



# **Biosurveillance: Detecting, Tracking, and Mitigating the Effects of Natural Disease and Bioterrorism**

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# Report Documentation Page

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# Outline of Presentation

- Define biosurveillance and provide examples of systems currently in use
- Describe conditions that led to creation and implementation of biosurveillance systems
- Outline technical, managerial, and inter-organizational challenges in effectively implementing and operating systems
- Discuss importance of collaboration and aligning goals among interagency and other organizational partners



# 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]
  - “The Secretary of Health and Human Services shall establish an operational national epidemiologic surveillance system for human health...” [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]

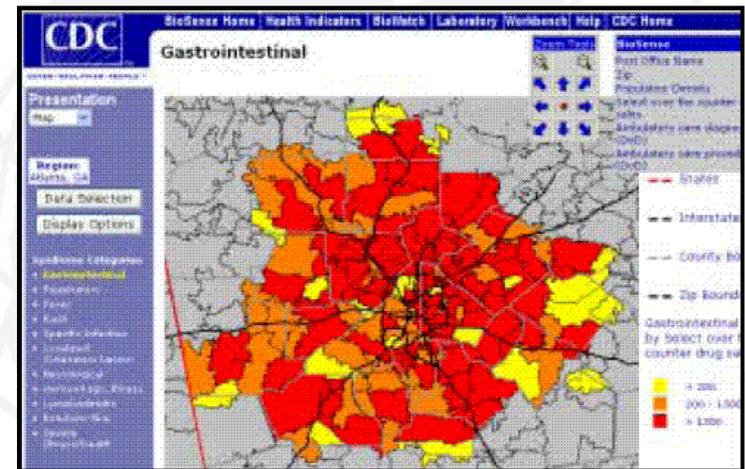
[1] [www.whitehouse.gov/news/releases/2007/10/20071018-10.html](http://www.whitehouse.gov/news/releases/2007/10/20071018-10.html)

[2] CDC ([www.cdc.gov/eop/dphsi/syndromic.htm](http://www.cdc.gov/eop/dphsi/syndromic.htm), accessed 5/29/07)



# Purpose: Early Event Detection and Health Situational Awareness

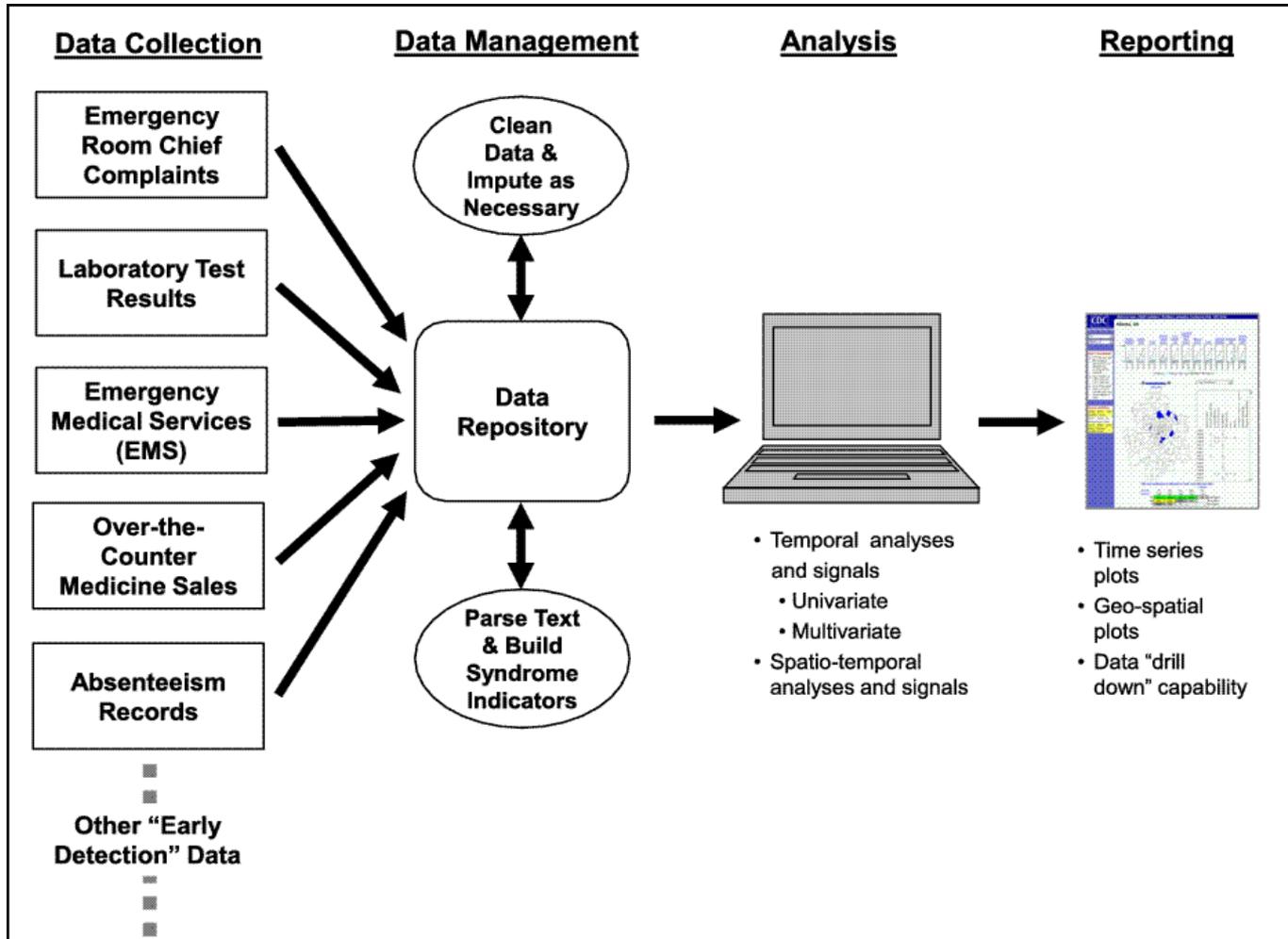
- “**Early Event Detection** (EED) is the ability to detect at the earliest possible time events that may signal a public health emergency. EED is comprised of case and suspect case reporting along with statistical analysis of health-related data.” [1]
- “**Health Situational Awareness** is the ability to utilize detailed, real-time health data to confirm, refute and to provide an effective response to the existence of an outbreak. It also is used to monitor an outbreak’s magnitude, geography, rate of change and life cycle.” [1]



[1] CDC (<http://www.cdc.gov/BioSense/publichealth.htm>, accessed 10/11/08)



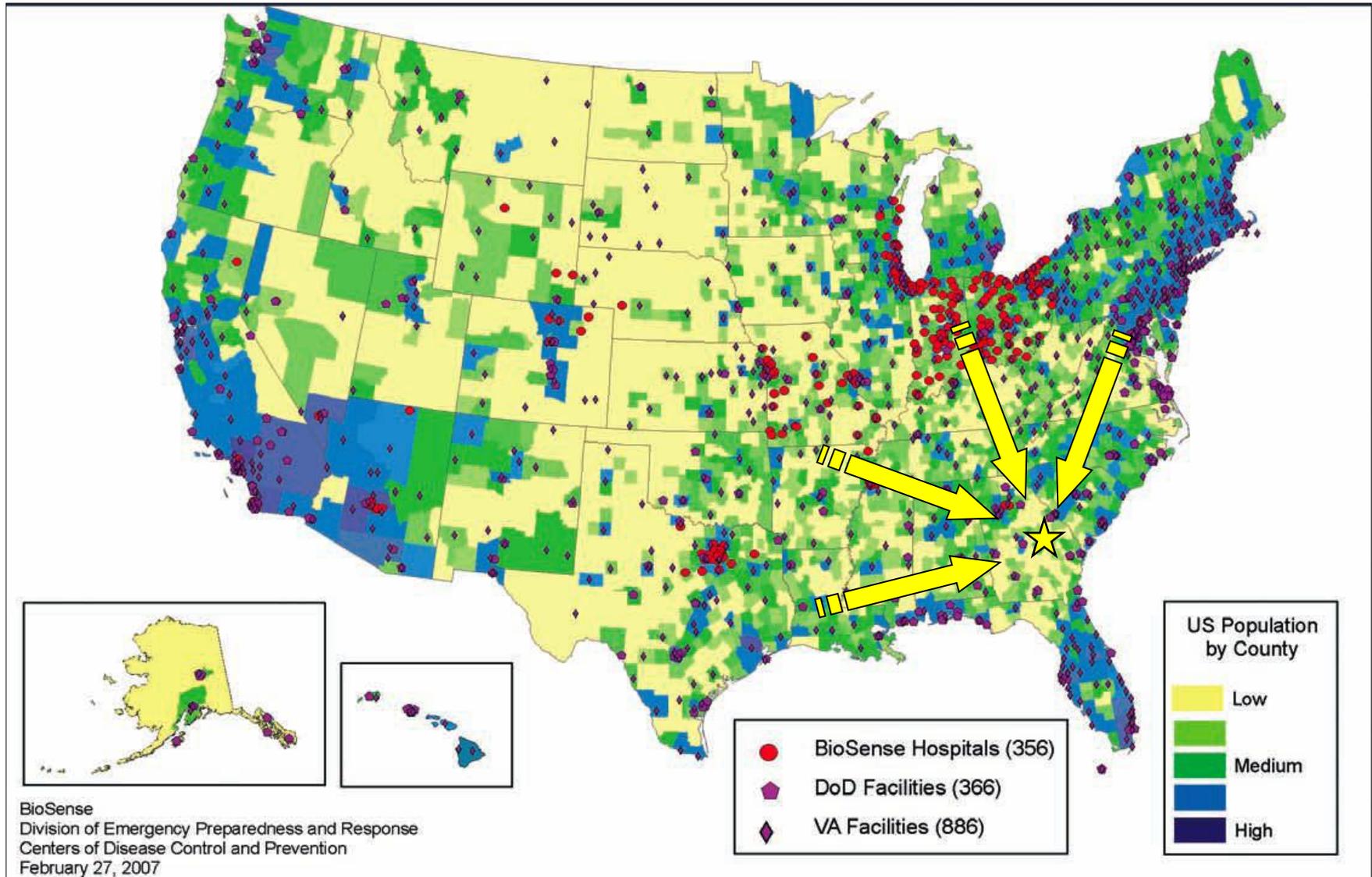
# It's a Never-Ending Analysis



*Data acquisition, analysis, and decision making repeated daily.*



# An Existing System: BioSense





# BioSense Display

BioSense Home
Health Indicators
BioWatch
Laboratory
Workbench
Help
CDC Home

Atlanta, GA

CDC

SAFER • HEALTHIER • PEOPLE™

Data Transmission

- ▶ OTC did not load this morning since DCTS was stopped last evening for the upgrade.
- ▶ VA is caught up with a normal load yesterday.
- ▶ DOD while small seems to be a normal load since it was weekend data.

Specific Infection

02/06 30030 DOD Spirillary Fever

02/07 30333 VA Boutonneuse Fever

02/10 30346 DOD Rocky Mountain Spotted Fever

Gastro-intestinal
Respiratory
Fever
Hemorrhagic Illness
Lymphadenitis
Localized Cutaneous Lesion
Neurological
Rash
Specific Infection
Botulism-like
Severe Illness/Death

◆ Method 1 ◆ Method 2 ◆ Cusum ◆ SMART ◆ Method 5

2/10/2004

Overall Region	Fri	Sat	Sun	Mon	Tue
OTC	15,438	15,987	11,206	18,536	16,717
VA_ACD	42	9	6	66	58
DOD_ACD	1	0	0	0	0

	Fri	Sat	Sun	Mon	Tue
30002 VA_ACD	0	0	0	5	0
30004 OTC	152	100	104	168	117
30005 OTC	75	44	53	106	109
30008 OTC	54	48	27	71	68
30011 OTC	58	84	42	65	64
30012 OTC	26	31	12	44	54
30013 OTC	59	109	32	97	81
30022 OTC	186	242	190	274	209
30038 OTC	98	127	44	99	74
30039 OTC	75	79	80	65	87
30062 OTC	530	555	395	621	567
30068 OTC	158	190	207	189	173
30108 OTC	80	121	57	80	81
30126 OTC	516	602	261	662	430
30189 OTC	164	95	155	155	153
30294 OTC	66	94	60	93	134
30296 OTC	97	157	62	114	85
30307 OTC	223	133	163	232	209

Data Records Received vs expected for most recent five Event Days

Records Per Day	Yesterday				
	Fri 2/06	Sat 2/07	Sun 2/08	Mon 2/09	Tue 2/10
OTC	106%	106%	101%	103%	4%
DoD	68%	69%	47%	4%	
VA	56%	29%	0%		

WWW.NPS.EDU

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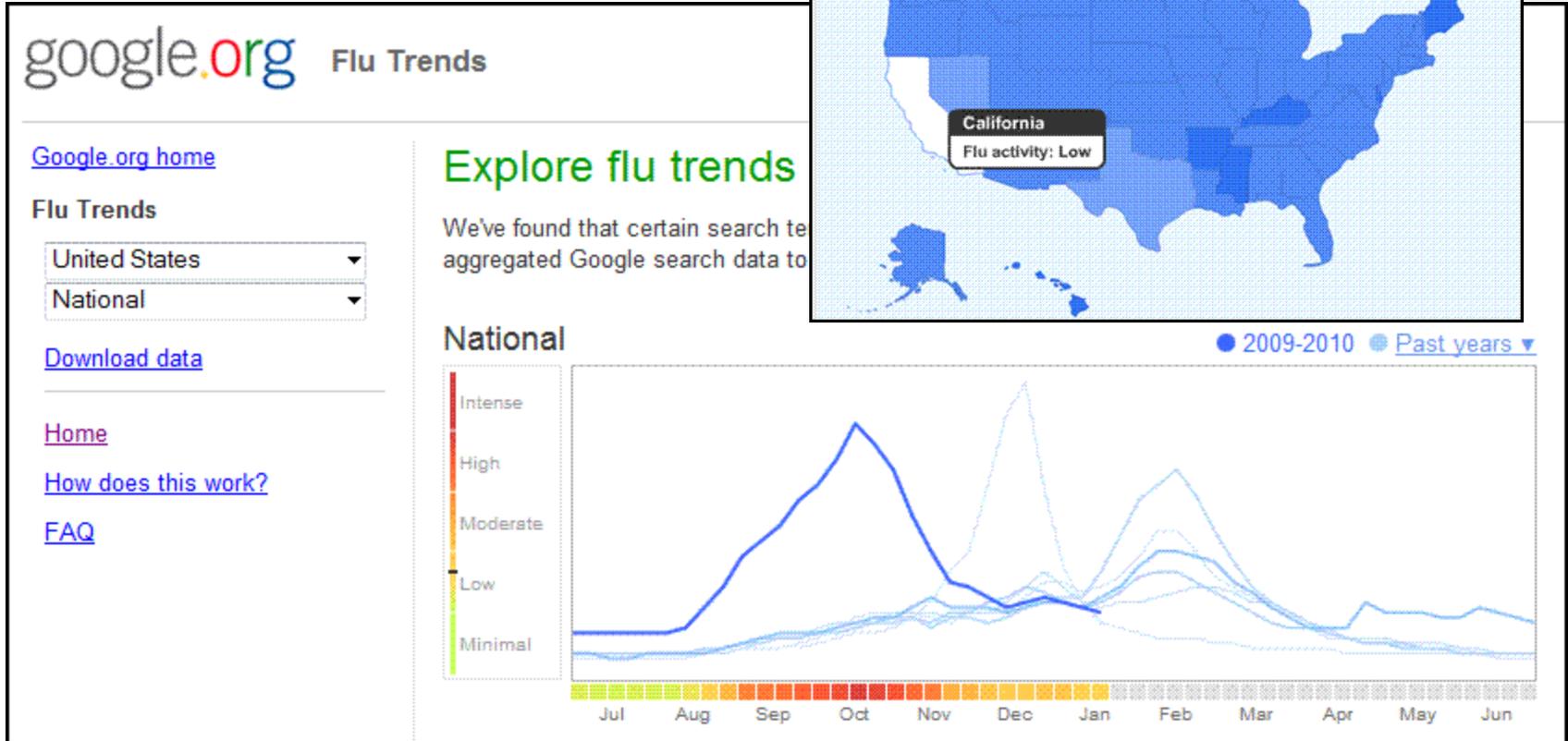


# Other Biosurveillance Systems

- **Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE)**
  - Developed and operated by the DoD
  - ESSENCE IV monitors for infectious disease outbreaks at more than 300 military treatment facilities worldwide
  - ESSENCE II monitors military and civilian outpatient visit data as well as over-the-counter pharmacy sales and school absenteeism in the Washington DC area
- **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
    - E.g., Monterey County Health Department uses EARS to monitor emergency room data from the county's hospitals and clinics daily



# Latest Entry: Google Flu Trends



See [www.google.org/flutrends/](http://www.google.org/flutrends/)



# How Good is Google Flu Trends?

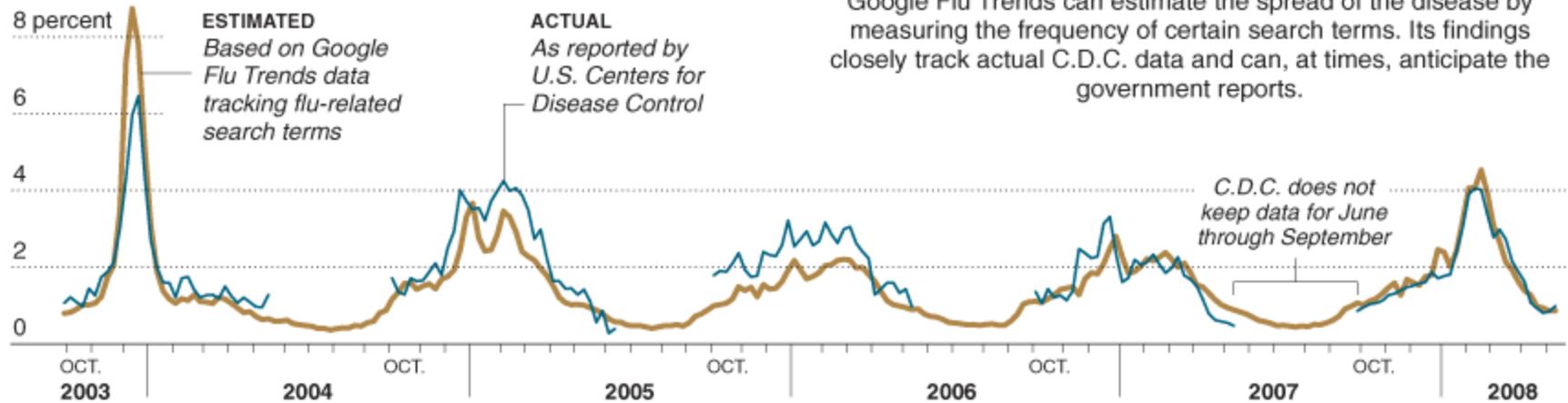
The New York Times

November 12, 2008

PERCENT OF HEALTH VISITS FOR FLU-LIKE SYMPTOMS *Mid-Atlantic region*

## Using Google to Monitor the Flu

Google Flu Trends can estimate the spread of the disease by measuring the frequency of certain search terms. Its findings closely track actual C.D.C. data and can, at times, anticipate the government reports.



Sources: Google; Centers for Disease Control

THE NEW YORK TIMES

- Google search results correspond to CDC “sentinel physician” data
- Google says it was able to accurately estimate flu levels 1-2 weeks faster than published CDC reports



# Conditions Driving Implementation

- Rise of militant extremism
  - Real concern that terrorist might try to use virulent bio-agent
- 9/11 and subsequent Anthrax attacks
  - Provided political imperative to improve homeland security
- Advances in computer and Internet technology
  - Near real time data collection and dissemination made possible

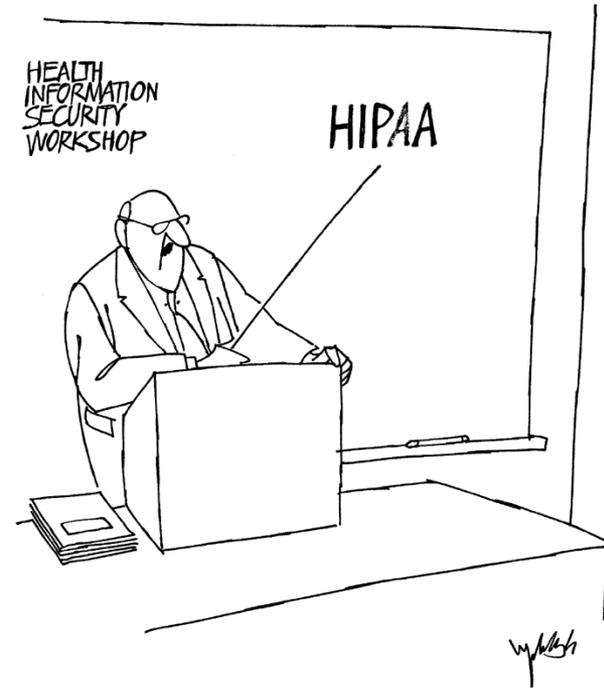


# Challenges to Implementation

- **Legal and regulatory** in order to gain access to data
- **Technological** related to designing and implementing computer hardware and software for collecting and assembling data
- **Ethical and procedural** issues inherent in managing and safeguarding data
- **Analytical** challenges of assessing the likelihood of outbreaks and of displaying data to enhance situational awareness.
- **Managerial** challenges of effectively assembling and operating the entire system

# Managerial Planning Considerations

- Goals - public service vs business
- Network type
- Executive sponsor
- Technological
- Legality
  - Data confidentiality
  - Memorandums of Understanding
- Sustainability



*"No, it's not a female Hippopotamus, anyone else know?"*



# Solutions to Implementation

- Align goals between health care institutions
- Use products that best fit your need
- Be creative with funding
- Create partnerships with academia





# Importance of Collaboration

## MCHD

Real world data sets  
Applied needs and skills

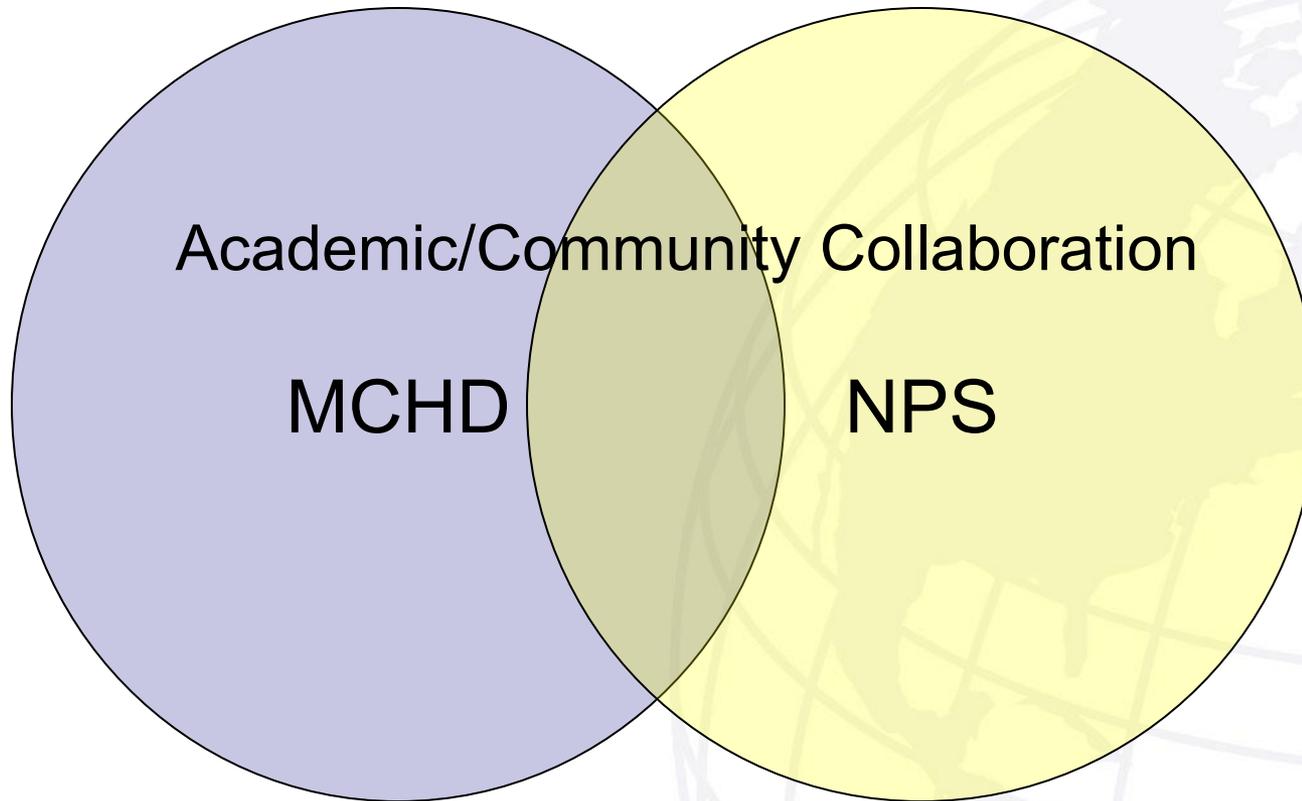
## NPS

Statistical expertise  
Dedicated research time



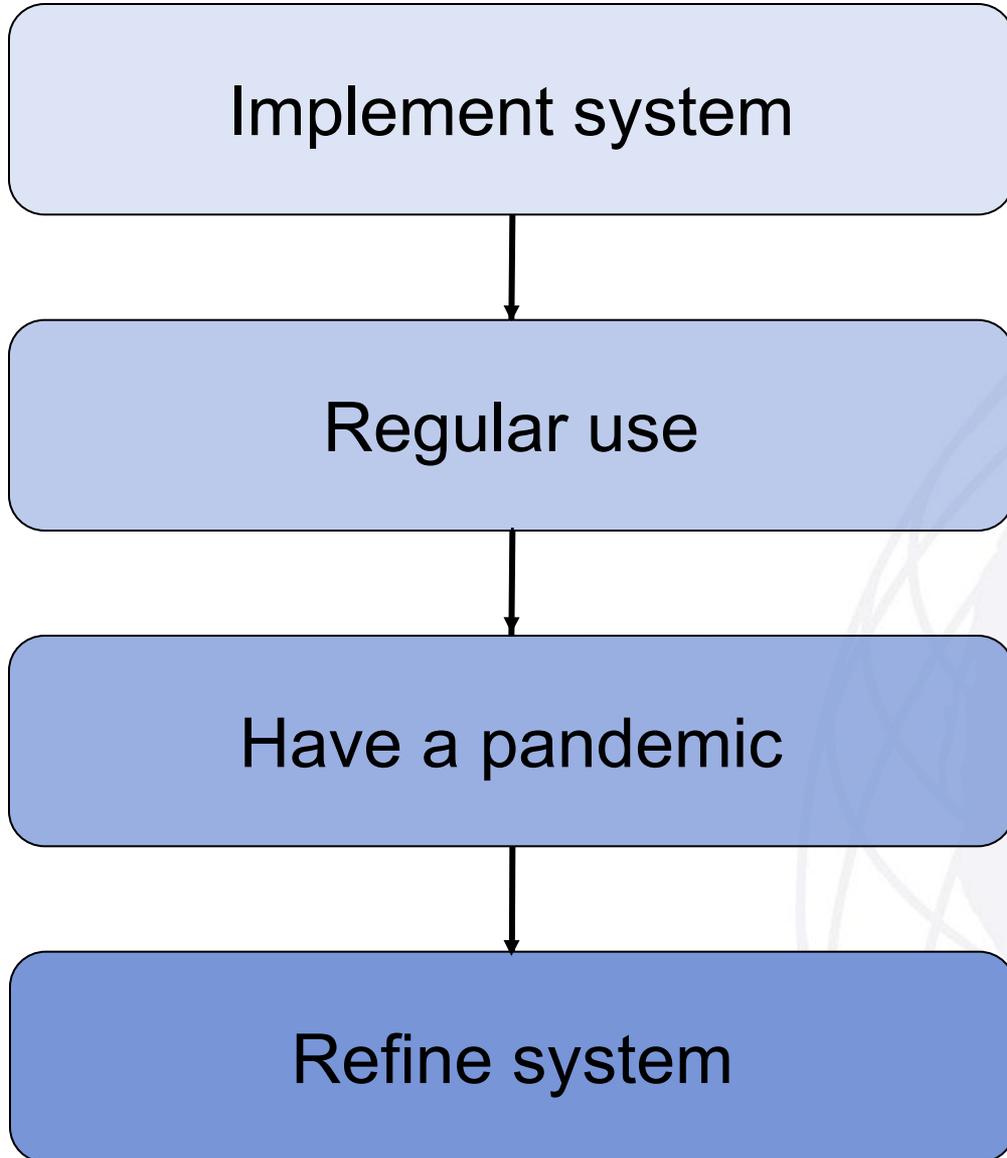
# Importance of Collaboration

## Intersection of Goals





# Importance of Events



EARS

Daily  
Observational and  
Situation  
Evaluation Report

Pandemic H1N1  
Influenza 2009

Inventory, school,  
provider  
surveillance



# Conclusions and Take-Aways

- National security issues now span all levels of government
- Analytical challenges are significant
- Plan, but be flexible
- Be aware of limitations of biosurveillance systems
- Be open to new partnerships



# Selected References

## Background Information:

- Fricker, R.D., Jr., Some Methodological Issues in Biosurveillance (with discussion), *Statistics in Medicine*, to appear. (Pre-prints available at <http://faculty.nps.edu/rdfricke/frickerpa.htm>.)
- Fricker, R.D., Jr., Syndromic Surveillance, in *Encyclopedia of Quantitative Risk Assessment*, Melnick, E., and Everitt, B (eds.), John Wiley & Sons Ltd, pp. 1743-1752, 2008.
- Fricker, R.D., Jr., and H. Rolka, Protecting Against Biological Terrorism: Statistical Issues in Electronic Biosurveillance, *Chance*, **91**, pp. 4-13, 2006.

## Detection Algorithm Development and Assessment:

- Fricker, R.D., Jr., and J.T. Chang, A Spatio-temporal Method for Real-time Biosurveillance, *Quality Engineering*, **20**, pp. 465-477, 2008.
- Fricker, R.D., Jr., Knitt, M.C., and C.X. Hu, Comparing Directionally Sensitive MCUSUM and MEWMA Procedures with Application to Biosurveillance, *Quality Engineering*, **20**, pp. 478-494, 2008.
- Joner, M.D., Jr., Woodall, W.H., Reynolds, M.R., Jr., and R.D. Fricker, Jr., A One-Sided MEWMA Chart for Health Surveillance, *Quality and Reliability Engineering International*, **24**, pp. 503-519, 2008.
- Fricker, R.D., Jr., Hegler, B.L., and D.A Dunfee, Assessing the Performance of the Early Aberration Reporting System (EARS) Syndromic Surveillance Algorithms, *Statistics in Medicine*, **27**, pp. 3407-3429, 2008.
- Fricker, R.D., Jr., Directionally Sensitive Multivariate Statistical Process Control Methods with Application to Syndromic Surveillance, *Advances in Disease Surveillance*, **3:1**, 2007.

## Biosurveillance System Optimization:

- Fricker, R.D., Jr., and D. Banschbach, Optimizing Biosurveillance Systems that Use Threshold-based Event Detection Methods, *Information Fusion*, to appear. (Pre-prints available at <http://faculty.nps.edu/rdfricke/frickerpa.htm>.)