

## REVIEW

# PREVENTING AVIAN INFLUENZA IN HUMANS: THE ROLE OF SIMPLE PUBLIC HEALTH INTERVENTIONS

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**Abstract.** An influenza pandemic due to influenza virus A H5N1 subtype is considered highly likely. Strategies for prevention and control of a pandemic include actions that need to be taken by the national authorities and communities. The availability of a vaccine and antiviral drugs in sufficient quantities for billions of people in the developing world is doubtful. Simple cost effective public health interventions can significantly reduce the risk of contracting infection. These interventions include precautions that will prevent people from contracting infection from sick or dying poultry and their products, human cases and a contaminated environment. Specific measures are based on principles of cutting short the transmission of infection in humans and inactivating the virus at its source. The paper describes context specific actions that can be implemented in both rural and urban settings by the communities themselves.

### INTRODUCTION

An influenza pandemic, a world-wide epidemic of influenza, occurs when a new influenza virus emerges in the human population causing severe illness and spreads rapidly across the globe. In the last century, pandemics of influenza occurred in 1918-1919 (Spanish Flu), 1957-1958 (Asian Flu), and 1968-1969 (Hong Kong Flu) which led to millions of deaths, unimaginable levels of illness, suffering, social disruption and economic disaster.

Influenza A virus H5N1 subtype is a novel pathogen which is spreading globally and is likely to be the causative agent of a future pandemic. The H5N1 subtype virus is primarily a pathogen of birds. Migratory birds are considered the carriers of this virus and a source of infection to poultry. Once the influenza virus is established in domestic poultry, wild birds cease to be an essential ingredient for its

spread. Infected birds excrete the virus in high concentrations in their feces and also in their nasal and ocular discharges. The virus spreads from flock to flock through the movement of infected birds, contaminated equipment, egg flats, feed trucks, and service crews. The disease generally spreads rapidly in a flock by direct contact. It is highly pathogenic in poultry with almost 100% mortality of infected birds in a short span of time (WHO, 2006a).

### EPIDEMIOLOGICAL FEATURES OF AVIAN INFLUENZA IN ASIA

Between December 2003 and April 2006, the H5N1 virus infected poultry in more than 50 countries in Asia, Africa and Europe with devastating economic consequences in several developing nations (OIE, 2006). More than 200 million birds have either died or have been culled to prevent the spread of infection (FAO, 2006). Early detection of disease in poultry followed by rapid and effective culling have been demonstrated to be the key in containing the spread of disease and elimination of the virus from poultry in a defined area. Thai-

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land and India have been successful in stamping out infection using this strategy.

The close interaction between human beings and poultry provides the virus ample opportunity to cause human infection. The absence of specific receptors in human beings prevents attachment of the virus to the surface of the respiratory tract and obviates establishment of infection. Therefore, so far human infection has been rare. In spite of this limiting characteristic of the H5N1 virus, occasionally this highly pathogenic avian influenza (HPAI) virus causes disease in human beings.

The first documented infection of humans with HPAI occurred in Hong Kong in 1997, when the H5N1 strain caused severe respiratory disease in 18 people, of whom six died (Sims *et al*, 2003). As of 31 October 2006, ten countries, Azerbaijan, Cambodia, China, Djibouti, Egypt, Indonesia, Iraq, Thailand, Turkey and Vietnam had reported 256 cases of H5N1 virus in humans to the World Health Organization (WHO, 2006b). One hundred fifty-two of these cases have died (case fatality rate of 57%). Most human cases, if not all, were linked to direct exposure to dead or sick poultry.

The situation is rapidly evolving and it is feared that association between human influenza viruses and HPAI or a mutation of latter could endow the virus with capability of human-to-human transmission. This could lead to a pandemic in a short time, which has been estimated to cause illness in up to 1 billion people and death in 2-7 million (WHO, 2005a). Since it is a novel human pathogen, immunity against HPAI is negligible making the entire population susceptible to infection. Recent observations suggest that two genetically different strains are prevalent, one in Europe and the other in Asia. This is likely to have implications for the development and production of a vaccine if and when the pandemic occurs.

The pandemic could cause severe strain on health systems and other essential services

leading to massive social, political and economic disruption.

## STRATEGIES AND INTERVENTIONS FOR PANDEMIC PREVENTION

Avian Influenza is an unprecedented challenge for Asia. Meeting this challenge and preempting the pandemic at the source calls for national preparedness to institute necessary measures, such as aggressive outbreak containment in poultry, enhancing animal and human surveillance, sharing information and laboratory materials, strategic stockpiling of antiviral drugs and personal protective equipment (PPE), building partnerships with national and international partners, creating awareness in communities through risk communication and strengthening health systems and human resource capacity. Communities can play a crucial role by employing simple measures that reduce the opportunities for human infection and destruction of virus at its source.

Several strategies that have been developed for implementation during different phases of an influenza pandemic are:

Pre-pandemic phase:

- Reduce opportunities for human infection.
- Strengthen the early warning system.

Emergence of a pandemic virus phase:

- Contain or delay spread at the source.

Pandemic declared and spreading internationally phase:

Reduce morbidity, mortality, and social disruption.

Conduct research during the pandemic.

Early detection of infection in poultry and humans can be achieved through surveillance and close collaboration between animal health and public health sectors. Rapid diagnosis is a function of laboratories. Culling, or stamping out, of poultry in affected areas is an important intervention to eliminate the source of infection. To preempt the pandemic, induce immunity in the susceptible population and reduce mortal-

ity due to H5N1 virus in humans, antiviral agents and a specific vaccine are required.

#### **Role of vaccines and antiviral drugs**

Vaccines and antiviral drugs have been the mainstay of prevention and control of several viral infections. However, a vaccine against HPAI is not currently available. The production of a vaccine can commence only after the viral strain responsible for the pandemic is isolated and its genetic characteristics and pathogenicity are elucidated. The production of a suitable vaccine and ensuring its availability is estimated to take 3-6 months (WHO, 2005b). Vaccines, the most important intervention for reducing morbidity and mortality, were available for the 1957 and 1968 pandemic viruses, but arrived too late to have an impact. The affected population in the first wave of the pandemic will not have access to such an intervention.

At present influenza vaccine production units are localized in the developed world with an annual capacity of 300 million doses (Stohr K, personal communication). Using innovative technologies this production capacity can be augmented up to 1,800 million doses. The access, of populations in the developing world, to a pandemic vaccine is thus likely to be extremely limited.

Antiviral drugs against human influenza A viruses of subtype H1, H2 and H3 (amantadine and rimantadine) are not effective against H5 subtype. Oseltamivir has been shown to be the only oral drug that can be used in patients with HPAI. With recent commencement of its production in India, the likelihood of availability of this drug has increased greatly. However, the high price of the drug and the possibility of emergence of resistance of the H5N1 virus to oseltamivir (Le *et al*, 2005) are issues which may hamper its effectiveness.

Antiviral drugs have a critical role in initial human cases if strategically used to pre-empt a pandemic. The logistics for ensuring availability of antiviral drugs within a required time

for those who need it is a challenge for the public health system. In contrast reduction of exposure to the virus from poultry and the use of simple tools to inactivate the virus are considered effective interventions that can minimize the risk of a pandemic. Compared to pharmaceutical tools, simple public health interventions are more likely to exert a greater influence on minimizing the impact of a pandemic.

#### **THE ROLE OF SIMPLE PUBLIC HEALTH INTERVENTIONS**

The H5N1 virus is now endemic in several countries, with increasing infection among birds. Hopes that the virus could be rapidly eliminated from poultry have not been realized, and the situation continues to cause grave concern. The risk of a pandemic depends on human exposure and infections. This risk continues as long as the H5N1 virus circulates in animals. Most human cases, if not all, have been linked to direct exposure to dead or sick poultry. Reduction of exposure to H5N1 infected birds reduces the risk for acquiring H5N1 infection from birds (especially poultry) (WHO, 2005c).

Simple public health measures are mostly applied at the individual level. Actions such as hand washing, avoiding wet markets and exposure to dead or dying poultry; ensuring food hygiene and protection from acquiring infection from a patient with avian influenza have a considerable impact on risk reduction. The public health authorities should provide information to the public regarding these effective and economical measures through a well planned communication strategy.

#### **Rationale**

Reduced risk for human infection from animals can result from risk communication to communities to make them aware of the risks and possible measures to reduce them. There are several cost-effective non-pharmaceutical interventions that can prevent human infection, reduce the spread of infection

Table 1  
Characteristics of H5N1 virus.

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Present in excretions (droppings) and secretions of poultry.
Survives for 4 days at 22°C on contaminated surfaces (door knobs and table tops).
One gram of contaminated manure can infect up to 1 million birds.
Remains infectious for 35 days in manure, water, soil, and contaminated equipment.
Can contaminate eggs and poultry meat.
Can survive in frozen carcasses and blood for three weeks.

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Table 2  
Susceptibility of H5N1 virus.

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Destroyed by heat at:
56°C in 3 hours
60°C in 30 minutes
71°C in 1 second
Inactivated by several disinfectants including sodium hypochlorite, formalin, and gluteraldehyde.
Inactivated at an acidic pH <7
Destroyed by soap which inactivates the virus by disrupting its outer lipid layer.

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amongst poultry and efficiently inactivate the virus (WHO, 2006c). These interventions are based upon several well-understood characteristics of the virus (Table 1).

#### Susceptibility of H5N1 virus

H5N1 is susceptible to a variety of easily available agents (Bhatia and Ichhpujani, 2004). Some of these are summarized in Table 2.

#### Application of simple public health interventions in different settings

Currently, human beings can acquire infection only in a setting where poultry-to-human transmission is possible. This has been ongoing since December 2003. Once the virus commences human-to-human transmission, the role of poultry as a reservoir of infection becomes redundant. Simple public health

interventions should focus on preventing transmission from poultry as well as patients and reducing the risk of exposure to the virus.

**Reduction of risk from infected poultry.** Avian influenza in poultry is manifest by poor appetite, a drastic decline in egg production, facial edema with swollen and cyanotic combs and wattles and petechial hemorrhages on the internal membrane surfaces. Death occurs rapidly and mortality approaches 100% (WHO, 2006d). The virus is present in the respiratory secretions and feces of the sick birds. Through this infectious material the soil, cages and poultry products become contaminated.

It is critical that any sudden sickness or death in poultry be immediately reported to the local authorities. An outbreak requires rapid culling of sick poultry, safe disposal of dead birds and disinfection of the contaminated objects. Culling of the birds is a highly specialized job and requires use of personal protective equipment to prevent cullers from becoming infected.

Humans should avoid unnecessary contact with live, sick or dead birds. The feathers and waste products require utmost care in handling. Steps should be taken to prevent children from coming into contact with poultry and poultry products. The markets where poultry and its products are sold should be avoided since, apart from the birds, the contaminated cages can be a source of virus. If a visit to such a market is unavoidable, the nose and mouth must be covered with a mask and hands should be washed thoroughly, immediately after finishing the task at the market.

#### Food hygiene for prevention of avian influenza.

To eliminate risk of getting the virus through food, poultry products should be properly cooked since H5N1 virus is killed when the internal temperature exceeds 71°C. The absence of pink flesh after cooking guarantees proper cooking of food. No cases of bird flu have occurred due to ingestion of cooked food. Freezing and refrigeration do not sub-

stantially reduce the concentration of viruses in contaminated meat. There is no evidence at present to conclude that any processed poultry products (whole refrigerated or frozen carcasses and products derived from these) and eggs in or arriving from areas currently experiencing outbreaks of avian influenza H5N1 in poultry pose a risk to public health. Nevertheless, the importance of good hygiene practices during handling of food, particularly poultry products, is paramount (WHO, 2006e).

Eggs obtained from affected areas could have the virus on the shell surface from contaminated soil or excretions of poultry. The virus can also enter the egg. The outer surface of the egg should be washed with soapy water, rinsed and the egg thoroughly cooked. Absence of runny yolk suggests proper cooking. Raw eggs should not be added to any cooked preparation. In addition, raw chicken and eggs should be kept separate from other food items to prevent cross-contamination.

Defeathering of poultry is extremely dangerous and requires complete respiratory protection, with the use of masks, hand washing and proper disposal of feathers. It is strongly advised not to do it at home.

Vegetables obtained from avian influenza-affected areas may become contaminated with virus-rich manure. The vegetables should be washed properly, rinsed in clean water for 15 minutes and washed again under running water before consuming. Hands should be washed thoroughly afterwards. Wherever possible, vegetables should be cooked properly. Steaming kills all viruses.

**Personal hygiene for prevention of avian influenza.** Hand washing is the single most effective intervention to protect human beings from respiratory and enteric infections (CDC, 2003). Proper hand washing destroys H5N1 virus. It also removes transient microorganisms that may have been picked up from the environment and prevents their transfer to patients, staff and equipment in a health care setting.

Hand washing is best performed using soap and warm running water. All areas of the hand should be washed thoroughly for a minimum of 15 to 20 seconds to give adequate time for the soap to kill the virus.

After washing, hands should be patted dried with a clean towel to remove moisture which is conducive for the propagation of several microorganisms.

If soap and water are not available, a 70% alcohol-based hand rub solution can be used in sufficient quantity to completely cover the hands. The hands should be washed using running water and soap if possible. Alcohol-rub only destroys the germs. It does not clean the hands. Hand-washing does both.

**Measures to be taken by poultry workers to prevent avian influenza.** Poultry workers play a vital role in preventing the spread of the disease. Poultry should be kept "roofed in" to prevent contact with wild or migratory birds. Chickens should not be allowed to mix with other bird species, such as ducks. Several measures (WHO, 2006e) are advised for poultry workers (Table 3).

**Prevention of avian influenza from a patient.** Currently avian influenza is suspected when flu-like symptoms (fever, chills, body aches, running nose and/or eyes, loss of appetite) occur in a person who has recently come in contact with poultry in a bird-flu affected area. Once a pandemic starts, exposure to poultry should not be a criterion for suspicion. The patient is infectious one day prior to appearance of symptoms and up to 5 days after being sick. Until medically evaluated, the patient should be made to stay at home and all surfaces that come in contact with his secretions should be wiped clean with a disinfectant such as Lysol, sodium hypochlorite or cleaned with soapy water. The patient should be given plenty of fluid, paracetamol and rest. The diagnosis of avian influenza is confirmed only by specific laboratory tests.

Table 3  
Actions by poultry workers to prevent avian influenza.

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Suspect bird flu if chickens suddenly fall sick and start dying rapidly.  
Immediately inform the concerned local authorities and the animal husbandry department.  
Keep children away from chickens.  
Wash your hands properly if you come into contact with sick or dying chickens, or with potentially contaminated objects.  
If bird flu is confirmed, cooperate with the local authorities in culling the chickens.  
Protect yourself and all workers on poultry farms by covering your nose and mouth with a mask, and eyes with goggles.  
Do not allow chickens or eggs to be taken out of a poultry farm. Destroy all eggs. Do not transport sick birds.  
Do not carry chickens from an infected poultry farm to your home for cooking.  
Do not reuse equipment, shoes or vehicles that have been used in the vicinity of sick birds till these are cleaned of fecal matter.  
Disinfect boots or shoes before entering and upon leaving a poultry farm.  
If someone develops flu-like symptoms, contact the nearest health center.

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Table 4  
Implementation of simple public health interventions in different pandemic phases.

Simple interventions	Pandemic phase		
	Pre-pandemic	Emergence of a pandemic virus	Pandemic declared
Protection of poultry from wild birds	+++	++	-
Prevention of spread from infected poultry	+++	+++	-
Protection of humans from infected poultry	+++	+++	-
Food hygiene	+++	+++	+
Personal hygiene (hand washing)	+++	+++	+++
Cough hygiene	+	+	+++
Protection from patients	++	++	+++
Social distancing	-	-	+++

-: Not needed; +: Useful; ++: Essential; +++: Critical

The respiratory secretions of the patient with avian influenza are rich in H5N1 virus. Large virus-laden droplets (>5 µm in diameter) generated when infected persons cough or sneeze are the predominant mechanism of transmission (Bridges *et al*, 2003). Patients should take precautions to prevent the generation of droplets and others should stay at least 1-2 meters away from him/her when he/she coughs or sneezes. Indirect inhalation is possible by shaking hands and contact with

door knobs and other surfaces or objects (Bean *et al*, 1982).

Both the patient and the attendant should wear masks. Wearing masks in public was shown in Beijing and Hong Kong to be associated with protection from SARS in multivariate analysis (Wu *et al*, 2004). The patient may be advised to be quarantined and kept under intensive medical care. Shaking hands with the patient should be avoided and objects handled by the patient should not be touched. Hands

should be washed thoroughly after coming into contact with the patient or his belongings.

**Prevention of avian influenza in live animal market (wet market).** Traditionally, Asians prefer freshly slaughtered meat. This is available in wet markets where members of the public go to buy small animals and birds that are live and slaughtered there, taken home to slaughter or purchased as already slaughtered meat. These markets provide optimal conditions for transfer of avian influenza virus from birds to customers or workers in the wet markets because of high risk practices in the wet markets.

Several measures that can protect individuals from acquiring infections in wet markets include: avoid buying live poultry or birds slaughtering at home, since defeathering and degutting poultry can be risky; follow hygiene practices when preparing food; separate raw and cooked food items; cook thoroughly; do not prepare and consume specialty raw dishes made from raw meat and blood, and keep food at a safe temperature.

#### **Social distancing**

Apart from ensuring care of the patients and providing essential services the national public health authorities may institute several measures to minimize or delay the spread of a pandemic. These interventions are directed at restricting movement in a defined area, closure of schools or places where a large number of people congregate (social distancing), imposing exit and/or entry screening and promulgating trade restrictions. The objective of these measures is to contain spread of disease.

Simple public health interventions and the phases of pandemic when these can be effectively implemented are shown in Table 4.

#### **COMMUNITY PARTICIPATION**

As soon as a pandemic is declared, health authorities will need to start a continuous process of risk communication to the public.

Many difficult issues – spread to other countries, shortage of vaccines and antiviral drugs, justification for the selection of priority groups for protection – will need to be addressed. Effective risk communication, supported by confidence in government authorities and the reliability of information, may help mitigate some of the social and economic disruption attributed to an anxious public. Countries are advised to plan in advance. A communication strategy for a pandemic situation should include training in outbreak communication and integration of communicators in senior management teams.

Communities must have faith in the government and adhere to instructions. In spite of best efforts some degree of social disruption is likely to occur in a pandemic. People must prepare in advance, procure emergency supplies, have contact numbers of important people available and manage their business to minimize losses. At the individual level, non-pharmaceutical measures can contribute significantly to the protection of individuals and contain the spread of disease. Creating awareness amongst communities should be ensured through utilization of all possible modes of print and electronic media.

#### **CONCLUSIONS**

As the present situation continues to evolve towards a pandemic, several opportunities to intervene are being crystallized. At present, interventions aim to reduce the risk that a pandemic virus will emerge and gather better disease intelligence, particularly concerning changes in the behavior of the virus that signal improved transmissibility. The second opportunity to intervene occurs coincident with the first signal that the virus has improved its transmissibility, and aims to change the early history of the pandemic. The final opportunity occurs after a pandemic has begun. Interventions at that point aim to reduce morbidity, mortality, and social disruption.

In each phase of a potential pandemic, several measures can be applied. Simple public health interventions are important, not only complementing pharmaceutical interventions but mitigating the impact of the pandemic through active community participation.

Containing an influenza pandemic is an enormous task. The global implications of a pandemic are staggering. The needs of countries are vast and multisectoral action is the only answer. The role played by communities through the use of simple public health interventions should complement the efforts of national agencies and must be employed in all earnest.

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