

# “Influenza Pandemic Preparedness For US Hospitals”

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# 21<sup>st</sup> Century Epidemics/Pandemics

- ▣ SARS pandemic 2002-2003
- ▣ Re-emergence of H5N1 HPAI virus 2003
- ▣ H1N1 influenza pandemic 2009
- ▣ Ebola of 2014 in the West
- ▣ MERS in Middle East, to South Korea  
Zika virus in the Americas 2016



# Influenza Division

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## Communications

Erin Burns, Team Lead

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### Influenza Prevention & Control Team

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### Pathogenesis Team

Terry Tumpey, Team Lead

### Pandemic Preparedness Team

Min Levine, Team Lead

### Molecular Virology and Vaccines Team

Ian York, Team Lead

National Center for Immunization & Respiratory Diseases

Influenza Division



# Objectives

- History of pandemics
- How and when an influenza pandemic can take place?
- Likely scenario?
- What can we do at a hospital level?

# Conclusion of WHO, International Committee Review

- “The world is ill prepared to respond to a severe influenza pandemic or to any similarly global, sustained and threatening public-health emergency.”

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# Why pandemics are so hard to manage and be prepared for?

- ▣ -Operational efficiency
- ▣ -Limited bed surge capacity
- ▣ -Limited supply of antivirals
- ▣ -Takes time to produce vaccines
- ▣ -Relatively rare events

# Impediments

- ▣ -Limitations of scientific knowledge
- ▣ -Difficulties in decision making under conditions of uncertainty
- ▣ -Complexities in international cooperation
- ▣ -Challenges in communication among experts, policymakers and the public

# Updates for 2015 and 2016

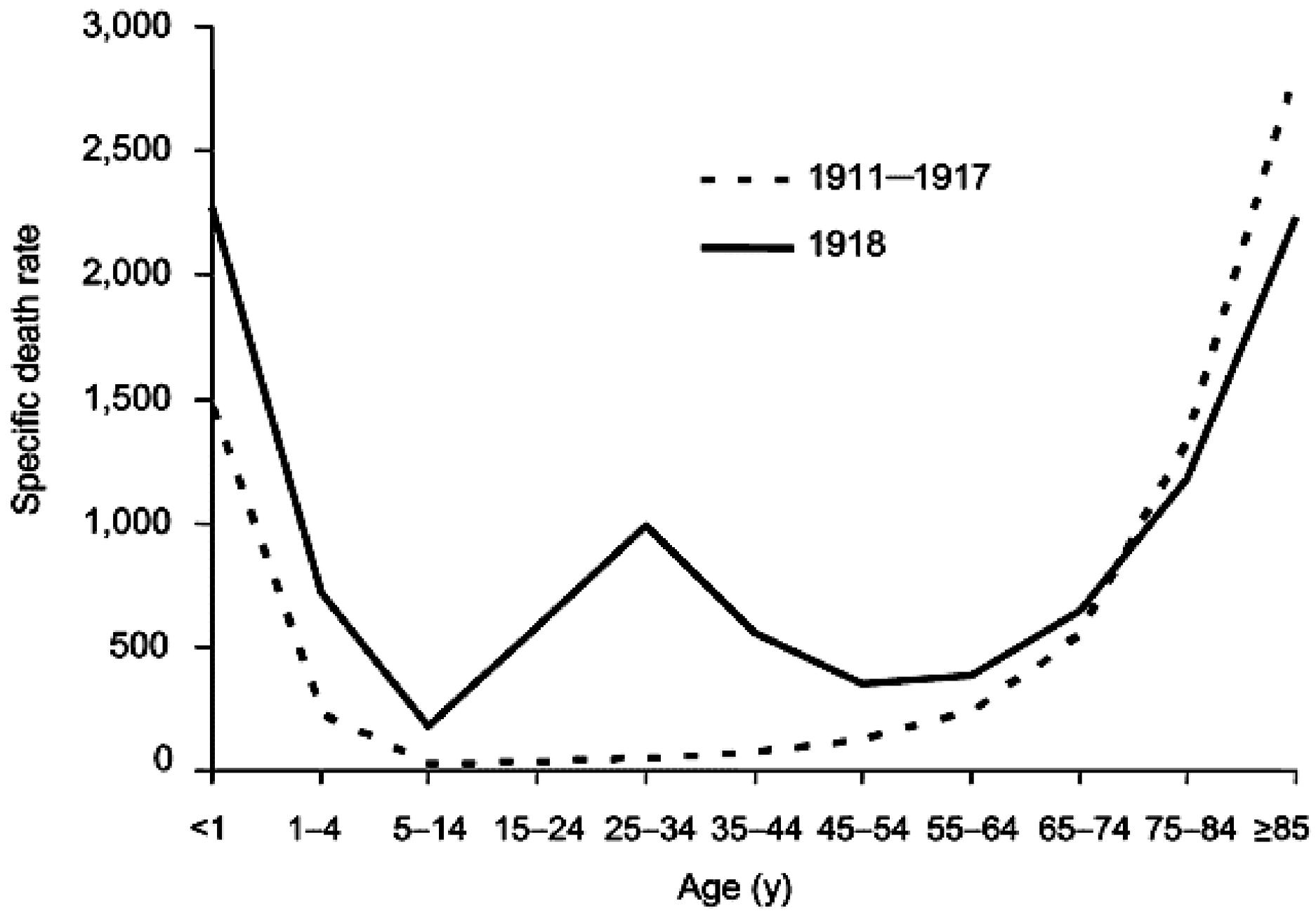
- An HPAI H5N2 virus was detected in a wild duck in the United States.
- H7N8 in Indiana farm
- H7N3 avian flu in Mexican poultry
- H5N2 in Taiwanese chickens
- H5N1 affecting more farms in Nigeria.





# Recent Pandemic History

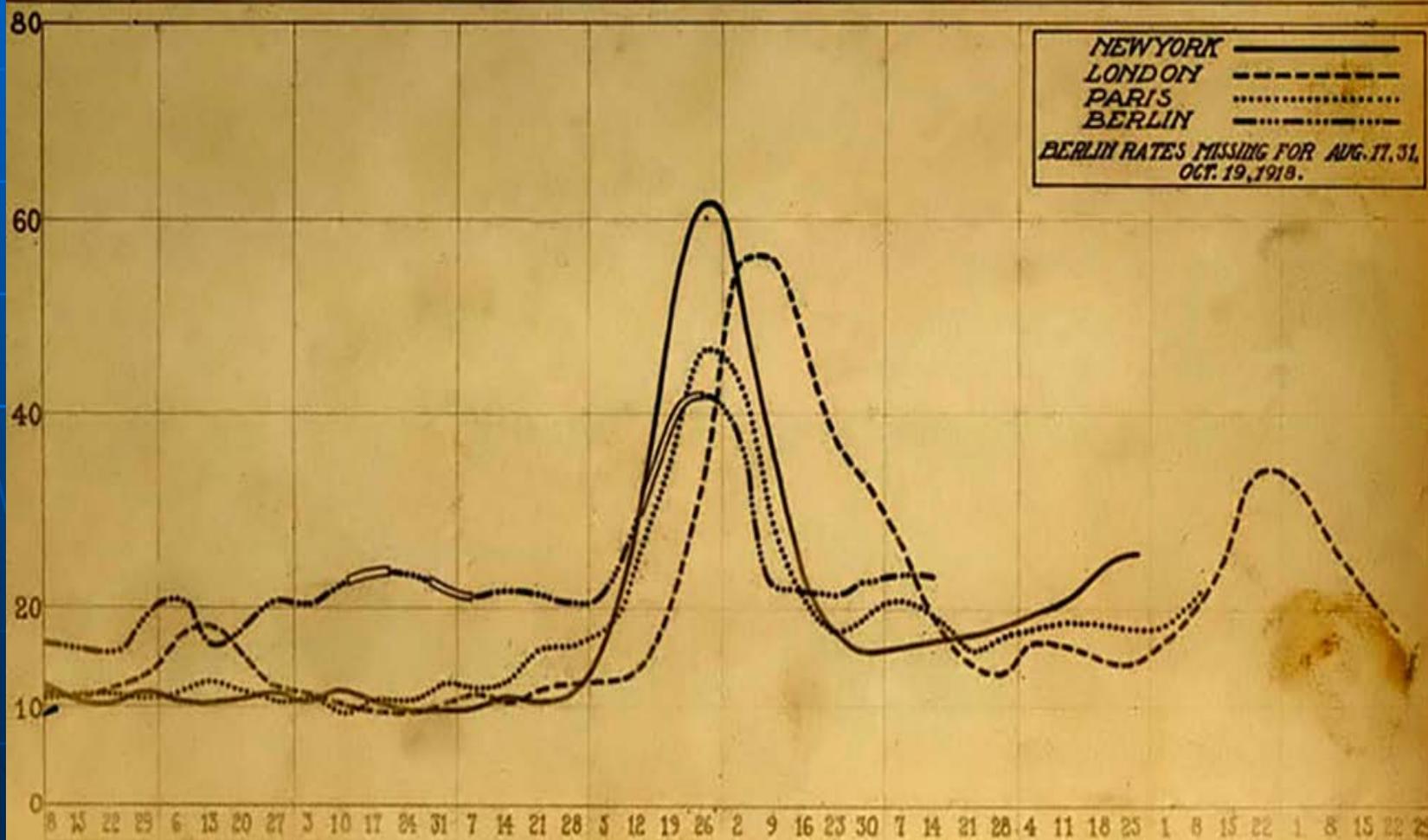
- The "Spanish flu", 1918–1919, 500 millions infected
- The "Asian Flu", 1957–58, 2 millions
- The "Hong Kong Flu", 1968–69, 1 million
- H1N1 Pandemic of 2009- 284,000 deaths



# INFLUENZA PANDEMIC

## MORTALITY IN AMERICA AND EUROPE DURING 1918 AND 1919

DEATHS FROM ALL CAUSES EACH WEEK  
EXPRESSED AS AN ANNUAL RATE PER 1000



# Origins of deadly pandemic debated

The “Spanish flu” outbreak of 1918-20 killed perhaps 50 million people worldwide. Here are three possible origins:



**ALDERSHOT, U.K.  
ÉTAPLES, FRANCE**

World War I's trenches were first seen as the source of the disease.

**SHANXI PROVINCE,  
CHINA**

A respiratory disease outbreak in 1917 may have been the first stirrings of the flu.

**KANSAS,  
U.S.**

At Camp Funston, 48 soldiers died in March 1918, just ahead of the outbreak.

# A letter from a physician wrote on the 1918 pandemic

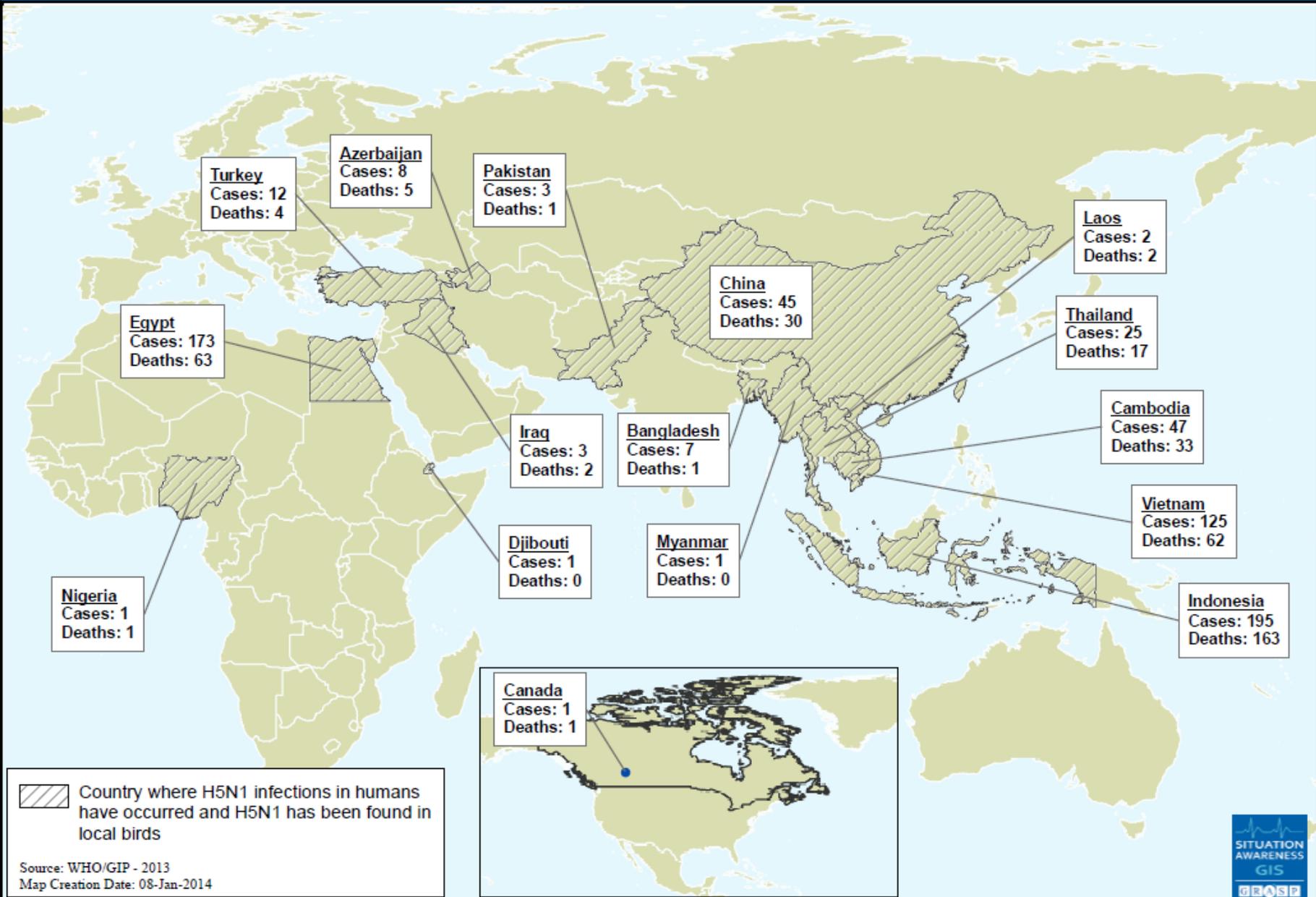
- "It is only a matter of a few hours then until death comes [...]. It is horrible. We have been averaging about 100 deaths per day [...]. Pneumonia means in about all cases death [...]. We have lost an outrageous number of Nurses and doctors. It takes special trains to carry away the dead."

# Recent Pandemic History in US

- ▣ H1N1 2009 to 2010 over 12 months
  - 60.8 million cases
  - 274,304 hospitalizations
  - 12,469 deaths
  - Fatality rate at 0.02%

# Highly Pathogenic Avian Influenza (H5N1) Human Cases and Deaths Since 2003

Status as of  
January 8, 2014  
Latest available update



# When can a pandemic occur?

- 1. A new influenza virus subtype must emerge
- 2. Must infect humans and cause illness
- 3. Must spread easily and sustainably among humans

# Why Influenza will always be a threat?

- ▣ -Socioeconomic and political development
- ▣ -Indigenous cultures and customs
- ▣ -Dietary habits
- ▣ -Mobility of 21<sup>st</sup> century







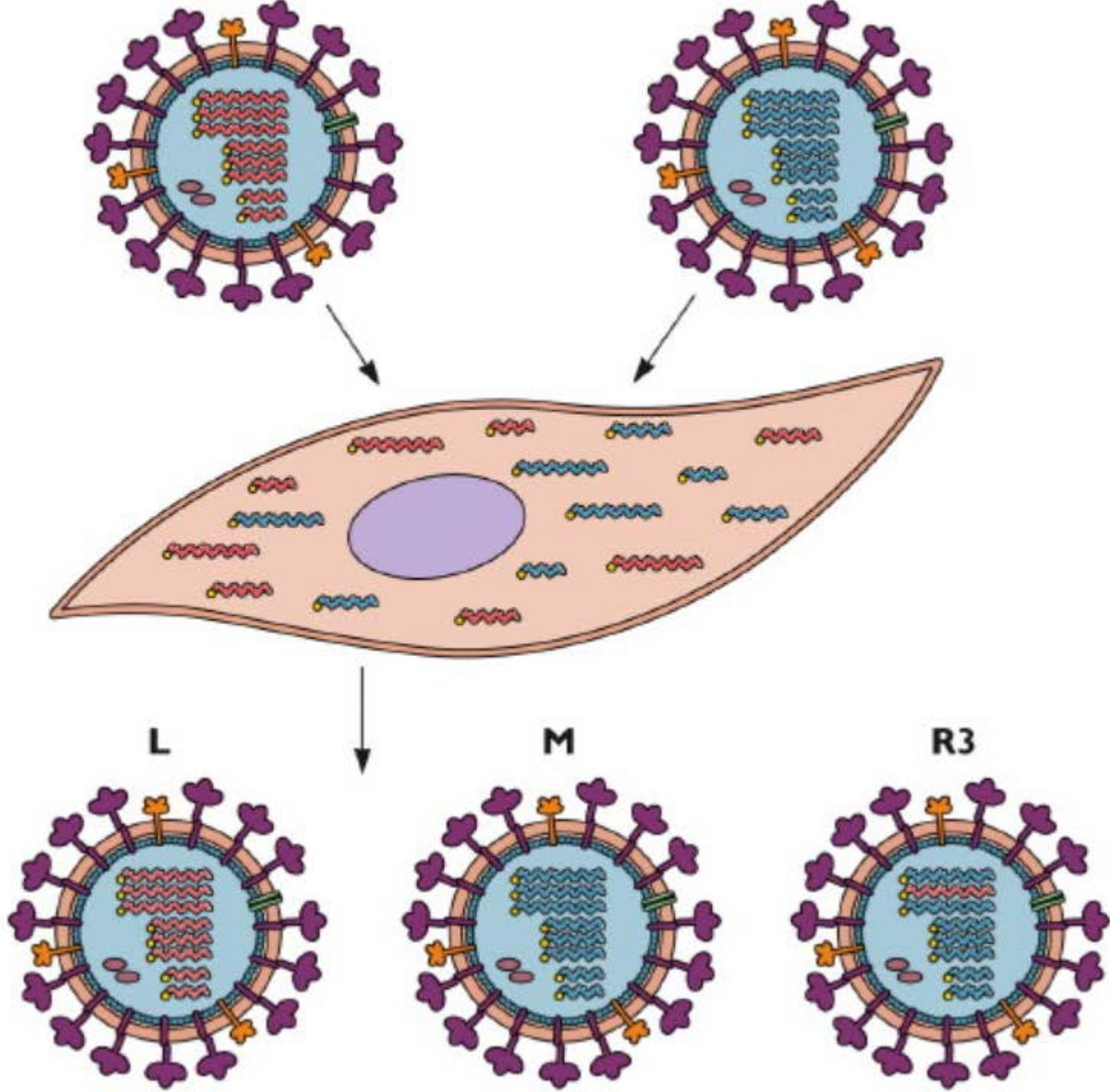


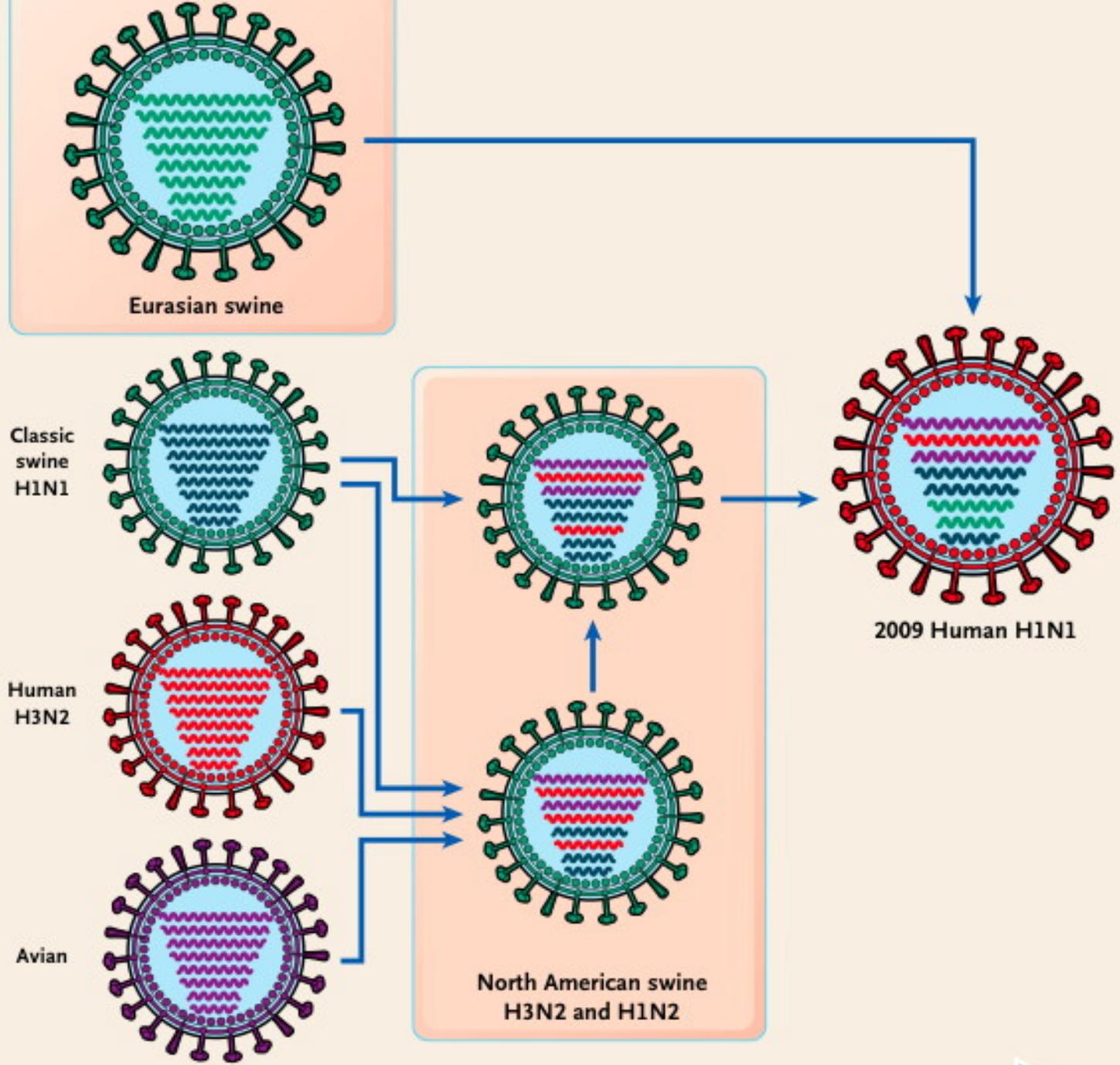


# Influenza Case Study in Airplanes in 1970s

- -54 people remained on the plane for three hours
- -Within 72 hours, nearly 75% of the passengers developed influenza. The source of the infection was a single person on the airplane with influenza

What are other pathways  
for an influenza  
pandemic?





1990

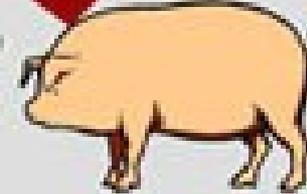
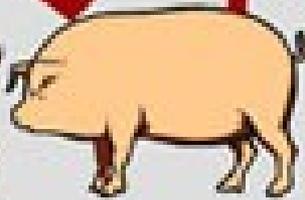
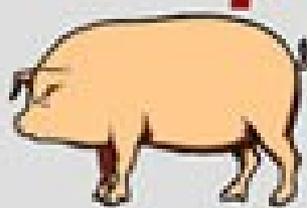
2000

2009

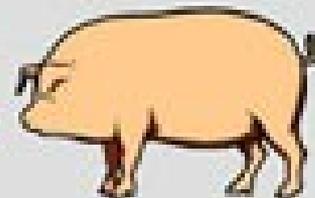
## Direct Transmission



## Adaptation



## Reassortment



# Study shows how easily pandemic H5N1 bird flu could evolve

Scientists discovered it took just five genetic mutations for a potentially pandemic strain of H5N1 bird flu virus to emerge

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**Alok Jha**, science correspondent

theguardian.com, Thursday 21 June 2012 14.11 EDT

 [Jump to comments \(35\)](#)

# U.S. panel defends call not to publish research about hyper-contagious mutant bird flu



**REUTERS** | February 1, 2012 11:49 AM ET

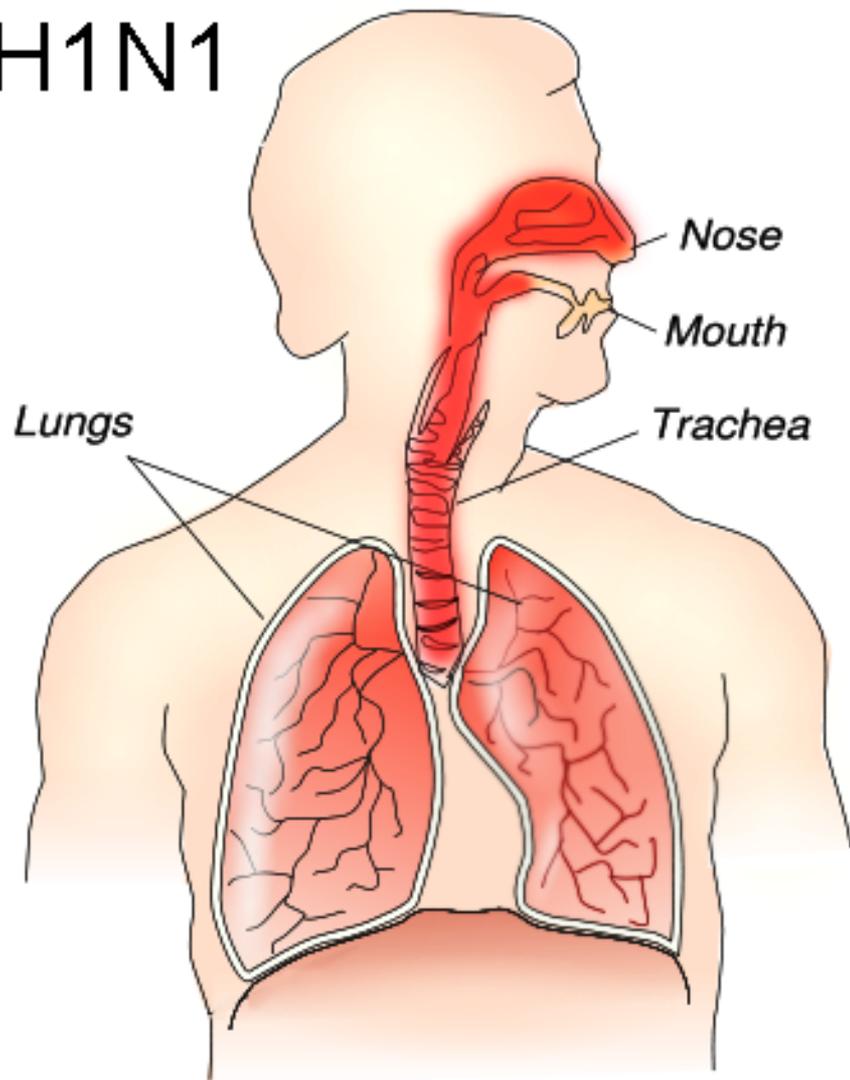
[More from Reuters](#)



# 'Appalling irresponsibility': Senior scientists attack Chinese researchers for creating new strains of influenza virus in veterinary laboratory

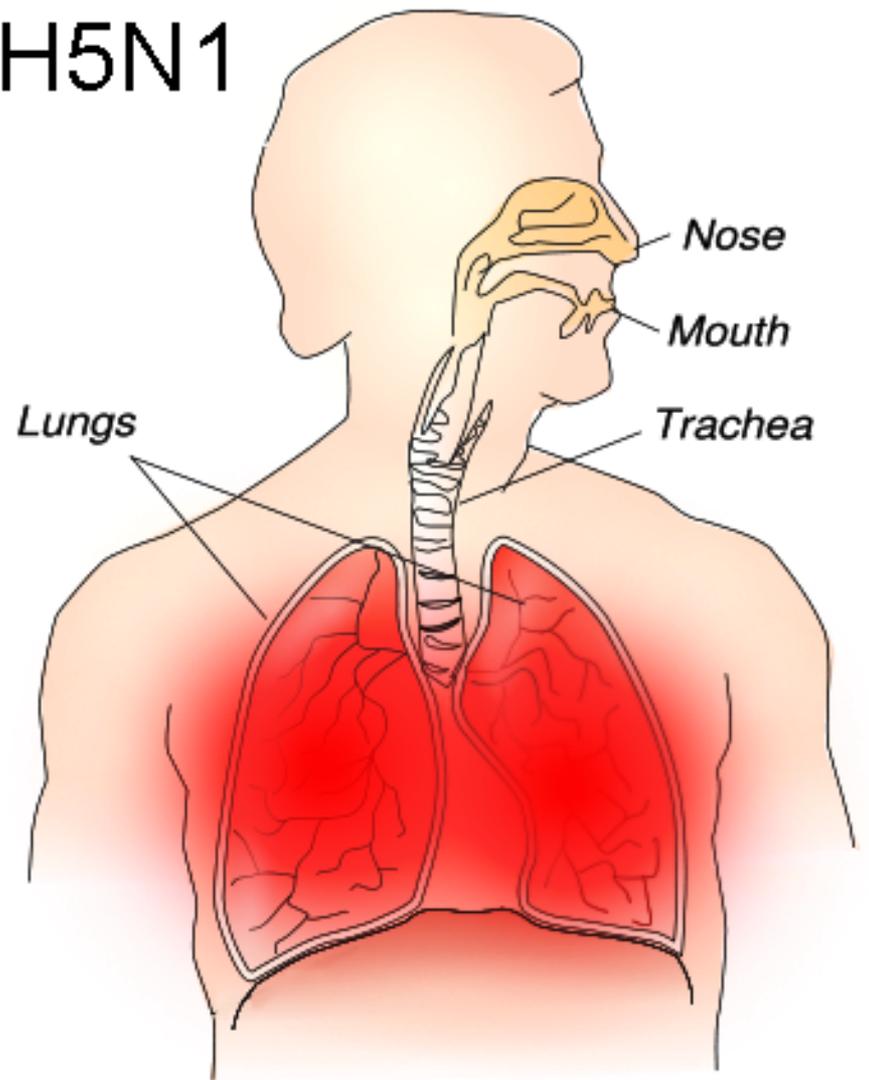


H1N1



Easily spread  
Rarely fatal

H5N1

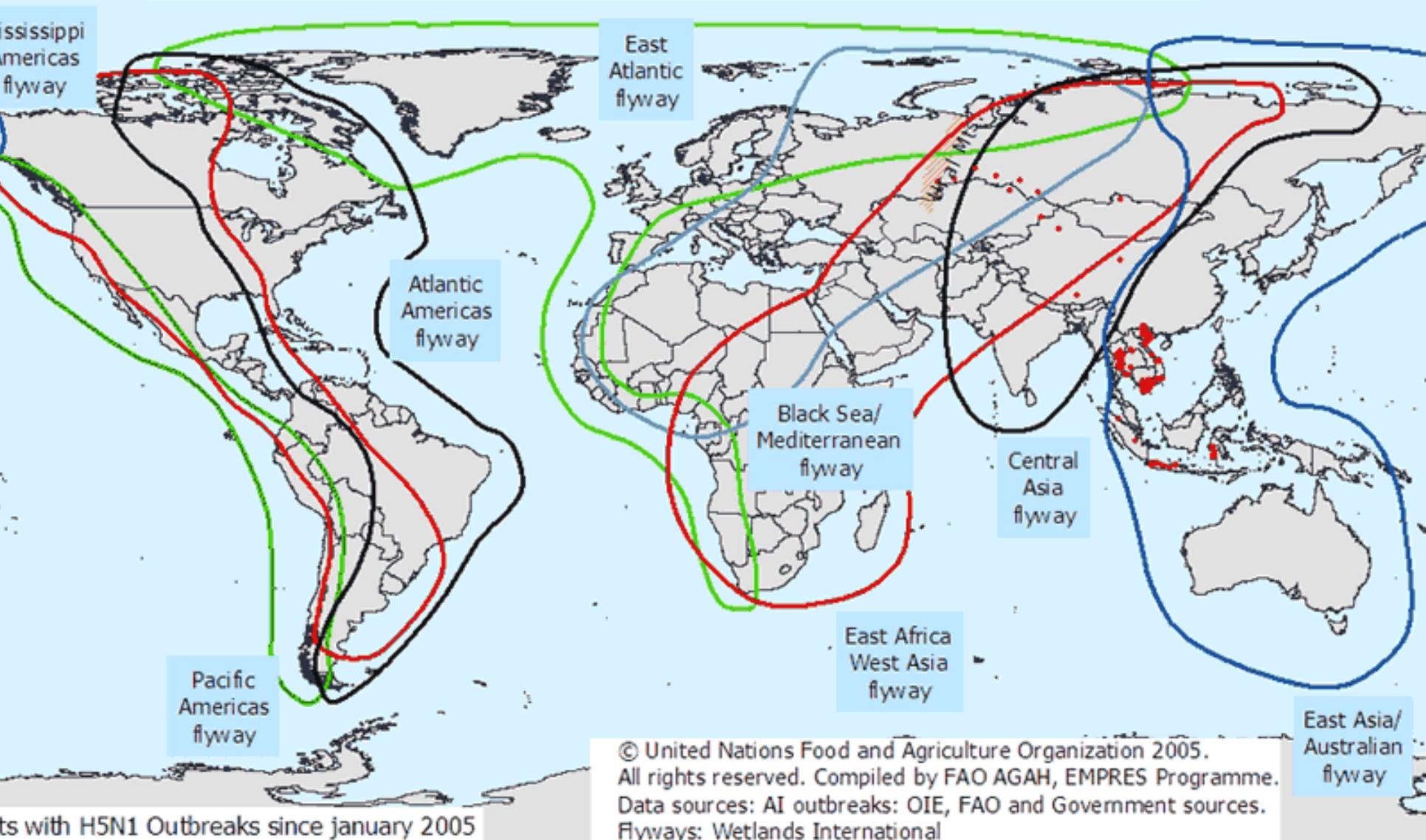


Spreads slowly  
Often fatal



# H5N1 outbreaks in 2005 and major flyways of migratory birds

Situation on 30 August 2005



ts with H5N1 Outbreaks since January 2005

# CDC explains mix-up with deadly H5N1 avian flu

Tweet 8+1 0



Jocelyn is a staff writer for *Science* magazine.

 Email Jocelyn

By Jocelyn Kaiser

15 August 2014 3:45 pm

[Comments](#)

A federal scientist may have accidentally contaminated a relatively benign avian influenza strain with the deadly H5N1 bird flu virus in part because he or she was overworked and rushing to make a lab meeting, according to an internal report released today by the Centers for Disease Control and Prevention (CDC).

In the March incident, CDC sent a sample of low-pathogenicity H9N2 bird flu virus that a lab had unknowingly contaminated with H5N1 to a U.S. Department of Agriculture (USDA) lab, which discovered the mistake when test chickens died. CDC Director Thomas Frieden first disclosed the incident in July at a press conference about other lab

accidents. Frieden was especially troubled, he said, because the H5N1 incident was not reported to top CDC leaders for 6 weeks.

# Influenza Basics

- Human influenza A and B viruses cause seasonal epidemics
- Influenza B viruses are not divided into subtypes
- Influenza type C infections cause a mild respiratory illness

# Influenza Basics

- The Influenza A virus subtypes are labeled according to an
  - H (hemagglutinin) (H1 to H16)
  - N (neuraminidase) (N1 to N9)
  - Pandemic potential

# Serotypes pathogenic in Humans:

- H1N1, which caused Spanish Flu in 1918, and Swine Flu in 2009
- H2N2, which caused Asian Flu in 1957
- H3N2, which caused Hong Kong Flu in 1968
- H5N1, which caused Bird Flu in 2004
- H7N7, which has unusual zoonotic potential<sup>[39]</sup>
- H1N2, endemic in humans, pigs and birds
- H9N2
- H7N2
- H7N3
- H10N7
- H7N9

# Incubation Period

- Following exposure to infected poultry, 7 days or less, often between 2-5 days
- In clusters of human to human transmission, 3-5 days

# Clinical Features of H5N1

- Most gave hx of recent exposure to dead or ill poultry
- Wide range of infection-mild symptoms to life-threatening disease
- Presentation may depend on duration of exposure to virus

# Clinical Features of H5N1

- Conjunctivitis only
- Influenza-like illness
- Severe respiratory illness
- Nausea, abdominal pain, diarrhea, vomiting
- Neurologic changes (altered mental status, seizures).

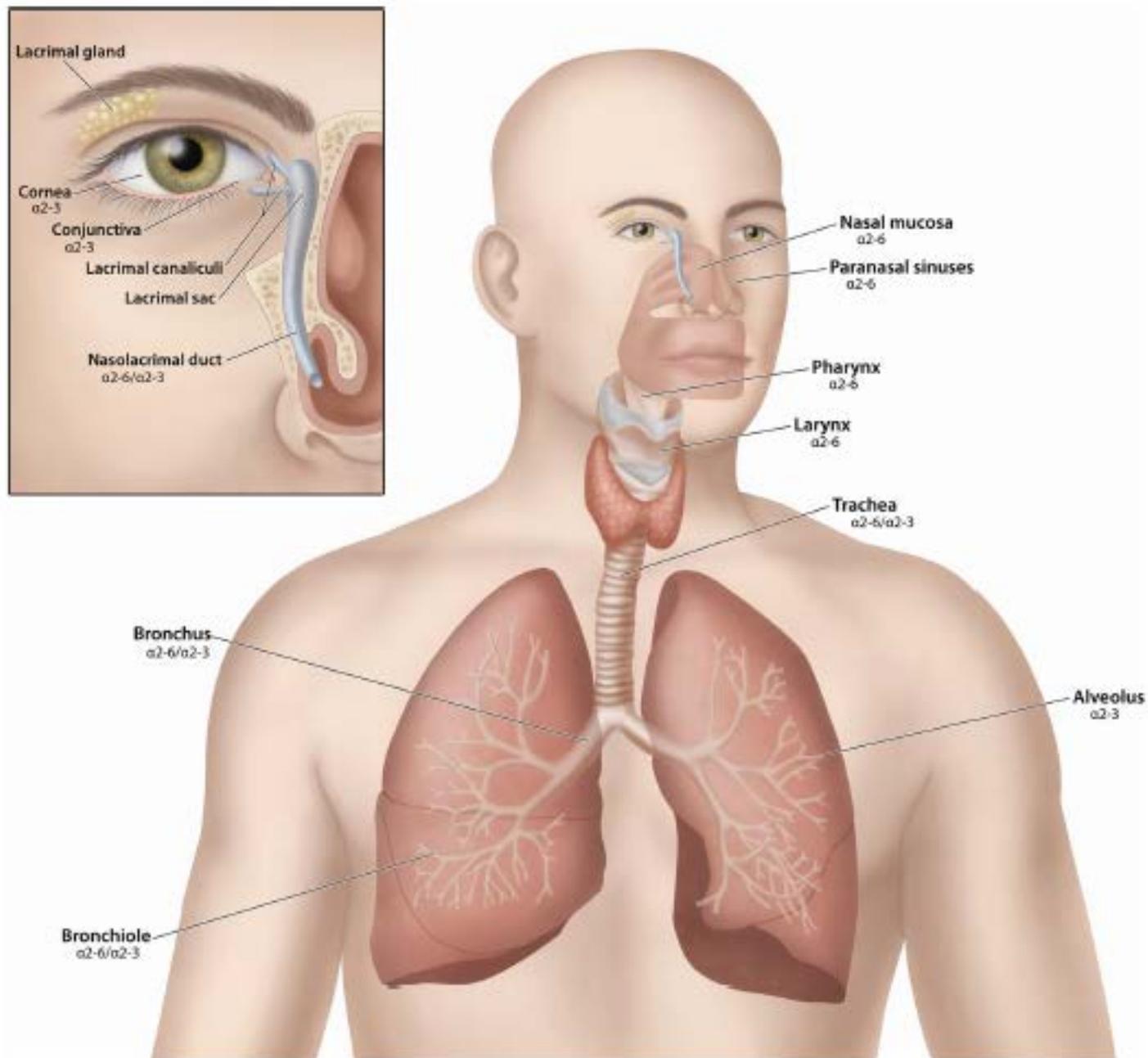
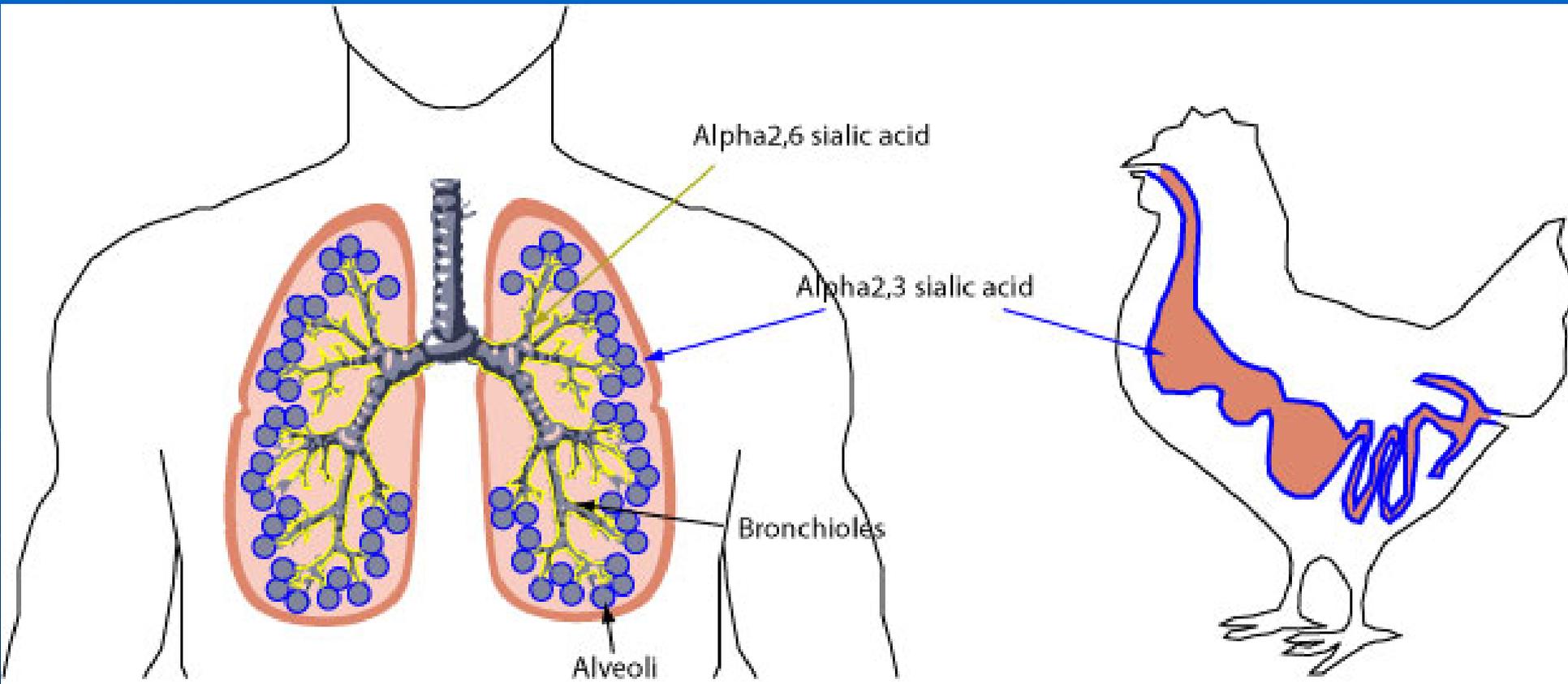


FIG 1 Distribution of sialic acids in human ocular and respiratory tract tissues. Major components of human ocular and respiratory tissues are depicted, with the predominant  $\alpha 2-6$ - and/or  $\alpha 2-3$ -linked glycan expressed on epithelial cells identified where known (see references 37 and 3). While these sialic acids are predominantly employed by adenovirus and influenza virus, additional cellular receptors and the viruses which utilize them are discussed in the text.







4A



How ready are our  
hospitals?

What is the likely  
scenario of an Influenza  
Pandemic?

# Ventilator ICU Bed Capacity in US?

Our nation has only 105,000  
ventilators as of 2005, per  
NEJM

**Table 1. Number of Episodes of Illness, Healthcare Utilization, and Death Associated with Moderate and Severe Pandemic Influenza Scenarios\***

Characteristic	Moderate (1958/68-like)	Severe (1918-like)
Illness	90 million (30%)	90 million (30%)
Outpatient medical care	45 million (50%)	45 million (50%)
Hospitalization	865,000	9,900,000
ICU care	128,750	1,485,000
Mechanical ventilation	64,875	742,500
Deaths	209,000	1,903,000

\*Estimates based on extrapolation from past pandemics in the United States. Note that these estimates do not include the potential impact of interventions not available during the 20th century pandemics.





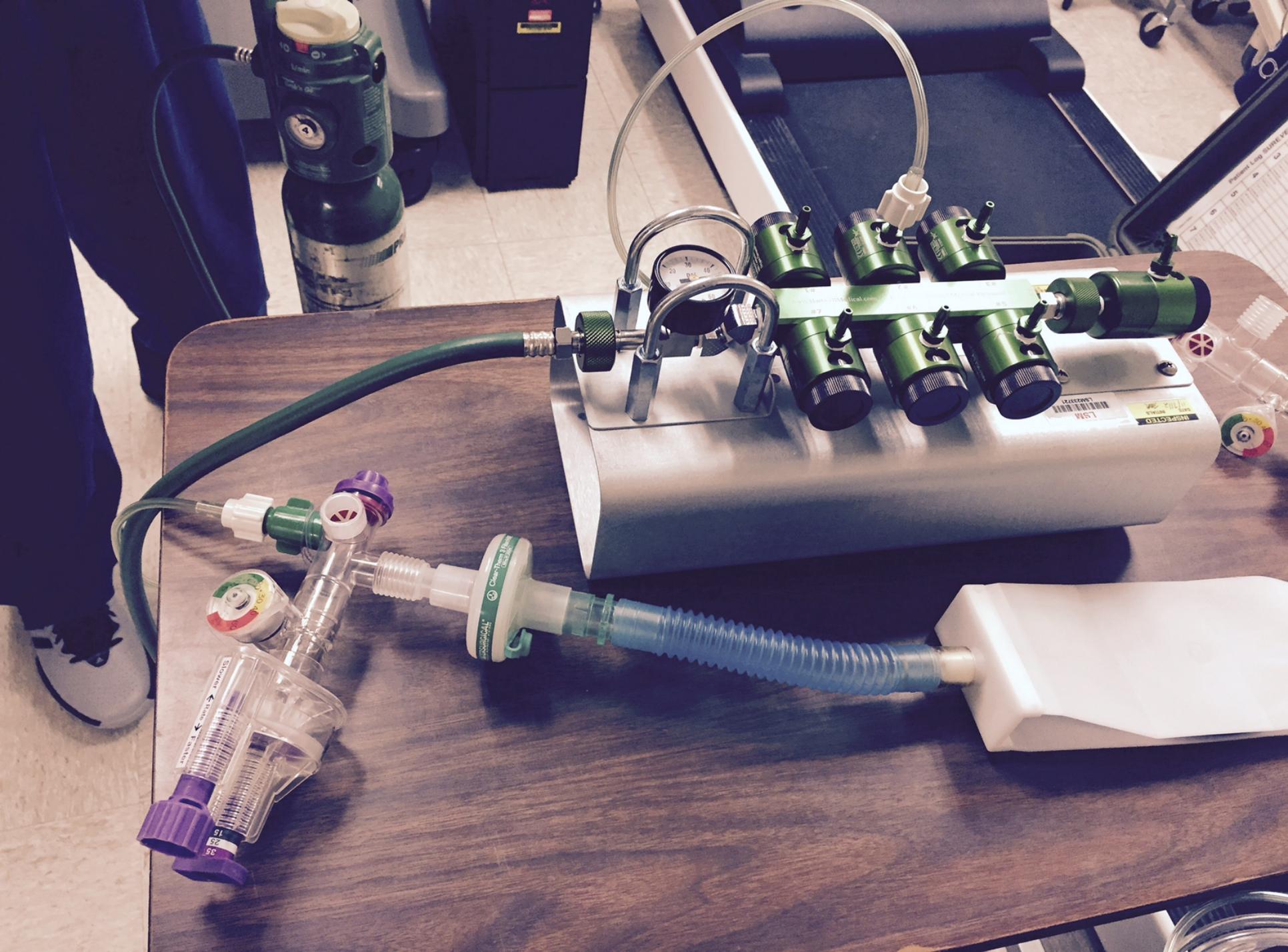
“A number of surveys have found that 16%–33% of HCWs may not report to work in the event of an influenza pandemic”

According to CDC on Emerging Diseases Article, “Pandemic (H1N1) 2009 Risk for Frontline Health Care Workers,” Volume 17, Number 6—June 2011



# Call for Ethics Committee

- -To decide who meets the criteria for intubation and to be ventilated
- -If limited antivirals, prioritize
- -Triage those deemed to be
  - Expectant
  - Suspected vs confirmed influenza

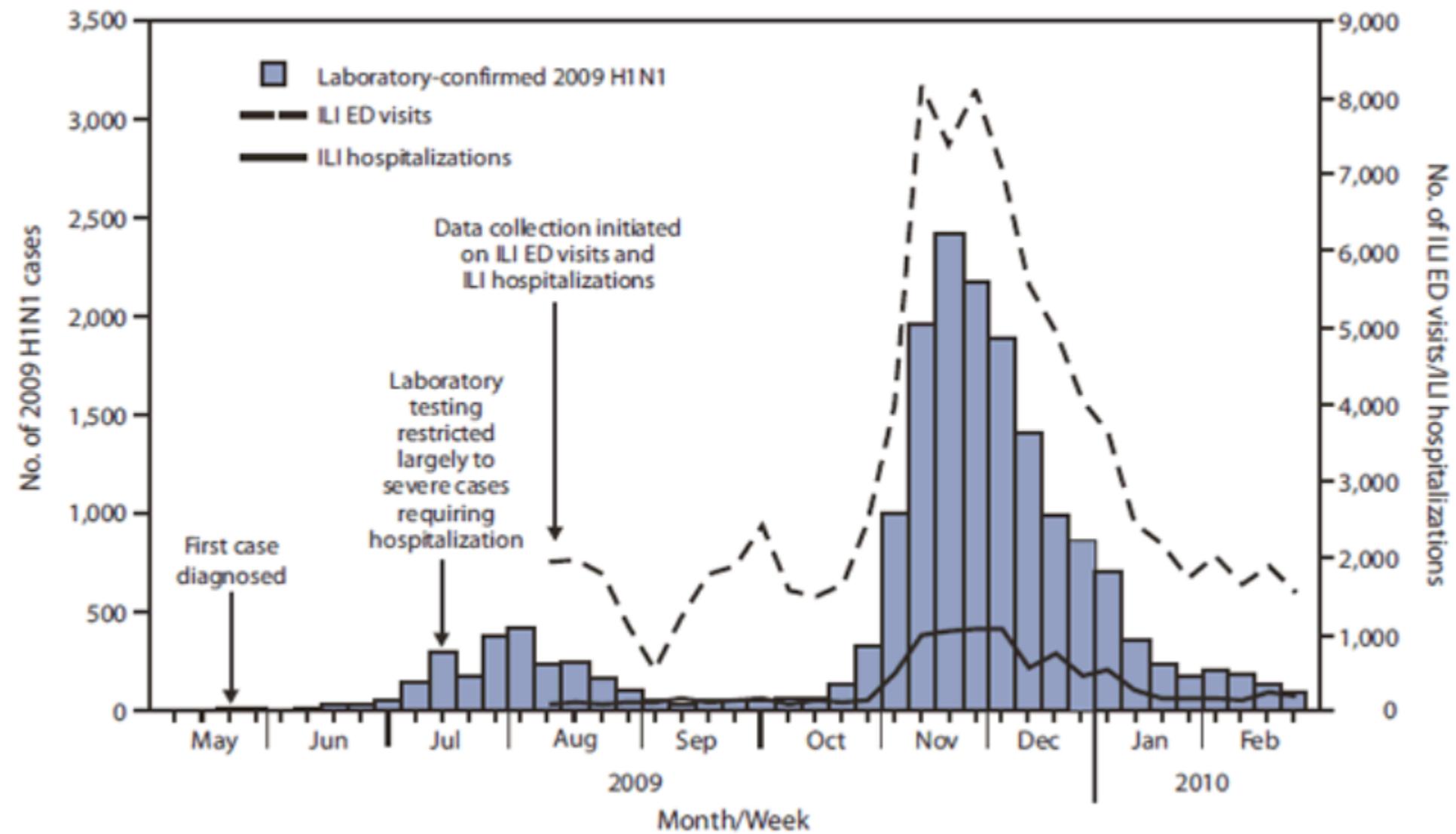


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**FIGURE 2. Number of laboratory-confirmed 2009 pandemic influenza A (H1N1) cases,\* influenza illness (ILI) visits to emergency departments (ED),<sup>†</sup> and ILI hospitalizations<sup>§</sup> --- Greece, May 1 -February 28, 2010**



\* By week of diagnosis (N = 18,075).

<sup>†</sup> ...

# What are our defenses?

- -National and global Surveillance
- -Infection Control
- -Pharmacotherapy
- -Vaccine
- -Social Distancing

# National Influenza Surveillance

1. Virological Surveillance-85 U.S. World Health Organization (WHO) Collaborating Laboratories and 185 National Respiratory and Enteric Virus Surveillance System (NREVSS)
2. Outpatient Illness Surveillance
3. Mortality Surveillance
4. Hospitalization Surveillance
5. Summary of the Geographic Spread of Influenza



# Bird flu and danger to humans

Bird flu, or avian flu, has a high mortality rate in humans, but as of yet, can ~~not~~ be transmitted from person to person.

... WHO, February 20th, 2006:  
"Human infections remain a rare event."

## Infection with type A virus H5N1

**1** Most virulent bird flu virus; mutates rapidly, altering its genetic material

**2** Humans infected by close contact with live infected poultry

**3** Birds carry virus and excrete it in feces, which dries, becomes pulverized and then can be inhaled or taken in by touch

**4** Humans have no immunity against this virus

## Reason for concern

Humans infected with bird flu could serve as a host for a new genetic subtype that can be transmitted from person to person

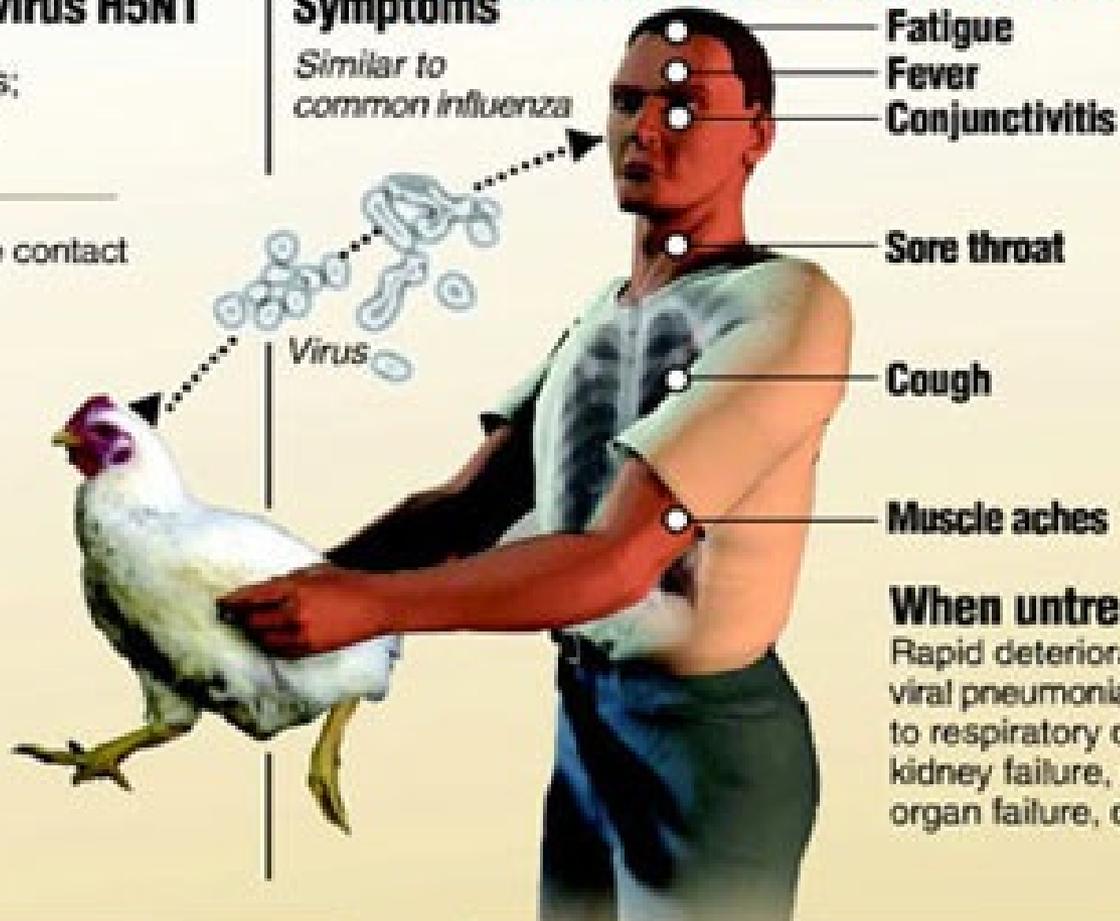


Might start influenza pandemic



## Symptoms

Similar to common influenza



Fatigue

Fever

Conjunctivitis

Sore throat

Cough

Muscle aches

## When untreated

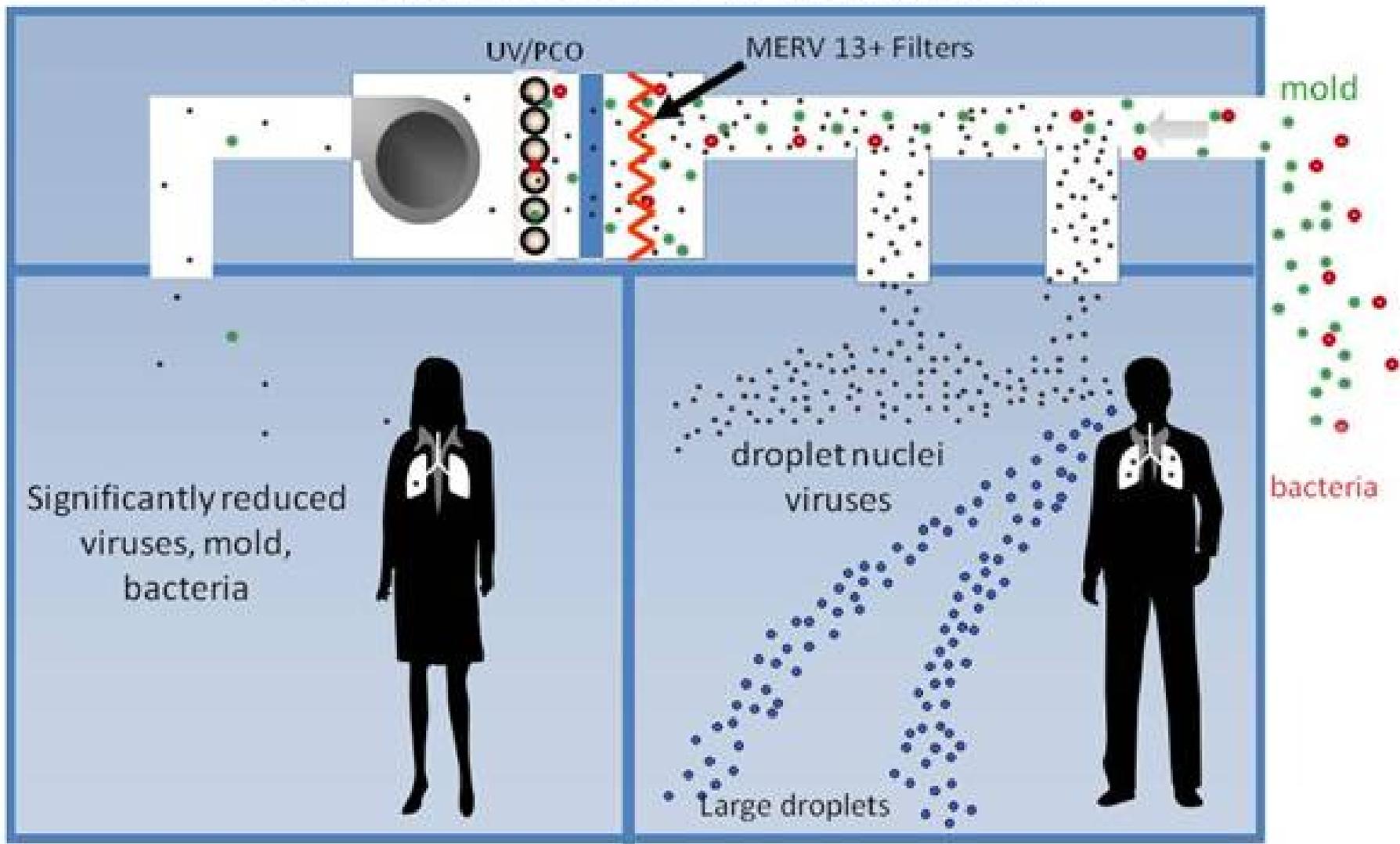
Rapid deterioration; viral pneumonia leading to respiratory distress, kidney failure, multi-organ failure, death

# Infection Control



# Biological Air Cleaning

## Airborne Disease Transmission



Graphic courtesy of Steven Welty, Green Clean Air

# Why Influenza tend to be more prevalent in colder climates?

- Transmission of infection was most efficient when the humidity was 20-35%;
- It was blocked at 80% humidity.



Room Humidifier





# Influenza Treatment

- -Tamiflu(oseltamivir) and Relenza(zanamivir)
- -Rapivab(Peramivir) in IV only
- -Supportive care
- -Aggressive bacterial treatment as needed

# Vaccine Production Options

- -Egg based
- -Cell culture
- -Recombinant DNA

Table. Adjusted vaccine effectiveness estimates for influenza seasons from 2005-2015

Influenza Season†	Reference	Study Site(s)	No. of Patients‡	Adjusted Overall VE (%)	95% CI
2007-08	Belongia 2011	WI	1914	37	22, 49
2009-10	Griffin 2011	WI, MI, NY, TN	6757	56	23, 75
2010-11	Treanor 2011	WI, MI, NY, TN	4757	60	53, 66
2011-12	Ohmit 2014	WI, MI, PA, TX, WA	4771	47	36, 56
2012-13	McLean 2014	WI, MI, PA, TX, WA	6452	49	43, 55
2013-14	Unpublished	WI, MI, PA, TX, WA	5990	51	43, 58
2014-15	ACIP presentation, Flannery	WI, MI, PA, TX, WA	9329	23	14, 31

# Public health response?

- ▣ Early identification of sources(national and international surveillance)
- ▣ Maintain good contact with possible cases
- ▣ Systemic culling of infected poultry
- ▣ Isolation and treatment of suspected or confirmed cases.

# Public health response goals

- ▣ -Goal to contain outbreak as much and early possible
- ▣ -Massive vaccination campaign to follow
- ▣ -Prophylaxis with antivirals

# Comparison of tools available to fight the next Influenza Pandemic



# 1918 Spanish Flu      21<sup>st</sup> Century

No antivirals

No ventilators

No antibiotics

1/3 of HCWs died?

Majority young 20-40s

yrs of age

# 1918 Spanish Flu

# 21<sup>st</sup> Century

No antivirals

No ventilators

No antibiotics

1/3 of HCWs died?

No antivirals ?

No ventilators

No antibiotics?

1/3 of HCWs will not  
show up for work

What are lessons from  
recent outbreaks?

**“We have the Spanish influenza situation well in hand now.”**

**—“100 Sailors at Great Lakes Die of Influenza,” *Chicago Daily Tribune*, September 23, 1918, p. 1.**

**Dr. John Dill Robertson,  
Health Commissioner for Chicago**

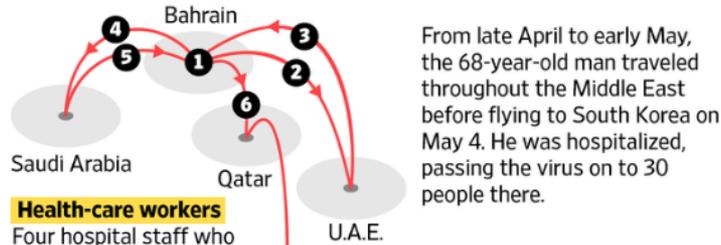
# Underestimate of the Pandemic

- -Sept 23, 1918, <50 deaths/day
- By October 1, > 400 deaths per day
- -Two weeks later, at the peak of the epidemic, > 2000 per day.
- -By early November, approximately 300



## How MERS Spread in South Korea

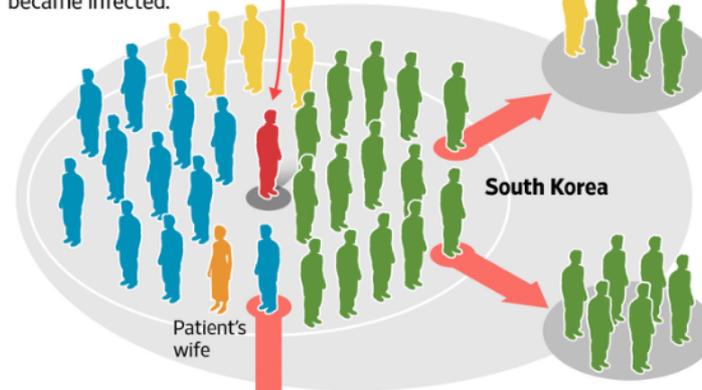
About a month after the country's first patient arrived from the Middle East, the virus had spread to 40 other people. A look at its initial path:



From late April to early May, the 68-year-old man traveled throughout the Middle East before flying to South Korea on May 4. He was hospitalized, passing the virus on to 30 people there.

### Health-care workers

Four hospital staff who provided care for the man became infected.



### Wife, visitors

Patient's wife was infected, as were 11 people who visited his room or ward. One caught the virus when visiting his father, who shared a room with the patient. He later traveled to China, where he was diagnosed.



### Fellow patients

Fourteen infected people were admitted to the same ward or had contact with the man as patients.

### Secondary cases

Ten people who had no contact with the patient, but were exposed to people he infected, caught the virus.

Note: Reflects cases through June 5. Sources: European Center for Disease Prevention and Control; Korea Centers for Disease Control and Prevention.

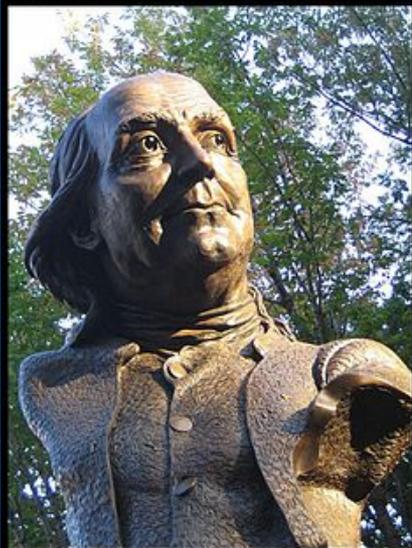
# SARS 2003 in Toronto

- Of the almost 375 people who contracted SARS in this outbreak,
- 72% were infected in a healthcare setting,
- 45% of these cases were HCWs, including 3 who died

# Lesson from “Tale of Two Cities”







# Summary

- Influenza viruses are the most adaptable and deadly
- Our defenses are weaker than we hope for
- The key is how well hospitals handle sentinel cases
- Swift public health response

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