Avian Influenza: Preparing for a Pandemic

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Abstract
Since 1996 to 2006 there have been regular outbreaks of influenza. The genetics of virus plays an important role in its virulence mechanism. In this era of the impending threat on the influenza pandemic it is imperative that there be exchange of knowledge regarding the virus and its virulence. This article tries to address the above motive. An exhaustive review of literature has been provided regarding this viral threat. ©

INTRODUCTION

Avian influenza officially reached India in February 2006 with the announcement of the H5N1 virus being detected in poultry in Navapur in the Nandurbar district. Although, no cases of avian influenza were detected in humans, there were sixty-six persons with upper respiratory infections, ninety-two poultry workers at affected farms, and ninety poultry workers at unaffected farms under observation for potential avian influenza.21

Recent History of H5N1
In 1996, H5N1 was first detected in a domestic goose from Guangdong Province in China.22 By 1997, the first infections with H5N1 were occurring in both poultry and humans. In the 1997 outbreak in Hong Kong, 18 people were infected with H5N1 virus; and, six of these individuals succumbed to the virus. To control this outbreak in the farms and wet markets of Hong Kong, 1.5 million poultry were eventually culled.15

Avian influenza then returned in 2003 with two members of a Hong Kong family becoming infected after visiting China. One of these family members died; and, an additional family member became ill with a respiratory illness (but was not tested for H5N1).15 Also, in December 2003, there were two tigers and two leopards in a zoo who had fed on fresh bird carcasses infected by H5N1. Both the tigers and leopards died of the virus.22

By 2004, there were new outbreaks being reported in Thailand and Vietnam.19 In addition, the avian influenza virus was detected in house cats in a household in Thailand.22 By 2005, there were outbreaks in humans being reported in Cambodia, Indonesia, Vietnam, and China. And, now in 2006, the virus has spread throughout Europe, Turkey, Iraq, Egypt, Nigeria, Niger, and India.1

Basic Overview of Influenza
There are three types of influenza viruses, which are known as A, B, and C. Type A viruses are further subtyped on the basis of two important surface glycoproteins, hemagglutinin (HA) and neuraminidase (NA). In addition, the influenza A subtypes and the influenza B viruses are further classified into strains. Influenza B viruses are only found in humans; and, these viruses have caused epidemics in the past, but never pandemics. As for influenza C, it only causes mild illness in humans.

Influenza viruses can be highly resilient in the environment. The viruses can survive in contaminated manure for at least three months in cool climates; and, one gram of H5N1-infected manure can contain enough viral particles to infect 1 million birds. Further, the virus can also survive in water for up to four days at 72°F, greater than one month at 32°F, and potentially indefinitely in frozen materials.8,18

Influenza A Viruses
Influenza A viruses can infect a variety of animals including pigs, whales, horses, seals, and humans; however, the viruses are usually specific to a species and do not normally cross the species barrier. For example, H1N1 and H3N2 subtypes have caused outbreaks in pigs, H7N7 and H3N8 subtypes have caused outbreaks in horses, and H3N2, H2N2, H1N1, and H1N2 subtypes have caused outbreaks in humans.18

Each subtype usually infects only infects a particular animal species; however, there have been past instances of crossing the species barrier. An example of this crossover is of the H3N2 outbreaks among pigs in the United States in 1998. Previously, H3N2 had been primarily in humans.19

The exception to the specificity of influenza A viruses is wild birds. Wild birds are the natural hosts for all

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subtypes of influenza A viruses; and, these birds are normally unaffected by the viruses. However, domestic birds such as chickens, pheasants, quail, geese, guinea fowl, ducks, and turkeys, can become very sick from these avian influenza viruses.12,18

Type A influenza viruses are further subtyped based on differences in the hemagglutinin (HA) and neuraminidase (NA) proteins found on the surfaces of the influenza viruses. There are 16 known HA subtypes and 9 known NA subtypes of influenza A viruses, which can recombine to create novel combinations of influenza.2

In addition, there are eight separate gene segments composing influenza A viruses. Reassortment of these gene segments allows the development of novel influenza A viruses that can lead to pandemics because of the lack of immunity in animal populations. This major antigenic change is known as antigenic shift. In contrast, the typical seasonal influenza viruses exhibit frequent point mutations that lead to more gradual shifts in their genomes. This process is known as antigenic drift; and, it is the reason that new influenza vaccines must be prepared each year.19,24

**Avian Influenza Subtypes**

Avian influenza viruses are subtypes of type A influenza viruses; and, there are multiple varieties of avian influenza. These varieties of avian influenza can be divided into low pathogenic and high pathogenic forms. The low pathogenic forms can be H5, H7, or H9. In contrast, the highly pathogenic avian influenza can be H5 and H7.9

Infection by the “low pathogenic” viruses may be asymptomatic and/or cause only minor symptoms such as decreased egg production and ruffled feathers.

Low pathogenic forms of avian influenza have been known to cause disease in humans. H5 infections had caused documented human infections. H7 infections infrequently cause conjunctivitis and/or upper respiratory symptoms. H9 infections have caused documented human infections.9

However, infection by the “high pathogenic” viruses may infect multiple internal organs. In addition, these highly pathogenic viruses may rapidly spread within a poultry flock and can result in 90 – 100% mortality in the flock within 48 hours.2

**Virulence Of Avian Influenza**

There have been concerns about possible mutations in the H5N1 virus that are increasing the possibility of a human pandemic. As with all influenza viruses, there have been numerous changes in the H5N1 genome. Influenza viruses are RNA viruses; and, these viruses lack effective genetic proof-reading. This minor mutations account for the genetic drift that is continual in the influenza genome.

Studies have indicated that the H5N1 viruses from 2003 and 2004 have become progressively more virulent and resilient in experimentally infected chickens and mice in comparison to the H5N1 virus from 1997. In laboratory studies, the viruses from 2004 showed greater lethality in both mice and ferrets, especially in ferrets. At least one of the 2004 isolates had eight amino acid alterations, including a Lys/Glu mutation at 627 of the PB2. This substituted Glu at position 627 is a previously identified H5N1 virulence factor in mice.4,20

Studies have examined the role of the hemagglutinin and neuraminidase proteins in the virulence of avian influenza. It has been found that both the cleavage site and glycosylation patterns in the hemagglutinin (HA) protein on the surface of the influenza virus have integral roles in determining the pathogenicity of H5 avian influenza viruses.

One study found that the amino acids 97, 108, 126, 138, 212, and 217 of the hemagglutinin protein, in addition to those amino acids within the cleavage site, affect pathogenicity. The study also found that an additional glycosylation site within the globular head of the neuraminidase (NA) protein contributed to the increased virulence of the H5N1 virus.11

Several studies also indicate that the neuraminidase has a role in pathogenicity. The neuraminidase protein allows the mobility of virions by removing sialic acid residues from the viral hemagglutinin during viral entry and exit from cells. Viruses with decreased neuraminidase activity cannot efficiently exit infected cells; and, increased neuraminidase activity has been correlated with increased hemagglutinin cleavage in multiple organs resulting in increased virulence especially neurovirulence (in experimental mice).11

Other studies have examined the role of the NS1 protein in the increased virulence of avian influenza. The NS1 protein of influenza A is a nonstructural protein expressed in great quantities in virally infected cells, but it has not been detected in the viruses. Phylogenetic relationships of the NS genes have shown two different gene lineages, known as groups or alleles A and B. Avian influenza viruses as well as mammalian influenza viruses are part of the A group; in contrast, the B group contains virtually only avian influenza virus strains.14

NS1 protein is synthesized early in the infection and has been hypothesized to inhibit the host antiviral defense mediated by alpha and beta interferons. This ability to inhibit interferon depends on the ability of the NS1 protein to bind double-stranded RNA, which is a known potent inducer of interferon. Certain amino acid residues within the NS1 protein allow this protein to bind to double-stranded RNA, and with just two amino acid mutations the virus can be attenuated. Therefore, this may help explain the remarked conservation of NS1 among influenza A virus strains and additionally provides an antigenic marker for these infections.14
Further, prior to the mass deaths of over 6,000 wild birds in late April 2005 at the Qinghai Lake nature reserve in central China, the H5N1 virus had only caused isolated deaths in migratory birds. However with the H5N1 virus from Qinghai Lake, it has been shown that there is a unique mutation at one site that in experiments is related to greater fatality in both birds and mice. Also, viruses nearly identical to the Qinghai Lake H5N1 virus have been in the outbreaks in Russia, Kazakhstan, Mongolia, Nigeria, Iraq, and Turkey.

Although it is not known which mutations are required to allow the H5N1 virus to become readily transmissible and sustainable in the human population, some recent viruses, including one virus from the January 2006 outbreak in Turkey, have had mutations in the receptor-binding site and the substitution of more mammalian-like amino acids. However, it could not be determined if these mutations affected the transmissibility of the viruses.

**CROSSING THE SPECIES BARRIER**

It has been known from previous studies that changes in receptor recognition and polymerase protein PB2 mutations allow avian influenza to adapt to mammalian hosts. One major factor in host range or the ability to infect a host is the affinity of the viral hemagglutinin for the host cell sialic acid receptor.

Hemagglutinin is the surface glycoprotein that allows the virus particle to bind to cell surface receptors containing sialic acid. The hemagglutinin protein is synthesized as a polyprotein precursor that is posttranslationally cleaved into two subunits. This cleavage step is essential for virus infectivity.

Normally, the avian influenza virus links to the terminal sugar chain of the avian host cell through an α2-3 bond; in contrast, the human influenza virus links to the terminal sugar chain of the human host cell through an α2-6 bond. As the avian influenza virus adapts to human hosts, it develops increasing affinity for the α2-6 bond. An example of this adaptation is the 1968 influenza pandemic in which the H3 subtype traversed the species barrier from ducks into humans in 1967 and 1968. However, an outbreak of H5N1 in the live poultry markets of Hong Kong in 1997 indicated that this adaptation to the human host need not be necessary for human infection. Viruses isolated in this outbreak from the chickens and the eighteen infected people (of whom six individuals subsequently died) were identical in all eight RNA segments. This illustrated that these unadapted viruses could replicate in humans; however, it did not appear that these viruses spread between humans thus preventing a larger epidemic.

In addition, alterations in the glycosylation patterns of the hemagglutinin and addition of polybasic amino acids at the cleavage site of the hemagglutinin protein correlate with increased virulence. Polybasic amino acids at the hemagglutinin cleavage site are characteristic of the H5 and H7 subtypes of highly pathogenic influenza A viruses. This polybasic region is targeted by both trypsin-like proteases and intracellular proteases thus allowing systemic spread and increasing virulence.

In another study, it was found that amino acid Asn 701 of the polymerase protein PB2 is one of the important determinants that allows avian influenza virus to cross the host species barrier and infect mice; although, the actual replication and fatal nature of H5N1 viruses likely results from multiple genes.

**TRANSMISSION OF AVIAN INFLUENZA IN BIRDS**

Avian influenza viruses are carried in the gastrointestinal tracts of wild birds throughout the world. These viruses are extremely contagious and can be shed in the saliva, nasal secretions, and feces of infected birds. The avian influenza viruses are normally asymptomatic in these wild birds; however, these viruses can sicken and kill domesticated birds such as chickens, ducks, and turkeys. These domesticated birds may be infected by either direct contact with other infected birds (both wild and domesticated) or through contact with contaminated soil, infected cages, infected water, and/or infected food.

In addition, it has been noted that domestic ducks in affected areas have developed “immunity” to some strains of H5N1; however, these asymptomatic ducks continue to excrete significant amounts of highly pathogenic virus. It is believed that these infected but asymptomatic ducks may be perpetuating the transmission of H5N1 in endemic countries.

Further, a study found a similar pattern of asymptomatic infection in seemingly healthy migratory birds in Southeast Asia. This study also found that the establishment of multiple unique lineages of H5N1 virus in domestic birds in Southeast Asia thus indicating the endemcity of H5N1 in those geographic areas.

**Transmission of Avian Influenza in Humans**

The main route of transmission of influenza viruses in humans is via inhalation of infected respiratory droplets from coughing and sneezing. Influenza viruses typically range in size from 0.08 to 0.12 micrometers. However, influenza viruses may also be transmitted via contact with infected surfaces and materials or through an intermediate host such as a pig.

Because humans are rarely exposed to avian influenza viruses, there is minimal immunity to these particular viruses in the general population; and, if an avian influenza were to become highly transmissible between humans, it could readily become an epidemic or pandemic because of this lack of immunity.

Since 1997, increasing numbers of humans infected...
Avian Influenza Symptoms in Birds

Important signs and symptoms of an avian influenza infection in birds include:

**Potential clinical presentation of avian influenza in birds**

- Edema of the head, eyelids, comb, wattles, and hocks
- Decreased egg production
- Soft-shelled or misshapen eggs
- Poor appetite
- Lethargy
- Sneezing and nasal discharge
- Coughing
- Purple discoloration of the wattles, combs, and legs
- Diarrhea
- Lack of coordination including muscle tremors and wing drooping
- Asymptomatic sudden death.


Avian Influenza Symptoms in Humans

In individuals infected with avian influenza, symptoms have varied according to the particular virus that caused the infection. Symptoms have ranged from the typical “flu” symptoms of fever, sore throat, cough, and muscle aches to much more severe symptoms including eye infections, pneumonia, acute respiratory distress, and potentially fatal complications.²

Normally, the typical seasonal influenza viruses cause only mild respiratory symptoms in the majority of people. Further, seasonal influenza viruses are more likely to produce severe symptoms in the elderly and immunocompromised.¹⁷

In contrast, the H5N1 virus has caused more rapidly fatal disease especially conditions such as primary viral pneumonia and multi-organ failure. Further, the majority of this morbidity and mortality has been in healthy children and young adults.¹⁷

Diagnostic Testing

The Food and Drug Administration announced the approval of a new laboratory test developed by the Centers for Disease Control and Prevention to diagnose H5 strains of influenza in patients suspected to be infected with the virus. The test is named, Influenza A/H5 (Asian lineage) Virus Real-time RT-PCR Primer and Probe Set. This test can provide preliminary results on suspected H5 influenza samples within four hours of testing in comparison to at least two to three days with previous tests.

In another study, the use of NS1 as a potential diagnostic marker for influenza virus infection in birds was examined. NS1 is a conserved nonstructural protein of influenza A viruses. The study detected antibodies to NS1 protein in poultry experimentally infected with NS1 recombinant protein and chemically synthesized NS1 peptides by using enzyme-linked immunosorbent assay (ELISA) and Western blot analysis. The study then performed a field test that was able to differentiate the presence of NS1 antibodies in avian influenza-infected poultry but not in poultry vaccinated by a commercial avian influenza vaccine.¹⁴

**PROPHYLAXIS AND TREATMENT**

There are four medications normally used to prevent and/or treat the “typical” influenza virus; and, studies have indicated that these four drugs can reduce the duration of influenza symptoms by 1 day if taken within 2 days of the onset of the illness. However, avian influenza is resistant to amantadine and rimantadine. The other two antivirals, zanamivir (Relenza) and oseltamivir (Tamiflu) appear to be effective against avian influenza.

Zanamivir and oseltamivir are neuraminidase inhibitors. These inhibitors block the action of neuraminidase which normally breaks the bonds attaching new influenza viruses to the exterior of an infected cell. The viral particles can not detach from the infected cell thus limiting the extent of the infection.

Zanamivir is approved for treatment of uncomplicated influenza virus infection in individuals over 7 years of age who have symptoms for less than 2 days. The recommended dosage for zanamivir is two inhalations twice a day for 5 days. Zanamivir is not recommended for those with chronic respiratory diseases including asthma or chronic obstructive pulmonary disease (COPD) because it can cause wheezing or serious breathing problems. It may also cause headaches and diarrhea.

Oseltamivir is approved for treatment of uncomplicated influenza virus infection in individuals over 1 year of age who have had symptoms for less than 2 days. The recommended dosage of oseltamivir for adults is orally twice daily for 5 days; and, for children, the dose of oseltamivir depends on the child’s weight. Even more importantly, Oseltamivir is approved for the prevention of influenza A and B in individuals over 1 year of age. The most common side effects with oseltamivir are nausea and vomiting. The dosage may...
also need to be adjusted if you have any type of kidney disease.

Neither of these drugs is recommended for routine use during pregnancy or nursing. Also, studies have shown that both influenza A and B viruses can develop resistance to zanamivir and oseltamivir.7

Avian Influenza Vaccines in Poultry

Traditionally, avian influenza vaccination of poultry uses inactivated whole-virus vaccine (via subcutaneous or intramuscular) administration. These inexpensive commercial vaccines are produced by using unpurified allantoic fluid emulsified in an oil-based proprietary adjuvant. Although these vaccines are useful in preventing symptoms in poultry, these vaccines can interfere with serologic testing including agar gel precipitin (AGP) test, which is considered the international “gold standard” for diagnosis of avian influenza in birds. Therefore, studies are underway for the development of other avian influenza vaccines for poultry.

One study described the creation and testing of an adenovirus-based influenza A virus vaccine targeted against the hemagglutinin protein of the A/Vietnam/1203/2004 (H5N1) strain which had been isolated during the human outbreaks in Vietnam from 2003 to 2005. A single subcutaneous immunization was effective in protecting domestic chickens from an intranasal challenge with the virus 21 days after the initial immunization.13

Avian Influenza Vaccines in Humans

Although clinical trials began in April 2005, there are no commercially available vaccines for humans against H5N1. Currently, both sanofi pasteur and Chiron are producing inactivated H5N1 viruses for NIAID clinical trials. From the preliminary sanofi pasteur data, it appears that two doses of 90-µg have produced the best immune response among the tested doses.23

However, for seasonal influenza, there are published recommendations for prioritization of influenza immunizations in order to reduce the likelihood of illness among individuals at high-risk for influenza illness or for spreading the virus. Although potential avian influenza vaccines are still in clinical trials, it is likely that these immunization recommendations are applicable in the advent of an avian influenza outbreak. According to the Advisory Committee on Immunization Practices (ACIP), priority groups who should receive influenza immunizations include:

<table>
<thead>
<tr>
<th>Individuals at high risk for influenza and influenza complications</th>
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<tbody>
<tr>
<td>(1) Individuals at high-risk for influenza complications including:</td>
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<td>(a) Individuals older than 65 years</td>
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<td>(b) Children between the ages of 6 months to 23 months</td>
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<td>(c) Pregnant women</td>
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<td>(d) Individuals living in nursing homes and chronic care facilities with other high-risk individuals</td>
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<tr>
<td>(e) Individuals with chronic conditions including pulmonary disorders, cardiovascular disorders, diabetes, congenital and acquired immunosuppressive conditions, renal dysfunction, hemoglobinopathies, spinal cord injuries, cognitive dysfunction, seizure disorder, neuromuscular disorders</td>
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<tr>
<td>(f) Individuals younger than 18 years on long-term aspirin therapy (to reduce the likelihood of Reyes Syndrome after an influenza infection)</td>
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<tr>
<td>(2) Individuals between the ages of 50 to 64 years because of the higher prevalence of the chronic medical conditions mentioned above</td>
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<tr>
<td>(3) Healthcare workers who have contact with individuals at increased risk for influenza</td>
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<td>(4) If there is sufficient vaccine, household members of individuals who are at increased risk for influenza.</td>
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Pandemic Potential for Avian Influenza

Pandemics start with the emergence of a new virus subtype that (1) can infect humans and (2) cause serious morbidity and mortality and then can have (3) ready and repeatable transmissibility within a human population. The lack of ready and repeatable transmissibility of the avian influenza virus between humans is one of the only factors preventing a potential H5N1 pandemic. However, further, mutations in the H5N1 virus and/or intermixing with human influenza viruses may remove this barrier to a H5N1 pandemic.17

Pandemic Preparation

Because pandemics are worldwide disease outbreaks, its effects are likely to persist and be widespread. It is necessary to prepare prior to this event.

Important measures for pandemic preparation include:

**Surveillance for Avian Influenza**

It is highly important that routine surveillance is carried out to detect the presence of avian influenza in both bird populations and human populations in order to prevent potential outbreaks and to minimize the spread of existing disease. Both sentinel surveillance and syndromic surveillance can be very effective methods for rapidly detecting avian influenza entering a community.

The sentinel provider system receives information...
from healthcare providers who have been recruited to report the number of influenza-like illnesses that they treat weekly. These figures are then used to calculate the percentage of patient visits for influenza-like illness. In addition, because avian influenza is first appearing in communities among birds rather than being transmitted between humans as seasonal influenza typically spreads, it may possible to have sentinel flocks of domestic poultry that are routinely observed and tested for the avian influenza virus. This method could provide an early warning that avian influenza has reached a community and that additional surveillance needs to be carried out within the human population. Surveillance using sentinel chickens has been very effective for arbovirus surveillance.

Syndromic surveillance uses a system based on classification of influenza-like illness, at least one of a set of syndromes. Each is linked to 13 syndromes. For a classification of influenza-like illness, at least one of a set of respiratory illness codes and a fever of at least 100°F.

Infection Control of Infected Poultry and Animals

Important precautions for handling potentially infected birds and animals include:

Precautions for avian influenza infected poultry and animals

<table>
<thead>
<tr>
<th>Precaution</th>
<th>Description</th>
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<tbody>
<tr>
<td>(1)</td>
<td>Avoid exposure to infected poultry and animals and their secretions and excretions if possible.</td>
</tr>
<tr>
<td>(2)</td>
<td>Decontaminate and properly destroy all potentially infectious material.</td>
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<tr>
<td>(3)</td>
<td>Do not eat, drink, or smoke while handling poultry or animals.</td>
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<tr>
<td>(4)</td>
<td>Wear protective clothing (coveralls, rubber gloves, rubber boots, goggles, N95 respirator) if handling potentially infectious poultry or animals.</td>
</tr>
<tr>
<td>(5)</td>
<td>Thoroughly decontaminate all surfaces and equipment with exposure to poultry and animals.</td>
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<tr>
<td>(6)</td>
<td>All individuals with exposure to infected poultry should be vaccinated against the current seasonal influenza to prevent possible co-infection with avian influenza and human influenza viruses because it is possible for host cells to be co-infected with both avian influenza and human influenza, which increases the possibility of intermixing of the RNA from both viruses, thus leading to an avian influenza virus highly adapted to humans.</td>
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<tr>
<td>(7)</td>
<td>All individuals with exposure to infected poultry should be treated with an antiviral drug during the period of exposure to the infected poultry and contaminated surfaces. Oseltamivir is the drug of choice for avian influenza prophylaxis; however, the choice of antiviral should be based on sensitivity testing if possible.</td>
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<tr>
<td>(8)</td>
<td>For one week after the last exposure to the infected poultry and contaminated surfaces, individuals should monitor themselves for fever, respiratory symptoms, and eye infections. If the symptoms develop, the person should have medical care; however, the health care provider needs to be notified prior to the appointment of the previous exposure to avian influenza and the recent development of symptoms.</td>
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**Pandemic preparation for avian influenza**

<table>
<thead>
<tr>
<th>Precaution</th>
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<tbody>
<tr>
<td>(1)</td>
<td>Develop preparedness plans to anticipate widespread illness and insufficient supplies.</td>
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<td>(2)</td>
<td>Participate and promote public health efforts.</td>
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<td>(3)</td>
<td>Communicate with healthcare providers regarding signs and symptoms of an outbreak.</td>
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<td>(4)</td>
<td>Implement prevention and control actions recommended by healthcare providers.</td>
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<td>(5)</td>
<td>Encourage sick employees/students to stay home to decrease the transmission of avian influenza.</td>
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<tr>
<td>(6)</td>
<td>Develop plans for the possibility of having a significant portion of workers/students absent due to illness.</td>
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<tr>
<td>(7)</td>
<td>Practice good health and hygiene habits.</td>
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<tr>
<td>(8)</td>
<td>Stay informed about pandemic influenza and be prepared to respond.</td>
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**Infection Control of Healthy Poultry**

Important measures to help ensure the health of domestic poultry include:

Protecting the health of domestic poultry from avian influenza infection

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<tr>
<th>Precaution</th>
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<tbody>
<tr>
<td>(1)</td>
<td>Prevent or decrease contact of visitors with your property and birds.</td>
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<tr>
<td>(2)</td>
<td>Prevent contact of migratory birds and game birds with your birds.</td>
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<tr>
<td>(3)</td>
<td>Thoroughly clean and disinfect every day all equipment that comes into contact with your birds and their secretions and excretions.</td>
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<tr>
<td>(4)</td>
<td>Wear clean clothes and disinfected shoes when in your bird area.</td>
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<tr>
<td>(5)</td>
<td>Wash your hands thoroughly before and after being in your bird area.</td>
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<tr>
<td>(6)</td>
<td>Remove bird droppings prior to disinfecting.</td>
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<tr>
<td>(7)</td>
<td>Properly dispose of dead poultry.</td>
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<tr>
<td>(8)</td>
<td>Clean and disinfect your vehicle before going home.</td>
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<tr>
<td>(9)</td>
<td>Keep new birds or birds that have recently returned separated from the other birds for at least 30 days.</td>
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<td>(10)</td>
<td>Do not share birds and equipment with neighbors and other bird owners and clean and disinfect any borrowed equipment before it reaches your property.</td>
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<tr>
<td>(11)</td>
<td>Know the early signs of bird diseases.</td>
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<tr>
<td>(12)</td>
<td>Report sick birds.</td>
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37.8°C must be indicated in the medical record. This information is collected from the medical records daily and counted by ZIP code. These results are analyzed statistically (taking into account the typical disease patterns in an area); and, unusual clusters of influenzalike illness can be detected rapidly.25

**Infection Control in Medical Settings**

Influenza viruses can be rapidly inactivated by thorough washing with soap and water. However, it is more difficult to inactivate the viruses in feces and soil.5 Alcohol-based hand rubs are also effective at eliminating influenza viruses if there is not visible soiling on the hands. Detergents, 10% household bleach, alcohol, and commercial disinfectants can also inactive influenza viruses.2

Although it has not been confirmed that avian influenza can be transmitted between humans, it has been recommended that the isolation precautions for SARS be used for all potential and diagnosed avian influenza patients in a healthcare setting. The patient should be a negative air pressure room. Gloves, gown, and an N-95 respirator are necessary for all patient contact; and, eye protection should be used when within 3 feet of the patient. In addition, proper hand hygiene is essential. If the patient needs to be transported, the patient should wear a surgical mask to contain respiratory secretions.8

These precautions should be continued for 14 days after onset of symptoms until either an alternative diagnosis has been made or laboratory results rule out

**Precautions During Food Preparation**

Important precautions to take to reduce possible exposure to avian influenza while preparing food include:

<table>
<thead>
<tr>
<th>Food preparation precautions for avian influenza</th>
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<tbody>
<tr>
<td>(1) Separate raw meat from cooked or other foods</td>
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<tr>
<td>(2) Avoid using the same chopping board or knife for preparing raw meat and other foods</td>
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<tr>
<td>(3) Wash your hands after handling raw meat or eggs</td>
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<tr>
<td>(4) Do not place cooked meat back on the same plate with raw meat</td>
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<tr>
<td>(5) Cook all poultry products including eggs and blood thoroughly (temperatures should reach 70°C (158°F))</td>
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<tr>
<td>(6) Wash egg shells in soapy water prior to handling and cooking</td>
</tr>
<tr>
<td>(7) Do not use raw or undercooked eggs in foods not to be cooked</td>
</tr>
<tr>
<td>(8) Thoroughly wash all surfaces and utensils with soap and water that have had contact with raw poultry or eggs</td>
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<tr>
<td>(9) Do not eat raw potentially infected poultry or animals.6</td>
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</tbody>
</table>


**Precautions Post-Avian Influenza Exposure**

Important precautions to take if you have possibly been exposed to avian influenza include:

<table>
<thead>
<tr>
<th>Post-exposure precautions for avian influenza</th>
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<tbody>
<tr>
<td>(1) Monitor your health for 10 days for symptoms including fever, cough, sore throat, and/or difficulty breathing.</td>
</tr>
<tr>
<td>(2) If you do develop symptoms, seek out a healthcare provider (however, prior to the visit, notify your provider of your symptoms and possible exposure to avian influenza so that preparations can be made to reduce possible transmission of the virus to unaffected individuals).</td>
</tr>
<tr>
<td>(3) Do not travel while ill (except for travel for medical care).</td>
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</table>


**India and Avian Influenza**

India has a diverse culture with varying practices and beliefs. Currently India is at the forefront of tackling the HIV/AIDS pandemic. With the number of immunocompromised people growing the chance that an infectious disease will achieve its pandemic vision is not impossible. These challenged populations increase in numbers when geriatric and pediatric subjects are added. We cannot forget the entire diabetic, poor, malnourished and cancer patients when we add these numbers. This scenario calls for a creation of an organized response system where Education and Outreach for Care and Support be incorporated not only during emergencies but also on a regular basis. Systems for surveillance and reporting have to be created and legally enforced in the private as well as governmental sector. Treatment protocols and veterinary controls should be enforced. Currently in India many of these efforts are already underway. A lot more can be done. Prevention is better than cure and planning is an answer to success. The fact is that like all developing nations India needs trained people in Public Health. These trained experts will help understand the fundamentals of maintaining the mental social and physical well being of the community along with preventing diseases and containing their consequences.

**Summary**

With the increasing changes in the H5N1 virus and its increasing spread across the world in the bird population, it is highly possible that H5N1 will become epidemic and possibly pandemic in the human population. There are measures that can be taken to reduce the likelihood of contracting and spreading avian
influenza although there are currently no avian influenza vaccines for humans and the efficacy of antivirals can not be confirmed for the H5N1 virus.

There is a dire need of public health education and expertise in India. Education is the answer to increasing the knowledge base. Organized Medicine should lead the role for the clinical education component. This article fulfills the above objective.

REFERENCES


