Avian influenza biosecurity: a key for animal and human protection

Nikolas Charisis

Summary
Modern biosecurity methods have provided the best way of preventing the spread of a communicable disease since people realised that human and animal contact can transmit exotic diseases. The avian influenza virus is readily transmitted through animal vectors and inanimate matter and incurs heavy losses to the poultry industry. Biosecurity measures include the prevention of vaccination of flocks in an endemic area and the isolation of farms from the surrounding world (villages, other farms, fields, etc.). Veterinary services work in liaison with owners to implement national quarantine and vaccination measures for the benefit of farmers and the industry and for protection of public health.

Keywords
Animal, Avian influenza, Biosecurity, Control, Poultry, Public health, Zoonosis.

Biosicurezza e influenza aviare: una chiave per la tutela degli animali e dell’uomo

Riassunto
I moderni metodi di biosicurezza costituiscono la via migliore per prevenire la diffusione di una malattia trasmissibile da quando si è compreso che il contatto tra l’uomo e l’animale può essere fonte di trasmissione di malattie esotiche. Il virus dell’influenza aviaria si trasmette rapidamente attraverso animali vettori e materiali vari causando pesanti perdite all’industria avicola. Le misure di biosicurezza comprendono la prevenzione mediante vaccinazione e isolamento delle aziende dell’area circostante (centri abitati, altre aziende, campi). I servizi veterinari operano in collaborazione con i proprietari per mettere in atto la quarantena nazionale e le misure di vaccinazione a beneficio degli allevatori, dell’industria e della salute pubblica.

Parole chiave
Animale, Biosicurezza, Controllo, Influenza aviare, Sanità pubblica, Zoonosi.

Introduction
Avian influenza (AI), perhaps the most severe viral disease of the 21st century, has been proved to be of poultry origin. The disease is caused by the virus H5N1 (Fig. 1). In 1933, scientists discovered that AI viruses caused disease syndromes that ranged from mild to severe signs in domestic poultry; they also related the poultry influenza to human flu. Today we know that AI, or ‘bird flu’, is caused by type A strains of the influenza virus family Orthomyxoviridae. A total of 15 subtypes of influenza virus have been identified. All highly pathogenic outbreaks have been caused by influenza A viruses subtypes H5 and H7. Influenza strain H5N1 has been transmitted from poultry to humans. The first human victims of the AI virus were recorded in Hong Kong in 1997.

Wild bird intestinal viruses perhaps date back to long before Homo sapiens, the ancestor of modern humans, appeared on Earth. These intestinal viruses have developed over the
millennia of wild bird domestication, into human viruses that caused relatively severe symptoms in their new hosts. During their long-lasting adjustment and adaptation to a new environment, they changed their habits as they emigrated from the intestines of birds to human lungs. Today, human flu viruses, although cousins of the AI virus, are completely harmless to wild birds, as is the original AI virus of wild birds for humans. However, the AI virus in wild birds is highly contagious for poultry and threatens backyard and commercial producers. This virus occurs naturally in healthy wild birds, especially ducks, but it is readily transmitted to domestic birds, such as turkeys, ducks, geese and chickens. The disease is considered a threat to the poultry industry and therefore all affected domestic flocks should be culled immediately, by incineration or deep burial, so as to contain its spread. Although breeders are compensated for culling their birds with a basic amount of compensation, there is always reluctance, especially on behalf of the poor, backyard producers, who need to feed their families or trade the eggs for a small income or for other goods. Other than backyard production, targeted for family consumption, there are always large numbers of poultry movements across the countryside as well as in cities and towns where bird markets are held. This basic need for the livelihoods of many peoples can facilitate the spread of the disease from backyard to backyard, as well as all the way from the market to the farm. Consequently, the number of people involved in the spread of the disease increases tenfold when the virus escapes from a farm. Therefore, all people working with poultry should exercise caution when in contact with birds and with other people who work with poultry. Other modes of transmission of the disease from one infected flock to another are infected birds that have been newly introduced onto a farm, visitors, merchants, workers or even equipment. Infected birds secrete virus through nasal secretions and faeces. Therefore, moving infected birds would naturally result in transferring the virus to the new location. Workers spread viruses in contaminated clothing, equipment, vehicles, etc. The AI virus can survive in manure for long periods of time depending on weather conditions, so it could easily be spread from one farm to another on soiled boots or on trucks. When on a farm, the virus spreads by ‘common’ equipment that is contaminated with infective faeces or nasal secretions that is then used again on other parts of the farm or by workers who move from one section of the farm to another; it can also be spread by feed, feeders, trucks, etc.

**Biosecurity**

Biosecurity measures are used to prevent the introduction of a disease into a disease-free
premises or the escape of a disease from contaminated premises to the surrounding disease-free area. Therefore, depending on the circumstances, biosecurity might be defined as 'biocontainment' which is the containment of the virus within the infected unit, i.e. in a hospital, on a farm, etc. or as 'bioexclusion' which is the prevention of virus introduction into a disease-free unit (Fig. 2).

Aspects of biosecurity

(a) **Biocontainment** is the containment of virus inside the infected unit (hospital, farm etc.)

(b) **Bioexclusion** is the avoidance of the entrance of the virus into an influenza-free unit

Biosecurity concerns all stakeholders (flocks, hospitals, health care settings, laboratories, processing companies, slaughterhouses, veterinary services, consumers etc.)

Figure 2

**Biocontainment versus bioexclusion**

Similar historical activities can be compared with the ‘quarantine’ of ships in European ports (first conducted in Venice), during pandemics or during the displacement of ‘lepers’ from villages and cities during Antiquity and the Middle Ages.

In those early times, people recognised the sources of many hazards, but they were unable to identify and classify the pathogenic agents.

This document deals mainly with the exclusion of the H5N1 AI virus from poultry establishments. However, neutralising the virus, or eliminating it, is, in itself, a very difficult task which needs to be done by those who come into contact with birds, their litter, their carcasses, their by-products, equipment, feed, etc.

When an AI virus enters a province, the authorities should decide what should be done to contain it and prevent it from spreading among the local poultry farms (large or small, including backyard poultry flocks).

Poultry owners in an affected area should be advised by the authorities, depending on the circumstances, either to vaccinate or to cull their birds and disinfect all premises; this is always the most effective action that can be taken, but small producers, especially farmers of backyard flocks, often avoid culling flocks, especially when the disease is of the mild form and/or when compensation for the culled birds is minimal or inexistent.

Role of veterinary services in the event of an outbreak of avian influenza

The veterinary services are the principal authorities that are responsible for ensuring that transmissible diseases are kept out of countries. They devote specific efforts to the country’s ports of entry, such as the sea ports, land borders and airports. However, in regard to AI, things have become more complicated because the disease is usually transferred from one country to another by migratory birds; therefore rendering efforts at border and entry points inadequate (Fig. 3).

However, authorities across the globe should not relax or despair, irrespective of the difficulties encountered in combating AI. The fight against exotic diseases starts at the national airport where passengers should be clearly informed that the country of destination is infected by AI. A large poster might draw attention to the subject, ensuring that passengers are fully informed (Fig. 4). In this way, both the health of the passenger and the economy of the country are protected.

Having been provided with this kind of information, the traveller should necessarily be advised by a trained employee, just prior to entering the aircraft, of the simple rules that he or she should observe during the journey, such as: ‘don’t visit animal fairs or open poultry markets, don’t bring back poultry meat or eggs or meat and egg products or live animals, etc.’
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Figure 3
Measures to be taken by the authorities

Irrespective of the measures taken at airports for people visiting an AI-infected country, additional and very strict measures should be applied upon the return of these travellers from the infected country.

Figure 4
Sample poster for the information of the general public in ports, airports, bus and train stations

All travellers should be interviewed; their own health and that of their family should be stressed during this interview, during which the traveller should be given the opportunity to reveal any possible contact with poultry, without the fear of facing prosecution, punishment or quarantine measures, except where necessary.

A very detailed investigation should be performed of all suitcases and luggage to ensure no live animals or animal products have been introduced.

Veterinary services should always inspect large poultry farms to assess whether biosecurity measures are being correctly implemented and, in parallel, to educate small poultry raisers or backyard owners of the aspects of the disease.

Industrial and commercial farms have access to high levels of biosecurity whilst, on the contrary, small farmers or backyard producers do not.

Obviously, should an infectious agent enter a large poultry farm, the premises would be closed and the birds culled, otherwise the economy of a country could be seriously threatened by an outbreak of AI. However, if
the virus enters backyard chicken establishments in a peri-urban or urban area, with minimum or non-existent biosecurity, the impact on human health might be very severe. Furthermore, the local veterinary services should register all flocks in their area of jurisdiction and be ready to implement the necessary quarantine measures, such as sampling for tests, informing all stakeholders who are economically involved in the bird rearing business, closing poultry farms, culling flocks and inspecting contaminated premises to ensure they have been disinfected correctly. Such activities might lead to the loss of farming jobs and cause further economic disruptions in the affected area. On the other hand, the general population should be advised to follow the instructions given by the authorities and to avoid panic which may lead to the collapse of the poultry industry.

To implement a biosecurity programme, the strain of the virus and its potential source should be identified and access of the virus to all installations avoided. At the same time, stockholders should always follow good agricultural and good animal rearing practices, i.e. the implementation of hygienic measures to protect animal health, such as annual vaccination programmes for endemic diseases, control of pests and parasites, regular disinfection of premises and equipment and, in general, all measures suggested by the local veterinary services.

In the event of an outbreak of AI, even of the low pathogenic form, all necessary measures should be implemented to isolate premises from neighbouring farms; this requires strict quarantine measures that do not necessarily need to be applied and supervised by the authorities but, more importantly, by the owner. Good farming practices should be practised throughout the year, not only in the event of outbreaks; otherwise the enterprise could become vulnerable to all kinds of communicable diseases.

Sources/reservoir of avian influenza virus

Sources or reservoirs for AI viruses are the birds, their feed and contaminated water. Lakes crowded by wild birds can be infected with the virus and, if so, will transmit it to the next generation of birds or other aquatic animals.

Feed from contaminated pastures can carry the infectious agents to adjacent farms or can be transported over long distances to contaminate another area, region, prefecture or even an entire country. However, live bird markets have been demonstrated to be the most important mode of virus transmission (Fig. 5). Vectors can be living organisms or inanimate matter, which create pools of the virus. The virus is then disseminated in the environment by vectors. Vectors can be people and their clothes, shoes, cars, tools, cages, tyres, trucks, etc. Among the most significant vectors are insects and rodents and, to a lesser extent, domestic animals with the exception, perhaps, of pigs; however the role of pigs in the transmission of communicable diseases of such magnitude, such as AI, is still uncertain.

Avoid bringing unsold birds back to the farm from the market
If they have been contaminated at the market, they will contaminate your stock

Figure 5
Transporting birds from contaminated farms to markets can spread the virus to other farms, provinces and regions of a country
Vaccination of humans against avian influenza

Vaccination is the most important biosecurity measure against AI, in general, but presently there is no vaccine available against H5N1 virus; only seasonal human influenza vaccines are available; these confer protection lasting between four and six months and an immunity response ranging between 70% and 90% of healthy adults (Fig. 6).

Presently there is no vaccine available against avian flu virus. Only human seasonal influenza vaccines are available; these influenza vaccines can protect people for 4-6 months with an immunity response ranging between 70% and 90% of healthy adults.

Vaccination of birds against avian influenza

Vaccination against common influenza is recommended for groups at risk as summarised below (Fig. 7):

- residents of institutions for elderly people and the disabled
- elderly, non-institutionalised individuals with chronic heart or lung diseases, metabolic or renal disease, or immunodeficiencies
- all individuals over six months of age with any of the conditions listed above
- elderly individuals above a nationally defined age limit, irrespective of other risk factors

- other groups defined on the basis of national data and capacities, such as contacts of high-risk people (e.g. poultry farmers, veterinarians, laboratory workers), pregnant women, health care workers and others with key functions in society, as well as children aged between 6 and 23 months.

Vaccination against common influenza is suggested for the following groups:

- institutions for the elderly and disabled
- all individuals over six months of age with chronic heart or lung diseases, metabolic or renal disease, or immunodeficiencies
- elderly individuals above a nationally defined age limit, irrespective of other risk factors

Figure 7
Population groups recommended for vaccination against human influenza

Vaccination of birds against avian influenza

Good quality inactivated vaccines have proved to be effective in reducing mortality, or preventing the disease in domestic poultry. Some vaccinated birds may nonetheless become infected and spread the virus to unvaccinated birds. Therefore, if vaccination is necessary, it should include all birds in the same establishment and those in close proximity (Fig. 8).

Vaccines are produced only for the protection of well-known AI strains, because there is no cross-protection among the haemagglutinin (HA) subtypes (there are 15 HA subtypes).

A recombinant virus vaccine containing the gene that codes for the production of the H5 antigen is available and is being used in some countries. Poultry are vaccinated with vaccines from inactivated viruses which do not pose a risk to the other birds or humans.

Vaccination ensures that infected but asymptomatic birds do not enter the human food chain and therefore they do not present a public health risk.
Good inactivated vaccines can reduce mortality or prevent the disease but they should be used very carefully. Some vaccinated birds may be infected and spread the virus to unvaccinated birds. Therefore, if vaccination is necessary, it should be performed in all birds living in the same or adjacent establishments. Vaccination ensures that infected but asymptomatic birds do not enter the human food chain.

### Hygiene

The following are some of the activities that should and should not be followed by farmers of backyard flocks, industrial poultry workers, suppliers, supervisors and others.

The following measures are among those that should be taken:
- use easily cleaned, washed and disinfected equipment whenever possible
- clean, wash and disinfect equipment used in poultry buildings before leaving the farm
- change clothes immediately before and after working in poultry buildings (Fig. 9).

The following measures are among those that should be avoided:
- only enter poultry buildings when absolutely necessary and only with the permission of the manager
- only introduce materials and equipment that are absolutely necessary and do not introduce any that are not easily sanitised (lunch bags, invoices, spare clothing and other items) into poultry buildings

### Biosecurity defence line

A biosecurity defence line can be established between the premises and the virus, as follows:
- build poultry houses in such a way as to prevent the entry of rodents, flies and insects
- do not raise multiple species of animals together – e.g. never raise chickens and ducks together because ducks are silent carriers of the virus and can infect chickens
- do not raise pigs and poultry together because pigs are ‘mixing vessels’ and transmit the virus to humans
- place baits and traps for rodents in and outside the poultry houses, always away from feed and live animals
- control insects regularly
- construct buildings so that they are easily cleaned and can be effectively disinfected
- limit the entry of non-essential visitors
- provide all those involved in the day-to-day activities of the farm (service personnel, delivery personnel, utility personnel, veterinarians, state health personnel) with appropriate coveralls, boot covers, gloves and masks
- disinfect footbaths should be placed at the entrance to poultry sheds (Fig. 10)
- all vehicles should be disinfected before and immediately after leaving the premises; they should be parked as far away as possible from the farm buildings
- dirty garments should be left in designated ‘dirty areas’ for proper cleaning
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Figure 10
Use of footbaths at the entrance to poultry sheds to prevent disease spread

- farm visitors should always wear appropriate disposable clothing
- disinfect all new equipment that is introduced onto the premises
- do not borrow equipment from other farms
- a visitor log system is advisable so the manager knows where visitors come from; if a problem does arise, someone’s footsteps may be retraced to find the source of the disease
- anyone working on a poultry farm should avoid contact with wild birds, waterfowl, backyard flocks, game birds, ratites and live bird markets
- purchase replacements from disease-free stock (areas, regions or, even better, countries)
- segregate new and young birds from the older ones and ensure the older birds are inspected last each day
- purchase feed from suppliers in AI-free areas, regions or countries
- ensure that the water source is reliable and has been chlorinated if necessary
- keep domestic animals away from clean poultry areas (dogs and cats are known to carry bacteria, such as the Salmonella and Pasteurella species, which are infectious for poultry)
- use fresh litter before new birds are introduced

- in the event of an outbreak of a communicable disease, clean the poultry houses completely and thoroughly disinfect them before restocking with new birds
- in the event of an outbreak of a communicable disease:
  - clean and disinfect all equipment and garments (in consultation with the local veterinary services)
  - clean all equipment regularly, especially feeders and water troughs
  - look out for abnormal signs among the birds and immediately report any suspect cases to the local veterinary services
  - remove all diseased and dead birds
  - dispose of diseased and dead birds effectively so that they will not lead to further spread of the disease
  - remove litter and manure regularly and ensure proper disposal thereof
- do not use untreated chicken faeces as fertilizer or livestock feed, because the virus can survive in faeces for a long period of time at low temperatures
- in the case of an outbreak, incinerate, bury deeply or compost any litter or manure in order to kill pathogens and prevent the spread of disease on the farm (Fig. 11)
- inform all staff working in all types of poultry raising facilities and especially family members, of their role in preventing the introduction and dissemination of a communicable disease, and advise them on measures that should be taken to protect their own health (it is imperative to convince them to participate actively in creating this biosecurity ‘fortress’ otherwise all efforts will be in vain); if an outbreak does occur, ensure the full participation of all involved (prohibit the maintenance of backyard poultry by staff – visit their houses to ensure they do not tend to the flocks).

During outbreaks of communicable disease, birds should be kept inside the hen house and 1.27 cm (0.5”) mesh hardware cloth should be placed over windows to ward off wild birds, rodents and insects.

Since keeping all birds in the hen house is absolutely necessary during an outbreak of AI, an artificial light should be used that is
beneficial for all types of poultry. Sunlight is also beneficial for undisturbed egg production but should be allowed on condition that windows are protected with good wire mesh.

A lack of hygiene and cleanliness often causes poultry diseases that might seriously affect the health and production of the birds. Therefore, all chicken houses and equipment should be cleaned and disinfected regularly and the litter should be collected, kept dry and protected from vermin and rodents (Fig. 12). Manure and litter should never be spread or stored where poultry have access to them.

In the case of an outbreak of AI, flocks should be isolated from any outside activity, such as other chickens, visitors, wild birds, domestic animals, etc. (Fig. 13).

**Measures to reduce transmission**

**Standard measures**

Activities in this phase are based on the assumption that an emerging pandemic virus will not immediately cause an explosive increase in the number of cases observed during a full-fledged pandemic. Assuming that the number of new cases is still manageable, activities should concentrate on investigation and laboratory confirmation of cases, appropriate management of cases in a safe environment, implementation of measures to control infection within the health care setting, contact tracing and monitoring, use of antiviral drugs for the treatment of cases and targeted prophylaxis, intensified surveillance and the real-time reporting of data. The interventions at this phase aim to reduce opportunities for further transmission to occur and thus, ideally, prevent the virus from becoming well adapted to humans.
number of cases exceeds the available number of single rooms, patients may be cohorted and managed in group isolation rooms. Depending on local circumstances and feasibility, group isolation rooms could be adapted to have negative pressure facilities.

Figure 13
Visitors should be kept out of poultry sheds

When the number of cases exceeds the capacity of existing health care facilities, sick people should be isolated in other designated areas or in individual homes, depending on the severity of illness. National governments should identify potential isolation facilities as part of their preparedness and planning during discussions with the World Health Organization (WHO). Patients should be transported to these facilities by trained staff wearing appropriate personal protective equipment and using designated vehicles. To minimise the risk of nosocomial transmission, people showing signs of mild, moderate or severe respiratory illness must be assessed in premises separated from those in which confirmed cases are being managed. Options for doing so include the establishment of fever clinics, home visits by medical staff, drive-through consultation services and other methods of triage and diagnosis that limit opportunities for exposure.

Antiviral treatment and targeted prophylaxis

In the containment zone, antiviral drugs should be administered to cases of moderate-to-severe respiratory illness to reduce morbidity and mortality, and to their contacts to reduce ongoing spread. Priority access to antiviral drugs and other medical interventions is expected to work as an incentive that increases the willingness of patients and their contacts to comply with recommended public health measures under what are likely to be stressful and demanding conditions. Local and national authorities, with support from the WHO, will jointly define (within the outbreak zone) the households, schools, workplaces, health facilities or other settings where the delivery of antiviral drugs, personal protective equipment and other medical supplies should be targeted. Should evidence of spread beyond the initial containment zone emerge, the containment areas designated for antiviral prophylaxis should be re-defined. This decision will be made in collaboration with local and national authorities and the WHO.

Exceptional measures, including use of the antiviral stockpile

Voluntary quarantine

Experience during the severe acute respiratory syndrome (SARS) outbreak suggests that quarantine, applied on a voluntary basis, may be as effective as enforced quarantine. The use of voluntary quarantine is also consistent with modelling studies that recommend the application of quarantine and other community-based measures as part of a containment strategy. However, for voluntary quarantine to succeed, the public will need to be informed and sensitised on benefits.

Governments should be prepared to enforce, legally and operationally, individual and community-based containment measures if warranted. This preparedness should include...
the examination of the ethical dimensions of enforced quarantine or compliance with other recommended measures. Wherever possible, authorities should apply the principle of proportionality, whereby the least restrictive measures are applied first, followed by a graded application of more restrictive measures when evidence indicates their necessity.

Local authorities should apply quarantine in the following situations:

- exposure has occurred in a defined group of people as, for example, in a household setting, at the workplace or school, or at a well-defined and circumscribed public gatherings
- exposure has occurred in a defined site or building (such as a hospital or an apartment building).

Quarantine may involve confinement at home or in a designed facility with appropriate equipment. People in home quarantine may need to be provided with food, access to communications, psychosocial support and supplies of their usual medications, especially for chronic conditions.

Social distancing

Modelling studies have indicated that certain ‘social distancing’ measures might increase the likelihood of successful containment. Such measures aim to increase the social distance between people in an outbreak zone and thus reduce opportunities for transmission to occur. Like quarantine, these measures are socially disruptive and some may cause considerable distress or discomfort in the affected population. Moreover, their actual impact on transmission patterns has not been documented fully in scientific studies. They are, nonetheless, included here as some elements of national pandemic preparedness plans. These may include the following:

- the closure of schools and workplaces, cancellation of mass gatherings and public transportation
- border controls.

Conclusions and recommendations

It should be stressed here that it is much easier to talk about biosecurity than to implement it, especially in small flocks and backyard poultry. Large industrial poultry farms are ‘supposed’ to implement at least the basic rules of biosecurity as part of their good agricultural and good farming practices. However, it is worth mentioning that many are still so overpopulated with birds that they overlook biosecurity in favour of increased production and profit.

Hen houses are often not properly washed and disinfected. Furthermore, cleaning and disinfection of hands, tools, clothes and the sanitisation of equipment are often neglected either because of a lack of education or the absence of guidance and inspection. Control of incoming and outgoing vehicles and people is almost unheard of on small- and medium-scale farms. However, it should be remembered that movement controls are one of the most difficult aspects of maintaining an effective biosecurity programme because it depends on human compliance. It is easy to make mistakes and very difficult to validate the implementation of biosecurity measures. Therefore, it is very important to remember a unique rule for both backyard poultry raisers and industrial poultry farms is to create ‘clean zones’ (Fig. 14) in the establishments and to ensure they are always kept clean.
Further reading


