Influenza Biology and the Avian Flu

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November 10th, 2005
You're All Going to Die

Yes, you should be afraid of avian flu

by David S. Bernstein | p. 16
Influenza and Avian Influenza

- Influenza is an infectious disease caused by Influenza virus
- Estimated to infect ~20% of US population annually
- 40,000 US deaths annually, primarily due to pneumonia

Avian Flu
- Infects and kills poultry, wild birds
- Outbreak of human cases from birds in Hong Kong, 1997
- Current epidemic since 2003
- 125 cases, 64 deaths in Cambodia, Thailand, Indonesia, and Vietnam (Source: WHO, 11/9/05)
- Infected wild birds found in Europe
Talk Outline

• Overview of Viruses and Influenza
  – How do viruses replicate?
  – What is influenza?
  – How do new flu threats arise?
• 1918: A worst case scenario for flu pandemics
• Current treatments
• Future outlook
Generic Viral Life Cycle

- Get viral genes into host cell
- Use host cell to copy viral genes, proteins
- Assemble new virus to escape and infect new cells
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Anatomy of Influenza

- Influenza virus has a small genome:
  - Influenza: 13,500 bases
  - Humans, Mice: 3 Billion bases

- Influenza genome has 8 segments, like chromosomes

- Influenza encodes only 10 proteins (30,000? for humans)

- Two viral proteins determine how serious disease will be - Hemagglutinin (H) and Neuraminidase (N)

- Flu viruses are named for their H and N genes (e.g. H5N1)
Influenza Diversity

- Influenza can infect:
  - Birds
  - Pigs
  - Horses
  - People

- Viruses from other animals may not be as good at spreading in people, but can be more deadly
- Tremendous genetic diversity between types of influenza
- Genes can be traded through Reassortment
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Influenza Reassortment

Avian Virus: Exists today
Contains H5N1,
Cannot spread between People

Human Virus: Exists today
No H5N1,
CAN spread between People

Infected Bird Cell

Reassorted Virus: Does not yet exist.
Contains H5N1,
CAN spread between People
Why does reassortment matter?

• Referenced by the media: Avian virus “mutating” to a form that can infect humans
• In addition to gradual evolution over time, influenza can change very rapidly by reassortment
• New types of influenza that people have no immunity to can gain the ability to spread rapidly
• What happens when influenza rapidly changes?
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A case of Avian Flu

• “Spanish” Flu pandemic led to 500,000 deaths in US
• 50+% of US Army deaths during WW I
• 20-50 million deaths worldwide
• What happened?

Why was the 1918 Virus So Deadly?

- New Avian influenza strain spread rapidly in people
- Most peoples’ immune systems were unprepared for this new strain
- Wartime conditions facilitated spread, impeded containment (only neutral Spain admitted they had an outbreak)

Pictures from the National Museum of Health and Medicine
http://nmhm.washingtondc.museum/
What did 1918 teach us?

- New strains kill
- Rapid spread even easier today with more global transportation
- Epidemiologists need to track information on outbreaks and respond quickly
- The world needs to be prepared for treatment of large numbers of people, anywhere, at any time

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Fighting Influenza: Immune Response

• Your body’s immune system naturally fights off most cases of influenza

• Two lines of defense
  — Rapid, non-specific response
  — Long term, specific response

• Avian influenza weakens your immune system by blocking a chemical called Interferon
  — Interferon is normally your first line of defense against viruses - it reacts before your immune system can determine what the exact threat is
  — By preventing this response, Avian viruses have longer to do damage before you can react
Influenza Vaccine Issues

- Takes 8-10 months to design, produce, and test a vaccine for a new strain
- Current vaccine does NOT protect against Avian flu
- Mass production is expensive and prone to contamination
- Recent trials suggest that Avian flu may require eight times more vaccine than typical for influenza
Antiviral Drugs: Tamiflu

- The best known anti-Influenza drug is Tamiflu (Oseltamivir)
- Drug against Influenza Neuraminidase
- Currently derived from the Chinese Star Anise plant, other sources are possible
- Drug is expensive and in short supply
- Why? Companies think it’s hard to profit from treating survivable infections

Roche plans to scale up production, make 300 million doses per year by 2007 (still too little!)
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What can we do?

Individuals:
• Wash your hands
• Exercise, good nutrition, sleep, and not smoking keep you healthy enough to avoid infection
• High risk people may qualify for a vaccine (against seasonal influenza, not avian influenza)
• Do NOT ask your doctor for antibiotics or horde Tamiflu

Public health officials:
• Detect outbreaks early
• Use drugs to protect first responders, prevent spread
Outlook

- Influenza virus is highly adaptable and almost certain to pose a threat to public health in the future.
- Treatment options are limited and insufficient to protect the entire world.
- More research is needed to find better treatments that are easier to manufacture.

Up Next: Maria will discuss the kinds of facilities needed for this and other kinds of research.