Centers for Disease Control
Early Aberration Reporting System

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Introduction

- Describe development / purpose of EARS
- Provide Case Definition for Aberration
- Review Aberration Detection Methods used in EARS
- Provide Recommendations for Sites
- Provide Examples from EARS
Developed by EPO and NCID
- Several methods developed previous to EARS
- EPO provided initial support for EARS
- NCID took over the support of EARS

Aberration Detection Methods
- Suite of available aberration detection methods
- Developed by both CDC and Non-CDC collaborators

Primary Purpose
- Providing aberration detection methods to local health departments that have been validated using several alternative data sources
EARS Background

- Currently used by many health department agencies for bioterrorism surveillance
  - States
  - Counties
  - Cities
- Also used at several public events
  - Democratic Convention 2001
  - Super Bowl 2001
  - World Series 2001
Define Aberration Detection

- Case Definition for Aberration
  - Change in the distribution or frequency of health events when compared to historical data.
  - This May or May not be an outbreak
  - This May or May not be of public health interest

Principles and Practice of Public Health Surveillance (2002)
Why is this case definition important?

- Validation of models requires a fair comparison across methods and data sources
- Data entry errors
  - Would not be considered a false positive according to our definition
  - Source of aberration is identified and understood
  - Important issue in evaluating sensitivity and specificity
- Other similar events should be modeled and understood as well
Important characteristics of aberration detection methods

- High Sensitivity
- Necessary communication among staff
- Need to notify appropriate authorities
- When do you follow-up on aberrations???
Review of Literature

Aberration Detection Method

Case Definition Methods

Pattern Recognition Methods

Infectious Diseases Methods

Chronic Diseases Methods
Infectious Disease Methods

- Long Term Implementation
  - Extended baseline methods (3-5 years)
  - Limited baseline methods (7 days - 3 years)

- Short Term Implementation
  - Implementation expected for less than 30 days such as political conventions
  - No initial baseline available (1-6 days)
Long Term Implementation
Extended Baseline Methods

- Historical Limits Method (Stroup et.al. 1989)
- Seasonally Adjusted CUSUM (Hutwagner et.al. 1997)
- Log Linear Regression (Farrington et.al. 1996)
- Compound Smoothing (Stern et.al. 1999)
- Cyclical Regression (Simonsen et.al. 1997)
Long Term Implementation Summary

- Validation of Methods
  - Selected 2 Methods for Implementation
    - Historical Limits Method
    - CUSUM Method
  - Methods complement each other
  - CDC has 5+ experience problem solving with these methods

- EARS will implement additional methods
  - Needs to further validate methods
Long Term Implementation
Limited Baseline Methods

- C1-MILD
- C2-MEDIUM
- C3-ULTRA

\[ 2 > \text{CUSUM}_{t-1} + \text{Current Count} - (\text{Baseline Mean} + \text{Baseline Std Dev}) \]

Baseline Std Dev
Baseline for C1-MILD (-1 to -7 day)

Baseline C2-MEDIUM (-3 to -9 days)

Baseline for C3-ULTRA (-3 to -9 days)
Short Term Implementation
No Available Baseline

- P Chart
- 2X2 Tables (chi square)
- Moving Average Chart
- CUSUM
Summary of Methods Available in EARS

- **Historical Methods**
  - Historical Limits
  - Seasonality adjusted CUSUM

- **CUSUM Methods**
  - C1-MILD
  - C2-MEDIUM
  - C3-ULTRA

- **Drop In Surveillance Methods**
  - P Chart
  - 2x2 Tables (Chi Square)
  - Moving Average Chart
  - CUSUM
Why Does Industry Continue To Use Quality Control Methods?

- First developed P-Charts in 1920’s
- CUSUM and P-Chart methods continue to be among the most important and widely used quality control tools in statistics
- Applied in manufacturing, engineering, environmental science, biology, genetics, epidemiology, medicine, finance, law enforcement and athletics
## Implementation Of Methods Based on Time

<table>
<thead>
<tr>
<th>Time</th>
<th>Implementation of Method</th>
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<tbody>
<tr>
<td>Event</td>
<td>Implement emergency surveillance</td>
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<tr>
<td>Day 1</td>
<td>P-Chart</td>
</tr>
<tr>
<td>Day 2-6</td>
<td>P-Chart, CUSUM</td>
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<tr>
<td>Day 7+</td>
<td>C1-MILD, C2-MEDIUM, C3-ULTRA</td>
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<tr>
<td>3 Years +</td>
<td>Multiple methods depending on data source</td>
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</table>
EARS Drop In Surveillance
Real Time Applications

- Foodborne outbreaks
- Respiratory illness
- Data entry errors
- Bioterrorism ??
<table>
<thead>
<tr>
<th>Event</th>
<th>Week</th>
<th>Count (YTD)</th>
<th>CUSUM</th>
<th>Detection Flags</th>
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<tr>
<td>Anthrax</td>
<td>48</td>
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<td>Botulism (Infant)</td>
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<td>68</td>
<td>2</td>
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<tr>
<td>Botulism (Other/Wound)</td>
<td>51</td>
<td>0</td>
<td>19</td>
<td>0</td>
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<td>Brucellosis</td>
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<td>1</td>
<td>94</td>
<td>2</td>
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<tr>
<td>Cholera</td>
<td>48</td>
<td>0</td>
<td>3</td>
<td>0</td>
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<td>Cyclosporiasis</td>
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<td>1</td>
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<td>87</td>
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<tr>
<td>EhrlichiosisHum Mono (HME)</td>
<td>48</td>
<td>0</td>
<td>24</td>
<td>0</td>
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<tr>
<td></td>
<td>51</td>
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<td>24</td>
<td>0</td>
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<tr>
<td>Enceph (St.Louis)</td>
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<td>0</td>
<td>12</td>
<td>0</td>
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<tr>
<td></td>
<td>51</td>
<td>0</td>
<td>12</td>
<td>0</td>
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</table>
Aberration Detection

Cryptosporidiosis

Nebraska

Weekly Count
Historical Mean

Aberration Detection Flags
■ Historical Limits  ★ CUSUM  ● Combined
FAQ

What Happened with Anthrax in NYC?

- Our methods did not detect anthrax in NYC
- Why did this happen?
  - We monitored Hospital EDs
    - Case definition for Inhaled Anthrax
    - 6 of 7 patients went to private physicians
      - Reported cutaneous anthrax
      - No one was monitoring this outcome at the time
- We believe our methods will detect these outcomes if they occur
  - New case definitions have been added
Summary of EARS

- Aberration Detection Methods
  - Suite of available aberration detection methods
  - Developed by both CDC and Non-CDC colleagues

- Primary Purpose
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- We have brought EARS CDs to distribute