Influenza and Novel Respiratory Infections
Implementing Effective Surveillance on the College Campus
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University Health Services
University of Wisconsin-Madison

Objectives

- Describe systems used for surveillance of influenza and other respiratory infections
- Identify strategies to implement an influenza surveillance program in a college health service
- Describe the current epidemiology of influenza and emerging respiratory infections in the U.S.
Disease surveillance, circa 1665

"Surveillance studies... help in defining and monitoring transmission rates, case load, and epidemic risk assessment, and assist in instituting infection control measures with new diagnostic methods and treatments."

Z.A. Memish et al. *Clinical Microbiology and Infection*, 2014

"...gathering data and sharing it freely is in the best interests of everyone’s health. Vigilant surveillance remains the best strategy for rapid response." ProMed
Influenza Surveillance Goals

- Provide situational awareness
  - Know when the season begins/ends
  - # tests performed/positivity rate, types/subtypes/strains circulating
  - clinical severity, community impact, age groups affected, reliability of diagnostic tests
- Detect novel or reassortant viruses
- Inform vaccine strain selection
- Detect and monitor antiviral resistance

Influenza Resources: The Latest Information

CDC Guidance & Epi: www.cdc.gov/flu/professionals/index.htm
CIDRAP (Univ of Minn): www.cidrap.umn.edu/
U.S. Influenza Surveillance Systems

- Virologic Surveillance (3 components)
- Morbidity Surveillance (3 components)
- Mortality Surveillance (2 components)

CDC

Health Departments

State-level data to state surveillance coordinators

www.cdc.gov/flu/weekly

CDC U.S. Outpatient Influenza-like Illness Surveillance Network (ILINet)

- Data from ~2900 health care providers nationwide including 397 college health centers
- Uses a standard case definition for ILI
- Online, weekly reporting of # of ILI patients and # of primary care encounters
- New providers welcome -- contact your state influenza coordinator to participate
College Health Surveillance Network
https://avillage.web.virginia.edu/chsn/Public

- Online resource of EHR data from 22 participating college health centers
- Covers 702K enrolled students, representative of 4-year public research universities
- ICD9 and CPT data are uploaded monthly
- Separate influenza-like illness surveillance tracked seasonally
College Health Surveillance Network

ILI Visits for Week Ending January 18, 2014
by School and Census Region

<table>
<thead>
<tr>
<th>School</th>
<th>Region</th>
<th>ILI cases</th>
<th>total cases</th>
<th>% ILI</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>Northeast</td>
<td>2</td>
<td>461</td>
<td>0.43%</td>
</tr>
<tr>
<td>102</td>
<td>Northeast</td>
<td>4</td>
<td>777</td>
<td>0.51%</td>
</tr>
<tr>
<td>104</td>
<td>Northeast</td>
<td>4</td>
<td>588</td>
<td>0.68%</td>
</tr>
<tr>
<td>106</td>
<td>Northeast</td>
<td>11</td>
<td>688</td>
<td>1.60%</td>
</tr>
<tr>
<td>Northeast Total</td>
<td></td>
<td>22</td>
<td>2514</td>
<td>0.84%</td>
</tr>
<tr>
<td>201</td>
<td>South</td>
<td>15</td>
<td>656</td>
<td>2.29%</td>
</tr>
<tr>
<td>204</td>
<td>South</td>
<td>1</td>
<td>1255</td>
<td>0.08%</td>
</tr>
<tr>
<td>205</td>
<td>South</td>
<td>24</td>
<td>890</td>
<td>2.70%</td>
</tr>
<tr>
<td>206</td>
<td>South</td>
<td>13</td>
<td>462</td>
<td>2.81%</td>
</tr>
<tr>
<td>207</td>
<td>South</td>
<td>6</td>
<td>930</td>
<td>0.65%</td>
</tr>
<tr>
<td>South Total</td>
<td></td>
<td>59</td>
<td>4193</td>
<td>1.41%</td>
</tr>
<tr>
<td>301</td>
<td>MidWest</td>
<td>18</td>
<td>1304</td>
<td>1.38%</td>
</tr>
<tr>
<td>302</td>
<td>MidWest</td>
<td>25</td>
<td>725</td>
<td>3.45%</td>
</tr>
<tr>
<td>303</td>
<td>MidWest</td>
<td>5</td>
<td>156</td>
<td>3.21%</td>
</tr>
<tr>
<td>304</td>
<td>MidWest</td>
<td>1</td>
<td>280</td>
<td>0.36%</td>
</tr>
<tr>
<td>MidWest Total</td>
<td></td>
<td>48</td>
<td>2185</td>
<td>2.20%</td>
</tr>
<tr>
<td>401</td>
<td>West</td>
<td>2</td>
<td>385</td>
<td>0.52%</td>
</tr>
<tr>
<td>403</td>
<td>West</td>
<td>11</td>
<td>1373</td>
<td>0.80%</td>
</tr>
<tr>
<td>West Total</td>
<td></td>
<td>13</td>
<td>1758</td>
<td>0.74%</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>141</td>
<td>10650</td>
<td>1.32%</td>
</tr>
</tbody>
</table>

Laboratory Surveillance and Diagnostic Testing

- Rapid Influenza Diagnostic Tests (RIDTs)
- PCR and Molecular Respiratory Virus Panels

Typical Viral Targets
- Influenza A and B
- RSV A and B
- hMPV
- Parainfluenza
- Rhino/Entero
- Coronavirus
- Adenoviruses

Tests for multiple pathogens are run on a single specimen.

Plus bacteria (B.pertussis, Chlamyphilia pneumoniae, M.pneumoniae) in some assays.
Other Surveillance Tools

www.google.org/flutrends/us/ (national, state, local)

www.outsmartflu.org (UW-Madison campus)

flunearyou.org (national, regional)
Outsmart Flu App at UW-Madison

crowdsourcing campus flu trends

www.outsmartflu.org

Syndromic Surveillance

- The use of pre-diagnostic, preliminary, or incomplete healthcare data (e.g. chief complaint, symptom history, working diagnosis) to define a disease syndrome
- Uses electronic data systems/EHRs as a data source
- Original focus was to detect bioterror events
- Useful to monitor seasonal trends or identify clusters of diseases that don’t require lab confirmation
- Examples: asthma, heat-related illness, GI illness, influenza-like illness
Illness timeline:  Syndromic data sources:

Day 0 - exposure
Day 1 - feels fine
Day 2 - headache, fever
Day 3 - cough
Day 4 - visits doctor
Day 5 - worsens
Day 6 - admitted to hospital
Day 7 - critically ill - ICU
Day 8 - death

Pharmacy sales
Nurse calls
Social media
Outpatient clinics
Ambulance (EMS)
ED visits
Admissions data
Lab orders
Clinical data

Diagnosed
Reported

Syndromic Data Feed (hospital ED)

ED admission data is uploaded daily to a central database
An integrated, national public health syndromic surveillance system. It provides local, state, and federal partners a timely regional and national picture of trends in disease syndromes and situation awareness.

**Biosense**

Implementing Influenza Surveillance in College Health

**Options:**
- Count patients with positive lab tests?
- Count patients with selected diagnoses?
- Count patients with selected syndromes?
  - based on chief complaint
  - based on HPI/symptoms
  - based on physical exam
Implementing Influenza Surveillance in College Health

- Remember mantra of “garbage in, garbage out”
- EHR must be configured to collect data correctly
- Use a standardized case definition, e.g. (for ILI):
  - fever $\geq 100^\circ F$ plus either cough or sore throat
- Need capacity to query and report relevant data

Using an EHR to track ILI

Diagnosis (ICD-9) surveillance option:
- count the # of times a specified ICD diagnosis code is used, e.g. 487.1 (influenza URI)
- dependent on proper provider coding
- uses a standard definition to define a case for surveillance purposes, but all providers must apply it uniformly

Fever ($> 100^\circ F$ [37.8° C], oral or equivalent) AND cough and /or sore throat (in the absence of a KNOWN cause other than influenza)
Our experience: providers significantly under-code this diagnosis

**ILI Diagnosis Query Example**
(Using Point & Click™ EHR)

Using an EHR to track ILI

**Syndromic surveillance option:**
- count the # of patients seen with specific clinical findings (fever, + cough or ST)
- dependent on provider documentation of symptoms, and the ability to query that data
- uses the same standard definition to define a case for surveillance purposes
- independent of the provider’s diagnosis

Fever (> 100° F [37.8° C], oral or equivalent) AND cough and/or sore throat (in the absence of a known cause other than influenza)
Using an EHR to track syndromic ILI: URI Template Example (using Point & Click™ EHR)

1. In the template editor, mark items as reportable and assign a field name

   ![Template Editor Screenshot]

   - Current URI Symptoms
   - Symptom: sore throat
   - Symptom: nasal congestion
   - Symptom: discolored nasal discharge
   - Symptom: sinus pressure
   - Symptom: ear pain, pressure or discharge
   - Symptom: cough
   - Symptom: dizziness
   - Symptom: chills or night sweats

   - Vital: temp ≥100
   - Vital:测得体温≥100
   - Vital: subjective febrile, not measured

2. Create queries for data in these fields using tblVisitNoteProperty

   - Finds temp ≥100 on vitals
   - Finds temp ≥100 in history
   - Finds sore throat OR cough in history

   (additional criteria are used to exclude positive lab tests for mono and strep)
This data is submitted to CDC and CHSN

### 2013-14 Influenza Season Summary

#### University of Wisconsin-Madison Syndromic ILI

<table>
<thead>
<tr>
<th>ILI</th>
<th>% of primary care visits meeting ILI surveillance definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Graph](image)
**2013-14 Influenza Season in Review**

- Primarily influenza A (H1N1)
- Peak activity last week in December
- Influenza B came late

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**College Health Surveillance Network**

**2013-14 Seasonal Influenza-like Illness**
Antigenic Characterization of 2013-2014 Influenza Viruses

<table>
<thead>
<tr>
<th>Virus</th>
<th>Antigen</th>
<th>Vaccine</th>
<th>% matched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influenza A H1N1 (2009)</td>
<td>A/California/7/2009-like</td>
<td>all</td>
<td>99.8%</td>
</tr>
<tr>
<td>Influenza A H3N2</td>
<td>A/Texas/50/2012-like</td>
<td>all</td>
<td>98.0%</td>
</tr>
<tr>
<td>Influenza B - Yamagata lineage</td>
<td>B/Massachusetts/2/2012-like</td>
<td>trivalent</td>
<td>69.6%</td>
</tr>
<tr>
<td>Influenza B - Victoria lineage</td>
<td>B/Brisbane/60/2008-like</td>
<td>quadrivalent</td>
<td>30.4%</td>
</tr>
</tbody>
</table>

Antigenic characterization of 2,408 influenza viruses [2,005 influenza A (H1N1) viruses, 387 influenza A (H3N2) viruses, and 247 influenza B viruses] collected by U.S. laboratories since October 1, 2013 by hemagglutination inhibition, reported 4/18/2014.

All That Is “the flu” Is Not Influenza

Neuraminidase Inhibitor Resistance Testing Results on Samples Collected Since October 1, 2013

<table>
<thead>
<tr>
<th>Virus</th>
<th>Oseltamivir</th>
<th>Zanamivir</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Virus Samples tested (n)</td>
<td>Resistant Viruses, Number (%)</td>
</tr>
<tr>
<td>Influenza A (H3N2)</td>
<td>499</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Influenza B</td>
<td>355</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>2009 H1N1</td>
<td>4,968*</td>
<td>59 (1.2)</td>
</tr>
</tbody>
</table>

*Includes specimens tested in national surveillance and additional specimens tested at public health laboratories in 19 states (AZ, CA, CO, DE, FL, GA, HI, ID, MA, ME, MD, ME, MN, NY, PA, TX, UT, WA, and WI) who share testing results with CDC.

Positivity of Respiratory Specimens by PCR at Wisconsin Laboratories (Excluding Influenza and RSV)

- Adenovirus
- Coronavirus
- human Metapneumovirus
- Rhinovirus/Enterovirus
- Parainfluenza
Viruses detected in the respiratory tract

Emerging Respiratory Viruses

- H7N9 Avian Influenza
- MERS-Coronavirus
- H3N2v (variant) influenza
Avian Influenza A (H7N9) Infection

Influenza A (H7N9) virus weekly and accumulating cases

Number of cases

Date of illness onset/when case reported (week)

Cumulative H7N9 case total

Avian Influenza A (H7N9) Infection
H7N9 surveillance

- Travel status: Watch (China)
  Going to China? avoid contact with poultry
  Returning from China? Monitor for ILI X 10 days
- Travel history should be routinely collected in the evaluation of any influenza-like illness
- ILI surveillance continues 52 weeks per year
- Most PH Labs have capacity to test for H7N9

Middle Eastern Respiratory Syndrome: MERS-Coronavirus

Background
- Emerged in the Middle East in 2012
- Virus is different than the SARS-CoV
- Virus reservoir: likely camels, possibly bats
- Transmission dynamics not well understood.
  Limited human transmission
MERS-CoV: Epidemiology

- Cases in 19 countries worldwide
- Three U.S. cases to date (May 2014)
- Age range 1y-94y (median 49y); 66% male
- ~30% mortality
- First known patient was a 25 yo university student, in a cluster of severe pneumonia cases in healthcare workers in April 2012. The source of his infection remains a mystery.

WHO data as of 5/14/2014


Distribution of confirmed cases of MERS-CoV by reporting country, March 2012 – 30 April 2014 (n=424)

See also: coronamap.com
MERS-CoV: Epidemiology

Severe respiratory illness with high mortality
- ARDS, renal failure, coagulopathies, pericarditis, GI symptoms

Underlying conditions common

Limited person-to-person transmission
- Family members
- Health care personnel

Asymptomatic and mild illness also seen
Travel status: Watch
Applies to 14 Arabian countries*

Travel history is important in the evaluation of acute respiratory illness

Infection control: airborne precautions
Use full PPE (glove/gown/eye protection), N95 respirator

*Bahrain, Iraq, Iran, Israel, Jordan, Kuwait, Lebanon, Oman, Palestinian territories, Qatar, Saudi Arabia, Syria, the United Arab Emirates (UAE), and Yemen

MERS-CoV: Surveillance

College healthcare providers should evaluate patients for MERS-CoV infection who:

- develop fever and pneumonia within 14 days after traveling from countries in or near the Arabian Peninsula or
- have had close contact with a symptomatic recent traveler from this area who developed fever and acute respiratory illness within 14 days of travel, or
- have had close contact with a probable or confirmed case of MERS

“we live in a highly interconnected world where no 2 points are separated by more time than it takes to silently incubate a respiratory virus and produce signs and symptoms, and virus, after arriving at a new destination.”

Ian Mackay PhD, virusdownunder.blogspot.com.au

Figure 3. Air traffic capacity of the MERS-CoV source region and its international destinations.