ESSENCE – A DoD Health Indicator Surveillance System

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What is ESSENCE?

Electronic Surveillance System for the Early Notification of Community-based Epidemics
Need for Improved Surveillance

- **Current systems**
  - Often depend on laboratory confirmation
  - Rely on passive participation
  - Are not automated

- **New “health indicator” / “syndromic” surveillance**
  - Rapid, automated systems based on syndromes
  - Non-traditional data sources
    - ICD9 codes, pharmaceutical sales, ER chief complaints
  - May provide earlier indication of outbreaks
  - Quickly provide necessary demographic information
Multiple methods of disease detection

- Traditional reportable disease surveillance
- Sentinel surveillance
- Astute clinicians
- Syndromic surveillance

A “system of systems”
Presentation outline

1. Identify near real time data
2. Symptom definitions
3. Data display
4. Identify abnormal trends
5. Privacy protection
6. Evaluation
1. Choosing near real time data

• Is the source already collected for another purpose?
• Is the source electronic?
• Is the source reliable?
• How long does it take?
ESSENCE incorporates ADM encounter information

• One entry per patient encounter
• Diagnoses
• Disposition
• Procedures
• Patient demographics
• Clinic demographics
Current Basis for Daily Surveillance

Patient Encounter SADR

MTF

Electronic (or scantron) entry at the clinic

FTP

ESSENCE

FTP

Password controlled access to secure web
ESSENCE Coverage

• December 1999
  National Capital Area (NCA)

• September 2001 to present
  All fixed MTFs world-wide including:
  
  ▪ 121 Army, 110 Navy, 80 AF and 2 CG installations
  
  ▪ grouped into 179 geographic clusters
Expanded geographic coverage allowed detection of concurrent outbreaks
2. Syndrome definition

Problem

• Would like to identify outbreaks faster than traditional methods

• Lack of universally applied syndrome definitions or code groups
Participating Agencies

- National Center for Infectious Diseases and Epidemiology Program Office, Centers for Disease Control and Prevention, Atlanta, Georgia

- Division of Preventive Medicine, Walter Reed Army Institute of Research (WRAIR), Silver Spring, Maryland

- Emergency Medical Associates of New Jersey Research Foundation, Livingston, New Jersey

- Bureau of Epidemiology Services, New York City Department of Health and Mental Hygiene, New York City, New York

- Harvard Medical School and Harvard Pilgrim Health Care, Boston, Massachusetts
Objectives

• Determine appropriate syndromic groups for infectious disease surveillance and for surveillance of agents of bioterrorism.

• Review and compare different sources of medical data to best develop ICD-9-CM code groups applicable to multiple users.
Which ICD9 Codes Should We Map to Syndrome Groups?

- **Clinical decision**
  - What are the diseases we are trying to detect?
    - Define the syndromes
  - What diagnoses fit under this syndrome definition?

- **Trend analysis**
  - How frequently are candidate codes used?
  - Is there an expected trend for the syndrome?
  - Is there a “gold standard” for comparing the trend?
    - How well do other ICD9s correlate with the gold standard?
    - Do any ICD9s show the same peak/trend earlier?
Which Syndrome Groups Should We Choose?

- Botulism
- VHF
- Plague (Bubonic)
- Anthrax (cutaneous), Tularemia
- Anthrax (gastrointestinal)
- Anthrax (inhalational), Tularemia
- Plague (pneumonic)
- Small Pox

- Botulism-like
- Hemorrhagic Illness
- Lymphadenitis
- Localized Cutaneous Lesion
- Gastrointestinal
- Respiratory
- Rash
Syndrome Groups Selected by Consensus

• Botulism-like
• Hemorrhagic Illness
• Lymphadenitis
• Localized Cutaneous Lesion
• Gastrointestinal
• Respiratory

• Rash
• Neurological
• Specific Infection
• Fever
• Severe illness or death potentially due to infectious disease
Customize Syndrome Groups

### Standard Set
- Botulism-like
- Hemorrhagic Illness
- Lymphadenitis
- Localized Cutaneous Lesion
- Gastrointestinal
- Respiratory
- Rash
- Specific Infection
- Fever
- Neurological
- Severe Illness or Death
  Potentially Due to Infectious Disease

### WRAIR Set
- Botulism-like
- Hemorrhagic Illness
- Gastrointestinal
- Respiratory
- Rash
- Fever
- Neurological
- Shock/Coma
# Syndrome Definition - Respiratory Example

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Definition</th>
<th>Cat A Agent</th>
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| Respiratory | **ACUTE** infection of the upper and/or lower respiratory tract (from the oropharynx to the lungs, includes otitis media)  
**SPECIFIC** diagnosis of acute respiratory tract infection (RTI) such as pneumonia due to parainfluenza virus  
**ACUTE** non-specific diagnosis of RTI such as sinusitis, pharyngitis, laryngitis  
**ACUTE** non-specific symptoms of RTI such as cough, stridor, shortness of breath, throat pain  
**EXCLUDES** chronic conditions such as chronic bronchitis, asthma without acute exacerbation, chronic sinusitis, allergic conditions (Note: INCLUDE *acute exacerbation* of chronic illnesses.) | Anthrax - inhalation  
Tularemia  
Plague - pneumatic |
Trend Analysis

- Is there an expected trend for the syndrome?
- Is there a “gold standard” for comparing the trend?
  • How well do other ICD9s correlate with the gold standard?
  • Do any ICD9s show the same peak/trend earlier?
One Approach

1. Begin with a larger set of potential ICD9s identified clinically
2. Select those with counts > 10 per day
3. Daily and Weekly analyses
   a) Correlation matrix/ Lagged Correlation
   b) Factor analysis
   c) Regression
   d) Signal-Noise
   e) Testing sensitivity/ timeliness for known outbreaks
3. Data display

- Web-based
- Interactive or static screens
- Software or “home grown” programs
- System maintenance
4. Identify abnormal trends

• Alert detection models
  – Statistical algorithms

• Visual tests
Statistical models used for alert detection in ESSENCE

- **Exponentially Weighted Moving Average (EWMA)**
  - Predictions based on exponential smoothing of previous several weeks of data
  - Recent days have highest weight

- **Autoregression (AR)**
  - Predictions based on past several weeks of data
  - Incorporates and adjusts for day of the week and holiday trends

- **SatScan**
  - Detects geographic clusters by comparing number of cases within overlapping circles
5. Privacy protection

• HIPPA
• De-identified data
• Password protection
• Secure website
6. Evaluation of data sources

• Comparison to gold standards
  – Chart review
  – Sentinel studies

• User feedback
Using ESSENCE architecture to survey for other problems

- Mental health visits and anxiety medication
- Sexually transmitted diseases
- Reportable diseases
- Military Disease and Non-battle Injury (DNBI)