

# Syndromic Surveillance

Richard S. Hopkins, MD, MSPH

Charleston, WV

November 14, 2012

# Outline

- Big picture: what is public health surveillance, and what is it for?
- Surveillance and situational awareness
- Purposes at local, state and national levels
- Relationship to program activities
  - Tuberculosis example
- Components for both 'routine' and emergency public health activities
  - Detection vs. monitoring
  - Role of statistics
- Potential sources of data for surveillance and situational awareness
- Syndromic surveillance as one part of an overall approach
- Distinctive characteristics of syndromic surveillance
- Influenza surveillance – Florida
- Other examples of utility of this approach from Florida
- Meaningful Use of electronic health records: opportunity knocks
- Technical options for a state-level syndromic surveillance system

# Public health surveillance

- The ongoing, systematic collection, analysis, and interpretation of health data, essential to the planning, implementation and evaluation of public health practice, closely integrated with the dissemination of these data to those who need to know and linked to prevention and control

# The prime directive

“The reason for collecting, analyzing and disseminating information on a disease is to control that disease. Collection and analysis should not be allowed to consume resources if action does not follow.”

(Foege WH et al., Int. J of Epidemiology 1976; 5:29-37.)

# How do public health decisions get made?

- Epidemiologists would like to think decisions are based on good population health data
- Sometimes they are
- But decision-makers legitimately consider lots of other factors
  - Budget priorities
  - Public acceptability
  - Consistency with values of leadership
  - Sustainability
- Comfort level of public health agency leaders with using and presenting data is sometimes a limiting factor

# If tuberculosis were new....

- Imagine that 'tuberculosis' is a newly recognized disease, already pretty widespread
- (This is where we were with AIDS in the late 1980s)
- Further, imagine that you have just been appointed to be your community's Health Officer, with responsibility for controlling infectious diseases
- Your community already has a well-developed system for taking care of sick people, with independent practicing doctors and hospitals

# What would you need to know?

- How is the disease acquired?
  - Other people, food, vectors, environment, etc?
- How long is the incubation period?
- When are people (most) infectious?
- What is the natural history of disease?
  - What fraction of infected people get sick and when?
- What are its clinical characteristics?
  - How distinctive is it?
- How do you make the diagnosis?
  - Is there a good laboratory test?
  - Can you identify people who are infected but not sick?
- Is there an effective treatment?

# What else would you need to know?

- How much disease is there currently?
- Is the amount of disease going up or down?
- In what population groups is it most common?
  - Do the most-at-risk groups have ready access to clinical care?
- How well does the public understand this disease?
  - Is there a stigma associated with it?

# Where does this knowledge come from?

- Some comes from planned studies
  - Clinical
  - Epidemiologic
  - Laboratory
- Information that is timely and community-specific comes from ongoing public health surveillance

# What are the responsibilities of a public health agency?

- According to the Institute of Medicine (1988), the core functions are just 3:
- Assessment
- Policy Development
- Assurance

# Assessment

- Looking across the whole community, what diseases are causing the biggest burden?
- For a disease of interest, how much is there?
- Is it increasing or decreasing? What are at-risk groups?
- Is there an effective control strategy available?
- Are appropriate actions already being taken by clinical and public health sectors?
- Are available resources adequate to control the disease?
  - Clinical services
  - Public health services
  - Legal authorities

# Policy development

- How important is prevention or control of this disease compared to other possible uses of community resources?
- What evidence-based steps can be taken to control this particular disease?
  - Are these acceptable to the community?
- What can we tell clinicians about how to best diagnose and manage cases of the disease?
- What, if any, supplemental clinical, public health and laboratory services are needed?
  - Where will the resources come from?
- Are changes in the law or regulations needed, and if so what should they say?

# Assurance

- When it is clear what actions need to be taken to control the disease, a central role of the public health agency is to assure that these steps are taken
- That does not mean that the PH agency has to do them itself
  - Important advocacy role in the community
  - Public-private partnerships are an important tool

# Five purposes of PH surveillance

- Allow public health agencies to take action in response to each reported case
- Allow rapid detection of and response to outbreaks of disease
- Support planning of public health and other prevention programs
- Support evaluation of public health and other prevention programs
- Provide timely data to clinicians to allow them to improve patient care

# Purposes by level

- At the local level, the main purpose of surveillance is immediate case and outbreak response
- At the federal level, the main purpose is for planning and evaluation, including policy recommendations
- At the state level both sets of purposes are important
  - Typically infectious disease surveillance is built on local case-finding
  - Non-infectious disease surveillance is typically managed at state level

# Methods of surveillance

- Individual case reports by doctors, hospitals and laboratories
  - Active or passive
- Sentinel sites
  - e.g. influenza
- Birth and death certificates
- Syndromic surveillance
- Extracts from electronic medical records
- Administrative data
  - Billing records, hospital discharge abstracts
- Population surveys
  - Behavioral Risk Factor Surveillance System

# ESF-8 activations in Florida since 2004 -- hurricanes

- Hurricane Charley -- 2004
- Hurricane Ivan -- 2004
- Hurricane Jeanne -- 2004
- Hurricane Frances – 2004
- Hurricane Dennis – 2005
- Hurricane Katrina – 2005
- Hurricane Rita -- 2005
- Hurricane Wilma -- 2005

# ESF-8 activations in Florida since 2004 – infectious disease events

- E. coli O157:H7 (60 cases) -- 2006
- Cyclosporiasis (800 cases) – 2006
- Influenza A/H1N1 – 2009-2010
- Tuberculosis outbreak, Jacksonville, 2012
- Fungal meningitis (23 cases, 1050 exposed people) 2012

# Other ESF-8 activations in Florida

- Chinese dry-wall health effects – 2009
- Deepwater Horizon oil spill – 2010
- Evacuation of critically wounded from Haiti after earthquake – 2010
- Wildfires and smoke -- 2006-2009
- Three Superbowls (Tampa, Miami, Jacksonville)
- Republican National Convention -- 2012

# What epidemiologic capabilities do public health agencies have to have normally?

- Surveillance
  - For individual cases
  - For outbreaks/events
  - To support policy development and evaluation
- Investigation
  - Cases
  - Outbreaks/events
- Summarize current situation
- Formulate evidence-based control recommendations
- In everyday practice, most implement control recommendations
- Laboratory support for all of the above
- Provider and public communications

# What epi capabilities does public health need to have during activations?

- Surveillance
  - For individual cases
  - For outbreaks/events
- Investigation
  - Cases
  - Outbreaks/events
- Summarize current situation
- Formulation of evidence-based control recommendations
- Laboratory support for all of the above
- Ability to function under difficult conditions
  - Healthcare system not functioning normally
  - Infrastructure damage
  - Displaced populations
- Ability to function effectively in complex ICS structures
- Ability to function under high stress
- Ability to deploy surveillance for unanticipated problems

# Routine vs emergency

- Most of the epidemiology and disease control skills we need for an emergency are ones we use every day
- It is important for us to be really good at our every day epi work so we are ready to go during an emergency
- Every case and every outbreak could be leading edge of a public health emergency – we triage informally
- Some skills are called for only occasionally in the absence of an emergency – large case-control study, new survey designed ‘on the fly’, quarantine orders, etc – and ‘on the fly’ surveillance!
- There are some skills needed in a large-scale-scale event that we basically never get to practice except in an exercise or a true emergency.

# Syndromic surveillance is one part of a larger approach to surveillance

- Notifiable disease surveillance
  - Passive surveillance
  - The ‘astute clinician’
  - Active case-finding in outbreak situations
  - Electronic laboratory reporting
    - Public health, hospital and commercial laboratories
  - Cancer and other registries
- Sentinel surveillance for specific conditions (ILI, RSV, etc)
- Vital statistics data (deaths, births)
- Population-based surveys (BRFSS, PRAMS etc)
- Others – hospital discharge data, HAI data collected through NHSN, poison centers, etc
- Syndromic surveillance

# Distinctive features of syndromic surveillance

- Deidentified
- Rapid
- No selection of records at sending end
- Reduced specificity – pre-diagnostic
  
- Focus is on information about the population, not about individuals
- Flexibility to monitor diseases/conditions that could not have been anticipated

# The basic model

- Daily electronic transmission of an electronic record in a standard format for every ED visit in participating hospitals
- Record is extracted from hospital's information system
- Requires no action by ED staff members
- Record includes age, sex, zip code, date, time, and chief complaint
- ESSENCE searches for key words in chief complaint and assigns each record to one or more syndromes
- Syndromes can be pre-defined or defined ad-hoc
- ED discharge diagnoses are filled in some days later with follow-up records

# Other approaches to SS

- Calls to nurse hotlines
  - Over the counter pharmacy sales
  - EMS trip reports
  - Prescription medication orders
  - Internet searches or mentions e.g. Google flu trends
- All have in common an effort to identify outbreaks early, before diagnoses have been made

# Syndromic surveillance and statistics

- If the main purpose of syndromic surveillance is outbreak detection, a disciplined approach to statistical analysis is essential
- Systems like ESSENCE and BioSense 2.0 have anomaly detection algorithms built in
- You can't optimize both sensitivity and positive predictive value at once
- You have to make practical decisions about how much time you want staff to spend each day assessing statistical alerts
- These practical decisions will drive your choice of algorithm and of alert level for investigation
- Experienced analysts get much quicker at assessing the patterns in the data they are familiar with
  
- Statistical analysis plays a much smaller role when the focus is on situational awareness

# Outbreak detection and SS

- We assume that earlier detection of outbreaks, with appropriate PH action, leads to prevention of disease
  - Stop this outbreak
  - Use findings to prevent future outbreaks
- Most outbreaks are detected through informal methods
  - We can take active steps to improve these methods
- Syndromic surveillance was 'sold' for outbreak detection
- Biggest value really seems to be assessing incident reports received other ways and monitoring events that are already known

# Situational awareness

- Assume a syndromic surveillance system with real-time population coverage of ED visits
- This system can provide information about:
  - Epidemic curve to date
  - Geographic distribution, current and over time
  - Population groups most affected (age, sex etc)
  - Changes in syndrome over time
  - Impact on emergency department capacity
- If data on admission status are gathered, you can monitor severity of illness by age, sex, over time and impact on hospital capacity

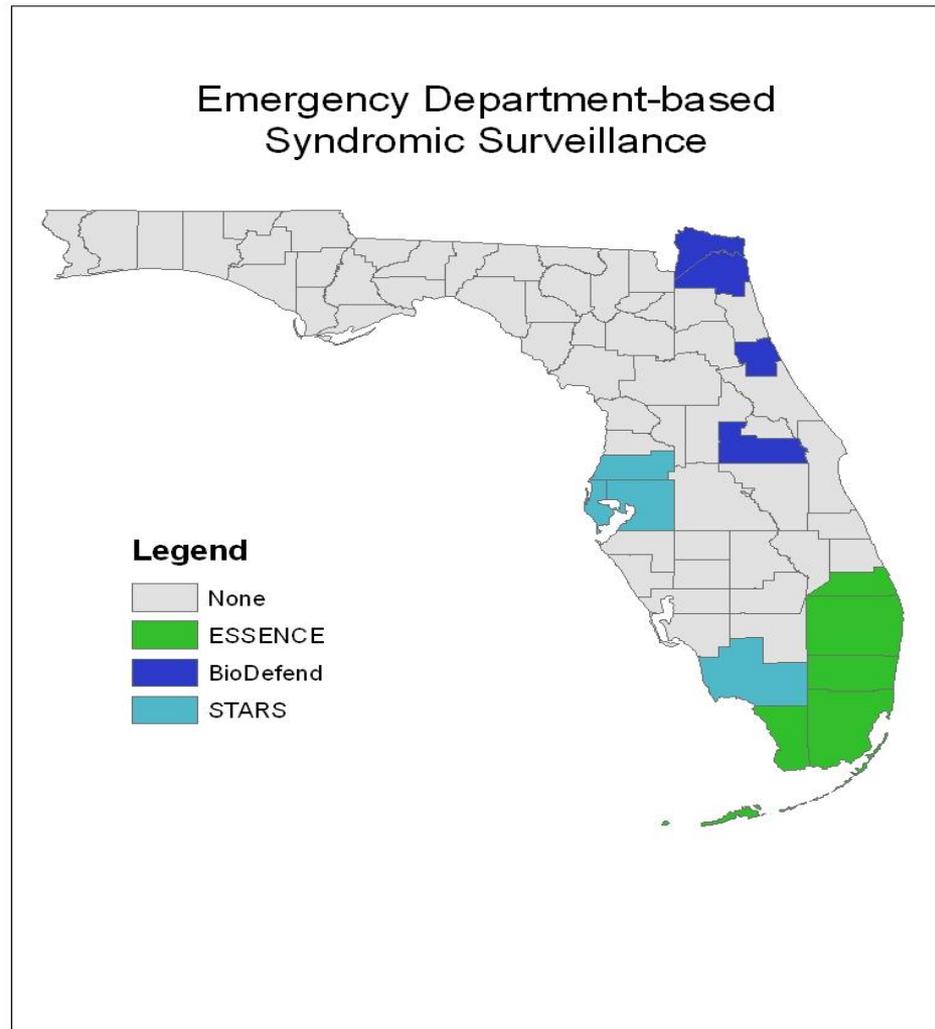
# A word about FL public health

- FL has 19 million people
- 67 county health departments
- Counties range from ~10,000 people up to ~2.4 million (Miami-Dade) and ~1.8 million (Broward)
- The 24 biggest counties account for >80% of the population – 43 others account for < 20%
- County Health Departments are part of the Florida Dept of Health, but get about 1/3 of their funding from their counties

# Syndromic surveillance beginnings

- FL did not request any funds for SS in the initial 2002 'Bioterrorism' grant proposal.
- Hillsborough County (Tampa) established drop-in surveillance for 2001 SuperBowl using EARS, continued it and expanded it to neighboring counties as STARS.
- Jacksonville area chose BioDefend, developed by USF, and implemented it using DHS money
- In 2005 Dept of Homeland Security offered BioWatch cities (Tampa, Jacksonville and Miami) technical support to get SS up and running
- DOH convened meeting of existing local syndromic surveillance systems with DHS and RODS, ESSENCE and BioSense sponsors
  - Miami-Dade initiated ESSENCE using this support

# Here is where we were in 2007



# SS Workgroup

- About 25 members recruited from local and state PH, emergency response organizations, hospitals
- Two in-person meetings plus conference calls
- Defined characteristics of local systems that could receive state funds
- Obtained highest-level Domestic Security sign-off
- Workgroup advised on choice of a state-level system that could receive feeds from local systems or from hospitals directly – ESSENCE was choice
- Once state-level ESSENCE was active, locals chose to phase out STARS and BioDefend
- Participation in original BioSense was not an option

# ESSENCE-FL Goals

- Establish a statewide syndromic surveillance system.
- Improve access to multiple public health surveillance data sources
- Provide intuitive, simple access to data for descriptive epidemiology, analysis, and report generation
  - Supporting multiple skill levels
- Close the public health surveillance loop
  - greater access to more timely information

## ESSENCE-FL Goals (2)

- Reduce need for spending to enhance other existing systems
- Provide a common environment where epidemiologists can:
  - Detect outbreaks
  - Monitor outbreaks/provide situational awareness
  - Carry out ongoing descriptive epidemiologic analysis over time, space, and multiple data sources
  - Characterize unanticipated public health issues

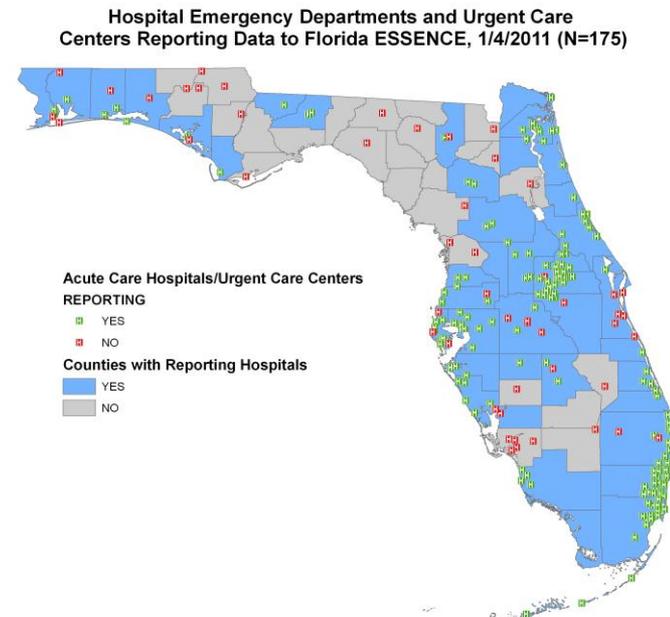
# Statewide ESSENCE Implementation

- Electronic Surveillance System for the Early Notification of Community-based Epidemics
- Web-based, automated electronic data collection and analysis that is available 24/7.
- Multi-tier web-based application
  - Web app (presentation), business logic, and databases
  - Data ingestion database, detection database, web database, detection algorithms, and web application

# Here is where we are now

- Statewide ESSENCE system receiving data from:
  - 176 hospitals and urgent care centers (~85% of Florida's ED visits)
  - All Merlin reportable disease data
  - All calls to the Florida Poison Information Network
  - All deaths from the Office of Vital Statistics

## Hospital Emergency Departments and Urgent Care Centers Reporting to ESSENCE as of 09/21/2011



# ESSENCE is two things

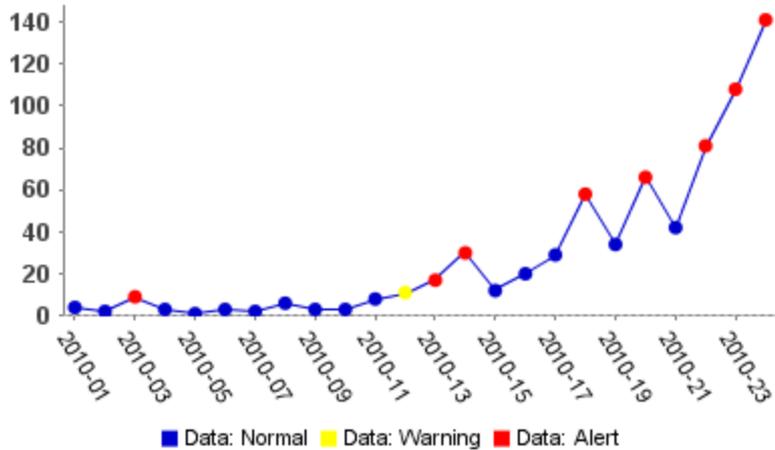
- A syndromic surveillance system
- A set of tools for managing surveillance data from many sources
- Your syndromic surveillance system does not have to do both

# ESSENCE-FL Data Sources

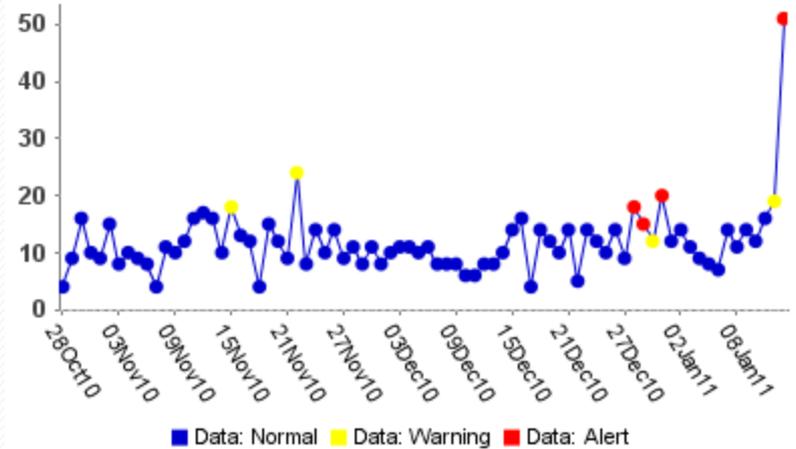
<b>Data Source</b>	<b>Timeliness of Data Transmission</b>	<b>Volume</b>	<b>Primary Unit of Analysis</b>
Emergency Department/Urgent Care Data	1 file each day from 175 facilities	Total: >25 million records	Syndromes, sub-syndromes, free text queries and stratifications by demographics
Merlin Data (reportable diseases)	1 file each hour	Total: ~350,000 case reports	Reportable disease cases and stratifications by demographics
Florida Poison Center Data	1 file every 20 minutes	Total: ~1.5 million calls	Major substance, minor substance, individual substance, clinical effects and stratifications by demographics
Florida Office of Vital Statistics – Mortality Data	1 file per day*	Total: ~2.1 million deaths	NCHS cause of death groups, flexible ICD-10 and free text queries and stratifications by demographics

# Event Detection

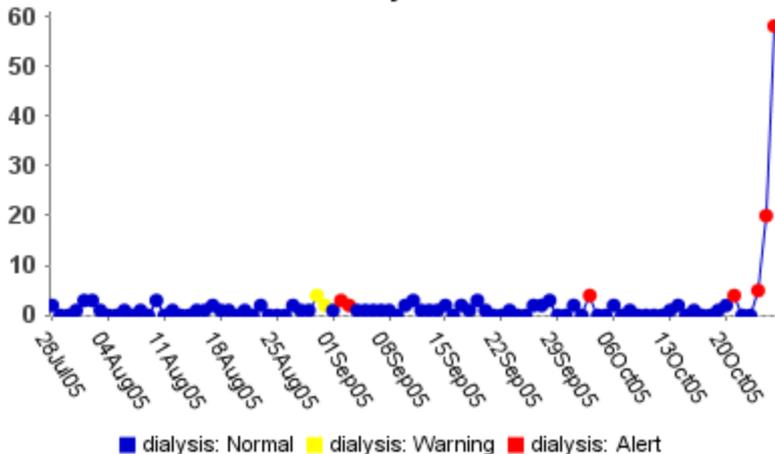
**ExcessiveHeat**



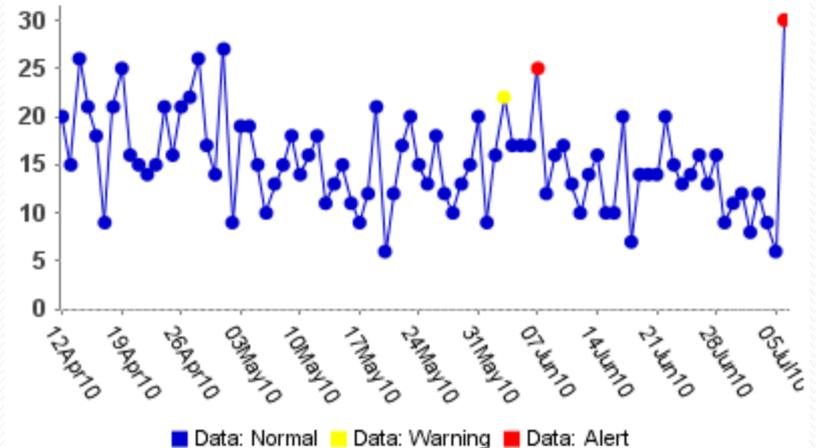
**Exposure**



**dialysis**



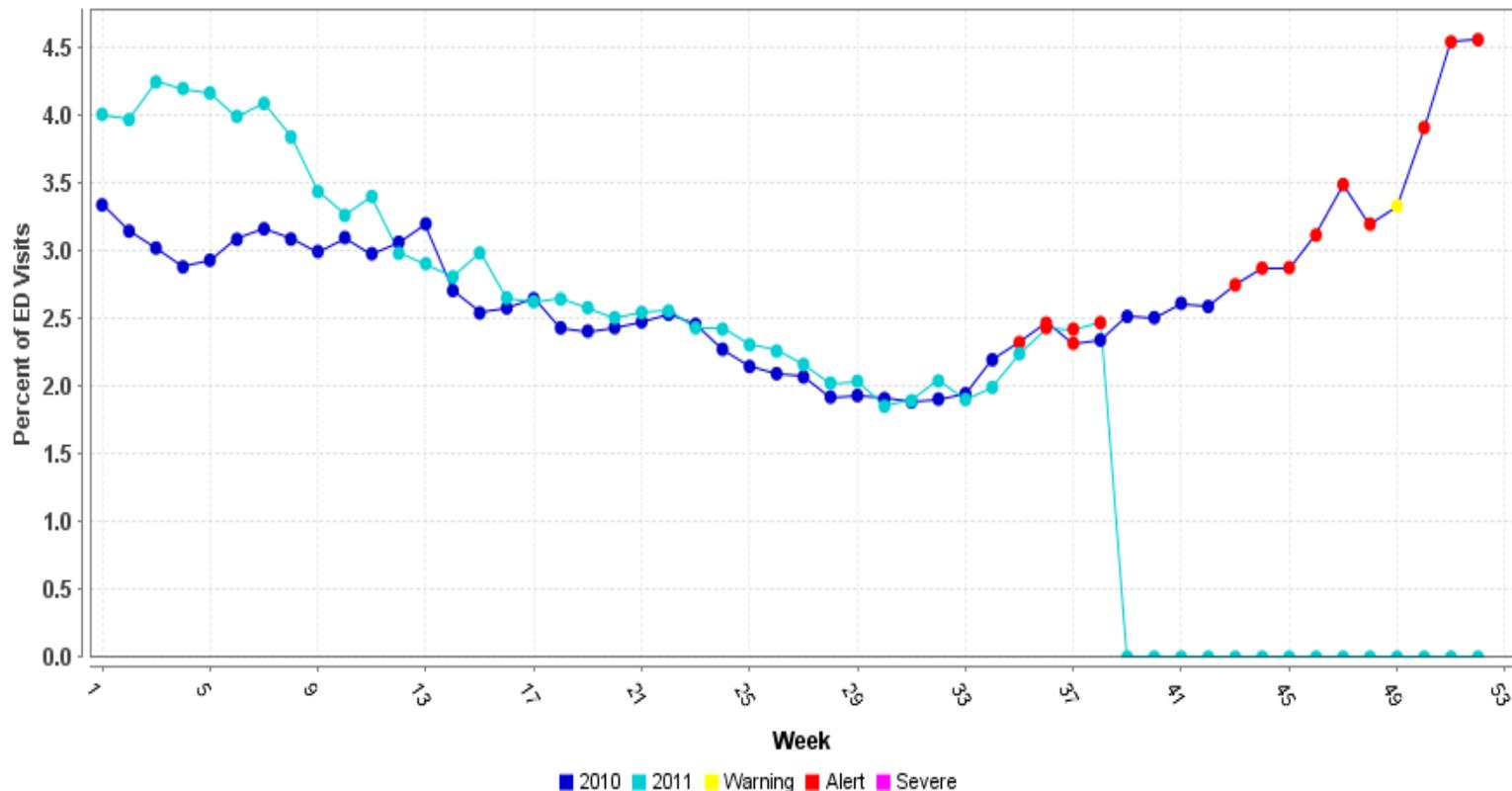
**NVD**



# Seasonal Outbreaks - ILI

- Using the ILI syndrome to monitor influenza season

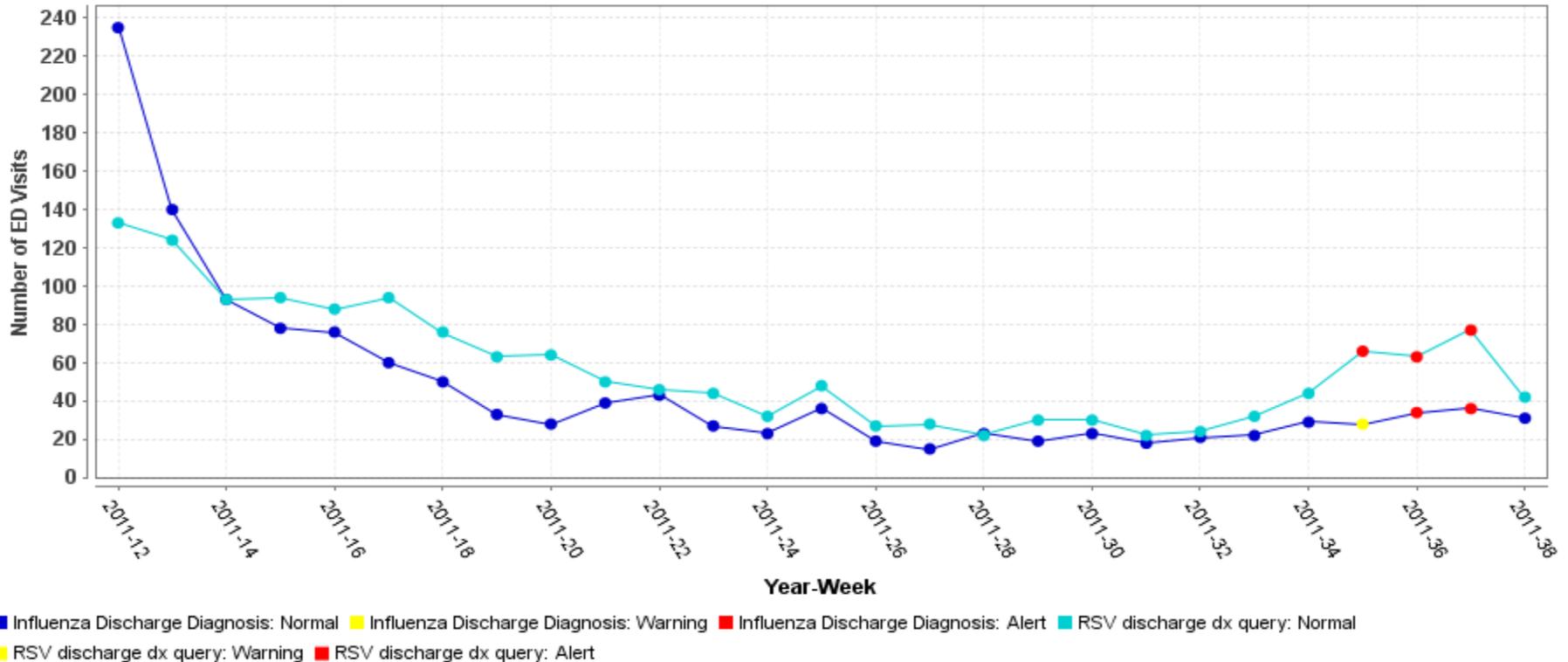
Percent of ED Visits Categorized as Influenza-like Illness, Florida, 2010-2011



# Seasonal Outbreaks

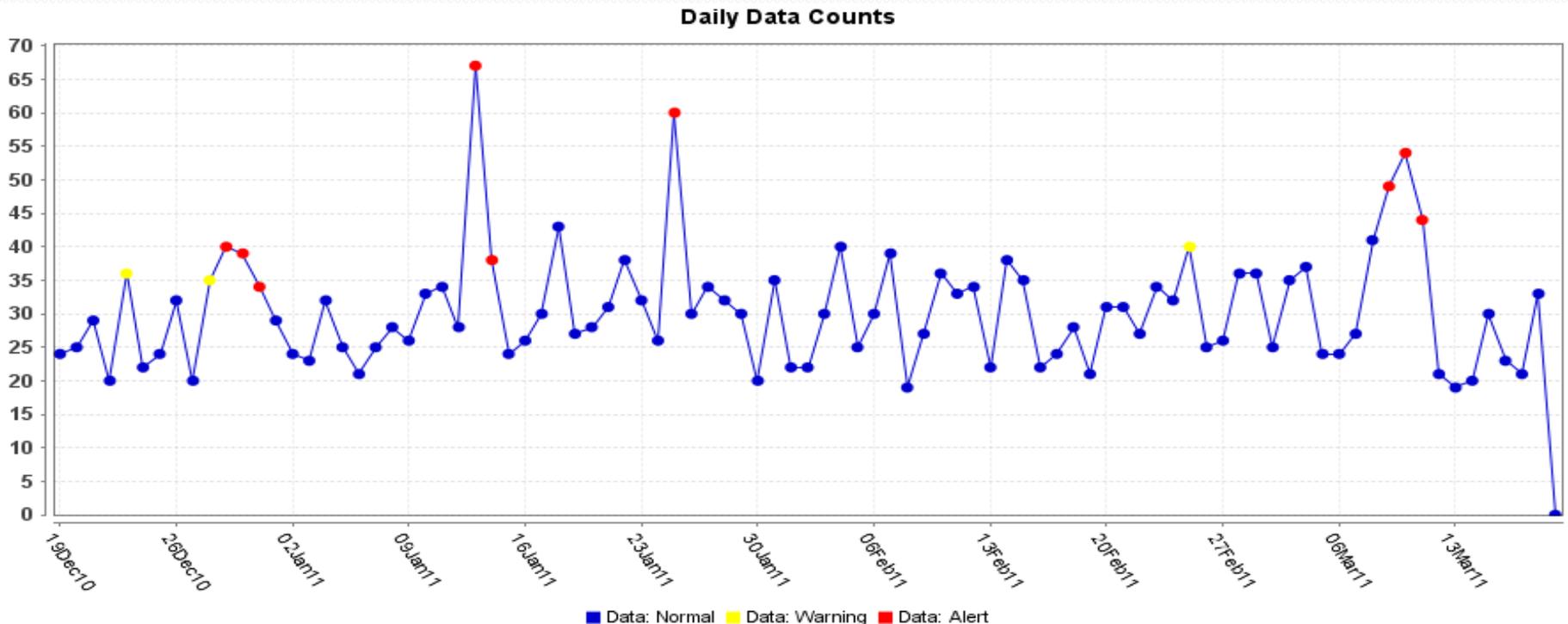
- Timing of respiratory related ED visits - RSV and Influenza

Free Text Discharge Dx Queries for RSV and Influenza, Florida



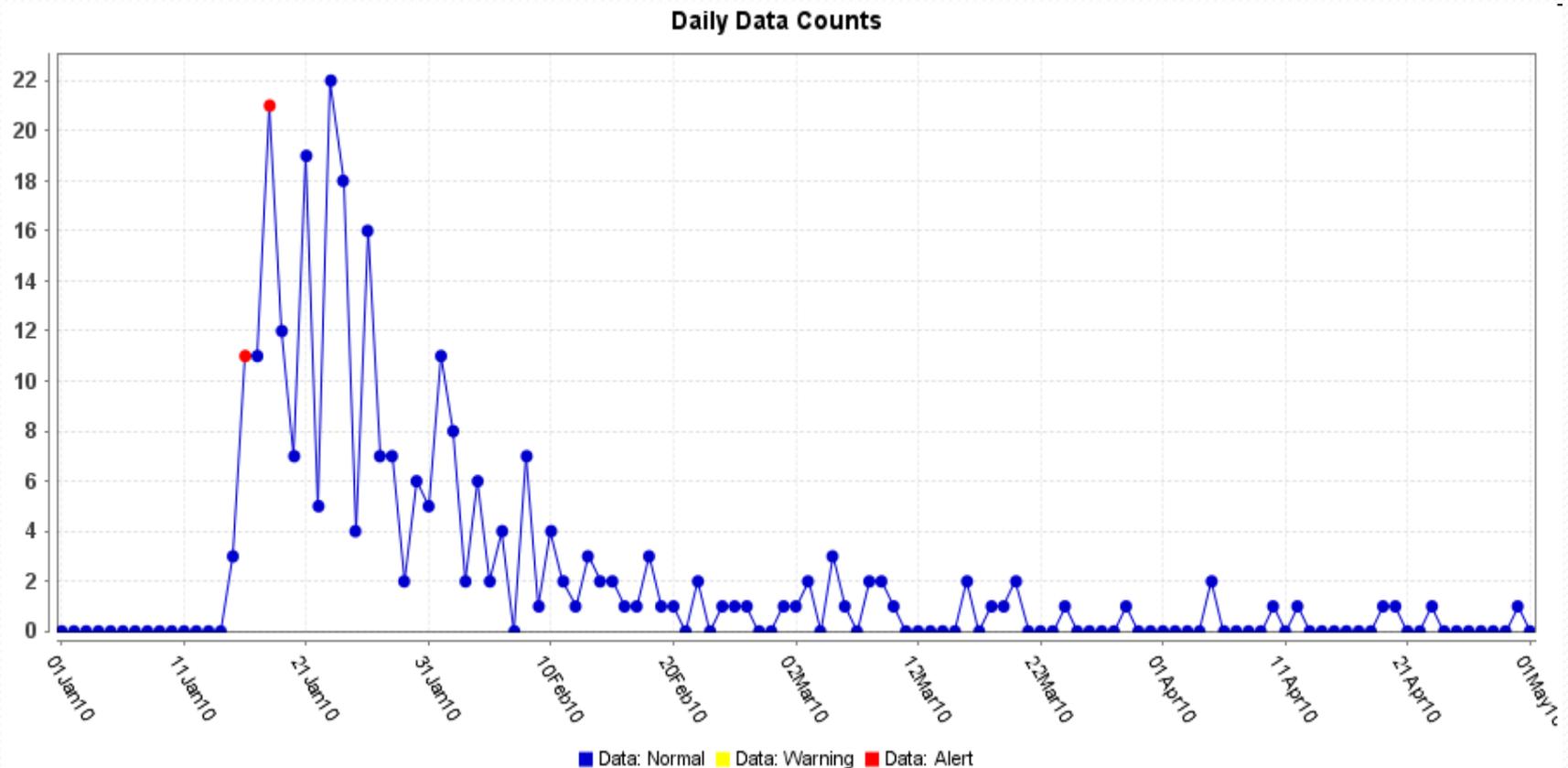
# Disease Name Search

- Records of Interest Syndrome Category:
  - Queries names of reportable diseases in the chief complaint (e.g. chickenpox, meningitis)



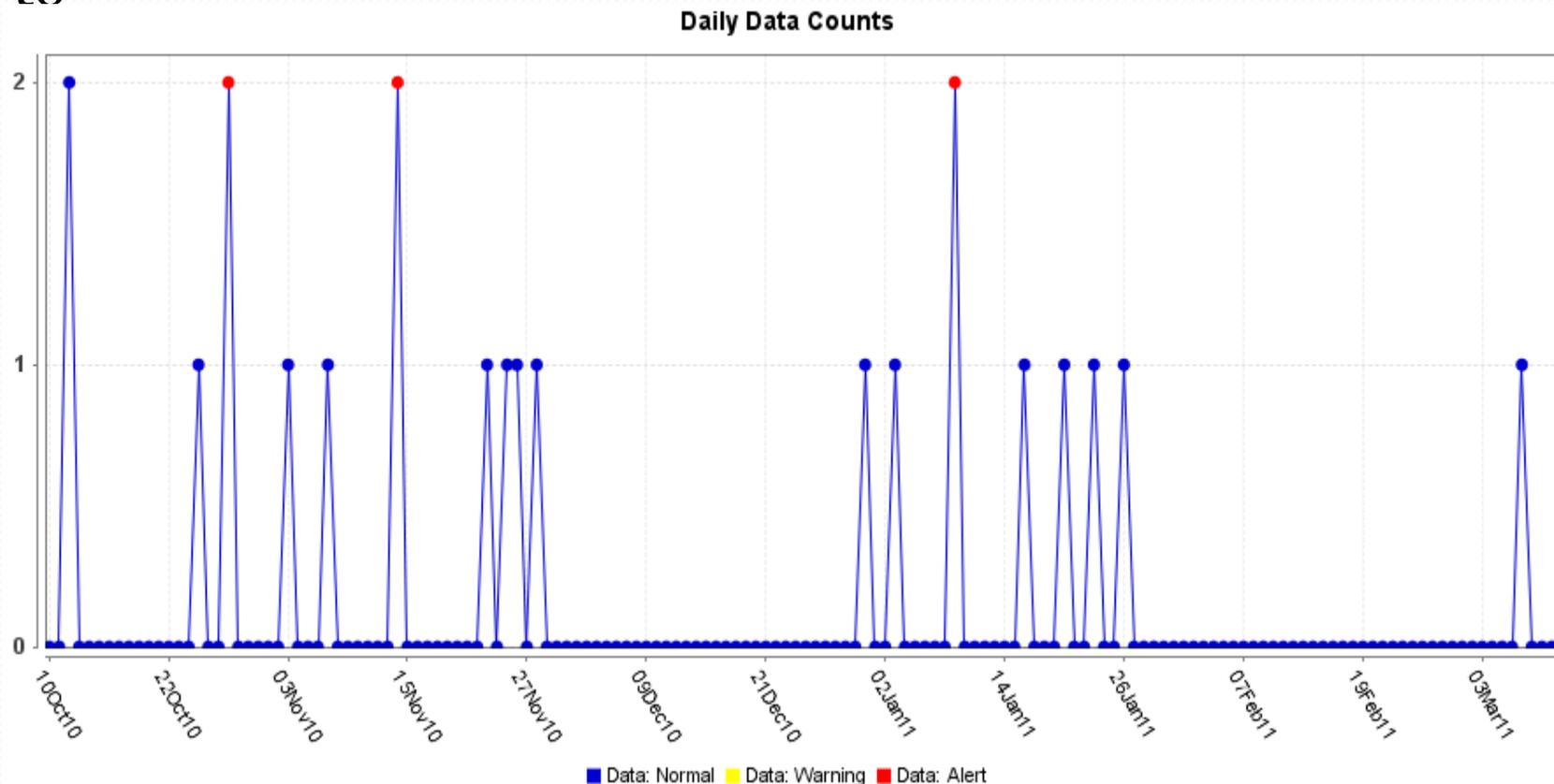
# Post Haiti Earthquake ED visits

- Flexibility to monitor emerging events
- ^earthquake^,or,^haiti^



# Haiti Cholera Outbreak

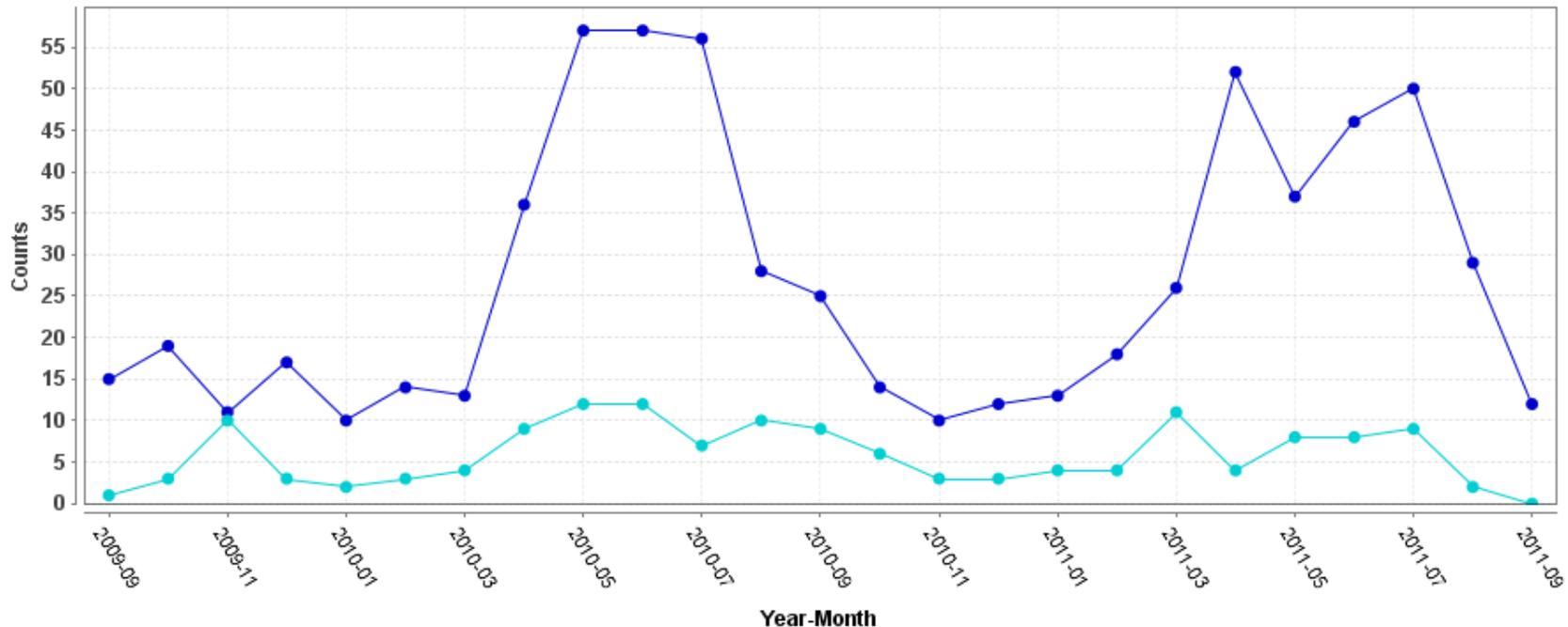
- Flexibility to monitor emerging events
- $\wedge$ haiti $\wedge$ , andnot,  $\wedge$ bronchhaitis $\wedge$ , or,  $\wedge$ cholera $\wedge$ , andnot,  $\wedge$ due to $\wedge$



# Drownings in those <1 to 4 yrs old

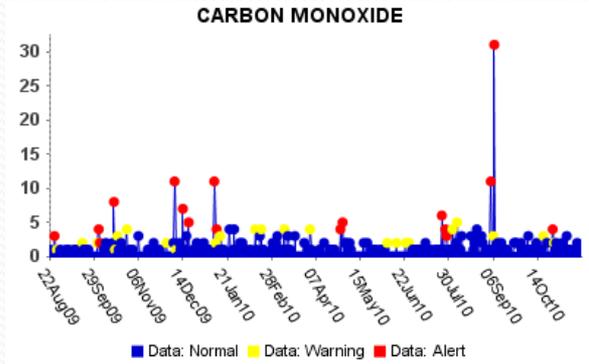
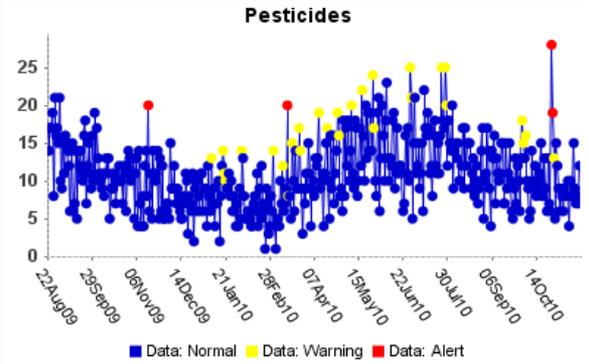
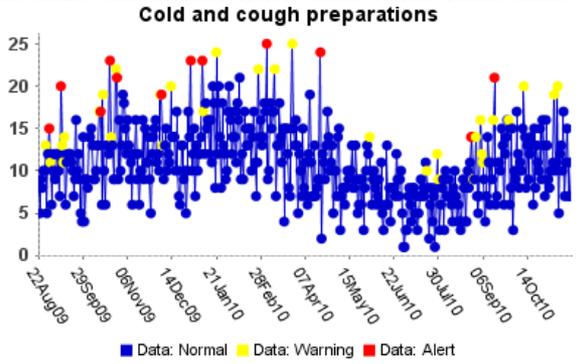
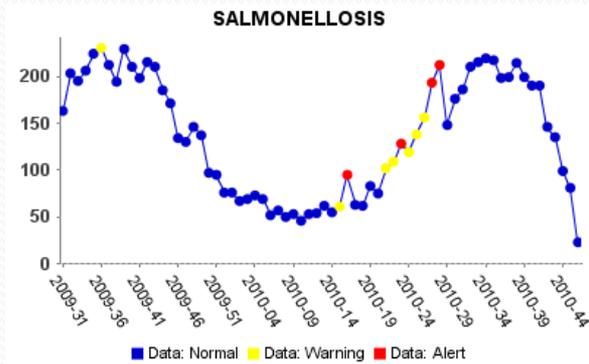
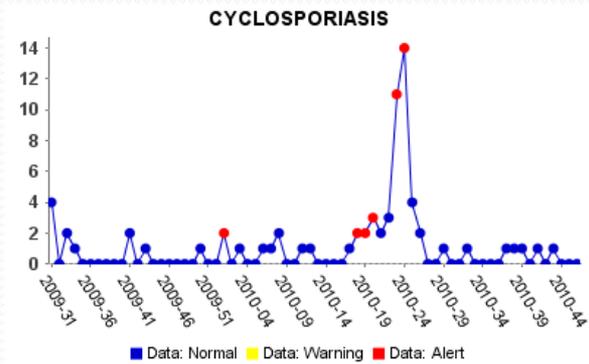
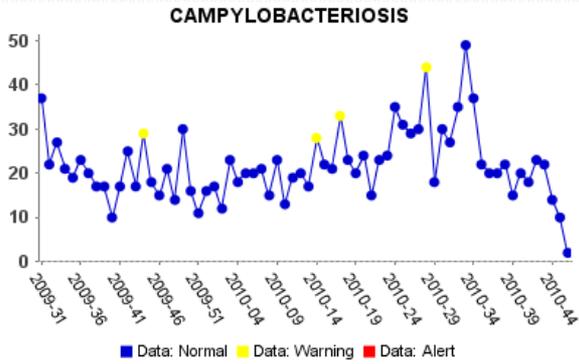
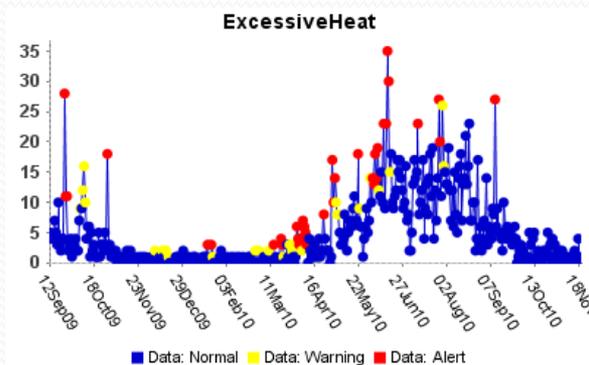
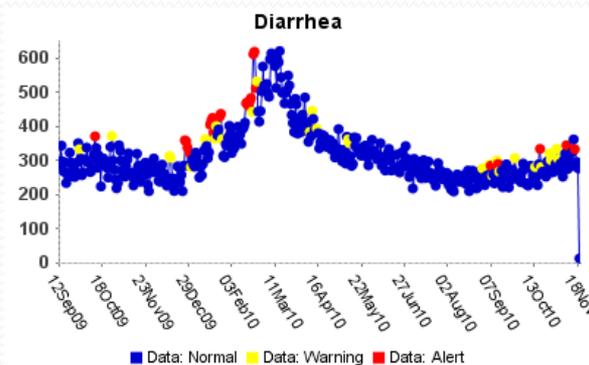
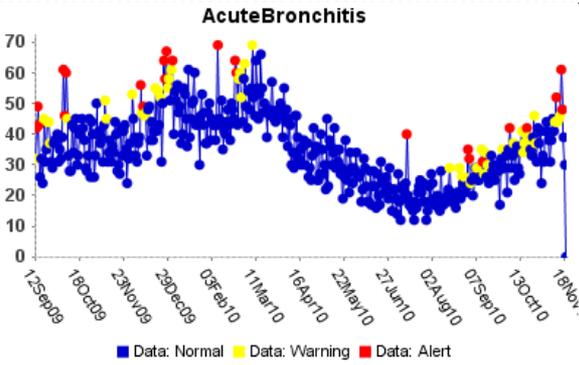
- Uses that go beyond our typical surveillance purposes. Other program areas may also benefit.
- Example: Combining ED and Mortality data in one graph

Drowning Query in ED and Mortality Data, Ages <1-4, Florida



■ Drowning ED query: Normal ■ Drowning ED query: Warning ■ Drowning ED query: Alert ■ Drowning Mortality query: Normal ■ Drowning Mortality query: Warning ■ Drowning Mortality query: Alert

# “myESSENCE” Dashboard – User Customized



# ED visits for 'overdose', 2007-2011, by month of visit

**Emergency Department Visits, Overdose Chief Complaints, 58 Florida Hospitals, Florida Residents 18 Years and Older, 2007 - Present**



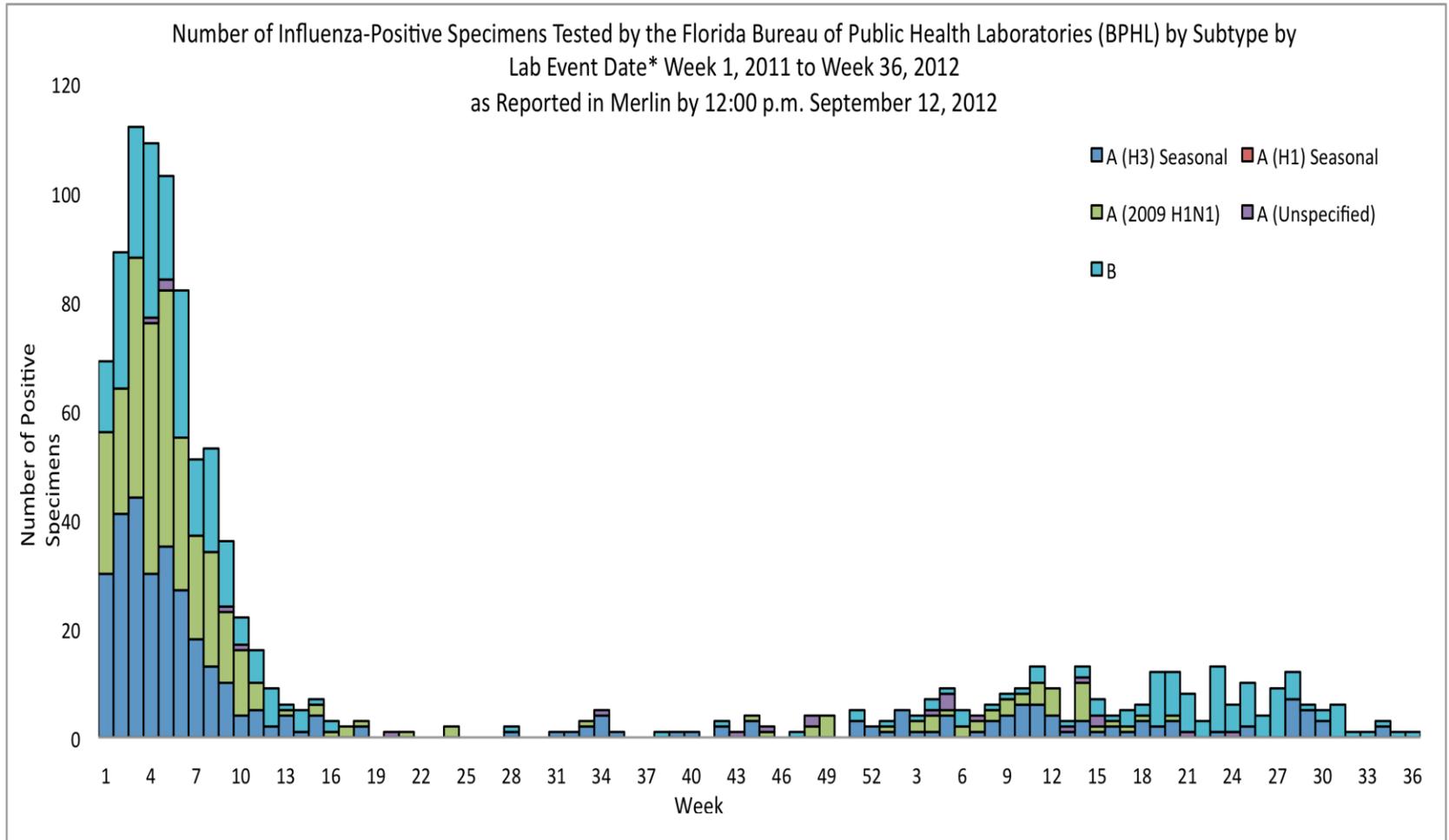
**Data Notes:**

ESSENCE Database as of 1/20/12 11:30am  
 Query: OVERDOSE, OVER DOSE, OD

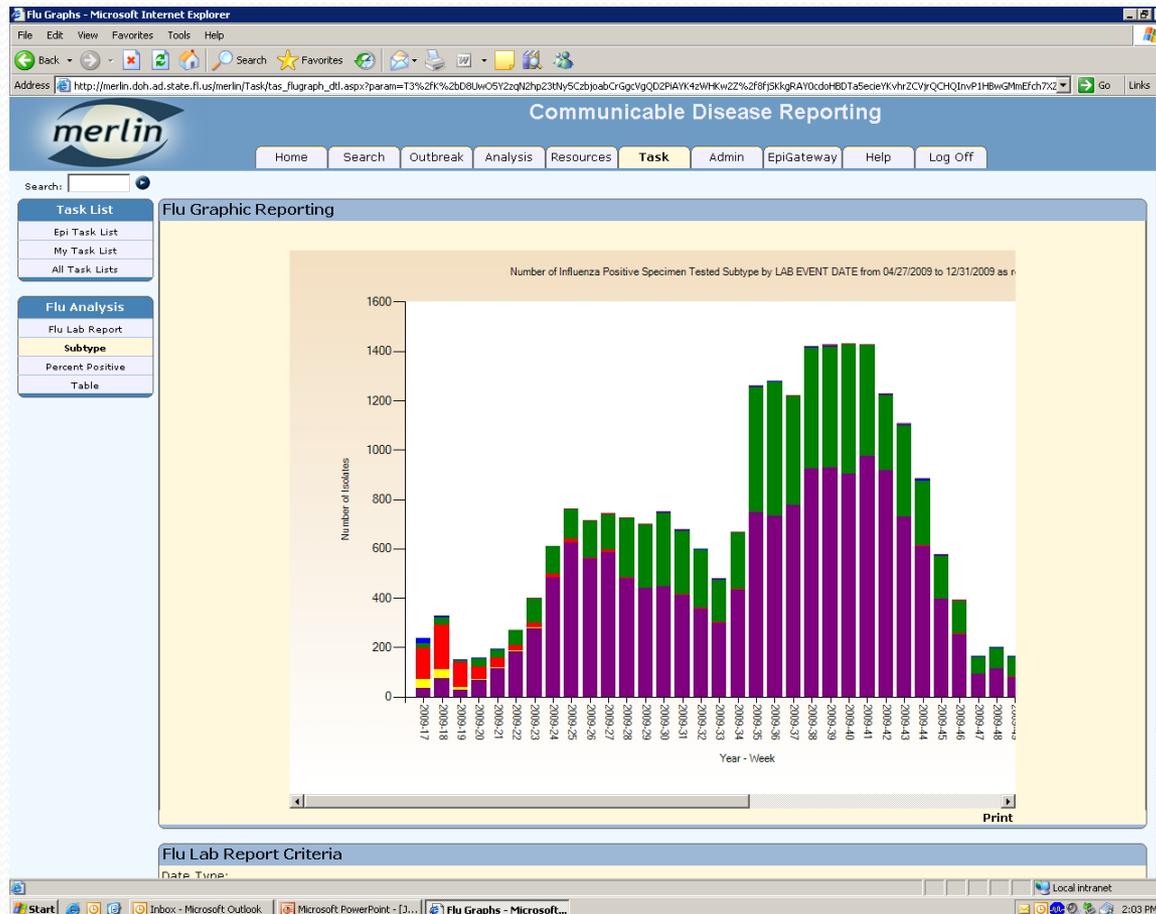
# Components of influenza surveillance in Florida

- Reports from public health lab testing (daily and weekly)
  - Convenience sample plus sentinel site testing
- ED visits for influenza-like illness (daily)
- Visits for ILI to sentinel practices (weekly)
- Reports of influenza activity by county health departments (weekly)
- Death certificates for pneumonia and influenza (weekly)

# Pattern of influenza strains in FL, 2011-2012

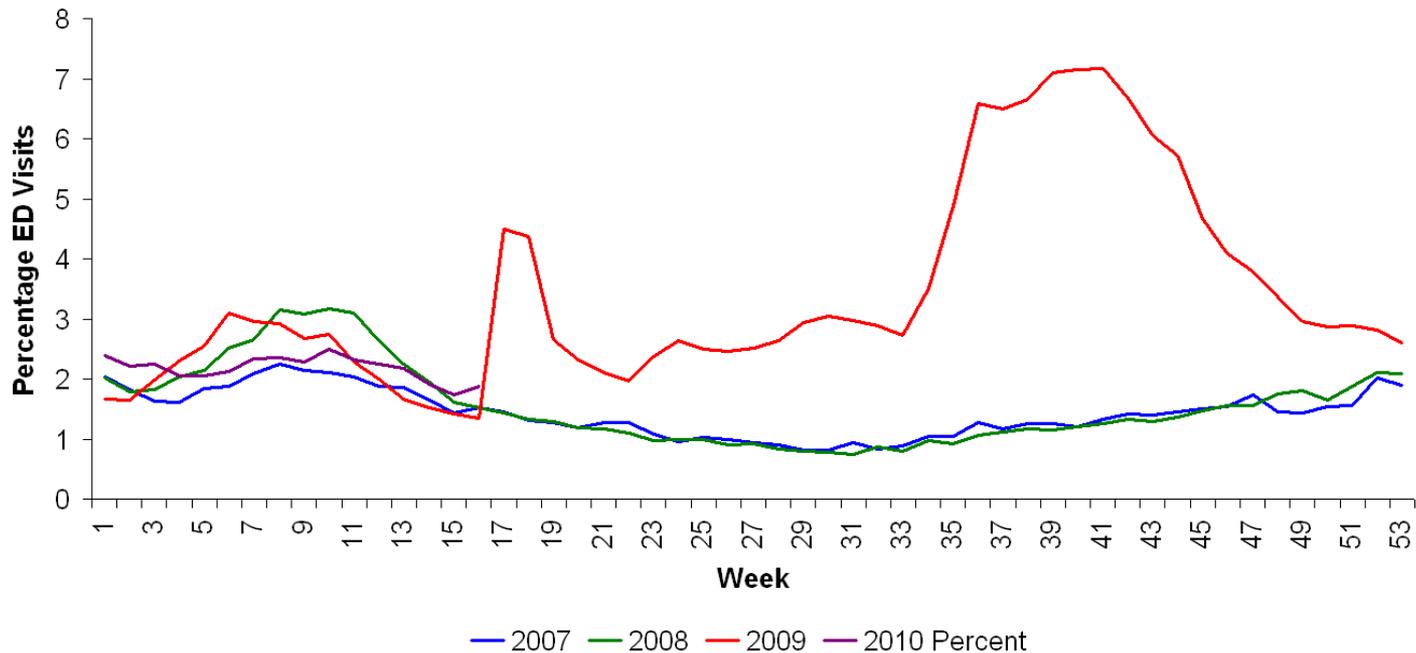


# Positive influenza lab reports from all capable labs



# ESSENCE, Influenza-Like Illness

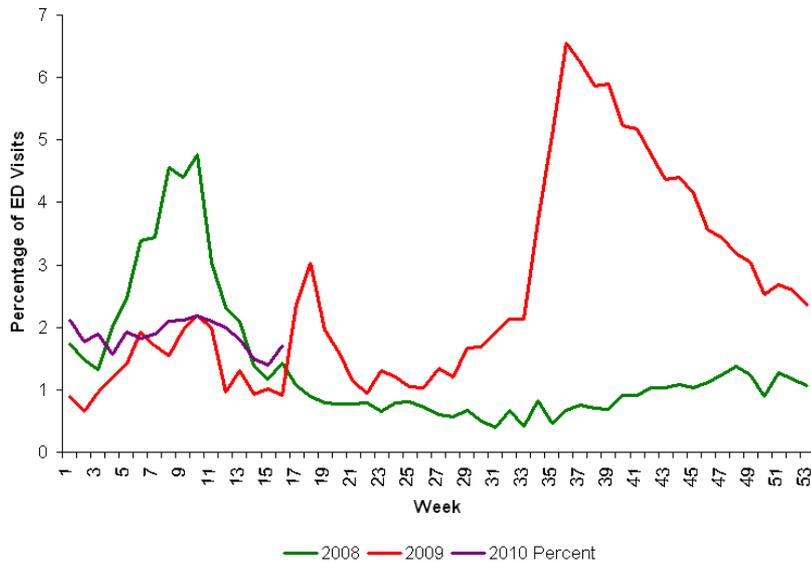
Influenza-like Illness Visits (by Chief Complaint) to Emergency Departments (ED)  
as a Percentage of All ED Visits, Florida ESSENCE Participating Hospitals  
(N=137), Week 1, 2007 through April 20, 2010



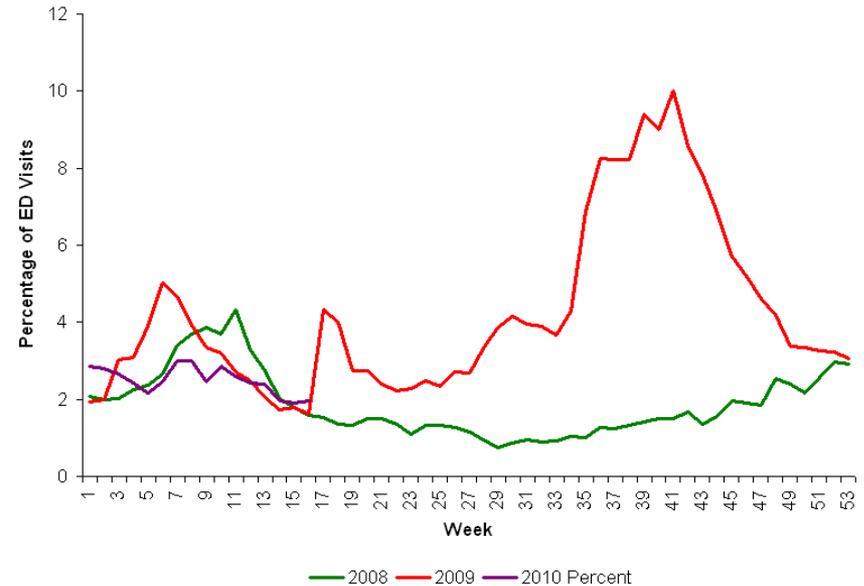
- Timely, accurate characterization of 75% of all emergency department visits
- Added discharge disposition as a data collection element
- 15,000-20,000 ER visits per day

# ESSENCE, Influenza-Like Illness

Percentage of Influenza-Like Illness from Emergency Department (ED) Chief Complaints, RDSTF Region 3 ESSENCE Participating Hospitals (N=14), Week 1, 2008 through April 20, 2010

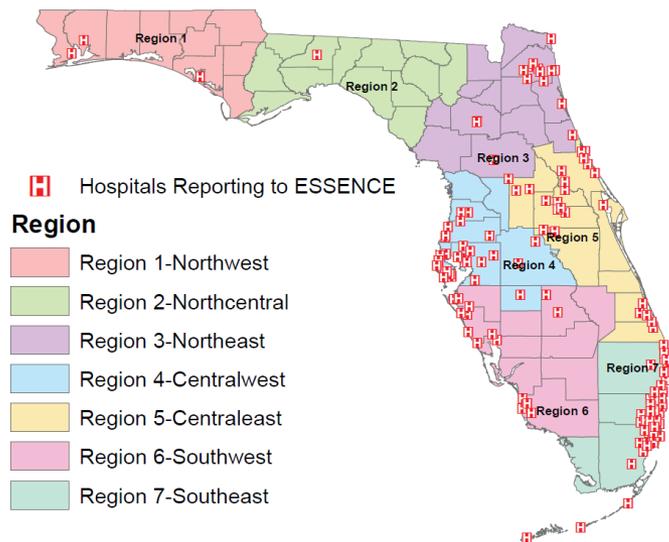


Percentage of Influenza-Like Illness from Emergency Department (ED) Chief Complaints, RDSTF Region 5 ESSENCE Participating Hospitals (N=24), Week 1, 2008 through April 20, 2010

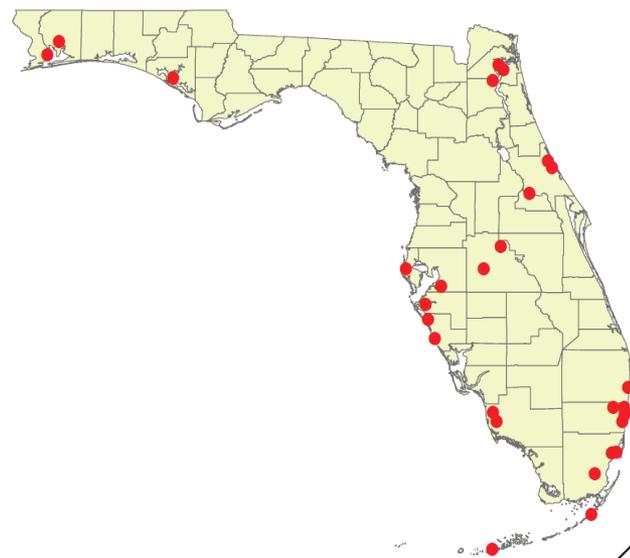


# ESSENCE, ED Admissions Data syndromic surveillance

Hospitals reporting Emergency  
Department (ED) Data to Florida  
ESSENCE, April 20, 2010 (N=137)



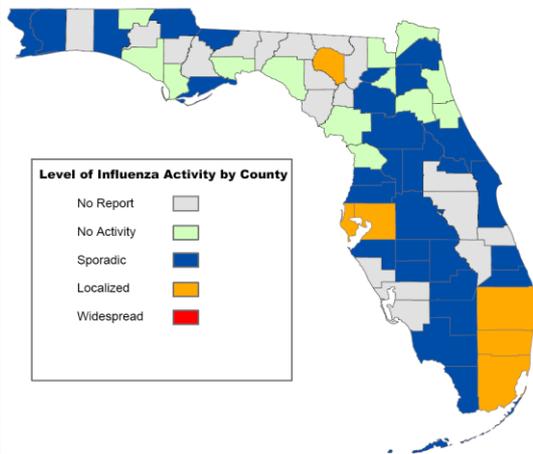
Hospitals reporting Emergency  
Department (ED) Admissions Data to  
Florida ESSENCE, April 20, 2010 (N=30)



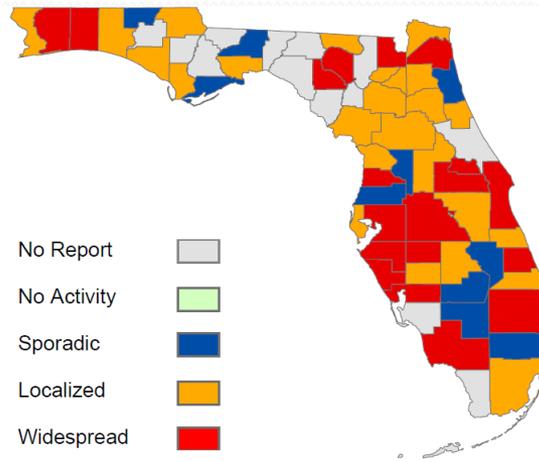
ED visits due to influenza-like-illness was most relied upon surveillance data

# EpiGateway, County Flu Activity Reporting

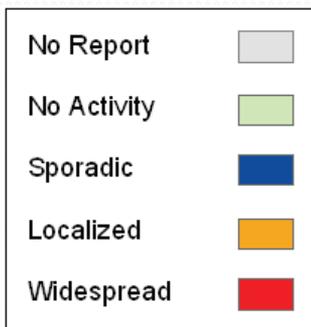
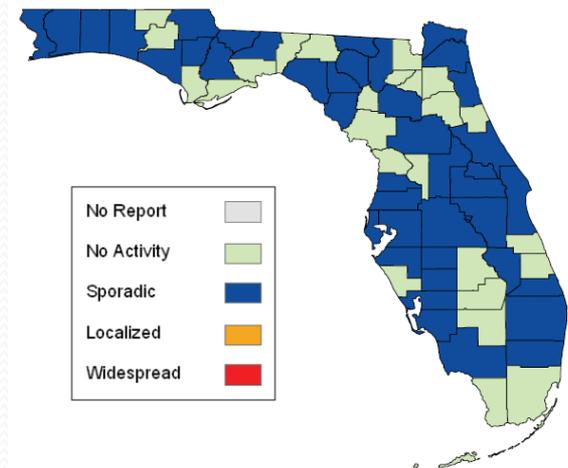
Week 17, 2009



Week 37, 2009



Week 3, 2010

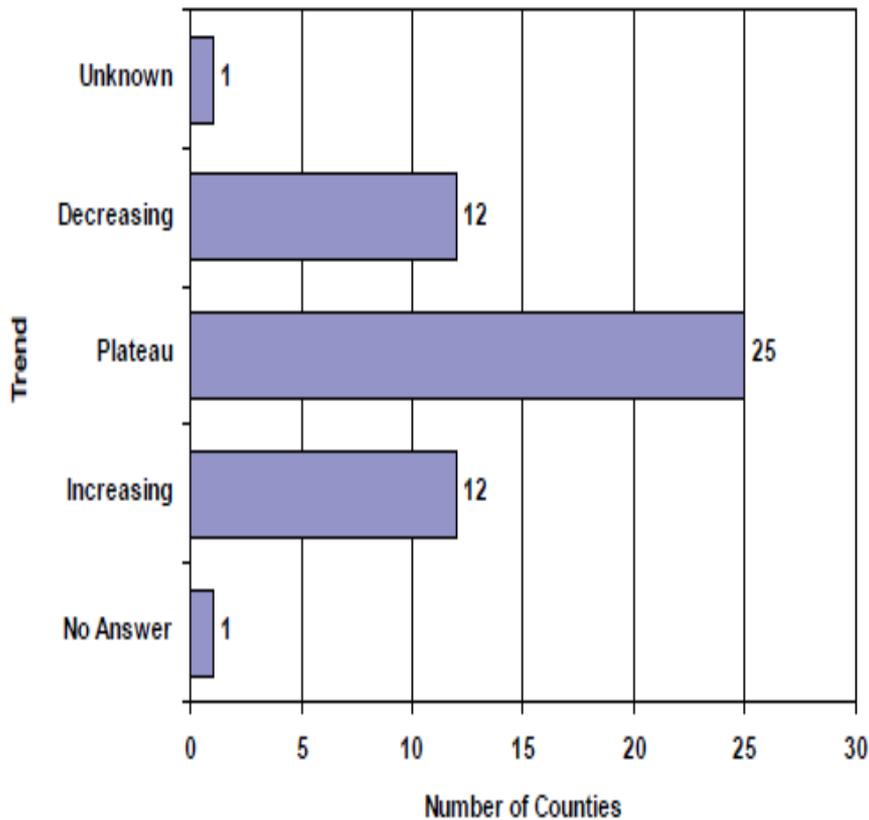


--General influenza activity assessment at local level, in place from day 1  
--Easy to understand display for non-epidemiologists

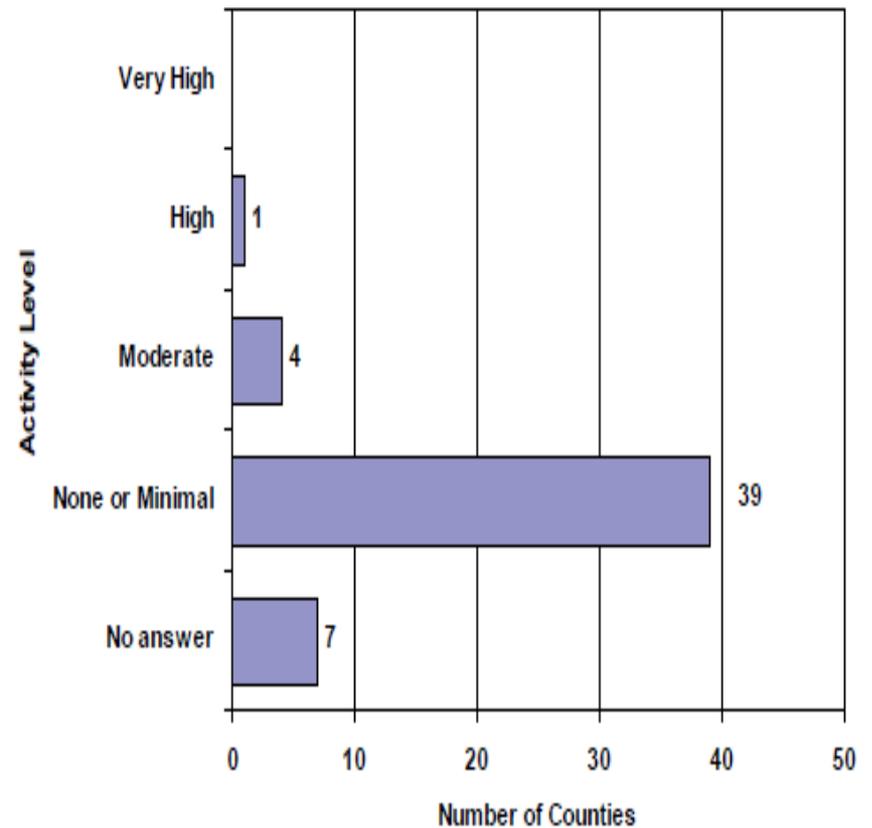
# EpiGateway, County Flu Activity Reporting

Week 41, 2009

Assessment of Overall Influenza Activity Trend



Assessment of Influenza Activity in Schools



# Factors contributing to success

- Syndromic Surveillance Workgroup
  - Respect for local initiatives
  - Build support for statewide solution
  - Work within Preparedness framework
- Build and maintain support of Preparedness leadership (state level, plus key County HD directors)
- Hire good people and support them well
  - Support presentations at national meetings
  - Support participation in national organizations
- Build relationships with Vital Statistics and Poison Centers
- Impending Meaningful Use requirements

# Surveillance opportunities -- MU

- More and more health-related information is computerized
- “Meaningful use” of electronic health records is requirement for Medicare/Medicaid subsidies
- Federal subsidies for electronic health records currently require hospitals and doctors to participate in
  - syndromic surveillance (ED visits), or
  - electronic laboratory reporting, or
  - electronic report of vaccine doses administered
- Stage 2 MU requirements will likely **require** ED SS and ELR for hospitals

# Meaningful Use, continued

- MU in a few years will also require hospitals and ambulatory care practices to send SS records to public health if they want the subsidy for EHRs
- Many PH agencies aren't ready for this yet
- International Society for Disease Surveillance has recently published draft standards for hospital and ambulatory records
- Hospitals would send one record on admission and another on discharge
- Ambulatory care practices would send one record for each outpatient visit – no expectation of linking records
- Record updates up to local implementation

# In and out of state

- Many West Virginia residents seek emergency care outside WV
- Many residents of other states seek emergency care in WV
- You may be interested in facility visits occurring in WV, or in facility visits by WV residents
- You will likely want to be able to examine at a minimum ED visits for important syndromes in facilities in communities adjacent to WV, to supplement a view of your own facilities
- Ideally would you want to be able to examine all visits by WV residents to facilities in your state and in OH, PA, VA, KY, MD?
- Lots of opportunities to influence what CDC and partners do with BioSense 2.0

# Thanks for inviting me!

- Richard S. Hopkins, MD, MSPH
- Tallahassee, FL
- [hopkinsrs@comcast.net](mailto:hopkinsrs@comcast.net)
- 850-894-9212