal basis for action, penalties and compensation. The plan should have been subjected to simulation exercises in advance to ensure that all participant are aware of, and equipped for carrying out, their

responsibilities. The FAO has developed a Good Emergency Management Practices Code for disease emergencies (Anon. 2005c).

The campaign should recognise that live infected birds are the major source of infection. Dead birds and contaminated people, equipment and faeces are also a risk but at a much lower level of likelihood. This means that containing and killing live affected birds is the first priority.

The critical elements of an eradication campaign are:

- Identification. Confirming that the condition is HPAI.
- Quarantine. A quarantine area is declared around the outbreak area.
- Standstill. All movement of poultry, people, equipment and poultry products from the area will be stopped.
- Slaughter. Affected or close contact birds should be humanely killed.
- Carcass disposal. Sanitary disposal of carcasses by burning or burying.
- Clean up. Removal of faeces and litter, cleaning and disinfection of premises and equipment.
- Compensation. Provision of compensation is essential to encourage compliance.
- Other costs. Social and economic cost of an outbreak must be considered.
- Human safety. Protection of smallholders and control personnel from infection.
- Investigation. Diagnostic and monitoring activities.

Wild birds may be infected with virus in an outbreak but it is uncertain if they are the source of infection or have become infected by contact with affected poultry. Attempts to prevent or control an outbreak by slaughter of wild birds appear to be unwarranted in the light of current knowledge. In any case the difficulty of eliminating all members of a wild bird population is likely to be impossible. Some protection can be obtained by providing added biosecurity measures such as bird proofing poultry housing and ensuring that drinking water is clean or adequately sanitised.

VACCINATION - Inactivated, recombinant, molecular and sub-unit vaccines.

Vaccines must be manufactured according to the international manufacturing and quality control standards referred to in the *OIE Manual of Standards for diagnostic Tests and Vaccines* (Anon. 2005d).

Stamping out remains the preferred means of control of HPAI but vaccines may be useful in control of the disease. There are three possible strategies for vaccine use:

- Vaccination in response to an outbreak.
- Vaccination in response to a “trigger” such as an outbreak in wild waterfowl.
- Preventive vaccination of all or part of a population of poultry when the likelihood and/or the consequences of an incursion is high.

A vaccine must be developed specifically for the type of virus involved in a particular outbreak. Use of vaccines to control the disease is contentious. Some experts feel that vaccinating hides the disease and hinders eradication. Others feel that vaccination

reduces the level of excretion of virus particles and thus enables farmers to continue production while other control measures are adopted.

Most use of vaccines in Europe and North America has been to control LPAI viruses and may not be applicable to HPAI. Vaccines have been used successfully, in combination with other measures, to control H5N1 HPAI viruses in Hong Kong.

A number of effective commercial vaccines are available. They provide protection against clinical disease and reduce mortality and the effects of disease on production. Most birds in a flock are also protected from infection. Those birds that remain unprotected may still shed virus but shedding is reduced, both in duration and quantity, resulting in reduced amounts of virus being shed into the environment. This reduces the chance of both birds and humans from becoming infected.

Most current vaccines are inactivated whole virus antigen in oil based emulsion adjuvant. A live recombinant fowlpox with H5 AI gene insert has been used in some countries.

A list of vaccines is available on the internet (Elkin 2005).

Vaccinated birds contain antibody and thus may not be accepted for international trade in live birds or poultry products as they cannot be easily differentiated from recovered (and possibly infected) birds.

Vaccines against H5 virus must contain the H5 antigen but may contain the same (N1) other N antigens. If different N antigens are used it may be possible to differentiate between recovered and vaccinated birds and products.

The disadvantage of inactivated vaccines is that efficacy is determined largely by the mass of antigen that can be administered parenterally. Catching and handling each bird is difficult and costly. Achieving a high antigen dose is also often a problem. Live virus can be administered by less difficult methods including orally in drinking water and by spray application. The live virus will multiply inside the bird and thus antigen mass is less important.

Several other vaccine types are being developed including adenovirus-vectored vaccines that can be administered in the drinking water and Newcastle disease vectored types that can be administered as a spray. Molecular and sub-unit vaccines are also being considered but are some way off being available.

Training of vaccination teams is most important to ensure efficacy, safety and the production of good records of vaccines used, birds vaccinated etc.

The use of vaccine may be considered in those cases where the likelihood of an incursion of HPAI is high, where there is a high poultry density and where improved biosecurity is not possible and control by stamping out is unlikely. Vaccination in such cases may minimise virus propagation, protect susceptible birds and reduce the risk to human health.

While the efficacy of vaccine against other poultry species is unknown it seems reasonable to vaccinate such birds held in contact with smallholder chickens when the latter are being vaccinated.

CONCLUSION

As the H5N1 virus is still spreading geographically and changing genetically it is important to follow its path by referring to the OIE website for current developments.

It is likely that control measures will change as experience with the disease develops. Stamping out will usually be applied in the event of an initial incursion of HPAI in a country or region but vaccination may be introduced as an added tool if the first response appears inadequate.

A country or region that is free of HPAI should review conditions for importation of fertile eggs, live poultry and poultry products and equipment in order to improve the biosecurity level.

The epidemic of H5N1 also has an important public health dimension, with the death to date of a number of people, giving rise to serious concern about the potential for emergence of a pandemic strain of human influenza virus through reassortment of avian and, potentially, pig influenza viruses.

It is now clear that H5 HPAI viruses are endemic in parts of Asia and that the existence of reservoirs of infection in ducks and, potentially, wild birds and pigs, presents a serious challenge to eradication.

These factors highlight the necessity for countries infected with or threatened by HPAI viruses to implement appropriate measures for prevention and control. It is equally important that FAO and international organizations continue to collaborate with donors and affected countries in identifying and implementing strategies for recovery and rehabilitation of countries affected by HPAI (Anon.2004).

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