- Summer 2000, AHRQ Contract
- September 8, 2001— Fort Dietrich
- September 10, 2001—BiGR Grand Rounds
**“Syndromic surveillance”**

- Syndromic surveillance refers to methods relying on detection of individual and population health indicators that are discernable before confirmed diagnoses are made.
- Syndrome examples:
  - Respiratory syndrome
  - Gastrointestinal syndrome

**Outbreak detection stages**

- Data acquisition
- Syndromic grouping
- Modeling
- Detection
- Alarm


**Data acquisition stage**

- Data are gathered from the sources that feed into the system.

**Syndromic grouping stage**

- Data are organized, according to a coding scheme that allows each patient to be assigned to a particular syndrome.
  - Chief complaints (Bayesian classifier)
  - ICD (DoD/CDC groupings)

**Modeling stage**

- Historical data, usually reaching back from one to several years, are analyzed to establish a model of the normal temporal pattern.
Detection stage

- The expected values (for example, daily frequencies of patients presenting in each syndromic group) are compared against observed values collected in the field in order to determine abnormal activity is occurring.

Alarm stage

- Thresholds are set for evaluation of whether or not the unusual patterns warrant notification.

Seasonal trends—8 year ensemble average

Day of week adjustments

Principal Fourier component analysis

Time series models

Adapted methods from economic forecasting, telecommunications engineering

Daily number of cases =

- autoregressive component
- harmonic components
- seasonal components
Observed data

Daily counts of ED visits for respiratory syndromes from 1992 to 2002

The model forecast

- Model with autoregressive components, seasonal trends, other trends, covariates

Reis & Mandl et al, BioMed Central 2003

But

How do you know if it works?

- Measure against biological phenomena
- Simulation

Temporal dependencies

The noise

Daily counts of ED visits for respiratory syndromes from 1992 to 2002

Controlled feature set models

- Flat
- Linear
- Exponential
- Multinomial
The signal

- **Parameters**
  - Outbreak size
  - Outbreak shape
  - Outbreak start date
  - Outbreak duration

Four filters (weighting schemes) applied

Diagnostic characteristics

- Measure performance using ROC curves
- Achieved a high sensitivity holding the false alarm rate at only one per month

It sounds like Osama Bin Laden, but it could be your mother

"It sounds like Osama bin Laden, but it could be your mother."

Reis, Pagano, Mandl PNAS 2003

Written up in Nature

Harvard team suggests route to better bioterror alerts
GIS

- Classical GIS
  - Point source
  - Case definition solid
  - Huge temporal windows

- GIS in RT surveillance
  - Could be anywhere
  - Case definition—not disease per se
  - Small temporal windows

Seasonal distributions

A curve fit to the cumulative distribution

Distribution of interpoint distances between emergency dept patients

Dramatic increase in power of detection using space+time, compared with just time

The cluster

A simulated outbreak

Our system

AEGIS

- Automated
- Epidemiologic
- Geotemporal
- Integrated
- Surveillance
Selected studies


Reis, Mandl. Integrating syndromic surveillance data across multiple locations: effects on outbreak detection performance. Proc AMIA Symp 2003

Reis, Mandl. Time series modeling for syndromic surveillance. BMC Med Inform Decis Mak 2003

Mohtashemi, Szolovits, Mandl. Transients and early detection of outbreaks of contagious infectious disease: towards real-time public health surveillance. Submitted

Sebastiani, Mandl, Kohane, Szolovits, Ramont. Pediatric Patients Are Natural Sentinels of Influenza Illness and Mortality. Submitted

Sources

- Ten hospital emergency departments by May 2004

www.chip.org/biosurv