Emerging Infections

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May 20, 2013

Emerging Infections: Outline

I. Definitions and contributing factors
II. Fungal meningitis
III. Carbapenem-resistant Enterobacteriaceae
IV. Novel coronavirus
V. Influenza

"Emerging Infections"

- New or reemerging disease
- Past 35 years
- Many caused by zoonotic agents
- Seen with increasing frequency
- Contributing or precipitating factors
- Can result from combination of factors

Examples

- Cholera
- Hantavirus, Hantaanvirus
- SARS, coronavirus
- HIV
- Hepatitis C
- Hemolytic Uremic Syndrome
- Novel influenza viruses
- Exserohilum rostratum / fungal meningitis

Factors Contributing to Disease Emergence[1, 2]

- Ecological changes (economic development, land use; agriculture; dams; deforestation and reforestation)
- Human demographic factors (population growth, migration, war and conflict; sexual behavior, IV drug use)
- International travel and commerce (movement of goods and people)

[1] Institute of Medicine Report, 1992; [2]Stephen Morse, EID Vol. 1, No. 1, Jan-March 1995

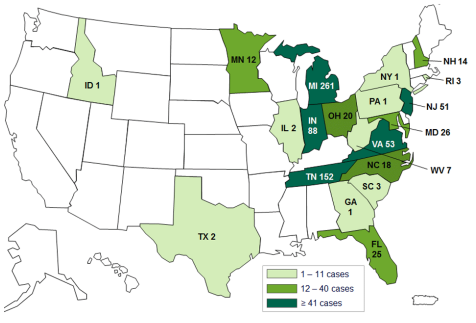
Contributing Factors (2)

- Technology and industry (mass food production, globalization of food supply, organ transplants)
- Microbial adaptation, evolution, e.g., genetic drift and genetic shift in Influenza A, selective (antimicrobial) pressure
- Breakdown in public health measures (conflict, bankruptcy, premature program cuts, inadequate sanitation / inadequate sterile environment)

Factors in Combination

- Egypt: Schistosomiasis (product of dam and irrigation), followed by hepatitis C outbreak resulting from inadequate mass injectable treatment in 1060s-80s
- Travel and poverty, introducing cholera in areas previously free: South America in the 1990s (ballast water of freighters); Haiti in 2010 (South Asian strain, outbreak onset following foreign aid arrival after earthquake)

FUNGAL MENINGITIS



http://www.cdc.gov/hai/outbreaks/meningitis-map.html

Conclusion

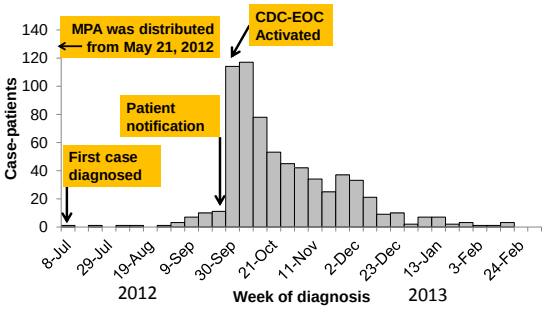
- **Largest healthcare-associated infection outbreak in US history**
  - Contaminated Methylprednisolone Acetate (MPA) caused substantial morbidity and mortality
- **Large number of exposed persons required rapid identification and notification**
  - Likely resulted in earlier diagnosis and treatment
  - Likely to have reduced morbidity and mortality

Scope of Problem with Compounding Pharmacies

← Compounding pharmacies intended to provide customized medication on small scale

Production en masse → without regulatory oversight for good manufacturing practices might result in compromised quality assurance

Epidemic Curve (n=680)



Case-Patient Diagnoses by April 1, 2013 (n=730)

- **584 had a single diagnosis**
  - 308 had parameningeal infection
  - 236 had meningitis
  - 33 had peripheral joint infection
  - 7 had a stroke
- **146 had more than one diagnosis**
  - 144 had parameningeal infection and meningitis
  - 2 had parameningeal infection and peripheral joint infection

Incubation Period*

Case definition	Median days	(range)
Stroke (n=7)	24	(3 - 157)
Meningitis (n=231)	36	(0 - 146)
Parameningeal infection (n=403)	49	(7 - 182)
Peripheral joint infection (n=34)	62	(22 - 190)

*Defined as the time between the date of the last injection prior to diagnosis to the date of diagnosis

Anne Purfield, Epidemic Intelligence Service Conference, April 22, 2013

Organisms Isolated from Unopened MPA Vials

- ***Exserohilum rostratum***
  - Predominant organism from clinical specimens and vials of MPA
- **Other bacteria and fungi**
- ***Aspergillus spp.* not recovered from vials**

Exserohilum rostratum

Anne Purfield, Epidemic Intelligence Service Conference, April 22, 2013

CARBAPENEM-RESISTANT ENTEROBACTERIACEAE (CRE)

http://www.takepart.com/article/2013/05/10/superbugs-CREs-ecoli-salmonella

What are CRE?

- Enterobacteriaceae:
  - Family of bacteria normally found in the GI tract
  - E. coli, Klebsiella, etc.
  - Cause infections when they get into the bladder, blood, or other areas where germs don't belong
- CRE:
  - Enterobacteriaceae that have become resistant to all or almost all antibiotics, including last-resort drugs called carbapenems

http://www.cdc.gov/vitalsigns/HAI/CRE

Why Should We Care?

- CRE infections are hard to treat, and in some cases, untreatable
- CRE easily spread their antibiotic resistance to other kinds of germs, making those potentially untreatable as well
- New carbapenemases (NDM, VIM) spreading from other countries

http://www.cdc.gov/vitalsigns/HAI/CRE

Why Should We Care?

4% & 18% About 4% of US hospitals had at least one patient with a CRE (carbapenem-resistant Enterobacteriaceae) infection during the first half of 2012. About 18% of long-term acute care hospitals* had one.

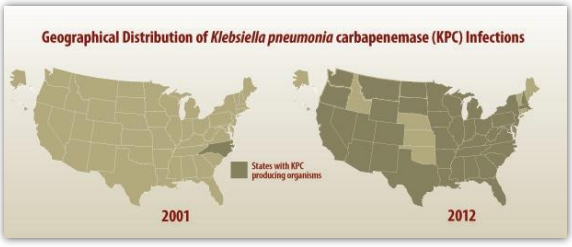
42 One type of CRE infection has been reported in medical facilities in 42 states during the last 10 years.

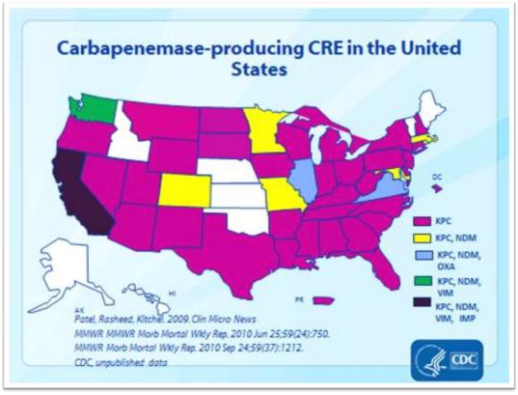
1 in 2 CRE germs kill up to half of patients who get bloodstream infections from them.

Untreatable and hard-to-treat infections from CRE germs are on the rise among patients in medical facilities. CRE germs have become resistant to all or nearly all the antibiotics we have today. Types of CRE include KPC and NDM. By following CDC guidelines, we can halt CRE infections before they become widespread in hospitals and other medical facilities and potentially spread to otherwise healthy people outside of medical facilities.

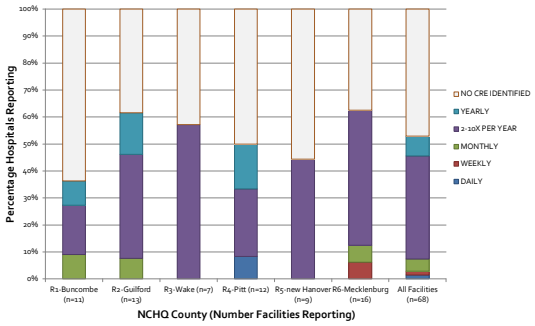
http://www.cdc.gov/vitalsigns/HAI/CRE

KPC in the United States



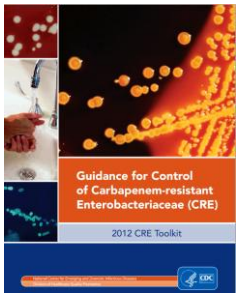


Frequency of CRE Identification among North Carolina Hospitals by Region

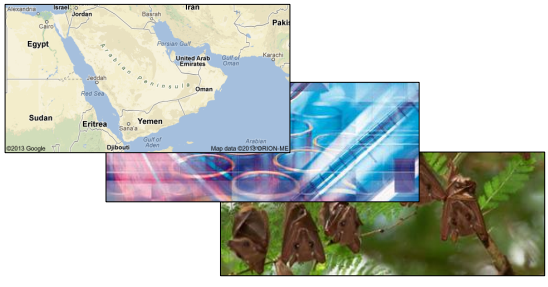


2012 CDC CRE Toolkit

- Guidance for healthcare facilities
- Guidance for regional prevention



NOVEL CORONAVIRUS (NCoV)



Images: CDC, Google Maps

NCoV: Background

- First identified in patient from Saudi Arabia, September, 2012
- Different from other coronaviruses in humans, including SARS
- Most similar to coronaviruses found in bats
- No specific treatment

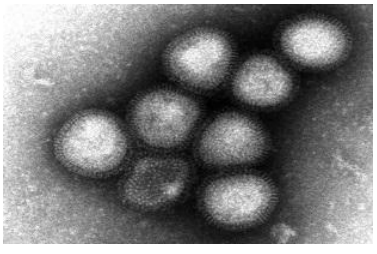
NCoV: Current Situation

- 34 cases from Arabian Peninsula (29), UK (3), and France (2)
- Severe acute respiratory illness
- 20 cases (59%) fatal
- "Clear evidence of limited, not sustained, human-to-human transmission"

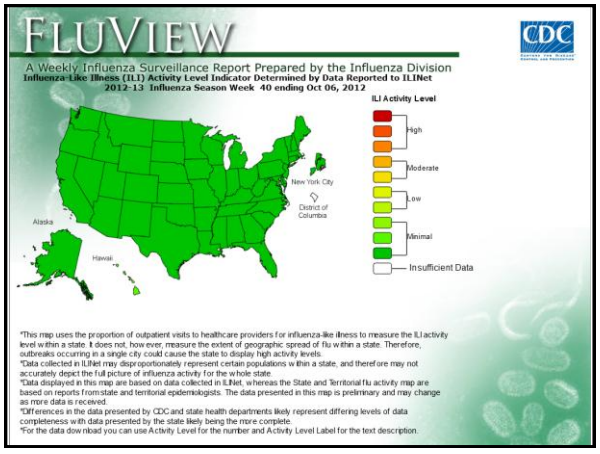
NCoV: Public Health Actions

- New recommendations for diagnosis and management of patients under investigation
  - e.g. patients who develop pneumonia within 10 days of travel to the Arabian Peninsula
- New recommendations for infection control during care for confirmed or probable cases
- No travel warnings or restrictions

INFLUENZA



H7N9 virus, WHO Collaborating Centre for Reference and Research on Influenza, National Institute of Infectious Diseases, Japan


FLUVIEW
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 40 ending Oct 06, 2012
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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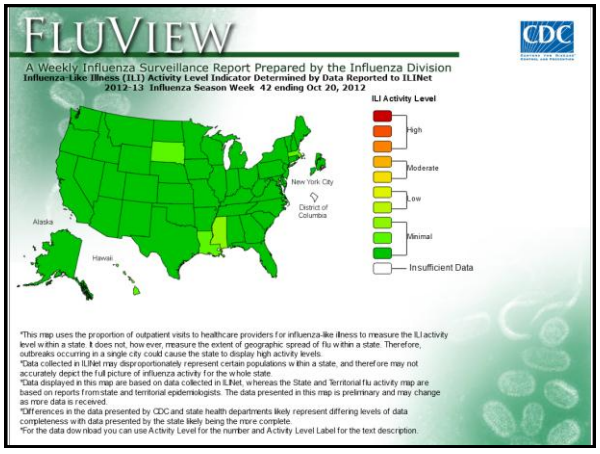
FLUVIEW
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Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 42 ending Oct 20, 2012
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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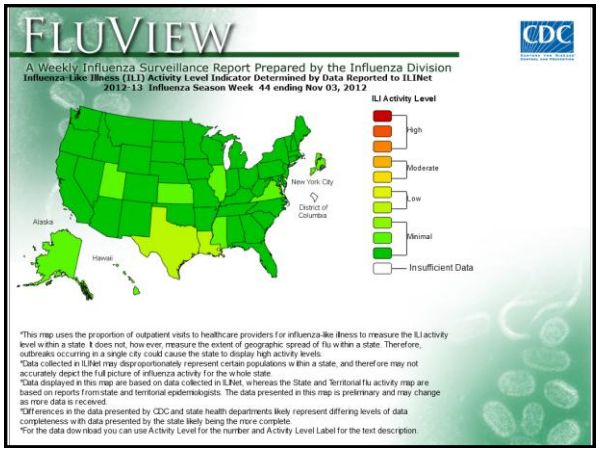
FLUVIEW
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 44 ending Nov 03, 2012
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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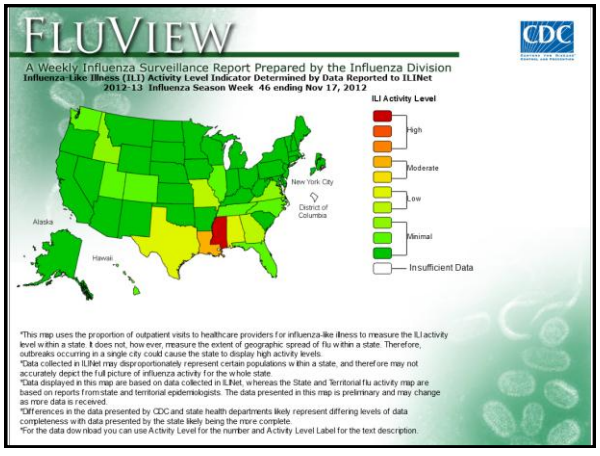
FLUVIEW
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Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 46 ending Nov 17, 2012
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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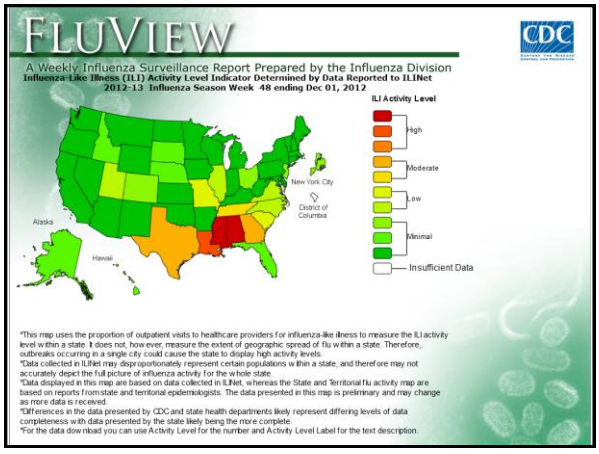
FLUVIEW
CDC
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Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 48 ending Dec 01, 2012
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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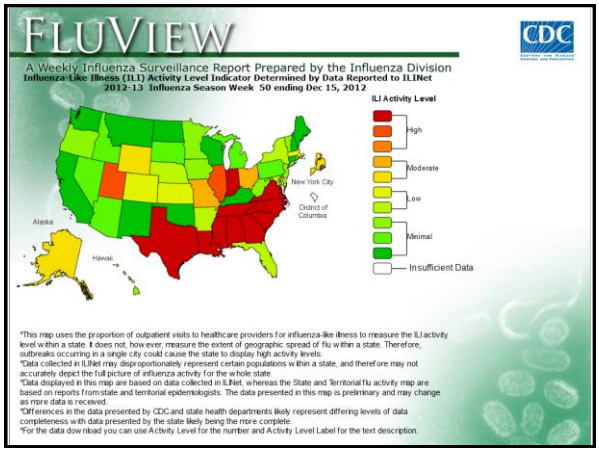
FLUVIEW
CDC
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Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 50 ending Dec 15, 2012
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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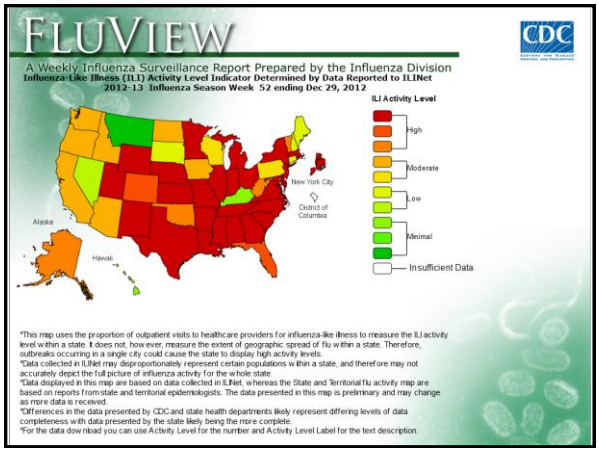
FLUVIEW
CDC
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 52 ending Dec 29, 2012
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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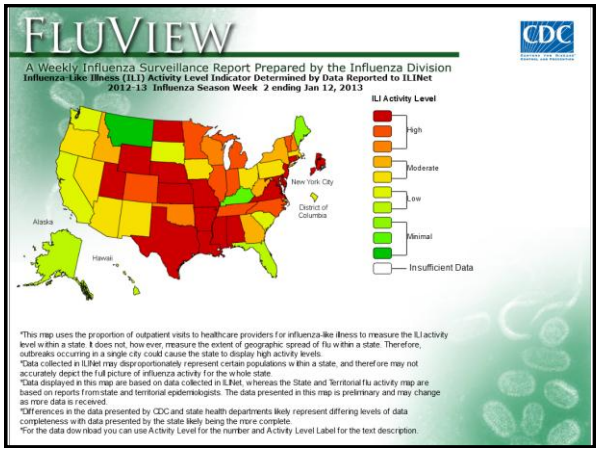
FLUVIEW
CDC
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 2 ending Jan 12, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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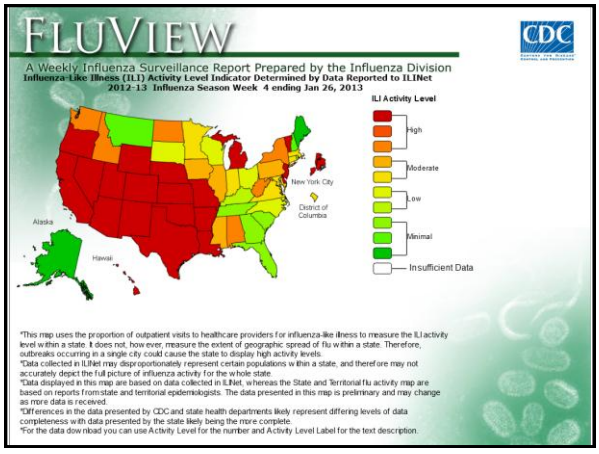
FLUVIEW
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Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 4 ending Jan 26, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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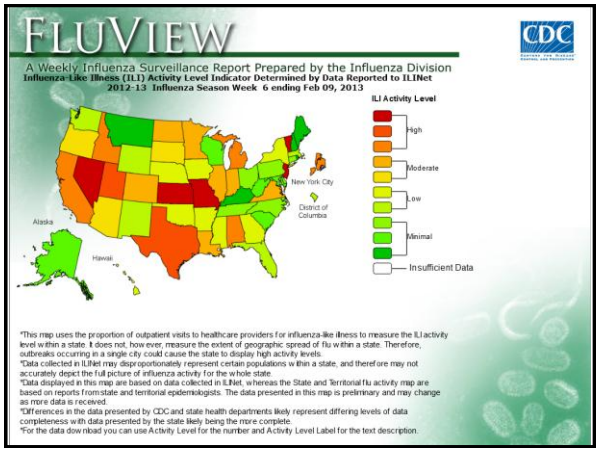
FLUVIEW
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 6 ending Feb 09, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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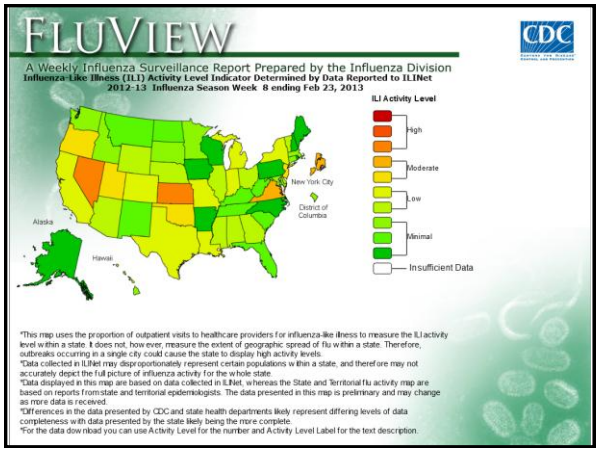
FLUVIEW
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Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 8 ending Feb 23, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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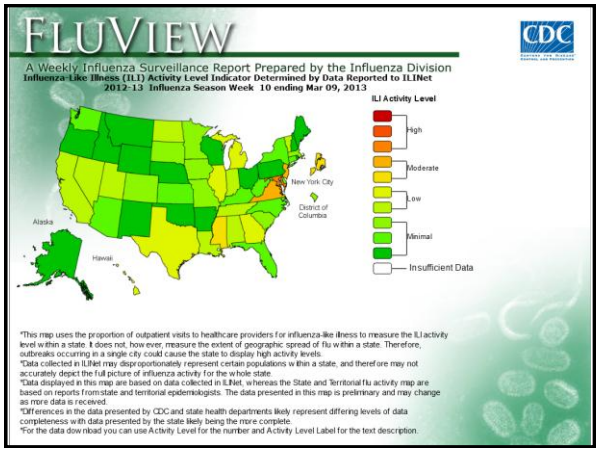
FLUVIEW
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Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 10 ending Mar 09, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
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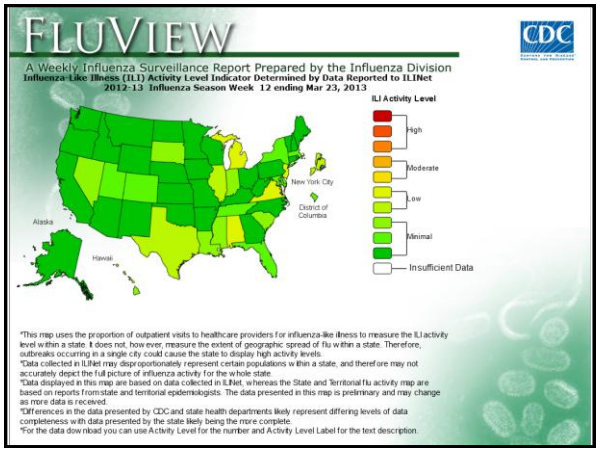
*For the data download you can use Activity Level for the number and Activity Level Label for the text description.


FLUVIEW
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 12 ending Mar 23, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
*This map uses the proportion of outpatient visits to healthcare providers for influenza-like illness to measure the ILI activity level within a state. It does not, however, measure the extent of geographic spread of flu within a state. Therefore, outbreaks occurring in a single city could cause the state to display high activity levels.
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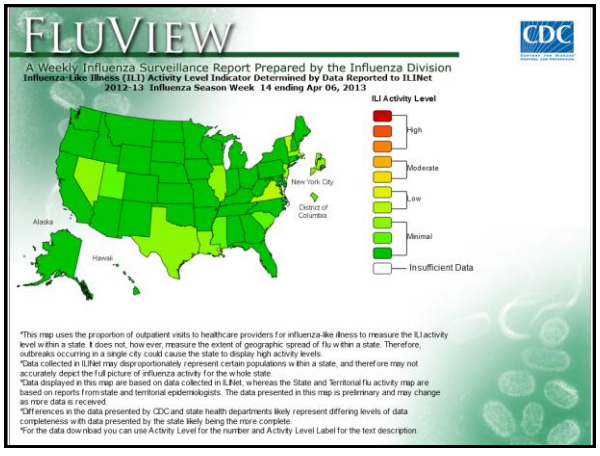
FLUVIEW
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 14 ending Apr 06, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
*This map uses the proportion of outpatient visits to healthcare providers for influenza-like illness to measure the ILI activity level within a state. It does not, however, measure the extent of geographic spread of flu within a state. Therefore, outbreaks occurring in a single city could cause the state to display high activity levels.
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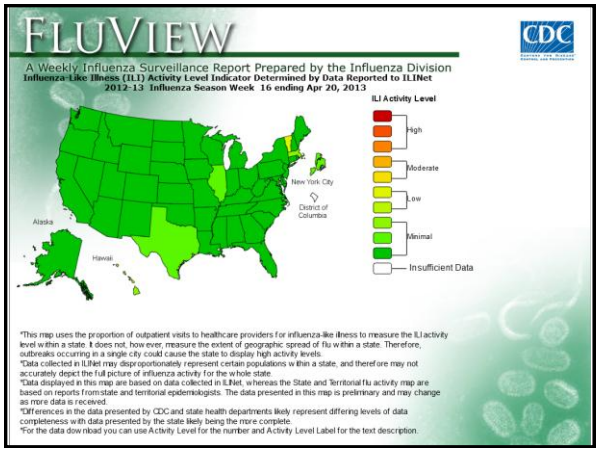
FLUVIEW
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 16 ending Apr 20, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
*This map uses the proportion of outpatient visits to healthcare providers for influenza-like illness to measure the ILI activity level within a state. It does not, however, measure the extent of geographic spread of flu within a state. Therefore, outbreaks occurring in a single city could cause the state to display high activity levels.
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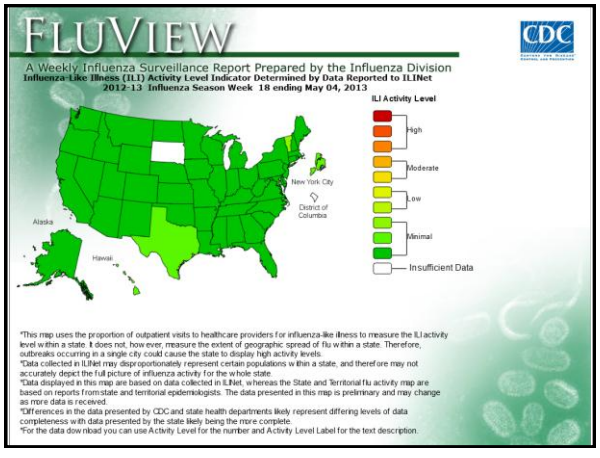
FLUVIEW
A Weekly Influenza Surveillance Report Prepared by the Influenza Division
Influenza-Like Illness (ILI) Activity Level Indicator Determined by Data Reported to ILINet
2012-13 Influenza Season Week 18 ending May 04, 2013
ILI Activity Level
High
Moderate
Low
Minimal
Insufficient Data
New York City
District of Columbia
Alaska
Hawaii
*This map uses the proportion of outpatient visits to healthcare providers for influenza-like illness to measure the ILI activity level within a state. It does not, however, measure the extent of geographic spread of flu within a state. Therefore, outbreaks occurring in a single city could cause the state to display high activity levels.
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Seasonal Flu is a Big Deal

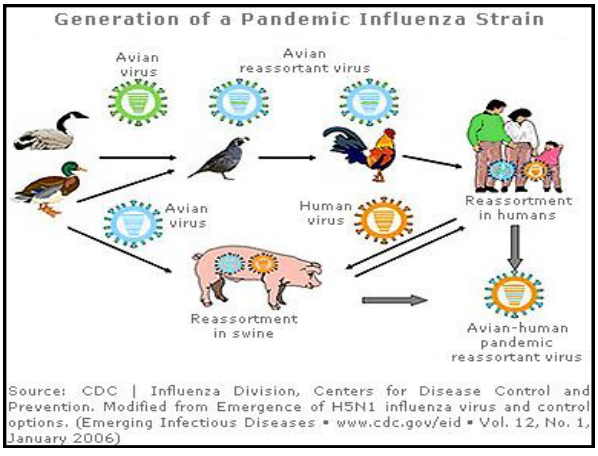
- Affects 5–20% of population each year
  - >200,000 hospitalizations*
  - Average 24,000 deaths (range, 3–49,000)**
- $10 billion direct medical costs,
- $87 billion total economic burden***

Thompson, JAMA 2004; **MMWR 59(33) 2010; ***Molinari, Vaccine 2007

Pandemic Influenza

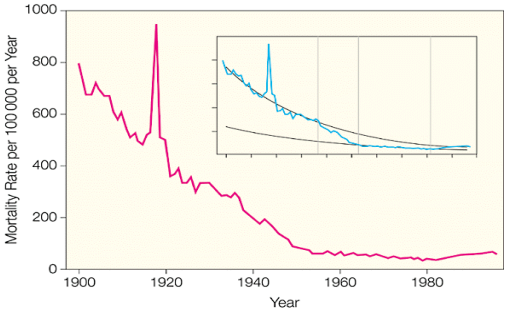
Three Conditions:

1. New ("novel") virus; all or most susceptible
2. Transmissible from person to person
3. Wide geographic spread



Source: CDC | Influenza Division, Centers for Disease Control and Prevention. Modified from Emergence of H5N1 influenza virus and control options. (Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 12, No. 1, January 2006)

Infectious Disease Mortality in the US, 1900–1996



Armstrong, et al. *JAMA* 1999;281:61-66. Adapted from CDC slide set

Impact of Past Influenza Pandemics

Pandemic, or Antigenic Shift	Excess Deaths in US	Populations Affected
1918-19 (A/H1N1)	500,000	Persons <65 years
1957-58 (A/H2N2)	70,000	Infants, elderly
1968-69 (A/H3N2)	36,000	Infants, elderly
2009-10 (A/H1N1)	12,500	Persons <65 years

Current Influenza Threats

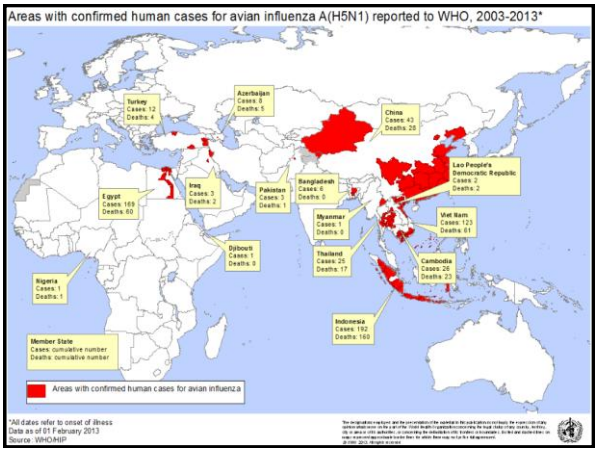
H5N1
H7N9

H3N2v

http://www.cdc.gov/flu/pdf/swineflu/prevent-spread-flu-pigs-at-fairs.pdf

H5N1 Avian Influenza

- First human cases identified in 1997
  - Hong Kong
  - 18 cases, 6 deaths
- Reemergence, 2003–present
  - Continued sporadic cases
  - Limited person-to-person spread
  - Progression from Asia to Middle East, North Africa
- WHO update — November, 2011:
  - 15 countries
  - 628 cases
  - 374 deaths (60%)



H3N2 variant (H3N2v)

- "Variant": Virus that normally infects pigs
- **2010:** Swine H3N2 with matrix (M) gene from H1N1 virus first identified in US pigs
- **2011:** 12 human cases of H3N2v infection detected in IN, IA, ME, PA, and WV
- **2012:** 307 cases in 11 states

H3N2v

- Illness similar to seasonal influenza
- Majority of cases were among children
- Most associated with prolonged exposure to pigs at agricultural fairs

Images: www.cdc.gov/flu

H7N9

- First human infection with avian H7N9 virus detected March, 2013
- 131 cases, 32 deaths (May 8, 2013)
- Most with severe respiratory illness
- Many cases had contact with poultry
- No sustained person-to-person transmission
- (Yet)

2 new diseases – H7N9 and coronavirus – could both spark global outbreaks

H7N9: Public Health Actions

- NC DPH issued memos to all providers with recommendations for detection, testing, and treatment of possible H7N9 cases
- State Lab able to provide testing
- CDC working with pharmaceutical companies on candidate vaccines
- No travel restrictions, special recommendations for US public

Take Home Point

"Public health preparedness is vital for detecting and responding to emerging infections. Despite our prevention efforts, everyday systems malfunction and cause harm, new infections emerge, and unforeseen illnesses arise. Although such events cannot be fully predicted, they should be expected, and effective responses to routine health events strengthen our ability to prevent, detect, and respond to the unusual."

Bell and Khabbaz, JAMA, Published online January 30, 2013