Influenza: An Impending Pandemic

Institute of Medicine
The National academics
Board on Health Science Policy
Committee on the Development of Reusable Facemask for Use During an Influenza Pandemic
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Influenza Virus

- RNA, enveloped
- **Viral family:** Orthomyxoviridae
- **Three types**
  - A, B, C
- **Surface antigens**
  - H (haemagglutinin)
  - N (neuraminidase)

Credit: L. Stammard, 1995
Influenza Virion

Diagram showing the structure of an influenza virion with labels for Hemagglutinin, Neuraminidase, Lipid bilayer, Matrix protein, Polymerase, Nucleoprotein, and RNA.
# Natural hosts of influenza viruses

<table>
<thead>
<tr>
<th>Haemagglutinin subtype</th>
<th>Neuraminidase subtype</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>N1</td>
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<tr>
<td>H2</td>
<td>N2</td>
</tr>
<tr>
<td>H3</td>
<td>N3</td>
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<td>H4</td>
<td>N4</td>
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<td>H14</td>
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<tr>
<td>H15</td>
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</tbody>
</table>
“Spanish Flu” A(H1N1): 1918-19

Approximately 20-40 million people died worldwide, and over 500,000 in US.
The big pandemic of 1918

The graph shows U.S. life expectancy from 1900 to 1960. There is a significant drop in life expectancy around the year 1918, which corresponds to the time of the 1918 flu pandemic.
Images from the 1918 Influenza Epidemic
National Museum of Heath and Medicine
The big pandemic of 1918

U.S. influenza and pneumonia deaths by age

Specific Death Rate

Age Divisions

<1 1-4 5-14 15-24 25-34 35-44 45-54 55-64 65-74 75-84 >85
Images from the 1918 Influenza Epidemic
National Museum of Heath and Medicine

AGE DISTRIBUTION OF INFLUENZA AND PNEUMONIA DEATHS IN BOSTON 1918

Young adults were affected most severely at the beginning of the epidemic. The disease then extended to other age groups as is illustrated by the increased proportion of deaths among children and old people during October and November.
Approximate beginning of the epidemic, 1918

Source: America’s Forgotten Pandemic - The Influenza of 1918 - 1989
“Asian Flu” A(H2N2) 1957-58

During the 1957-58 Asian flu epidemic, a school child in Islington, London, gargles to keep the virus at bay.

More than a million people died worldwide and about 70,000 in US.
Spread of H2N2 Influenza in 1957

“Asian Influenza”
Members of the Red Guard in China covered their mouths against flu germs in 1968 on the orders of Chairman Mao. The Hong Kong flu of 1968-69 killed more than 1 million people worldwide, and 34,000 in US.
Recorded Influenza Pandemics

1: epidemic, 2: probable pandemic, 3: pandemic
Definitions

- **Epidemic** – a located cluster of cases
- **Pandemic** – worldwide epidemic
- **Antigenic drift**
  - Changes in proteins by genetic point mutation & selection
  - Ongoing and basis for change in vaccine each year
- **Antigenic shift**
  - Changes in proteins through genetic reassortment
  - Produces different viruses not covered by annual vaccine
Reassortment (in humans)

Migratory water birds

Source: WHO/WPRO

Chotani, GIDSAS-JHU, 2006
Reassortment (in pigs)

Migratory water birds

Source: WHO/WPRO

Chotani, GiDSAS-JHU, 2006
From birds to humans

- Migratory water birds
- Domestic birds

- Hong Kong, SAR China 1997, H5N1
- Hong Kong, SAR China 1999, H9N2
- The Netherlands 2003, H7N7
- Hong Kong, SAR China 2003, H5N1

Source: WHO/WPRO
Mutation (in humans)

Migratory water birds

Source: WHO/WPRO
Possible spread of HPAI along major flyways of migrating birds

This map represents poultry distribution in Asia along with major lakes and wetlands and the location of outbreaks of H5N1 type of Avian Influenza since January 2005 (map updated to 18 Aug. 2005). The sources of data are as follows: AI outbreaks: OIE, FAO and Government sources. Poultry density: FAD-AGA. Global Lakes and Wetlands Database (GLWD-3): UNEP/GRID (Data provider: WWF) Major waterfowl flyways: WFP and Wetlands International (Oceania).
Countries Reporting Confirmed Occurrence of H5N1 Influenza in Poultry and Wild Birds Since 2003

As of March 3, 2006. Source: WHO/WPRO
Current Pandemic Concerns

Chotani, GIDSAS-JHU, 2006
The H5N1 Influenza Pandemic Threat

- Avian infection in Hong Kong
  - 18 human cases and 6 deaths (33%)
  - Culled poultry

- Ongoing avian H5N1 infections

- Avian infection in 9 countries
  - 34 human cases and 23 deaths (68%)
  - Culled >100 m chickens

- Avian infection in 4 countries
  - 7 human cases and 6 deaths (86%)
  - Person-to-person?
Affected Countries with Confirmed Human Cases of H5N1 Influenza since 2003

As of March 3, 2006. Source: WHO/WPRO
Cumulative Number of Confirmed Human Cases of Avian Influenza A/(H5N1) since 26 December 2003 to 2 March 2006

- 174 Cases
- 94 Deaths

No. of Reported Cases

<table>
<thead>
<tr>
<th>Countries</th>
<th>174 Cases</th>
<th>94 Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td>4</td>
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<td>China</td>
<td>14</td>
<td>8</td>
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<tr>
<td>Indonesia</td>
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<td>20</td>
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<tr>
<td>Iraq</td>
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<td>2</td>
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<tr>
<td>Thailand</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>Turkey</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>93</td>
<td>42</td>
</tr>
</tbody>
</table>

Source: WHO

Chotani, GIDSAS-JHU, 2006
Cumulative Number of Confirmed Human Cases of Avian Influenza A/(H5N1) since 26 December 2003 to 2 March 2006

Source: WHO
Cumulative Number of Confirmed Human Cases of Avian Influenza A/(H5N1) since 26 December 2003 to 2 March 2006

Survived, 80, 46%

Deaths, 94, 54%

Source: WHO
Influenza is a highly contagious disease

- Typical incubation 2 days (range 1-4 days)
- Individuals are contagious for 1 to 4 days before the onset of symptoms and about 5 days after the first symptoms
  - Peak viral shedding - first 3 days of illness
- Subsides usually by 5-7th day in adults
  - can be 10+ days in children
- Approximately 50% of infected people do not present any symptoms but are still contagious
Most human influenza infections are spread by virus-laden respiratory droplets that are expelled during coughing and sneezing.

Influenza viruses range in size from 0.08 to 0.12 µm. They are carried in respiratory secretions as small-particle aerosols (particle sized <10µm).

Sneezing generates particles of varying sizes

- 10-100 µm
The 3 modes of transmission include:

- Droplet transmission
- Airborne transmission, and
- Contact transmission
**Droplet Transmission**

- *Droplet transmission* occurs when contagious droplets produced by the infected host through coughing or sneezing are propelled a short distance and come into contact with another person’s
  - conjunctiva,
  - mouth, or
  - nasal mucosa.
Airborne Transmission

- **Airborne transmission** occurs when viruses travel on dust particles or on small respiratory droplets that may become aerosolized when people sneeze, cough, laugh, or exhale.
  - They can be suspended in the air much like invisible smoke.
  - They can travel on air currents over considerable distances.
  - With airborne transmission, direct contact with someone who is infected is not necessary to become ill.
Contact Transmission

Two Types

- Direct: involves body-to-body surface contact
- Indirect: occurs via contact with contaminated intermediate objects, such as contaminated hands, or inanimate objects (fomites), such as countertops, door knobs, telephones, towels, money, clothing, dishes, books, needles etc.
Survival of Influenza Virus on Surfaces*

- Hard non-porous surfaces 24-48 hours
  - Plastic, stainless steel
    - Recoverable for > 24 hours
    - Transferable to hands up to 24 hours
- Cloth, paper & tissue
  - Recoverable for 8-12 hours
  - Transferable to hands 15 minutes
- Viable on hands <5 minutes only at high viral titers
  - Potential for indirect contact transmission

*Humidity 35-40%, temperature 28C (82F)

Source: Bean B, et al. JID 1982;146:47-51
Affects of humidity on infectivity influenza, Loosli et al, 1943
Survival of Influenza Virus on Surfaces*

( WHO) recommends that environmental surfaces be cleaned by:

- disinfectants such as Sodium hypochloride 1% in-use dilution, 5% solution to be diluted 1:5 in clean water for materials contaminated with blood and body fluids;
- bleaching powder 7 gram/liter with 70% available chlorine for toilets and bathrooms; and
- 70% alcohol for smooth surfaces, tabletops and other surfaces where bleach cannot be used.
- Environmental cleaning must be done on a daily basis.

Whether it is an infected human or a contaminated environmental matrix, each source (Panel A) generates particles with a characteristic range of sizes. The length of time a particle resides in the air (physical decay, Panel B) depends on its initial size, its composition, and environmental factors. Similarly, the length of time an airborne organism remains infectious (biologic decay) is affected by the infectious agent's initial metabolic state, genetic characteristics, and environment. The portion of the respiratory tract of a susceptible host in which inhaled particles are deposited (Panel C) is a function of the particles' aerodynamic size; in the middle of the range, particles may be deposited in both the upper and the lower airways.
Types of protective masks

- Surgical masks
  - Easily available and commonly used for routine surgical and examination procedures

- High-filtration respiratory mask
  - Special microstructure filter disc to flush out particles bigger than 0.3 micron. These masks are further classified:
    - oil proof
    - oil resistant
    - not resistant to oil
  - The more a mask is resistant to oil, the better it is
  - The masks have numbers beside them that indicate their filtration efficiency. For example, a N95 mask has 95% efficiency in filtering out particles greater than 0.3 micron under normal rate of respiration.

- The next generation of masks are called Nanomasks. These boast of latest technologies like 2H filtration and nanotechnology, which are capable of blocking particles as small as 0.027 micron.
Reusability

- Disposable respirators
  - Should not be cleaned
  - Face-fitting is required for optimal efficacy
  - Cannot be shared
  - May be used until breathing becomes difficult, or they become damaged, dirty, or grossly contaminated with sweat/saliva.
  - If contact transmission is of concern, it may be appropriate to dispose of the respirator immediately after each use.
  - Otherwise, it may be stored and reused according to the facility’s infection control policy and procedure.

- Reusable respirators may be disinfected using a mild bleach and water solution (0.1% sodium hypochlorite).
What have been reviewed....

- The past pandemics
  - How quickly they spread
- The various strains that are circulating
- Basic definitions associated with influenza
- The current situation in birds and humans
- Basic facts:
  - The virus
  - Modes of transmission and survivability
  - Types of various masks and
  - Reusability
The Next Pandemic?

- Potential impact of next pandemic (CDC)
  - 2-7.4 million deaths globally
  - In high income countries:
    - 134-233 million outpatient visits
    - 1.5-5.2 million hospitalizations
    - ~25% increase demand for ICU beds, ventilators, etc.
# CURRENT WHO PHASE of PANDEMIC ALERT

<table>
<thead>
<tr>
<th>Phase Description</th>
<th>Risk Description</th>
<th>Alert Level</th>
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</thead>
<tbody>
<tr>
<td>Inter-Pandemic Phase</td>
<td>Low Risk of Human Cases</td>
<td>1</td>
</tr>
<tr>
<td>New Virus in Animals, NO Human Cases</td>
<td>High Risk of Human Cases</td>
<td>2</td>
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<tr>
<td>Pandemic ALERT</td>
<td>No or Very Limited Human-to-Human Transmission</td>
<td>3</td>
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<tr>
<td>New Virus Causes Human Cases</td>
<td>Evidence of Increased Human-to-Human Transmission</td>
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<tr>
<td>PANDEMIC</td>
<td>Evidence of Significant Human-to-Human Transmission</td>
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<tr>
<td></td>
<td>Efficient &amp; Sustained Human-to-Human Transmission</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: WHO Global Influenza Program

Chotani, GIDSAS-JHU, 2006
Take-home messages

- The threat to public health will remain so long as the virus continues to cause disease in domestic poultry
- The outbreaks in poultry are likely to take a very long time to control
- Should the final prerequisite for a pandemic be met, the consequences for human health around the world could be devastating
- Regardless of how the present situation evolves, the world needs to be better prepared to respond to the next influenza pandemic
Timing has a lot to do with the outcome of a rain dance

“The only thing more difficult than planning for an emergency is having to explain why you didn’t.”

Be Proactive NOT Reactive!!!!

We have to prepare for the next pandemic!!!