Using and Improving EARS for Local Public Health Biosurveillance

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and

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• Define biosurveillance
• Discuss evolving need for syndromic surveillance at Health Department
• Describe the EARS program and its use within Monterey County
• Quantitative and qualitative analysis of modifications to EARS’ logic
What is Biosurveillance?

• Homeland Security Presidential Directive HSPD-21 (October 18, 2007):
  – “The term ‘biosurveillance’ means the process of active data-gathering … of biosphere data … in order to achieve early warning of health threats, early detection of health events, and overall situational awareness of disease activity.” [1]

• Syndromic surveillance:
  – “…surveillance using health-related data that precede diagnosis and signal a sufficient probability of a case or an outbreak to warrant further public health response.” [2]

Need for Syndromic Surveillance

- County Health Officer wanted greater use of real-time surveillance data
- Preparedness grants required enhanced surveillance
- Lag-time in receipt of reports from local hospitals; reports from only two hospitals
Early Aberration Reporting System (EARS)

- Developed by the CDC
- Originally designed to monitor for bioterrorism during large-scale events that often have little or no baseline data
- Now used by various state and local public health departments for routine health surveillance purposes
Benefits of the EARS Program

- Data stays at the local level
- Flexibility to modify syndromes as needed
- Analysis occurs on-site
- Decreased lag-time in reporting
- Program available at no cost
Data Collection and Reporting

Data Collection: Hospital 1, Hospital 2, Hospital 3, Hospital 4, County Clinics

Data Management: Health Department

Analysis: Syndrome Definitions

Reporting: ILI & DOSE Reports
### ED Census and Clinic Services Census*

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
<th>Total Hospital Census</th>
<th>Clinic Services Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>No alert flags on the previous day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>One alert flag on the previous day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>Two alert flags on the previous day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Three alert flags on the previous day or three</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>consecutive days of single or double alert flags</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*ED Census and Clinic Services Census*:

**Note that the hospital ED aggregate and syndemic surveillance only includes data from facilities providing information for the reported days.

### Syndromic Surveillance*:

(ERS output for Monterey County aggregate w/o clinics) [Shown as # of patients]

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrointestinal</td>
<td>No alert flags on the previous day</td>
<td>58</td>
</tr>
<tr>
<td>Influenza-Like Illness</td>
<td>One alert flag on the previous day</td>
<td>6</td>
</tr>
<tr>
<td>Lower Respiratory</td>
<td>Two alert flags on the previous day</td>
<td>9</td>
</tr>
<tr>
<td>Upper Respiratory</td>
<td>Three alert flags on the previous day or three</td>
<td>29</td>
</tr>
<tr>
<td>Neurological</td>
<td>consecutive days of single or double alert flags</td>
<td>30</td>
</tr>
</tbody>
</table>

**Note that the hospital ED aggregate and syndemic surveillance only includes data from facilities providing information for the reported days.**
Note: Restricted ILI syndrome definition
• Designed by the CDC to be a drop-in surveillance system
• Increasingly being used as standard health surveillance system
  – E.g., by the Monterey County Health Department
Assessing Modifications to EARS

- Flexibility of EARS is a strength
- However, what happens when the syndrome definitions are changed?
  - I.e., how do the changes affect detection performance (sensitivity and specificity)?

<table>
<thead>
<tr>
<th>Actual Status</th>
<th>Test Outcome</th>
<th>Sensitivity =</th>
<th>Specificity =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sick</td>
<td>Positive</td>
<td>TP</td>
<td>#TP</td>
</tr>
<tr>
<td>Healthy</td>
<td>Positive</td>
<td>FN (Type II error)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>FP (Type I error)</td>
<td>#TN</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>TN</td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity = \[
\frac{\#TP}{\#TP + \#FN}
\]

Specificity = \[
\frac{\#TN}{\#TN + \#FP}
\]
Creating Syndromes

• Syndromes derived by searching for key words in chief complaints
• Three important parts to the process:
  – Defining symptom aliases
    • Lists of words, abbreviations, and medical jargon that are mapped to a specific symptom
  – Text matching algorithms
    • Computer logic that specifies when a match has occurred
  – Syndrome definitions
    • Syndromes can be derived from the symptoms in a variety of ways
<table>
<thead>
<tr>
<th>Symptom Alias</th>
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<th>Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>SROETHROAT</td>
<td>SORETHROAT</td>
<td>COL</td>
<td>COLD</td>
<td>C0UGH</td>
<td>COUGH</td>
</tr>
<tr>
<td>SSOERPHTHOAT</td>
<td>SORETHROAT</td>
<td>NOSE</td>
<td>COLD</td>
<td>C9UGH</td>
<td>COUGH</td>
</tr>
<tr>
<td>ST</td>
<td>SORETHROAT</td>
<td>URI</td>
<td>COLD</td>
<td>CCOUGH</td>
<td>COUGH</td>
</tr>
<tr>
<td>TBROAT</td>
<td>SORETHROAT</td>
<td>EAR PAIN</td>
<td>COLD</td>
<td>CIUGH</td>
<td>COUGH</td>
</tr>
<tr>
<td>THROAT</td>
<td>SORETHROAT</td>
<td>DISCH</td>
<td>COLD</td>
<td>CKUGH</td>
<td>COUGH</td>
</tr>
<tr>
<td>TH4OAT</td>
<td>SORETHROAT</td>
<td>OM</td>
<td>COLD</td>
<td>OUGH</td>
<td>COUGH</td>
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**Actual Chief Complaint Examples:**

1) NP FOR HIV TEST PER VERONICA/CHART MADE/LM
### ILI Symptom Aliases

<table>
<thead>
<tr>
<th>SymptomAlias</th>
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### Chief Complaint Examples:

1) NP FOR HIV TEST PER VERONICA/CHART MADE/LM
2) RTN RE-COLPO/LM
## ILI Symptom Aliases

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<td>SROETHROAT</td>
<td>SORETHROAT</td>
<td>COL</td>
<td>COLD</td>
<td>COUGH</td>
<td>COUGH</td>
</tr>
<tr>
<td>SSORE THROAT</td>
<td>SORETHROAT</td>
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### Chief Complaint Examples:

1) NP FOR HIV TEST PER VERONICA/CHART MADE/LM
2) RTN RE-COLPO/LM
3) R/S PREV APPT CALL NOT GOING THROUGH
Text Matching Logic Example: ILI

- **EARS (CDC) Logic**
  - If an ILI symptom alias is found anywhere within the chief complaint text, then it will be flagged as an ILI indicator

- **Enhanced (NPS) Logic**
  - For short words (≤3 characters)
    - No variations on alias words allowed
    - Example: ST
      - NP FOR HIV TEST PER VERONICA/CHART MADE/LM
    - Example: COL
      - RTN RE-COL PO/LM
  - For longer words (≥4 characters)
    - Variations on one side of the alias word is allowed
    - Example: COUGH
      - PT COUGHING FOR 4 DAYS
    - Example: OUGH
      - R/S PREV APPT CALL NOT GOING THROUGH OUGH
ILI Syndrome Definitions

• **Standard EARS (CDC) def’n:**
  - “sore throat” *or*
  - “cold” *or*
  - “cough”

• **Expanded (MCHD) def’n:**
  - “cold” *or*
  - “cough” *or*
  - “fever” *or*
  - “chills” *or*
  - “muscle pain” *or*
  - “headache” *or*
  - “flu” *and not* “shot”

• **Restricted (MCHD) def’n:**
  - “fever” *and* “cough” *or*
  - “fever” *and* “sore throat” *or*
  - “fever” *and* “cough” *and* “sore throat” *or*
  - “flu” *and not* “shot”
**Base Case**

EARS Text Matching Logic
EARS Symptoms Aliases
EARS Syndrome Definitions

9,093 total “flu”
(out of 153,696 total records)
Base Case
EARS Text Matching Logic
EARS Symptoms Aliases
EARS Syndrome Definitions

9,093 total “flu”
(out of 153,696 total records)

Variant 1a
EARS Text Matching Logic
Expanded Symptoms Aliases
Expanded Syndrome Definitions

5,154 added
291 deleted
13,956 total “flu”

Variant 2a
EARS Text Matching Logic
Restricted Symptoms Aliases
Restricted Syndrome Definitions

51 added
8,410 deleted
734 total “flu”
Base Case
EARS Text Matching Logic
EARS Symptoms Aliases
EARS Syndrome Definitions

Variant 1a
EARS Text Matching Logic
Expanded Symptoms Aliases
Expanded Syndrome Definitions

Variant 1b
Enhanced Text Matching Logic
Expanded Symptoms Aliases
Expanded Syndrome Definitions

Variant 2a
EARS Text Matching Logic
Restricted Symptoms Aliases
Restricted Syndrome Definitions

Variant 2b
Enhanced Text Matching Logic
Restricted Symptom Aliases
Restricted Syndrome Definitions

9,093 total “flu” (out of 153,696 total records)

5,154 added
291 deleted
13,956 total “flu”

51 added
8,410 deleted
734 total “flu”

2 added
8,544 deleted
5,414 total “flu”

0 added
111 deleted
623 total “flu”
Expanded ILI Syndrome Counts vs. California Sentinel Providers

Emergency Room Influenza-Like Illness Visits for Monterey County and California, 2008-2009 Season

Note: 1. Graph based on ILI chief complaint data as proportion of all patients accessing services for a given week from California sentinel providers and an aggregate from Monterey County Hospitals CHOMP, SVMH, and Mee, and Monterey County Clinical Services. 2. Missing data points for Weeks 19 through 27 will be incorporated at a later date.

Source: MCHD Influenza-like Illness (ILI) Surveillance Report Week 33 Ending 8/22/09
Restricted ILI Syndrome Counts vs. California Sentinel Providers

Emergency Room Influenza-Like Illness Visits for Monterey County and California, 2009-2010 Season To Date

Note: Restricted ILI syndrome definition
• How to figure out which combination of methods works best?

• Attempted to compare to ICD-9 codes, but codes for Monterey clinic data not sufficiently precise

• Currently evaluating EARS performance in detecting 2009 H1N1 outbreak using the various definitions and logic
  – Comparing signals to known cases
In Conclusion

- Small changes in syndrome definitions, symptom aliases, and text-matching logic can have large effects on the resulting syndrome counts and overall “trend”
- Recommend on-going research that conducts comparisons between methods under various conditions
  - Must assess how changes affect sensitivity and specificity
- Exercise caution!!
Questions?
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