The Bird Flu

The imminent plague

i. Appendix

i) Group Members

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ii) Legend

1. A-Category header text
2. **A**-Sub-header text
3. **A**-Secondary sub-header text
4. A-Tertiary sub-header text
5. **A**-Hyper-linked text

iii) Glossary

A

Abrupt - exceedingly sudden and unexpected.

Adverse - unfavourable, undesirable.

Avian - pertaining to birds.

Antigen - a substance that when introduced into the body stimulates the production of an antibody. Antigens include toxins, bacteria, foreign blood cells, and the cells of transplanted organs. Also known as allergen.

Antigenic - of or relating to antigens.

C

Cull - kill.

Cell lysis - dissolution/destruction of a cell

E

Epidemic - an outbreak of a contagious disease that spreads rapidly and widely.

Epithelial - outermost surface

Eradicate - destroy completely.

F

Fatigue - tiredness, exhaustion.

G

Genome - the full DNA/RNA sequence of an organism.

Genus - in biology, a taxonomic group containing one or more species.

H

Haemagglutinin - an antigenic glycoprotein found on the surface of the influenza viruses that is responsible for binding the virus to the cell that is being infected.

Hypothesize - speculate, believe on uncertain or tentative grounds.

I

Immunize - render unsusceptible to a disease.

Incubation - the phase in the development of an infection between the time a pathogen enters the body and the time the first symptoms appear.

Influenza - an acute, highly contagious viral disease also known as flu.

Inhibit - block or limit.

L

Lipid - a fat. It is an oily organic compound, and an essential structural component of living cells.

M

Magnitude - relative size or extent.

Malaise - physical discomfort, eg aches and pains.

Matrix proteins - structural proteins linking the viral envelope with the virus core.

Mutation - an event that changes genetic structure or an alteration in the inherited nucleic acid sequence of the genotype of an organism. Basically causes an overall change/alteration in structure/form.

N

Nucleoprotein - a nucleic acid combined with a protein, as in a chromosome.

Neuraminidase - surface protein responsible for enzymic processes of the virus, like breaking free from a host cell after replication.

P

Pandemic - an epidemic that is geographically widespread, occurring throughout a region or even throughout the world.

Pathogenic - able to cause disease.

Pathology - path/processes of a disease.

Pneumonia - respiratory disease characterized by inflammation of the lung parenchyma (excluding the bronchi) with congestion caused by viruses or bacteria or irritants.

Poultry - chickens, turkeys, ducks or geese raised for food.

Protein - a complex natural substance that has a globular or fibrous structure composed of linked amino acids. Proteins are also essential to the structure and function of all living cells and viruses.

Q

Quarantine - isolate to prevent the spread of infectious disease

R

Replication - the process whereby DNA/RNA makes a copy of itself before cell division.

Respiratory - pertaining to respiration or the act of breathing.

RNA - abbreviation for Ribonucleic Acid. In some viruses such as the avian influenza virus, RNA is the main genetic material and code present in the nucleus.

S

Strain - a group of organisms within a species that differ in small ways from similar groups.

Stockpile - accumulate a storage pile for future use.

Surveillance - continual observation of a group.

Swine - pigs.

Symptoms - any physical or mental changes caused by diseases.

T

Transmission - the act of transferring/spreading a disease.

V

Vaccination - act of taking a vaccine used to prevent the risk of contracting a certain disease.

Virology - study of viruses and viral diseases.

Virus - Simple submicroscopic parasites that often cause disease and that consist essentially of a core of RNA or DNA surrounded by a protein coat and that is unable to replicate without a host cell. May also refer to the disease caused by the virus itself.

ii. Contents

c) Video
d) People

1. Scientific Background

I. Introduction

All over the world, influenza, which is the scientific name for flu, is periodically being spreaded in the forms of local outbreaks and small-sized epidemics throughout the years. However, periods of time with high amount of humidity tend to allow the influenza virus to transmit more rapidly. The infection of the influenza virus may occur with or without any warning and subsequently, the number of people infected by the virus in an epidemic can be as small as a few hundreds of people or as many as hundreds of thousands of people.

Epidemics can be short-lived or long-lived. Short-lived epidemics last only for a few days or weeks but long-lived epidemics, also known as pandemics, can last for months. For most people, the influenza virus may appear only to be a mild disease which can be cured within days. However, for the elderly and the sick, the influenza virus is a life threatening disease.

It is important for all of us to prevent epidemics from occurring as much as possible as a widespread of the virus will result in large losses in work productivity and a downslide in the world economy. Therefore, the World Health Organisation (WHO) plays its part by establishing an international network to connect world laboratories for research and monitoring of the antigenic changes in the surfaces of the influenza virus and the extent to which the virus is spreading in the world.

II. The Viruses

a) Properties

Influenza Virus	
Genus	*Orthomyxovirus*
Family	*Orthomyxoviridae*
Diameter	80 - 120 nm
Core Diameter	9 nm
Shape	Rounded and can be long and filamentous
Replication Method	Nuclear
Genome	Segmented (-)sense RNA
RNA Structure	Helical
Properties	Labile, susceptible to heat, drying, detergents and solvents (due to the lipoprotein envelope)

b) Structure

In total, the influenza virus has 4 types of antigens. Hemagglutinin (HA) and neuraminidase (NA) are found in the outer surface of the particle and the matrix (M) and the nucleoprotein (NP) are found in the inner surface of the particle. It is the type of the nucleoprotein (NP) which determines the type of the virus. There are three forms of the nucleoprotein (NP) and hence there are three main types of the influenza virus.

Outer Surface

A lipid envelope forms the outer covering of the particle and two types of glycoprotein are projected from the envelope. They are hemagglutinin (HA) and neuraminidase (NA) which appear as rod-shaped projections of the particle. Hemagglutinin (HA) has two types of subunits, HA1 and HA2 respectively and they are responsible for the attachment of the virus to the receptor protein on the cell membrane. There are 13 major types of hemagglutinin (HA). On the other hand, neuraminidase (NA) is responsible for enzymic properties of the virus and there are 9 main types of neuraminidase (NA). It is also observed that there is a smaller quantity of neuraminidase (NA) surface proteins than hemagglutinin (HA) surface proteins.

Inner Surface

The matrix protein (M) is found. The RNA of the virus is related to the nucleoprotein (NP) closely and they form a helical structure. The genome of the virus is segmented and there are 7-8 RNA fragments of ribonucleoprotein (RNP), all of which are needed for replication. (7 RNA fragments for Type C Influenza Virus) Ribonucleoproteins (RNP) are chemically binded to the matrix (M).

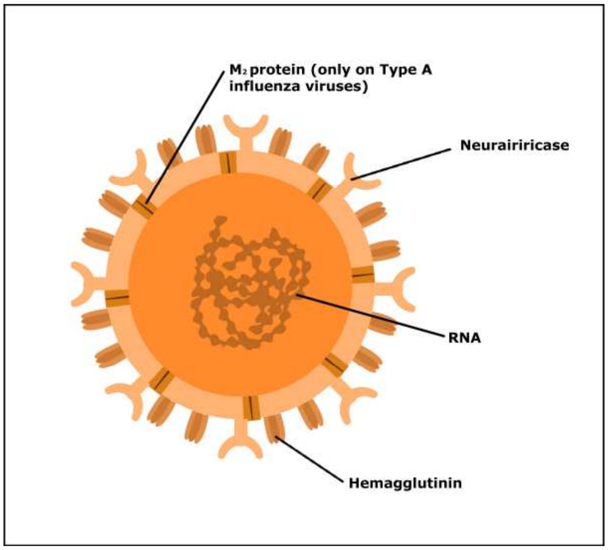


Fig 1.1 The influenza virus structure
The matrix protein (M protein) surrounds the nucleocapsid and makes up 35-45% of the particle mass.

c) Classification

Influenza Viruses			
Type	**Type A**	**Type B**	**Type C**
Classification Within Each Type (based on nucleocapsid and M protein antigens)	Classified by specific internal proteins	Classified by specific internal proteins	Classified by specific internal proteins
	Further classified by subtypes on the basis of the two main surface glycoproteins hemagglutinin (HA) and neuraminidase (NA)	Not further classified by subtypes	Not further classified by subtypes
Magnitude Of Illness	Can cause influenza epidemics and pandemics	Causes less severe clinical illness epidemics rather than pandemic outbreaks	Causes a very mild illness and does not cause significant clinical illness
Host Range	A wide variety of mammals, including man, horses, pigs, ferrets and birds	Mammals only	Mammals only

III. Strains, Types and Sub-types

a) Influenza Type A and its subtypes

Wild birds are the natural hosts of the Influenza Type A virus. Hence, they are also the sources of the influenza viruses which are spreaded to other organisms especially mammals, which include humans, pigs and horses.

As mentioned before, influenza viruses are differentiated into types A, B and C based on the nucleoprotein (NP) of the virus. For Influenza Type A viruses only, they are also further divided into HA subtypes and NA subtypes based on the two outer glycoproteins of the virus, the hemagglutinin (HA) and neuraminidase (NA). In total, there are 15 HA subtypes and 9 NA subtypes currently discovered. Hence, there are many possible HA and NA combinations of viruses. On top on this, subtypes are also differentiated into strains.

Human Influenza Viruses

All three Influenza Types, Type A, Type B and Type C, can infect humans. Some common subtypes of Influenza Type A virus transmitted among humans are H1NI, H1N2 and H3N2.

Avian Influenza A Viruses

As mentioned before, wild birds are the natural hosts of the Influenza Type A virus. Most of the Influenza Type A virus only causes asymptomatic or mild infection in birds. The extent of how serious the infection is to birds will depend of the strain of the virus.

Nevertheless, some particular Influenza Type A strains like the subtypes H5 and H7, are deadly to certain vulnerable species of birds like chickens and turkeys. These subtypes may cause a widespread rapidly over different regions in the world and they are fatal to vulnerable birds.

Low Pathogenic Avian Influenza (LPAI) and Highly Pathogenic Avian Influenza A Viruses (HPAI)

Other than classifying Influenza Type A virus based on the subtypes, HA and NA, Influenza Type A virus are also differentiated to Low Pathogenic Avian Influenza (LPAI) and Highly Pathogenic Avian Influenza (HPAI) based on criteria like the genetic combinations of the molecules and the pathogenesis of the virus after specific testing.

Low Pathogenic Avian Influenza (LPAI)

For most of the time, Low Pathogenic Avian Influenza (LPAI) viruses are related to mild disease in poultry. However, they may also evolve into High Pathogenic Avian Influenza (HPAI) viruses. This has been observed in several avian influenza outbreaks in the past. Some common strains of the Low Pathogenic Avian Influenza (LPAI) include H7N7, N9N2 and H7N2.

Direct human contact with living or dead birds infected with Low Pathogenic Avian Influenza (LPAI) is usually the cause of the transmission of the virus to humans. The symptoms of Low Pathogenic Avian Influenza (LPAI) in humans are very mild, like conjunctivitis, and are akin to Human Influenza viruses symptoms.

Highly Pathogenic Avian Influenza (HPAI)

Highly Pathogenic Avian Influenza (HPAI) viruses tend to cause severe diseases and are usually fatal in poultry. Some common strains of the Highly Pathogenic Avian Influenza (HPAI) include the subtypes H5 and H7 like H5N1, H7N3 and H7N7. However, recent research found out that some strains of Highly Pathogenic Avian Influenza (HPAI) do not cause any illness to some poultry, like ducks at all.

The symptoms of Highly Pathogenic Avian Influenza (HPAI) in humans depend on the strain of the virus. H7N3 and H7N7 can cause mild symptoms while H7N7 and H5N1 can be a severe and fatal disease.

Common Influenza Viruses Between Birds And Humans

Birds can only be affected by Influenza Type A viruses and birds are susceptible to all subtypes of the viruses. There are several distinct differences in the genetic combinations of Influenza Type A viruses which affect birds only and those which affect both birds and humans.

Three main subtypes of Influenza Type A viruses which affect both birds and humans include:

Influenza A H5

There are nine different strains of the H5 subtype discovered. The Highly Pathogenic Avian Influenza (HPAI), H5N1, is known to have spreaded rapidly in Asia and Europe in humans and it may be very fatal and deadly to humans in some circumstances.

Influenza A H7

There are nine different stains of the H7 subtype discovered. Unlike H5N1, the subtype H7, does not usually infect humans after direct contact with infected birds. However, it is still possible of infection in humans. The symptoms of H7 subtypes are ranged form mild to serious and they include conjunctivitis and upper respiratory problems. H7 subtype can be associated with Low Pathogenic Avian Influenza (LPAI) and Highly Pathogenic Avian Influenza (HPAI). Examples of each type include H7N2 and H7N7 for Low Pathogenic Avian Influenza (LPAI) and H7N3 and H7N7 for Highly Pathogenic Avian Influenza (HPAI).

Influenza A H9

There are nine different strains of the H9 subtype discovered. H9 subtype is even more uncommon to infect humans and on top of this, all records show that the H9 subtype is classified as a Low Pathogenic Avian Influenza (LPAI).

Other Animals Influenza A Viruses

Other than birds and humans, Influenza Type A viruses also infect other animal species. Some examples include H3N8 and H7N7 which infect horses and H3N8 which infect dogs. Other animals which are susceptible to Influenza Type A viruses include pigs, seals and whales.

b) Influenza Type B

Influenza Type B viruses are normally circulated among humans only. Unlike Influenza Type A viruses, Influenza Type B viruses are not differentiated into subtypes but they are also differentiated into strains. In general, Influenza Type B viruses do not causes epidemics as frequently and severely as Influenza Type A viruses. As such, Influenza Type B viruses have not caused pandemics yet. Nevertheless, Influenza Type B viruses can also cause morbidity and mortality in humans.

c) Influenza Type C

Like Influenza Type B viruses, Influenza Type C viruses are not differentiated into subtypes but they are also differentiated into strains. Influenza Type C viruses do not cause epidemics and pandemics. It is also noted that the flu shot does not protect humans against Influenza Type C viruses.

IV. Antigenic Drift And Antigenic Shift

The structure of the influenza virus does not remain the same over the time. It changes in two methods, antigenic drift and antigenic shift. All types of Influenza viruses change constantly by antigenic drift whereas antigenic shift only occurs once in a while. On top of this, Influenza Type A viruses are more susceptible to experience both methods of changes but Influenza Type B viruses can change only by antigenic drift.

a) Antigenic Drift

Antigenic drift is the minor mutation of the surface glycoproteins, namely hemagglutinin (HA) and neuraminidase (NA) of the influenza virus. Antigenic drift occurs over a long period of time and it is a gradual process.

This is the process in which antigenic drift occurs. Firstly, when a human has been infected by the influenza virus, he/she develops an antibody against the particular strain of virus after he/she recovers. Hence, in order for the influenza virus to continue being able to infect humans, it changes its outer surface glycoproteins which are the hemagglutinin (HA) and neuraminidase (NA) by a slight mutation. These minor changes in the outer surface of the influenza virus may deceive antibodies to allow themselves to infect the body.

Hence, due to the process of antigenic drift, influenza viruses are able to infect the same person for multiple times. Another result caused by antigenic drift is the seasonal epidemics occur in winter every year. In order to prevent these occasional epidemics, scientists have to create vaccines based on regular global surveillance around the world. It is also for safety precautions that people get a flu shot every now and then to protect themselves.

b) Antigenic Shift

In contrast to antigenic drift, antigenic shift is a major change to the virus structure to create an absolutely new subtype of influenza virus.

Antigenic shift can occur in two ways. The first method is by direct human contact with poultry infected with avian influenza virus and the second method is by the mixing of the human influenza virus with the avian influenza virus by a process named genetic reassortment. A new subtype which humans have little resistance and immunity to will develop and a possible pandemic may occur.

This process of antigenic shift in influenza viruses has been hastened by species which are capable of being infected by different types of the influenza virus. This species, in particular, is the pigs. The pigs are capable of being infected by the avian influenza virus, the human influenza virus and also the swine influenza virus. Hence, there is a very high possibility for genetic reassortment to occur in a pig infected by different types of the virus which will result in a novel influenza virus.

The results of genetic reassortment in pigs are undesirable. A new human influenza virus with the outer surface glycoproteins, hemagglutinin (HA) and neuraminidase (NA) of the avian influenza virus may be created. If this is the case, human to human transmission of the influenza virus will be possible because the human immunity system is unable to detect the new glycoproteins on the influenza virus. As a result, a global pandemic may happen.

Although direct contact with poultry infected with avian influenza virus does not usually lead to influenza infections in humans, there were cases in which humans have been infected by certain subtypes of the avian influenza virus.

Below are some of the conditions required for a global influenza pandemic to occur:

- A novel influenza virus which humans have no protection against is introduced
- A novel influenza virus which is able to cause serious illness

A novel influenza virus which is able to be transmitted from human to human easily

V. Symptoms of Influenza in Humans

a) Common Symptoms

Symptoms of Influenza in Humans
Fever (above 40° C)
Chills (possibly with shivering)
Muscle aches and pains
Sweating
Sore Throat
Nasal Congestion
Dry Cough
Headache
Fatigue
Malaise

Note: Some or all of the above symptoms may be present.

b) Signs and Risks

Although the virus is deposited in the respiratory tract, signs and symptoms can be observed and detected throughout the entire body. Contrary to common belief, Influenza is actually pathologically distinct from diseases like the common cold or the stomach flu. Both stated diseases are often confused with the "flu", which is incorrect. The range of severity of the symptoms of flu is wide and can be mild rhinitis at one end, to even fatal pneumonia at the other.

Some common signs and symptoms of flu are:

Abrupt onset of symptoms Patients may have the feeling of being completely pin down during the initial hours of rapidly appearing symptoms. This happens within about 2 to 4 days of incubation. Cold symptoms instead appear over a course of a few days.
Fever Patients usually experience a fever of over 37.8° C on the first day. This would usually subside on the second to third day. However, in more serious patients, fever may spike again on the third or fourth day.
Chills / Sweats / Headache Patients may (or may not) develop chills, headaches and/or sweating before or accompanying the fever.
Sore Throat Sore throat experiences usually described as a "burning" sensation.
Dry Cough Happens at the onset of illness.
Substernal soreness, photophobia and ocular problems When severe substernal pain is detected, it usually point towards the primary involvement of the trachea. Other symptoms also include prolonged fatigue, weakness and general distresses like diarrhoea and nausea.
Malaise Severe and persistent Malaise.
Myalgia Possible severe myalgia will occur, usually in the back and the extremities. Related to the severity of the fever.

When symptoms first appear, constitutional symptoms would seem more severe then respiratory symptoms. However, when the former subsides, respiratory symptoms become more evident.

Typical signs and symptoms of flu in adults include an abrupt onset of symptoms within 2 to 4 days of incubation of the virus. These symptoms include fever which surpasses 37.8° C that peaks within the first day. This will continue on for about another 4 days. Other symptoms include dry cough, headaches, chills, sweating, sore throat, myalgia, malaise and anorexia. One key differentiating factor of influenza infection from other common respiratory illnesses is that symptoms of malaise would severe and persists for several days. Other symptoms may include muscle fatigue, photophobia and other general distresses like abdominal pains and nausea. As for children, they experience relatively the same type of symptoms except that abdominal distress and myalgia appear more frequently. Their maximum temperature may also be higher, indicating febrile convulsions. Symptoms such as headaches and malaise are usually difficult for children to verbalize and express and may have occurred earlier than they first appeared. Fever and rhinitis are common in children of ages less than 5. In very young infants, rhinitis might be the only respiratory symptom.

In comparison to adults or teenagers, patients in the lower age groups usually tend to experience more of vomiting or diarrhoea. These symptoms nevertheless can be easily detected. However, symptoms such as malaise or myalgia are more difficult to identify in children if present.

c) Flu vs Cold Symptoms

Signs and Symptoms	**Flu**	**Cold**
Onset	Sudden	Gradual
Fever	High (over 38° C), usually lasting 3 to 4 days	Rare
Nasal Congestion	Sometimes	Usual
Sneezing	Sometimes	Usual
Dry Cough	Non-productive and can become severe	Hacking
Sore Throat	Sometimes	Common
Headache	Prominent	Rare
Myalgia (aches and pains)	Usual, often severe	Slight
Fatigue and weakness	May last for 2, 3 weeks	Very mild
Extreme exhaustion	Early and prominent	Never occurs
Chest discomfort	Common	Mild

d) Reported Symptoms Of Avian Influenza

Reported symptoms of Avian Influenza in human subjects ranged from typical influenza symptoms as mentioned above, to eye infections (conjunctivitis), severe pneumonia and respiratory diseases such as viral pneumonia, acute respiratory disorder and other possibly fatal complications. The symptoms of Avian Influenza depend on what type of virus caused the infection.

VI. H5N1 Virus

The Influenza Type A virus, with the subtypes of H5 and N1, H5N1, is an avian influenza virus deadly to birds which are the original carriers of the Influenza Type A viruses.

Although the H5N1 virus does not usually infect humans, there were already 160 reported cases of humans infected by this strain of influenza virus ever since January 2004 according to the World Health Organization (WHO). Majority of the humans infected by the H5N1 virus had direct contact with living or dead infected poultry. In fact, there was only one confirmed case in which human to human transmission of the H5N1 virus occurred. Hence, the strain is still not capable of transmission beyond one person.

Out of the influenza viruses capable of infecting both birds and humans which includes the H7 subtype, the H5N1 emerged as the deadliest. The H5N1 virus was identified in the most number of cases of humans infected by avian influenza viruses and the mortality rate of humans is as high as 50 percent. This can be observed in outbreaks in Asian and European countries. It is also noted that humans below the age of 5 and above the age of 65 have the highest mortality rate due to their weak immunity systems.

Although there has only been one proven case of the human to human transmission of the avian influenza virus, there is a high possibility speculated by scientist all over the world that a new strain of the influenza virus will emerge due to the slow and gradual processes of antigenic drift and antigenic shift. If the human body has absolutely no protection against a specific strain of the influenza virus, human to human transmission of the influenza virus will be easily accomplished and the first influenza pandemic may occur in this century.

The exact date of when the influenza virus will mutate to form a new strain deadly to human beings is unknown. However, all is not lost. The present structures of the influenza viruses are monitored by global surveillance and scientists and experts from advance and high tech science laboratories all over the world are working closely with each other and racing against time to develop a vaccine against a possible new strain of the influenza virus.

VII. Infection Process

a) Pathology of Influenza Infection

After the influenza virus has been inhaled into the human body, it will attack the epithelial cells in the lining of the bronchial tree and the nasopharynx.

The steps in which the influenza virus penetrates the respiratory system are as follow:

- The glycoprotein, hemagglutinin (HA), on the outer surface of the influenza virus binds to the layer of sialic acid coat of the target cell
- After contact with the target cell has been established, the target cell will be triggered to engulf the influenza virus
- The RNA of the influenza virus which is found in the inner surface of the influenza virus enters the nucleus of the target cell and the nucleus starts the replication of the RNA protein
- The glycoprotein, neuraminidase (NA), on the outer surface of the influenza virus breaks off the layer of sialic acid coat of the target cell to allow new viruses to be released from the cell and the new viruses will be spreaded across the mucous lining of the respiratory tract. After the replication of the RNA protein, cell lysis will occur after several hours.

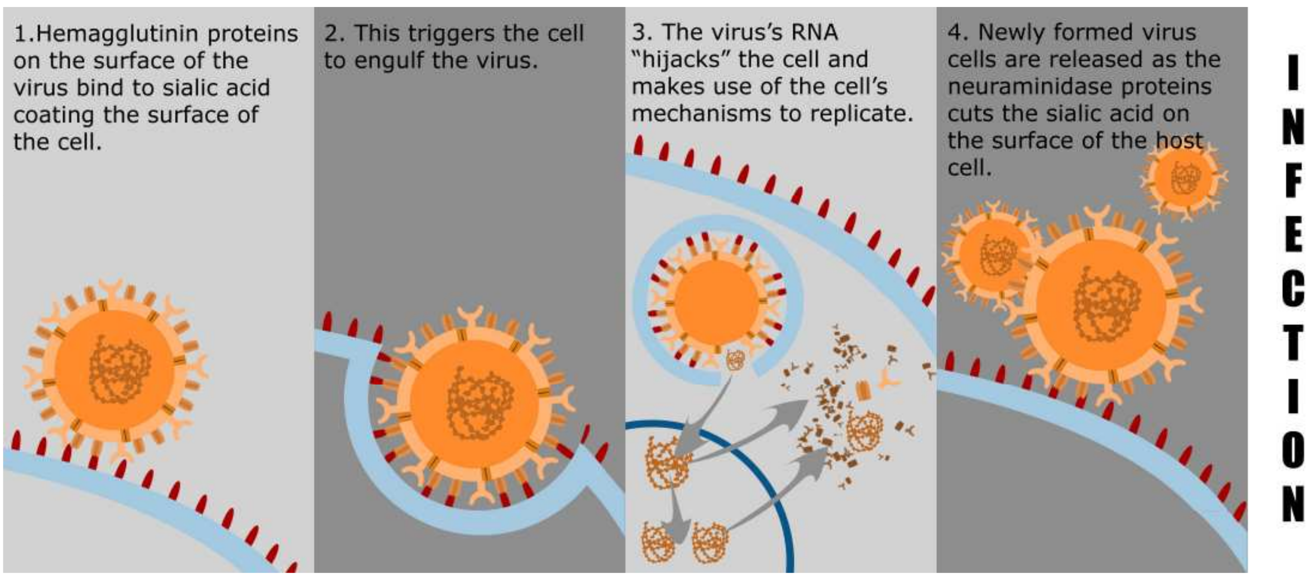


Fig 1.2 Pathology of influenza infection

VIII. Reservoirs of infection

There are three main ways in which avian influenza is spreaded. According to a United Nations officer, we are only 2 genetic mutations away from a global pandemic. Therefore, everyone should be aware about these routes of which the avian influenza is spreaded so that we can better guard ourselves against the deadly virus.

a) Seasonal linked flyways

This is the first way in which the avian influenza virus is spreaded from country to country. However, studies suggest that this may not be the fastest and main route in which the virus is spreaded as the migratory paths of birds are seasonal.

b) Illegal poultry trade

Shockingly, this may be one of the fastest way in which the virus can spread in this world of globalisation. In United States, a suspicious cargo was intercepted and poultry from Thailand were found inside. This type of illegal imports happen because poultry products from Thailand are banned as there were cases in which the poultry in Thailand were found to have the H5N1 virus. Therefore, a black market exists for farmers to sell off their poultry in desperation.

c) Habitat of farm animals

Although the avian influenza virus affects pigs, ducks and chickens, only the chickens are the most vulnerable to it as pigs and ducks are known to have a higher resistance to the virus. Therefore, it is deemed necessary to practice species separation. Pigs and ducks should be separated from chickens as chickens are the common host in the avian influenza is spreaded. As migratory birds and turkeys are the most susceptive to the virus, animal health should be monitored at all times. Besides, chicken meat is one of the highest consumption type of meat in the world as most religions do not forbid the consumption of chicken. Therefore, farmers should ensure that the chickens in the farms are always in a good health condition. The utmost important step to prevent a pandemic is to the curb the source of infection – the chickens.

IX. Discoveries found about the last 3 pandemics

Scientists in United States of America have found out recently that in the three major pandemics (Spanish Flu, Hong Kong Flu and Asian Flu) in the last century were caused by the avian influenza virus instead of the human influenza virus. The avian influenza viruses responsible for the three pandemics are not “smart” virus as they kill the hosts (either bird or human). Although the viruses are very devastating, they were not spreaded easily as the viruses tend to die together with the host body. Therefore, the viruses died off by themselves after a while.

Like all types of parasites, the avian influenza virus’ aim should instead be to expand its colony. Unfortunately for us, scientists discovered that the avian influenza viruses have mutated genetically to become “smart” viruses in recent times in order to make sure that the host does not die so that the viruses can be spreaded to other hosts.

X. Comparison between Avian Flu, Flu and SARS

Diseases	Avian Flu	Flu	Severe Acute Respiratory Syndrome (SARS)
Virus	Influenza Type A (H5NI, H7N2)	Influenza Types A (H1, H2, H3 and N1, N2), B and C	SARS-associated coronavirus (SARS-CoV)
Symptoms	Fever, Cough, Headache, Myalgia (aches and pains), Fatigue, Weakness, Extreme exhaustion, Moderate chest discomfort, Stuffy Nose, Sneezing, Sore throat	Fever, Cough, Headache, Myalgia (aches and pains), Fatigue, Weakness, Extreme exhaustion, Moderate chest discomfort, Stuffy Nose, Sneezing, Sore throat	Fever of above 38 degrees Celsius, Cough, Headache, Myalgia (aches and pains), Fatigue, Weakness, Detection of pathological changes through X-ray
Incubation Period	1 to 5 days and is contagious before and after the appearance of symptoms	1 to 3 days and is contagious before and after the appearance of symptoms	3 to 10 days
Transmission Route	Direct contact with bird faeces or saliva	Flying particles of phlegm or saliva	Direct contact or flying particles of phlegm or saliva or body fluids
Prevention Measures	Avoid direct contact with birds and have a good personal hygiene	Flu vaccination and have a good personal hygiene	Have a good personal hygiene
Treatment Methods	Influenza antiviral medications	Influenza antiviral medications	Antiviral medications, antibiotics, interferon and supportive treatments
High Risk Industry	Poultry, Butchery, Farm and Medical Industries	General Population	Medical Industry

XI. Conclusion

In conclusion, I feel that all of us should be mentally prepared for a global pandemic of the influenza to occur. According to experts of the influenza virus, as a global pandemic of the influenza virus has not occurred in this century, there is a high possibility for one to occur within the next couple of years and a global pandemic is bound to occur – it is just a matter of time for the influenza to develop a new strain.

Although human infection of the avian influenza virus is often associated with people who have close contact with poultry, the deadly avian influenza virus is constantly growing and developing over the course of time by antigenic drift and antigenic shift. We have yet to fully understand the influenza virus and its impact in humans. There are a lot of unanswered questions left blank. The difference between Low Pathogenic Avian Influenza (LPAI) and Highly Pathogenic Avian Influenza (HPAI) is still unclear as some HPAI viruses do not cause any significant illness at all.

Nevertheless, organisations all over the world, like the World Health Organisation (WHO), is actively monitoring the situation of the influenza virus and their outbreaks in various parts of the world, hoping to find some patterns and properties of the virus in order to protect the world community. However, for the rest of us, we should be constantly on the look out and on our guards to be regularly updated about the current situation of the influenza virus so that we will not be panicking our lives in times of danger.

2. Treatment and Prevention

I. Treatment

There are mainly four approved drugs used to treat or prevent influenza – amantadine, oseltamivir, rimantadine and zanamivir. Rimantadine and amantadine are effective only against type A influenza. Zanamivir and oseltamivir inhibit both influenza A and B viruses.

a) Adamantane Deriatives (Amantadine/Rimantadine)

How they work

These two chemically related drugs act against influenza A viruses but not against influenza B viruses. They inhibit the activity of the influenza virus **M2 protein**, which forms a channel in the virus membrane. This basically disables the virus from entering its target cell.

Side Effects

Amantadine and rimantadine may cause CNS (Central Nervous System) and gastrointestinal adverse side effects in healthy young adults. However, incidence of CNS side effects like anxiety, insomnia, difficulty in concentrating, lightheadedness and nervousness is apparently reported to be higher with amantadine than with rimantadine. This could be due to the fact that rimantadine has been marketed for a shorter period, and thus has not been evaluated and tested as many times. Gastrointestinal side effects like nausea and anorexia can occur in a small percentage of persons taking either drug.

Side effects of amantadine and rimantadine are usually mild and cease soon after administration of the the drug is stopped, and can diminish or disappear after the first week with continued drug ingestion. Serious side effects, like marked behavioral changes, delirium, hallucinations, agitation, and seizures, have been observed however. These severe side effects have been associated with high plasma drug concentrations and are usually observed most often among old people or those who already have underlying renal insufficiency, seizure disorders, or certain psychiatric disorders. Also, when an overdosage of these drugs is administered, CNS, renal, respiratory, and cardiac toxicity can occur.

b) Neuraminidase Inhibitors (Oseltamivir/Zanamivir)

How they work

The surfaces of influenza viruses are dotted with neuraminidase glycoproteins. The enzyme Neuraminidase is needed for the viruses to break free from an infected cell after replication, setting free new viruses that can infect other cells and spread infection. Neuraminidase inhibitors block the enzyme's activity, preventing new virus particles from being released and thereby limiting the spread of infection. Oseltamivir and Zanamivir are the two approved neuraminidase inhibitors. Oseltamivir (commonly known as Tamiflu) is orally administered in tablet form, while Zanamivir (commonly known as Relenza) is administered via an inhaler.

Side Effects

Few serious central nervous system (CNS) adverse effects have been reported for the neuraminidase inhibitor drugs. Nausea and vomiting have been observed in patients after Oseltamivir had been administered to them.
Nausea, diarrhea, dizziness, headache, and cough have also been reported during zanamivir treatment, but these were also seen when patients were given inhaled powdered placebo (fake) drug. A logical hypothesis would be that such symtoms are probably caused by the inhalation process rather than the drug itself. Thus, Zanamivir is not recommended for use in patients with respiratory diseases due to its property of having to be inhaled.

c) Comparing the Drugs

In general, the Adamantane deriative drugs seem to be as clinically effective as the neuraminidase inhibitor drugs. It is noted however that there are fewer reports of the neuraminidase inhibitors causing serious side effects than compared to Amantadine and Rimantadine, though the frequency or severity of side effects between the two drugs have not been directly compared. Resistance towards the adamantane deriative drugs also seem to arise more rapidly compared to the neuraminidase inhibitors.

Tamiflu (Oseltamivir) is also preferred between the two neuraminidase inhibitors, mainly because of the fact that, as mentioned above, Relanza (Zanamivir) has to be inhaled and would not be practical if the patient has breathing problems or respiratory diseases arising from the infection itself. Hence most experts currently agree that Tamiflu is the best of the four available drugs, however other drugs should be considered if the virus seems to develop a resistance towards Tamiflu when an epidemic breaks out.

II. Prevention

a) Chemical

A method or strategy which could be used for treatment or prevention of the avian influenza would be mass vaccination.

Vaccination – Basic Information

During vaccination, viruses that are killed with chemicals or heat, mock viruses that are cultivated with their virulent properties disabled, or simply toxic compounds from the virus could be injected into humans, developing immunity and at the same time giving rise to mild or insignificant adverse effects.

What basically happens is that our immune system will recognize these vaccines as foreign particles and destroy them, before creating a whole mass of selective lymphocytes and antibodies ready to neutralize any similar virus before it enters cells or recognize and destroy infected cells before it can multiply.

Problems with Vaccination

Production time – Scientists have always manufactured vaccines by harvesting viruses in chicken eggs. However, H5N1 viruses are as lethal to chicken eggs as well as live poultry. The virus can only be deactivated by altering its genetic code by a process known as reverse genetics, making it harmless to chicken eggs and increasing its rate of replication. Vaccines could only be harvested after this, and the whole process could take up to 6 months. A reaction time of 6 months is far too long when a new outbreak occurs.

Viral mutation - As mentioned in the previous sections (refer to Antigenic Drift And Antigenic Shift), the avian influenza virus has the ability to mutate and change its structure. Thus, the usefulness of the vaccine might be gone in a few months.

Will vaccination be able to fully eradicate/prevent the risk of an outbreak?

Definitely not. Once strains of viruses causing large-scale human infection are present, of which the vaccines could then be made from, an outbreak would have already occurred. It is also impossible to try to anticipate the form what the virus will mutate into and manufacture the deactivated virus prototype as a vaccine.

What role then can vaccination play in the fight against avian influenza? When a new outbreak of influenza virus appears, a vaccine could be quickly cultivated and mass vaccination could be carried out, limiting the spread of infection to a small group of people. The vaccine manufacturing process, as mentioned above, could be a long one however, and an enormous amount of people worldwide could have already been infected with the virus by the time a vaccine could be manufactured. Vaccination alone is not enough to allow the world to be able to cope with an outbreak.

b) Physical

Most of the preventive measures currently available only serve to contain and limit the spread of infection; they will not be able to fully eradicate and stop and outbreak from taking place.

Quarantine measures

Like during the 2003 SARS outbreak, when many countries put in place quarantine measures to cope with the outbreak, similar measures should also be used during the fight against the avian influenza. Relatives of infected persons or people who have interacted with them during their period of infection, as well as travelers who have been to affected countries should be quarantined, so as to minimize the rate of human to human transmission.

Stockpiling of Antiviral Drugs

Countries should have flu antiviral drug reserves so as to be able to cope with an outbreak quickly whenever one is reported, by spraying of disinfectant in the infected area and treating new cases of human infections quickly.

Bird Culling/Ban of live poultry

Close contact with live infected poultry is the main source of human infection. A direct method of preventing the virus from jumping from birds to humans would be to kill infected poultry within the region of infection. Bans on live poultry exports from infected regions should also be imposed, so as to limit the spread of infection and prevent the influenza from spreading across countries. However, this requires quick and efficient communication, so that infected birds could be culled before the virus is able to spread to humans outside the area.

Travel Restrictions/Advisories

Travel to countries or areas hit with the avian influenza should either be totally restricted, or if not, travelers to be advised to undergo vaccination, avoid contact with poultry, or other preventive measures, so as to prevent the virus from jumping across straits and limit the spread of infection.

Social habits

Although there are currently no proven incidences of Avian Flu transmission through humans, unhygienic social habits, eg. spitting or passing of human excretion, coughing/sneezing loudly and indiscreetly, in public, should still be heavily discouraged, with fines imposed if possible (like in Singapore where fines were imposed on casual spitting during the 2003 SARS scare), as it is usually through these uncouth habits when people get in contact with bodily fluids of others where viruses are widely transmitted. Other habits like sharing of food and drinks should also be discouraged as these will serve as means through which the virus can be easily transmitted.

Eating habits

People must exercise care especially when consuming poultry products, and avoid eating raw or half-cooked meat and eggs. In fact, all forms of raw food should be avoided as far as possible. There is however no evidence that people can contract avian flu by consuming cooked chicken meat and eggs, as heat treatment will effectively destroy any viruses. As long as thoroughly cooked, or canned, poultry products available in the market are safe for consumption. People should also be encouraged to adopt a balanced diet which includes fresh fruits and vegetables, as well as regular exercise in order to build a strong immune system.

Increased Awareness

There is little point having so many methods of prevention, if no one knew about them! People must know the basic how-s, what-s and why-s about avian flu, and most importantly, how they can prevent the risk of ever contracting it. Governmental bodies and the media have the responsibility to ensure that people are aware about vaccination, when and how to get it, as well as what countries to avoid visiting as far as possible. They must also be educated to practice good social and eating habits, as mentioned above.

If everyone could be aware on any rising pandemics and how to protect their children's as well as their own health, there would no disease outbreaks that cannot be prevented.

III. Conclusion

In order to be able to stop the virus in its tracks and limit the spread of infection to a small area once an outbreak is reported, quick and effective intervention is key. A mixture of vaccination, quarantine measures, bird culling, antiviral drugs and other measures will be able to ensure that infection is confined to a small area once an outbreak is reported, however, the flu will still go out of control if measures are taken to stop the flu only after the virus has already spread to a large area. Thus, nothing is more important than **effective communication** between poultry farmers and scientists to quickly intervene any signs of flu infection.

3. Reactions and Impacts

I. Past and Present Reactions

a) Bird Flu Crisis Overview

The first reported case of bird to human transmission of the H5N1 virus was discovered in Hong Kong in the 1997. At first, it was observed that the poultry, particularly chickens, in the area were dying off at an alarming rate. The world brushed this aside as it was simply a virus killing of birds. Then, a boy was brought in to a hospital with a strange and unknown illness. It was later identified as the H5N1 avian influenza virus. Then, more cases emerged. The scientific community was alarmed, and after talks with Hong Kong authorities, the islands entire populations of birds – over a million, were culled. The scientists briefed a sigh of relief, they had thought the virus had been stopped in its tracks.

However, unknown to them, the virus was being spread by wild birds who acted as asymptotic carriers, carrying the disease without displaying any of its symptoms, bringing it along on their intercontinental migrations.

Six year later, in the late 2003, the disease once again surfaced, this time in South East Asia. It spread like wildfire amongst the poultry farms of the region and within nine months, there were over forty reported cases, with 32 dying from the disease. A mortality rate of 70%! Unheard of in the diseases of recent times!

At around that time, outbreaks of avian influenza H5N1 occurred among poultry in eight countries in Asia (Cambodia, China, Indonesia, Japan, Laos, South Korea, Thailand, and Vietnam). More than 100 million birds either died from the disease or were killed in order to try to control the outbreaks. By March 2004, the outbreak was reported to be under control. Since late June 2004, however, new outbreaks of influenza H5N1 among poultry were reported by several countries in Asia (Cambodia, China [Tibet], Indonesia, Kazakhstan, Malaysia, Mongolia, Russia [Siberia], Thailand, and Vietnam). It is believed that these outbreaks are ongoing. Thailand had instated measures to combat the virus, sending in personnel to spray disinfectant on afflicted areas.

By the end of 2004, the bird flu had spread across all of South East Asia. It had been reported in Thailand, Vietnam, Cambodia among other countries. Even more alarming, it was recently discovered that the 1918 virus also originated from birds and H5N1 is mutating in similar ways. As Southeast Asia struggled to contain the disease, the virus spread across the globe. Recently, the avian influenza has been observed among birds as far away as Europe.

H5N1 infection also has been reported among poultry in Turkey Romania, and Ukraine. Outbreaks of influenza H5N1 have been reported among wild migratory birds in China, Croatia, Hong Kong (SARPRC), Mongolia, and Romania.

As of February 2, 2006, human cases of influenza A (H5N1) infection have been reported in Cambodia, China, Indonesia, Thailand, Turkey, Vietnam, and most recently, Iraq.

In early 2003, the virus started killing aquatic birds which originally carried the virus asymptotically. The scientific community was alarmed as this meant a mutation in the virus, which could bring it one step closer to being easily communicable amongst us.

In a zoo just outside Bangkok, 45 tigers died after being fed infected chicken. But what was more disturbing was that it was discovered that the virus was spreading between the tigers. At the same time, it was observed that the virus was spreading through laboratory cats in the same way. This raised an alarming possibility, the transmission of the virus amongst mammals of the same species.

The question now was: Was this happening amongst humans?

In 2004, an eleven year old girl was rushed to a provincial hospital in Thailand. Only a few days ago, she had fallen sick from playing with infected chickens. However, she was by the time she was brought in, she was already having difficulty breathing. The doctors did all they could, but after three hours, the girl died. Soon after, the mother and aunt became sick with viral pneumonia. Twelve days after her daughter's demise, the mother passed away as well.

Currently, the main fear is that the virus would mutate into a virus that is easily communicable among humans-via air, body fluids, etc., exploding across the globe and spreading at an exponential rate.

In light of this situation, governments across the globe have begun to initiate measures to safeguard their country against a possible pandemic. The British government, for example, has stockpiled 14.6 million doses of the anti-viral drug, Tamiflu, and is preparing to obtain more supplies. It has said that in the event of an outbreak, it will ensure that everyone in the country will get vaccination and treatment if necessary.

As can be seen, early on, the virus did not seem much of a threat. However, as time progressed and the virus spread and mutated, more people are beginning to take notice, and governments are starting to pay heed to the warnings. And there's still much to be done.

b) Reactions worldwide

Scientific Community

The scientific community is not sitting idle while the events unfold. Work is underway to develop a new vaccine for the disease. Vaccines are developed by cultivating the virus in chicken eggs, however, H5N1 attacks and kills chicken eggs, rendering efforts to cultivate it useless. The answer the scientific community has come up with to combat this problem is reverse genetics, making the H5N1 virus harmless to chicken eggs and facilitating the development of a vaccine.

Scientists are also exploring other options available as *Tamiflu* production is limited. Research is being done to develop other drugs that might be as effective, or perhaps more effective at combating this deadly virus.

The World

In the wake of the spread of the H5N1 virus, the world has begun to take notice, and many countries are rushing to stockpile drugs and draft preventive measures. More funding has also been channeled towards development and research into combating this disease.

Britain for example has stockpiled 14.6 million courses of *Tamiflu*, and has measures in place for **physical prevention** in the case of an outbreak. Thailand has deployed personnel to spray disinfectant on infected farms and villages. Many countries in Southeast Asia have to date culled millions of birds in an effort to stem the spread of the virus.

However, it is still spreading at a frightening pace. Recently there have been reports of bird flu in birds as faraway as Germany, France and other European countries.

c) Present Problems

The main fear of the scientific community now is that the H5N1 virus might mutate into a disease that is easily communicable among humans. Scientists hypothesize that this may occur when a human infected with human flu contracts the H5N1 virus as well. As we have mentioned in the scientific background, the influenza genes, being made of RNA are highly volatile and easily mutate. Thus if the two influenza viruses were to "meet", an exchange of genetic material could take place, forming a deadly virus that will spread like wildfire through the human population. In Europe and developed countries, this threat is relatively negligible. But it is in countries in regions like South Asia, with many families farming and raising livestock as a livelihood, that this threat is a very real and present danger. A boy infected with flu might be out tending to his chickens, which are infected with H5N1 and end up being infected with both viruses. It is in such an environment where the virus is most likely to mutate.

The problem with this is that it is such a difficult problem to tackle. With many countries in the world poverty-stricken or with a backward countryside, it is difficult to force the people to give up their livelihood, or provide compensation for the many millions affected should a culling scheme come into effect.

On the subject of the situation in developing countries, there is also another major problem, rural farming and culture. The rural farmers of the tropical regions in South-East Asia, such as Vietnam and Thailand, do not have the expertise, knowledge or capital to implement preventive measures such as species separation and bird vaccination. Thus propagating the spread of the disease.

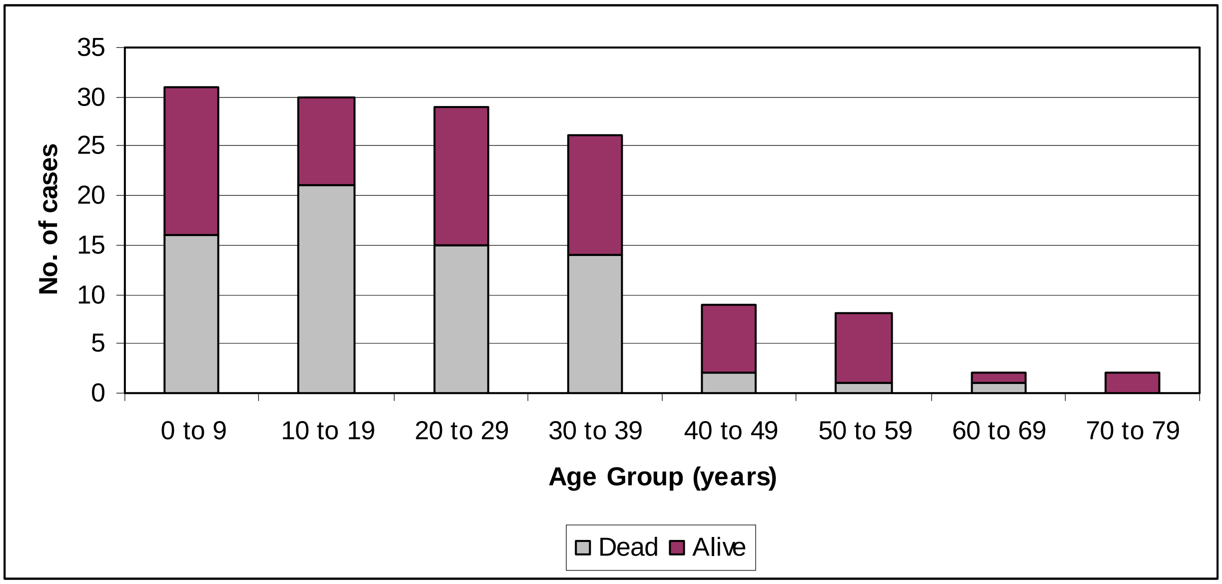
Another problem is the relative lateness that this H5N1 problem has received the attention it requires from the global community. Vaccine production has only begun recently and it would be a year or two before it is ready for use in terms of quality and quantity. Production is slow and the development tedious, therefore it would take a combined effort of the global scientific community to develop effective drugs, vaccines and counter-measures against a pandemic of the scale expected of a human H5N1 virus.

The lack of availability of these drugs has also led to stockpiling by many countries, communities, families and people. The increase in demand has led to a shortage of drugs limiting the availability to the richer developed countries, leaving the poorer under-developed countries in the lurch. This is a serious problem as the countries currently most heavily affected and expected to be most heavily affected by the H5N1 outbreak are not getting the supplies they need. Patent issues are also limiting the production of drugs like *Tamiflu* to singular companies, greatly lowering the production limit and resulting in further shortage.

If these problems are not solved before the outbreak of a human H5N1, the consequences would be dire indeed. Drug shortage would lead to limited access, resulting in social unrest as people struggle to obtain these silver bullets. Thus it is very important that present issues are resolved.

d) Present statistics

Below are statistics regarding the outcome of H5N1 cases reported as of December 2005, categorized by age group:



Source: Printout of presentation by Dr. Somachi Peerapakorn, WHO Thailand

II. Possible Impacts

a) Worst-case scenario

Causes

The current protections we have against the H5N1 viruses are few and far between, with nothing new expected in the immediate future. While the race is on to develop vaccines and drugs to counter the virus, these would take months to develop and years to produce enough quantity to treat the estimated amount of casualties. Also, many countries are unwilling to commit large amounts of resources to prepare for a disaster that might not even happen. The United states. For example, is still diverting a large amount of their resources towards defence, sparing only a fraction of the amount to help develop an anti-viral drug.

-Not enough has been done, vaccines are currently unavailable, and it will take at least six to nine months for it to be developed and a further several months to manufacture enough doses for the world.
-Anti-viral drugs are also being produced relatively slowly.

Impact Worldwide

If the virus does indeed mutate into the kind that is easily communicable amongst humans, and if it strikes in the immediate future, say next month, or even tomorrow, the world will be thrown into chaos. The already tense state of fear with regard to the possibility of such an occurrence will explode; millions of people worldwide will be scrambling for some of the already scarce supply of anti-viral drugs. Prevention measures such as screening will be carried out at airports and immigration checkpoints, however the symptoms might take as long as 2 days from the time of infection to surface, plenty of time for thousands of infected individuals to slip into the country. As the pandemic spreads and shows no sign of weakening, investors and traders will rush to sell of their stocks, businesses in affected areas will close as employees are in fear of contracting the deadly disease, leading to the crashing of markets worldwide and economic breakdown in much of the developed world. But that is only the start.

As the pandemic marches on, hospitals become overwhelmed; social unrest is widespread as people fight to get a hold of anti-viral drugs, which are now kept under tight control in order to ensure that only those that really need them get them. Local law enforcement and military forces will be spread thin as manpower ill be in short supply resulting from personnel either fall sick or refuse to participate for fear of contracting the disease. The same will go for Healthcare services as hospitals run out of drugs and adequate medical equipment. The government is in disarray, unsure how to deal with the devastating situation unfolding before their eyes. They institute martial law to control the spike in civil disorder, but without the proper enforcement, it comes to naught. Meanwhile, families are advised to stay home and in an effort to lessen the load on healthcare services, the sick are told to only approach the hospitals if there are severely ill.

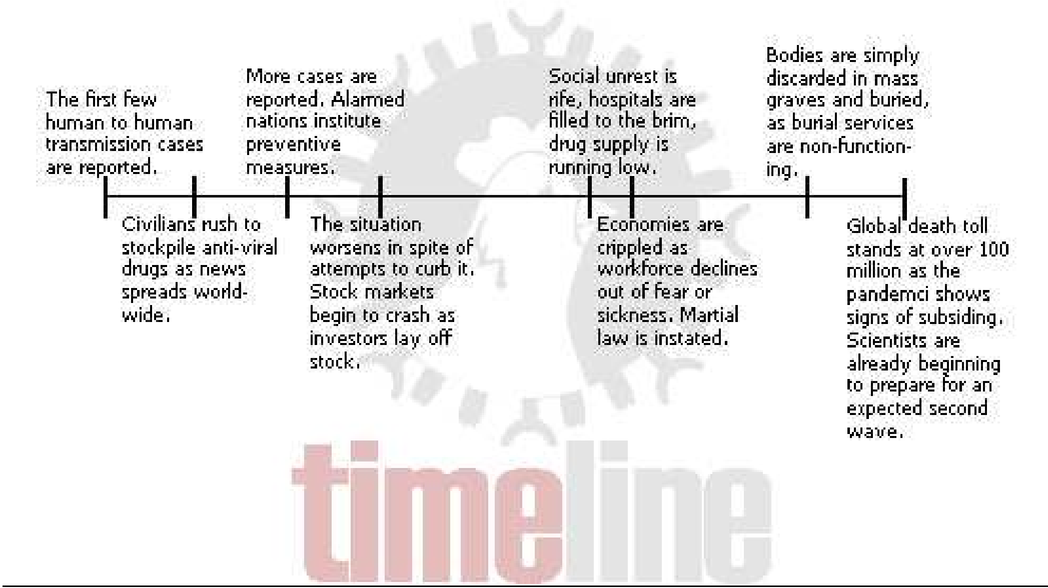
By now mass burials will be commonplace, industries and economies are crippled as whole countries come to a standstill. The basic amenities are scarce, and people are struggling to survive. The death toll stands at 100 million and could reach 150 million before the pandemic subsides.

9 weeks after the first cases were reported, the worldwide death toll stands at 130 million, and finally the pandemic begins to subside. However, there is more to come. Experts predict a second wave will arrive soon, and the scientific community scrambles to find a cure.

Such is the worst-case scenario feared by many experts and scientists today.

-Screening will be done at immigration, but the symptoms take two days to show, plenty of time for thousands of infected individuals to slip through.
-The outbreak causes an economic catastrophe as businesses shut down and traders frantically rush to sell their shares in the light of the pandemic.
-Social unrest as anti-viral drugs are scarce and limited to medical facilities. People will fight to get a hold of these drugs.
-Hospitals are overwhelmed, equipment is in short supply and drugs run out.
-Doctors face tough decisions as to who will get care.
-About 20% of those admitted to hospitals will die.
-Mass burials as burial services are overwhelmed.
-Civil disorder spiral out of control
-Industry is crippled, economies are in ruins.
-The death toll stands at 100 million and could reach 150 million before the pandemic subsides.
-Basic amenities are scarce as whole countries come to a standstill.
-Worldwide death toll stands at over 130 million.
-Second wave expected soon.

Timeline



Estimates

The following is an estimate of the economic impact of the avian flu crisis on major cities in Asia by the Asian Development Bank (ADP).

	Estimated Reduction in Annual GDP Growth, 2006 (percentage point)		Estimated Reduction in Annual GDP Levels, 2006 (US$ billion)	
Economy	**Demand Shock**[1]	**Supply Shock**[2]	**Demand Shock**	**Supply Shock**
China	4.9	0.4	80.6	6.6
Hong Kong	17.3	0.2	34.4	0.4
South Korea	6.0	0.3	36.3	1.8
India	5.4	0.3	33.6	1.9
Indonesia	2.6	0.2	5.4	0.4
Malaysia	11.1	0.2	12.4	0.2
Philippines	2.7	0.3	2.5	0.3
Singapore	22.4	0.4	23.9	0.4
Thailand	11.4	0.3	17.7	0.5
Total[3]	6.5	0.3	282.7	14.2

[1] Reduction in consumption, trade in services and investment
[2] Reduction in labor due to incapacity or mortality
[3] East Asia and South Asia, excluding Japan

Source: Asian Development Bank estimates

b) Opposing ideas

However, there are those who believe that the H5N1 virus does not pose a threat to mankind. Some believe that if H5N1 were to mutate into a virus transmissible between humans, it would have already done so. Others believe that if H5N1 were to mutate into such a virus, it would become less deadly. This theory is based on the concept natural selection, if a virus is so deadly that hosts are quickly killed, before it can be transmitted to many people, with the right measures, it will die out as quickly as it appears. Support for this theory can be seen during the 2003 SARS scare. The virus was deadly, however, it was quickly brought under control as patients were quickly quarantined and it failed to transmit, eventually dying out.

Another reason for skepticism is the relatively low infection rate of the virus. Of millions of people in contact with probably billions of infected birds, only about 200 people have been infected. This is in stark contrast to past pandemics where infection rates are very high amongst those exposed.

III. History of the Influenza Virus

a) Spanish Flu (1918-19)
This strain of flu is believed to have originated at Fort Riley, Kansas, in the United States. It is believed to be mutated of an avian flu strain by genetic drift and antigenic shift in poultry and pigs. Recently however, evidence points to the virus jumping directly from birds to humans, bypassing the pigs.

The flu spread fast and intensely, mostly due to war conditions of the time as plenty of young men were being shipped overseas to do battle. Casualties are reported from all over the world, with global mortality rate at 2.5 – 5% (Wikipedia) of the human population.

Most who contracted it were young and healthy individuals, mostly dying of pneumonia within days of the first slight cough. For the fatalities whose cases progressed relatively slower than others, they died of bacterial pneumonia, malnourishment or even animal attacks in some countries. (Wikipedia)

In response, many cities and countries closed down public places and prohibited mass gatherings. Economy was crippled in most places as available workforce dipped, and people were too scared to venture out in the open. In some food stores, the orders were not taken face to face, rather, the customers were made to place their orders outside the store and wait for their purchase. (Wikipedia)

b) Asian Flu (1957-58)
This strain of flu caused a pandemic which was relatively milder than the catastrophe of the 1918 "Spanish Flu". Believed to have originated in China, worldwide death toll is estimated at 1 to 4 million. This flu is also believed to have originated of an avian influenza virus.

c) Hong Kong Flu (1968–69)
This strain of flu evolved via antigenic shift from the "Asian Flu" virus (H2N2), originating in Hong Kong, before spreading to the United States. Worldwide death toll estimated at 750, 000, mostly because of the previous occurrence of the "Asian Flu" which is rather similar to this strain, so many people had already built up antibodies against the virus. Overall, this pandemic is the least lethal of all flu pandemics in the 20^{th} century.

d) Analysis
All the above-mentioned pandemics have been found to originate from birds, and recent developments in the current avian flu situation share a striking similarity with the development of the 1918 Spanish Flu virus. We believe that there is a real possibility of the current H5N1 virus to evolve into a strain that is capable of transmission amongst humans and thus spark of a pandemic. However, there is a likely, just as probable, chance that the virus weakens upon mutation. In the end, whatever will happen, only time will tell, and it is impossible to guess the out come of the situation today.

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•Dr. Sri Chander, a regional health advisor from World Vision, for taking the time off from his busy schedule to provide us with an interview/lecture on the topic.
•Various members of the public and fellow students whom we have surveyed
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