Syndromic Surveillance

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2013 Environmental Health Surveillance Workshop
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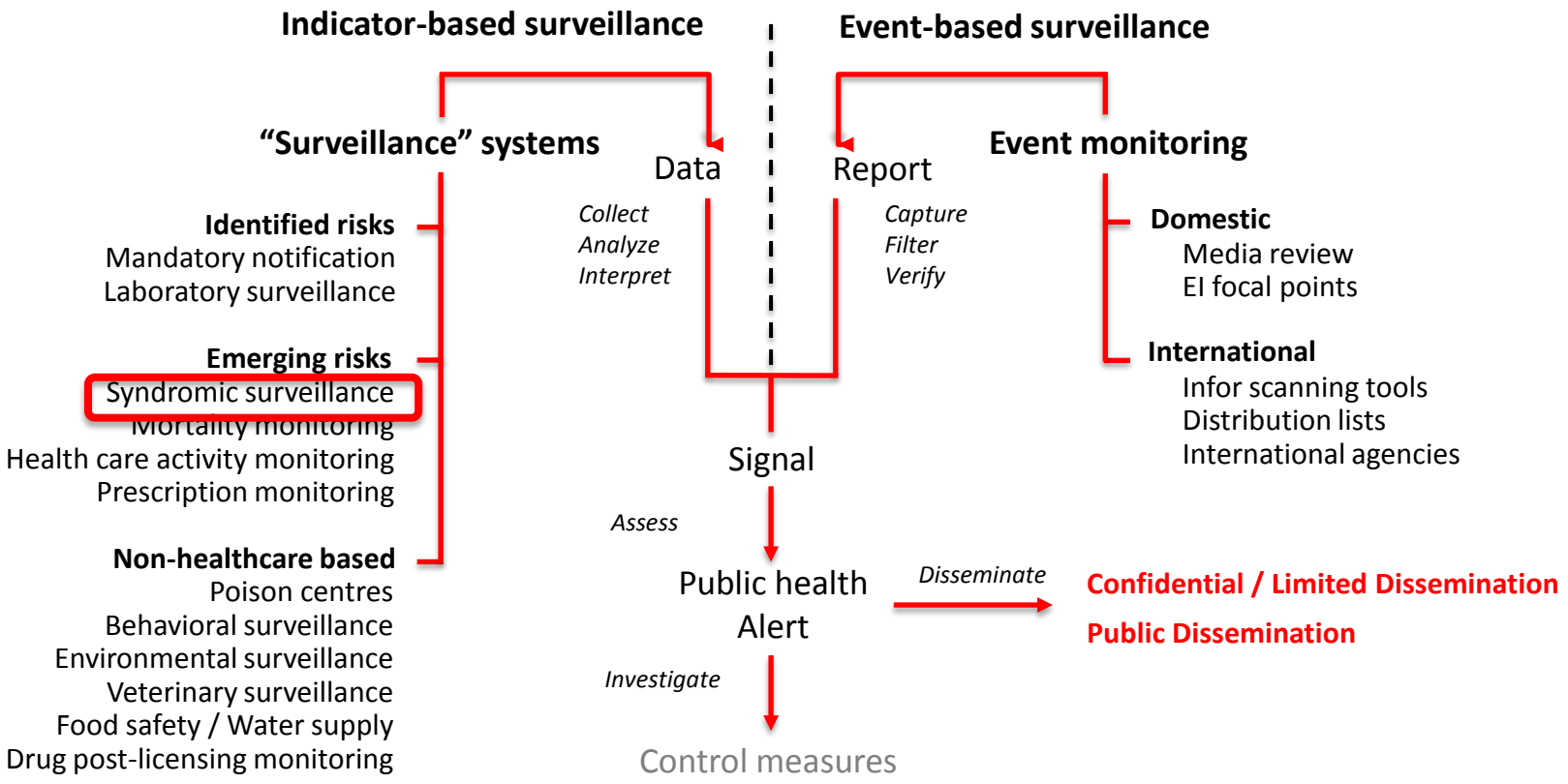
Syndromic Surveillance in Context



ECDC (2008). **Surveillance of Communicable Diseases in the European Union:** A long-term strategy 2008-2013.

Characteristics
1. Automation
2. Syndromes

Implications
1. Real Time
2. No Reporting Burden

Applications
1. Identify Impact
2. Augment Systems

1. Real Time

***Panel:* Definition of syndromic surveillance**

A real-time (or near real-time) collection, analysis, interpretation, and dissemination of health-related data to enable the early identification of the impact (or absence of impact) of potential human or veterinary public health threats that require timely public health action.

1. Identify Impact

Syndromic surveillance is based not on the laboratory-confirmed diagnosis of a disease but on non-specific health indicators including clinical signs, symptoms as well as measures (eg, absenteeism, drug sales, animal production collapse) that provide a provisional diagnosis (or "syndrome").

2. Syndromes

The data are usually collected for purposes other than surveillance and, where possible, are automatically generated so as not to impose an additional burden on the data providers. This surveillance tends to be non-specific yet sensitive and rapid, and can augment and complement the information provided by traditional test-based surveillance systems.

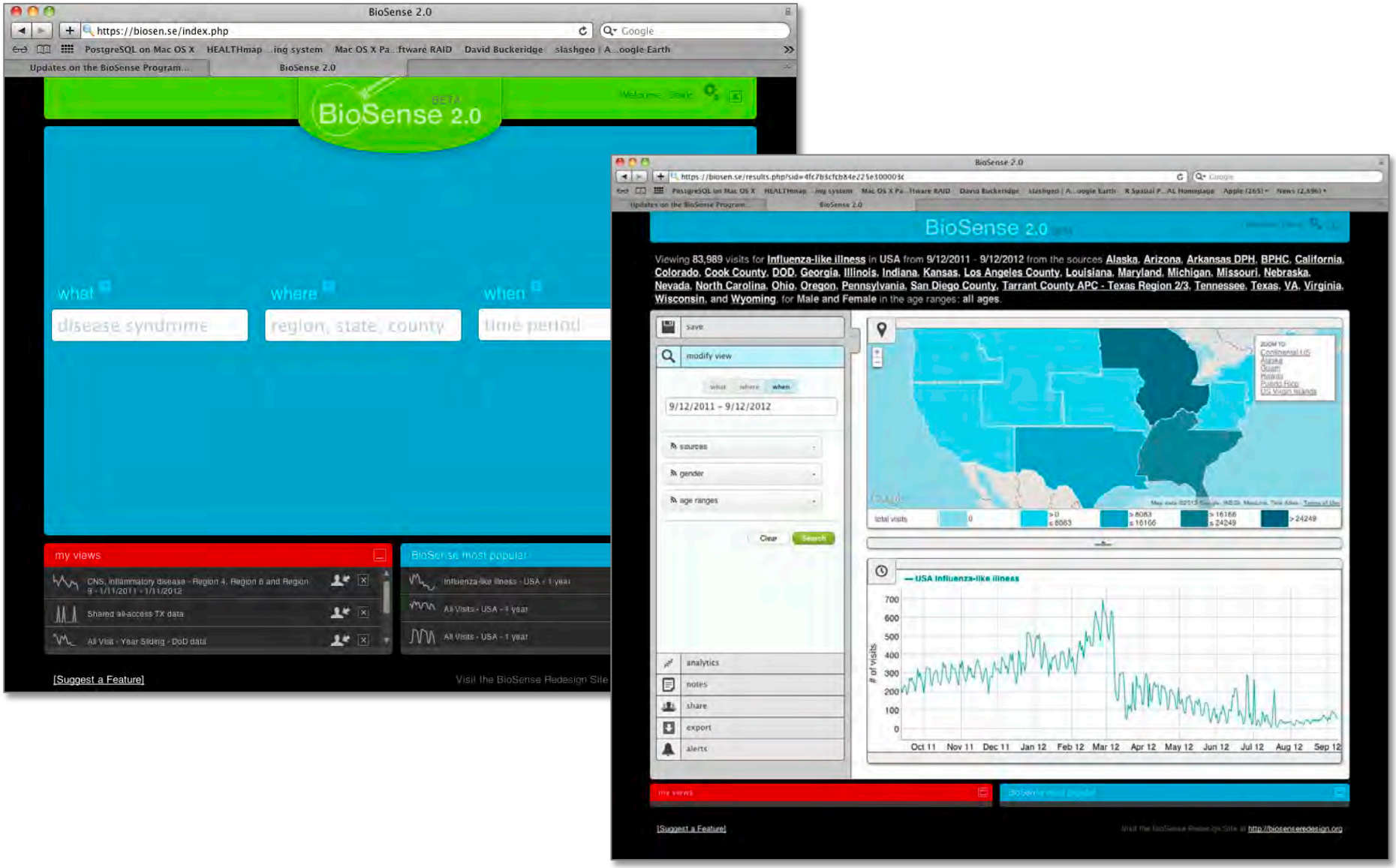
1. Automation

2. No Reporting Burden

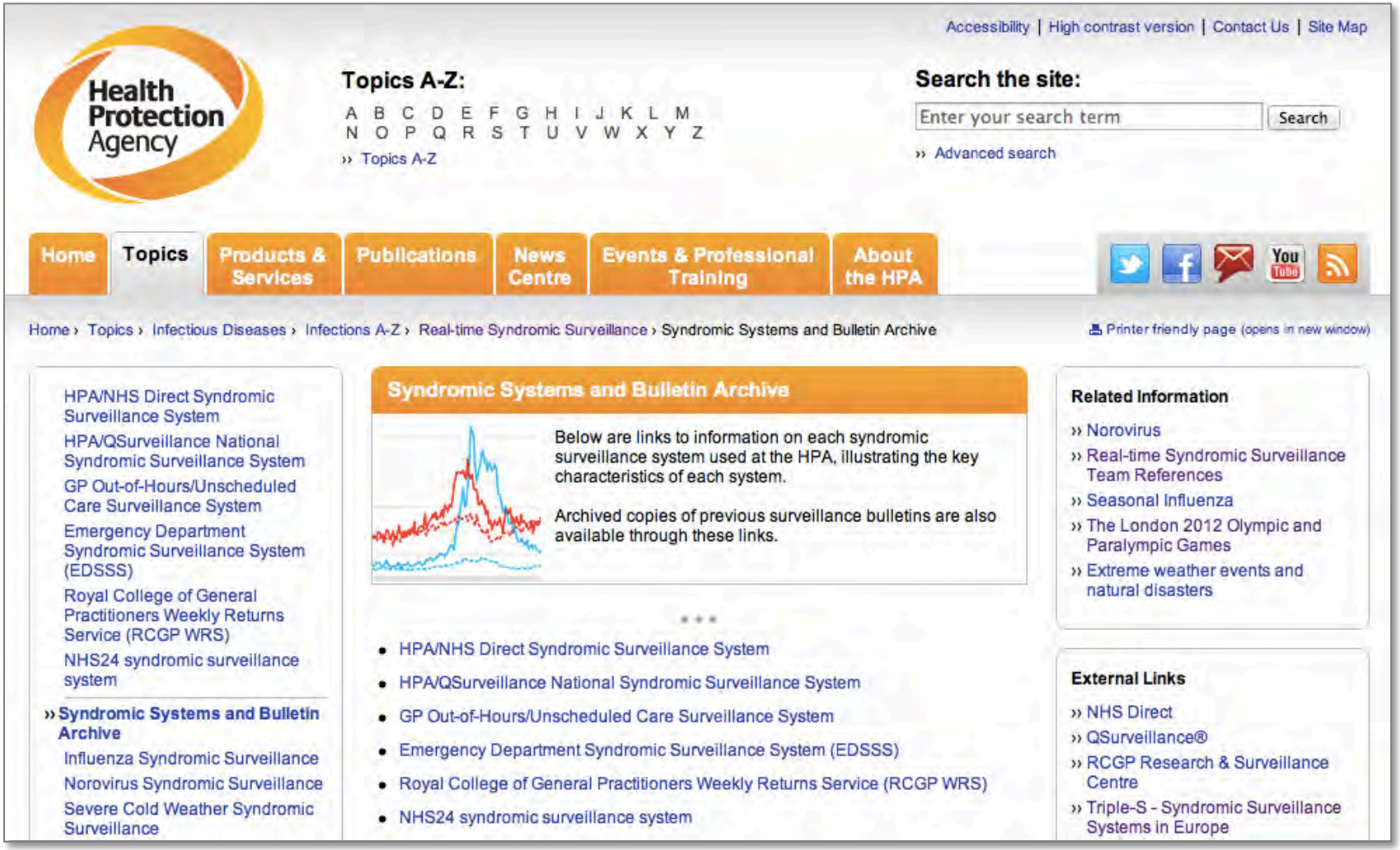
2. Augment Systems

Triple S Project. Assessment of syndromic surveillance in Europe. Lancet. 2011 Nov 26;378(9806):1833–4.

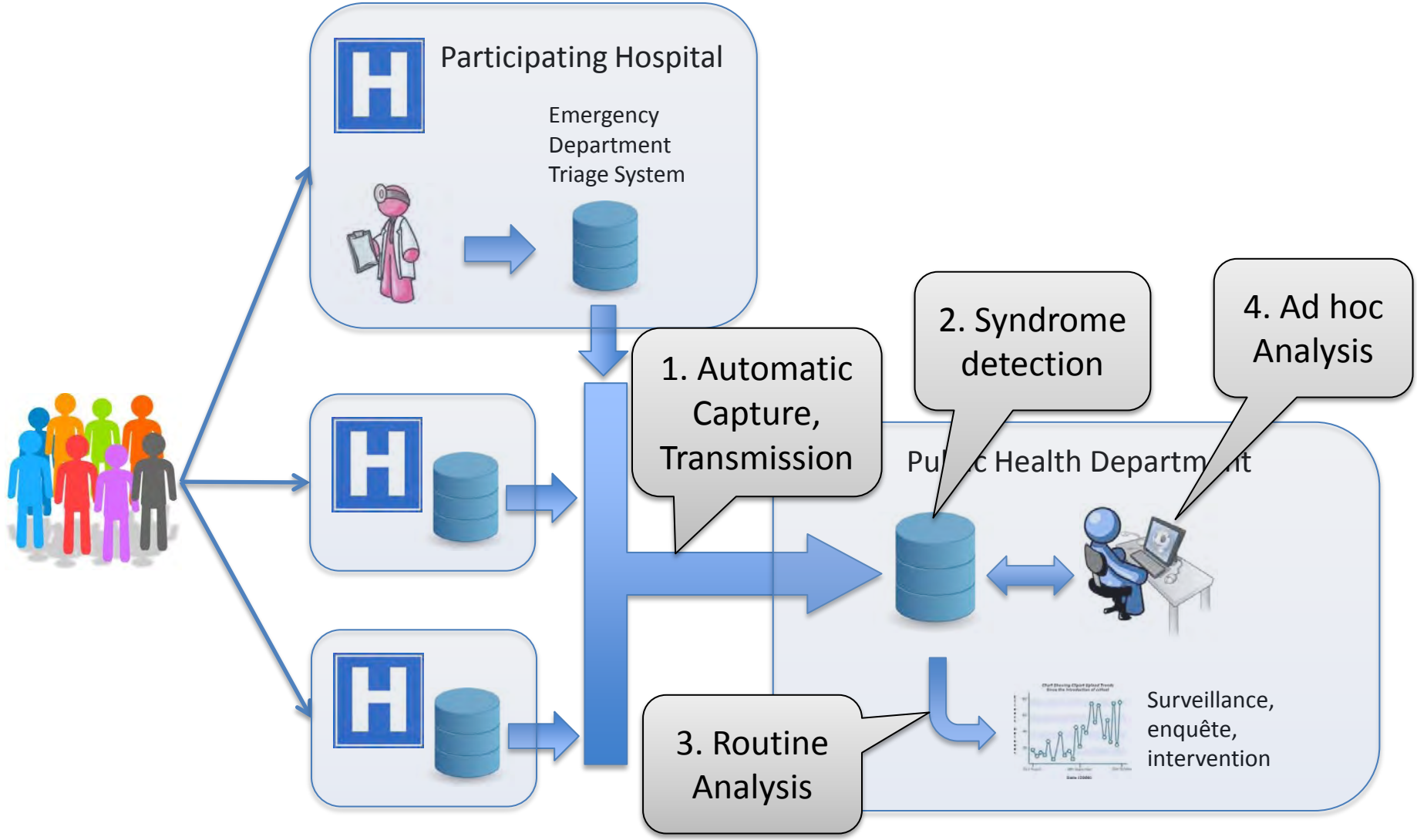
The US CDC BioSense 2.0 System



The UK HPA Syndromic Systems

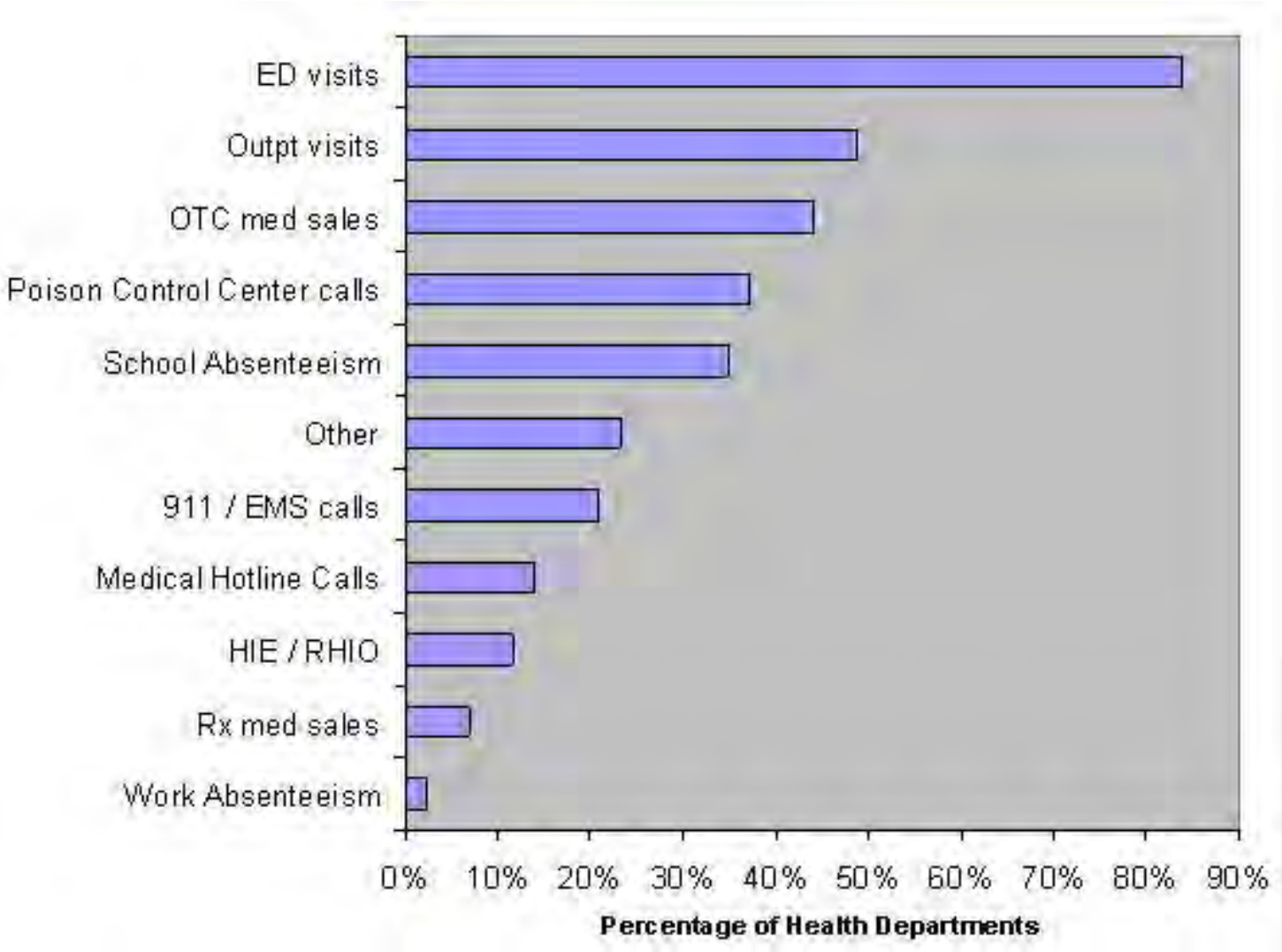


Syndromic Surveillance Process



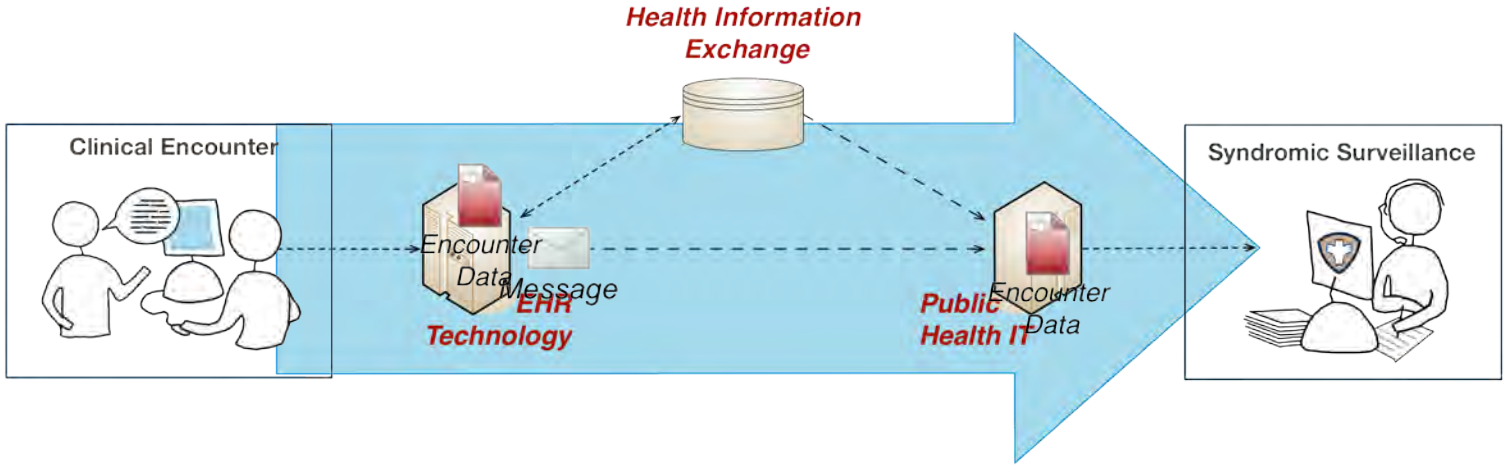
DATA CAPTURE

Common Settings for Data Capture



Beuhler JW, Sonricker A, Paladine M, Soper P, Mostashar F. Syndromic Surveillance Practice in the United States: Findings from a Survey of State, Territorial, and Selected Local Health Departments. Advances in Disease Surveillance 2008;6:3.

Automated Capture and Transmission

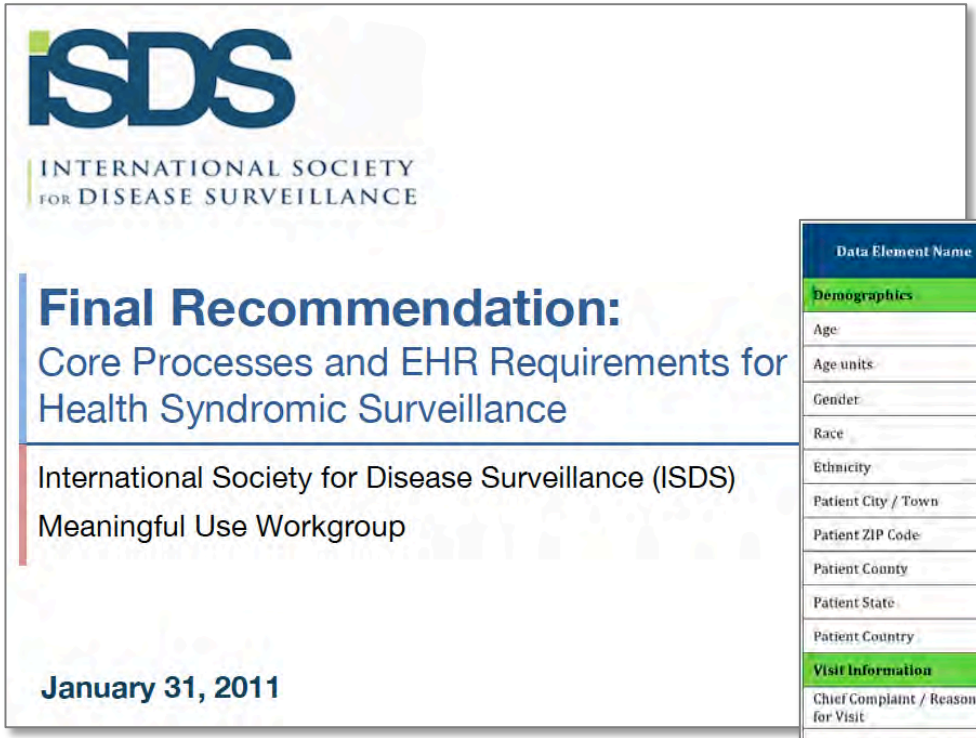


Encounter Data

Message

Public Health
Prevent. Promote. Protect.

Standards for Data Capture



Data Element Name	Description of Field	Inpatient	Ambulatory	Emergency Department / Urgent Care[1]
Demographics				
Age	Patient age at time of visit	RE	RE	RE
Age units	Unit corresponding to numeric value of patient age	RE	RE	RE
Gender	Stated gender of patient	RE	RE	RE
Race	Race of patient	RE	RE	RE
Ethnicity	Ethnicity of patient	RE	RE	RE
Patient City / Town	City or town of patient residence	RE	RE	RE
Patient ZIP Code	ZIP Code of patient residence	RE	RE	RE
Patient County	County of patient residence	RE	RE	RE
Patient State	State of patient residence	O	O	O
Patient Country	Country of patient residence	O	O	O
Visit Information				
Chief Complaint / Reason for Visit	Patient's self-reported chief complaint or reason for visit	RE	RE	RE
Admit or Encounter Reason	Provider's reason for a patient admission or encounter	RE	RE	
Admission or Encounter Date/Time	Date and time of patient admission or encounter	R	R	R
Date of Onset	Date that patient began having symptoms of condition being reported	-	-	O
Patient Class	Patient classification within facility	R	R	O
Hospital Unit	Hospital unit where patient is treated	RE	-	-
Diagnostic and Pre-Diagnostic				
Diagnosis Type	Qualifier for Diagnosis / Injury Code specifying type of diagnosis	RE	-	R
Primary Diagnosis	Primary diagnosis of the patient's condition	RE	RE	RE
Additional Diagnosis	Additional diagnoses of the patient's	RE	RE	RE

SYNDROME DETECTION

Detecting Syndrome Cases

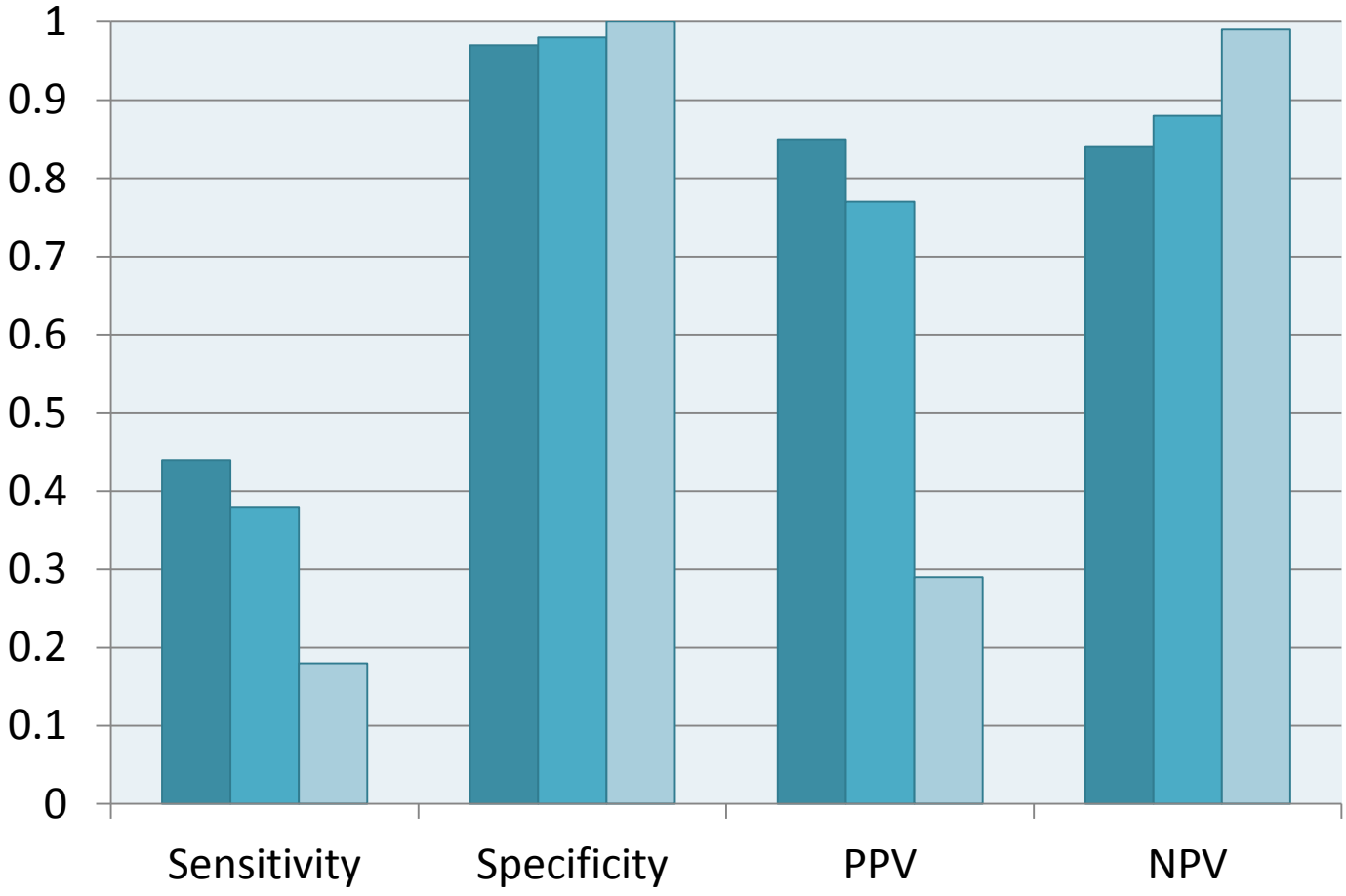
- Each visit is classified into a syndrome (e.g., respiratory, influenza-like-illness, …)
- Classification uses information from a clinical information system
  - **Code Based:** Search for specific codes; or
  - **Natural Language:** 1) Build a statistical model of the word distribution in true as opposed to false cases, or 2) Use text ‘templates’ to search for words or experessions

Standards for Syndrome Definition

Clinical condition: vomiting		
Concept (relation to condition)	**Keywords, regular expressions representing keywords and UMLS CUI**	
Vomiting **(Condition name)**	vmt, n/v, v/n, v/d, d/v, v+d, d+v, n+v, v+n, v + d, d + v, d & v, dry heaves, emsis, f v, fv, n v, n & v, n v, n v d, n&v, n+v, nv, nvd, retching, v d, v f, v&d, v+d, vimiting, viomiting, vmt, vo, voimiting, voiting, vom, vometing, vomi, vomikting, vomintg, vominting, vomit, vomited, vomiti, vomitibg, vomitin, vomitine, vomiting, vomitinig, vomitiong, vomitng, vomitt, vomitting, vomittng, vomitus, vommiting, vomoting, vomtiing, vomtiming, vomting, vomtiting, puke, n v, retching, v d, vomit, vomicking, cant hold any food down, threw up, throw up, throwing up, emesis, emisis	
	Regular expressions (3 of 73 shown below) and UMLS CUI:	
	\bd\s&\sv\b	C0042963 Vomiting
	\bdry heaves\b	C0232602 Retching
	\bvomitus\b	C0042965 Vomitus
Spitting up **(Synonym)**	**Keywords:**	
	bringing up, spitting up	
	Regular expressions and UMLS CUI:	
	\bbringing\sup\b	C0042963 Spitting up
	\bspitting\sup\b	C0042963 Spitting up
Hematemesis **(Related concept)**	**Keywords:**	
	hematemesis, coffee ground emesis, throw* up blood, vomit* blood	
	Regular expressions and UMLS CUI:	
	\bhematemesis\b	C00189261 Hematemesis
	\bcoffee\sground\semesis\b	C1510416 Coffee ground vomiting
	\b(throw\w*?\s+up|vomit)\s*\+\s*blood\b	C00189261 Hematemesis

Chapman WW, Dowling JN, Baer A, Buckeridge DL, Cochrane D, Conway MA, et al. Developing syndrome definitions based on consensus and current use. J Am Med Inform Assoc. 2010. pages 595–601.

Syndromic Case Detection can be Accurate for Broad Categories



Cadieux G, Buckeridge DL, Jacques A, Libman M, Dendukuri N, Tamblyn R. Accuracy of syndrome definitions based on diagnoses in physician claims. BMC Public Health 2011;11:17.

Syndromic Surveillance Summary

- Defining Syndromic Surveillance
  - Characteristics: Automated, syndromes
  - Implications: Real time, no reporting burden
  - Applications: Impact (rule-out), augment systems
- Innovations Applicable to Surveillance
  - Automation of data capture for ‘clinical’ settings
  - Advances in real-time data analysis
  - Integration of data from multiple systems

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Pattern Analysis (in Public Health Surveillance)

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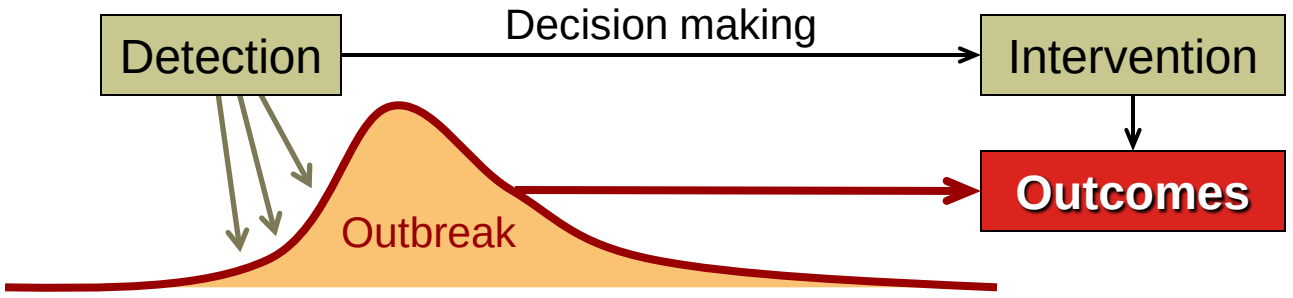
Problem Formulation



- Benefits of detection are measured by intervention outcomes: reducing morbidity, mortality and cost
- Intervention strategies are outbreak-specific:
  - anthrax: early medical treatment of infected individuals
  - waterborne *c.parvum*: preventing new infections by limiting exposure
- Intervention outcomes depend not only on timeliness of detection
  - level of compliance (e.g. with boil-water advisory)
  - extend and duration of exposure to pathogen
  - incubation time
  - …

Public Health Context

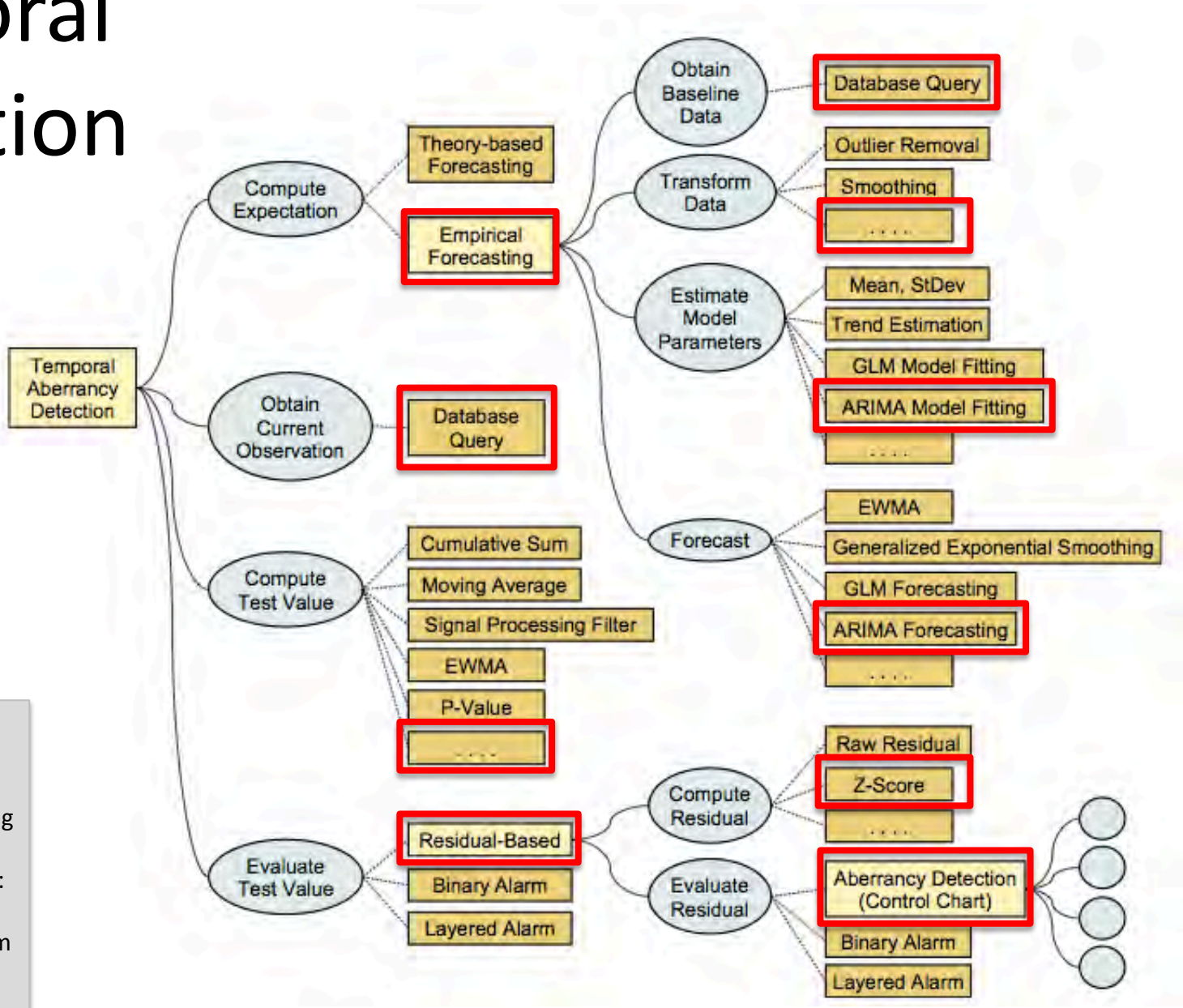
- Prospective analysis
  - Repeated routinely
  - Analysis should build on previous results
- Multiple data sources
  - Statistical analysis of one data source rarely provides definitive information for action
  - Integration of analysis results is a difficult problem
- Dynamic decision making
  - Surveillance informs actions
  - Possible actions should drive surveillance

DETECTING PATTERNS

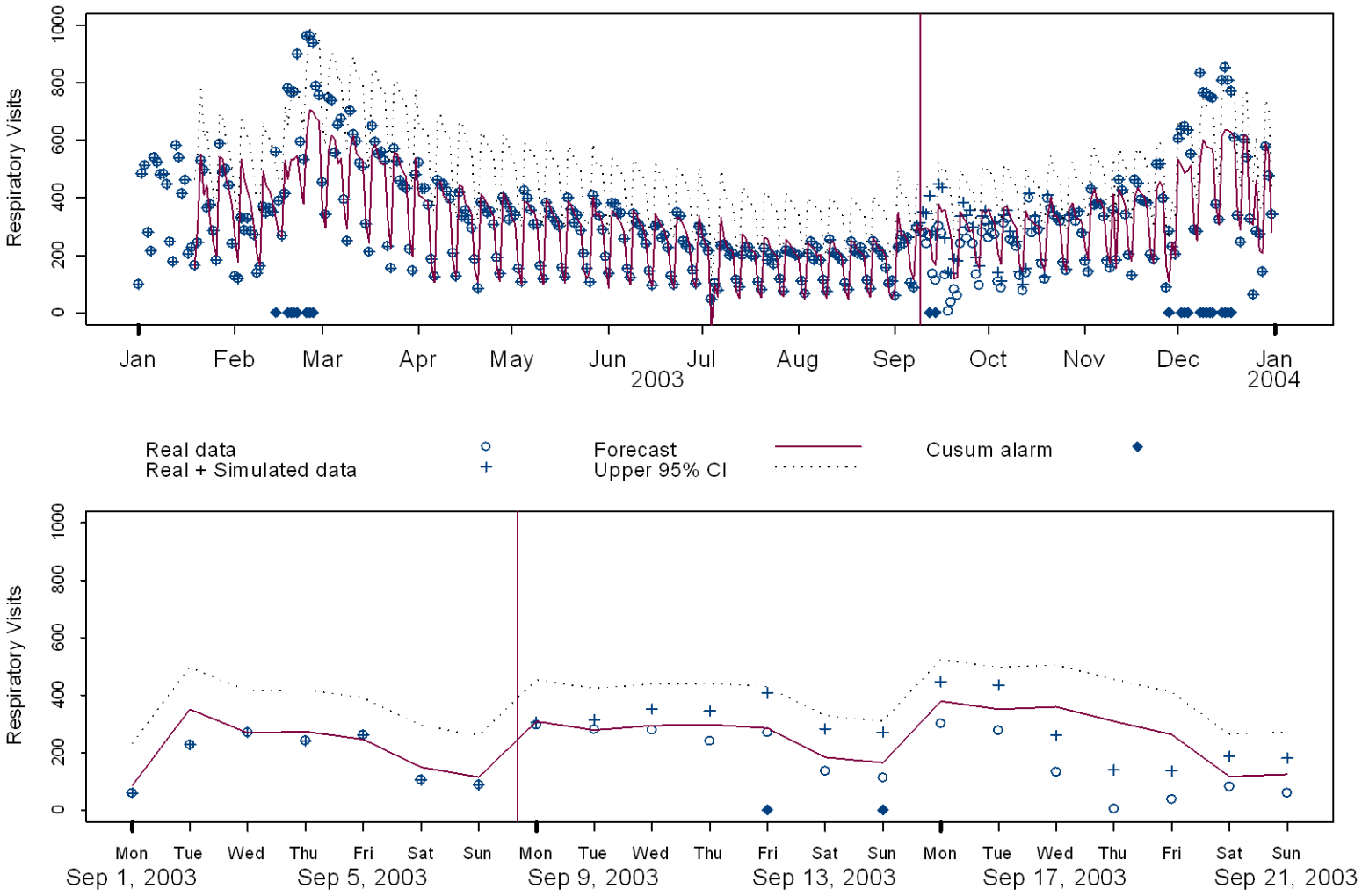
Surveillance Analysis Framework

- Target
  - Omnibus alternative hypothesis
  - Specified alternative hypothesis
- Dimensions
  - Time: Critical aspect of any analysis
  - Place: Often spatial, sometimes space—time
  - Person: Usually stratification
- Integration
  - Combining multiple data sources and systems
  - Linking analysis results with actions, effectiveness

Temporal Detection



Buckeridge DL, Okhmatovskaia A, Tu S, O'Connor M, Nyulas C, Musen MA. Understanding detection performance in public health surveillance: modeling aberrancy-detection algorithms. J Am Med Inform Assoc. 2008 Nov;15(6):760–9.

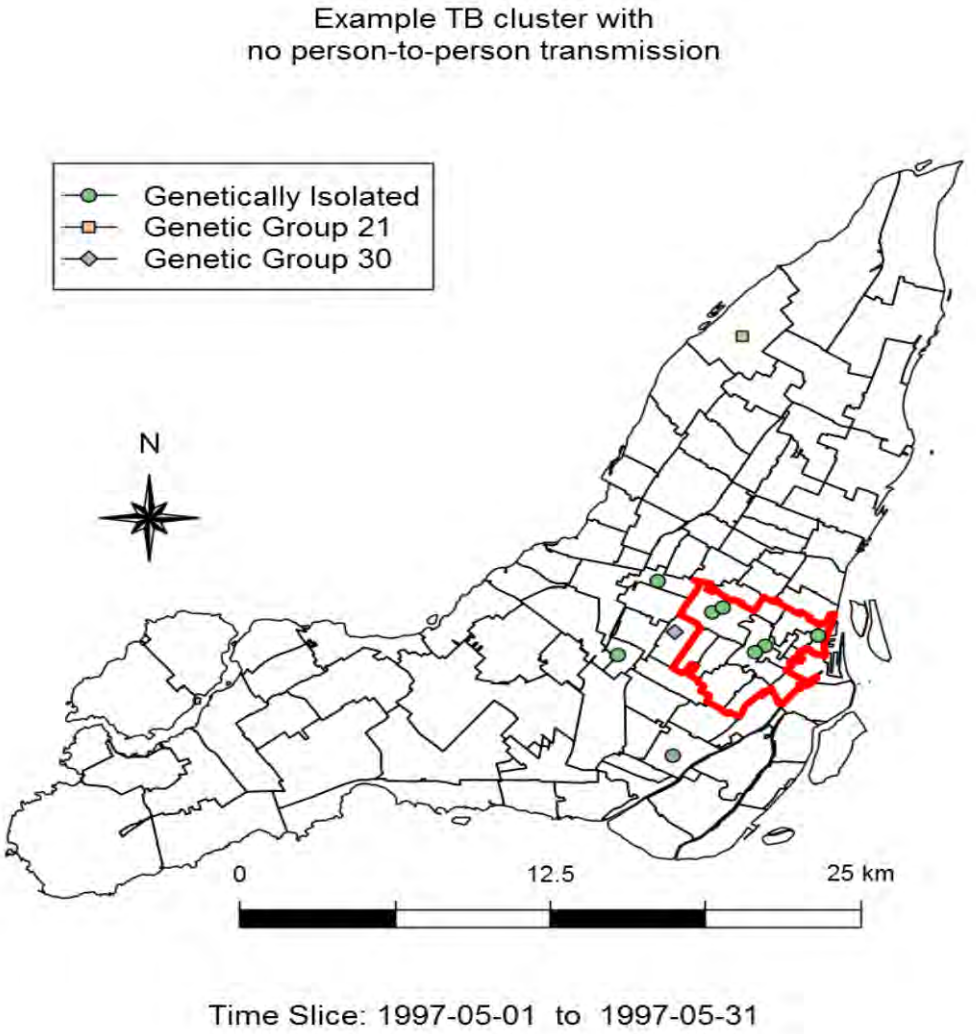


An evaluation model for syndromic surveillance: assessing the performance of a temporal algorithm. Buckeridge DL, Switzer P, Owens D, Siegrist D, Pavlin J, Musen M. MMWR Morb Mortal Wkly Rep. 2005 Aug 26;54 Suppl:109-15.

Space—Time Detection

- Spatial data model
  - Point based
  - Region based
- Popular approaches
  - Independent monitoring of sub-regions
  - (Bayesian) Spatial regression
  - Scan statistics

Space—Time Cluster Detection



EVALUATING DETECTION

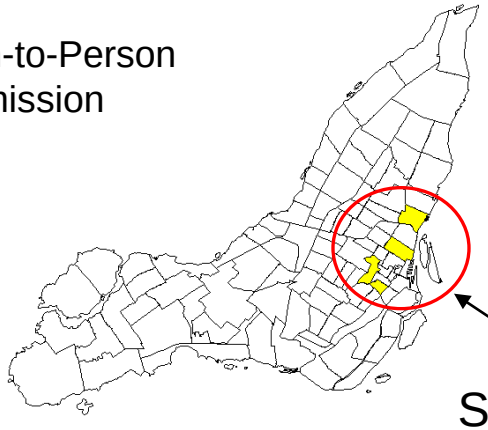
Evaluation Framework

- Evaluation Paradigms
  - Statistical Measures
    - Diagnostic test: sensitivity, specificity, timeliness
    - Process control: average run length
  - Health and Economic Outcomes
    - Prevented utilization, morbidity, mortality
    - Cost-Effectiveness very rarely assessed
- Evaluation Approaches
  - Real data: Limited availability, low numbers
  - Simulated data: Alone or with real data, complexity

Statistical Measures, Real Data

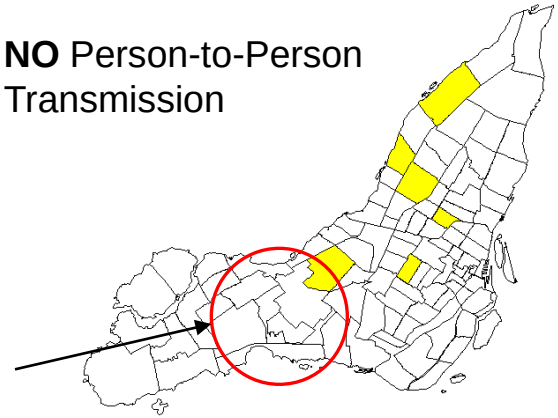
1999-03 to 1999-07

Person-to-Person Transmission



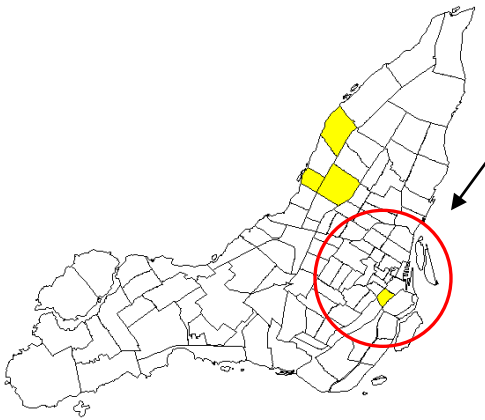
2000-01 to 2000-01

NO Person-to-Person Transmission



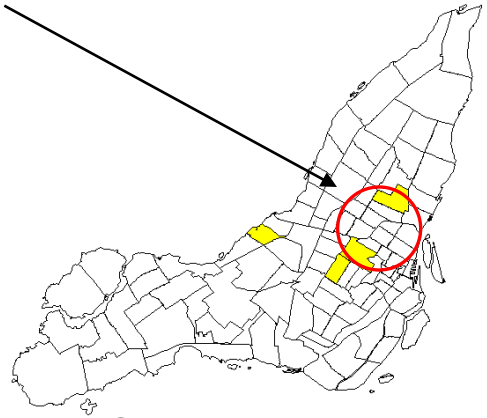
Statistically significant clusters

2002-02 to 2002-02



NO Person-to-Person Transmission

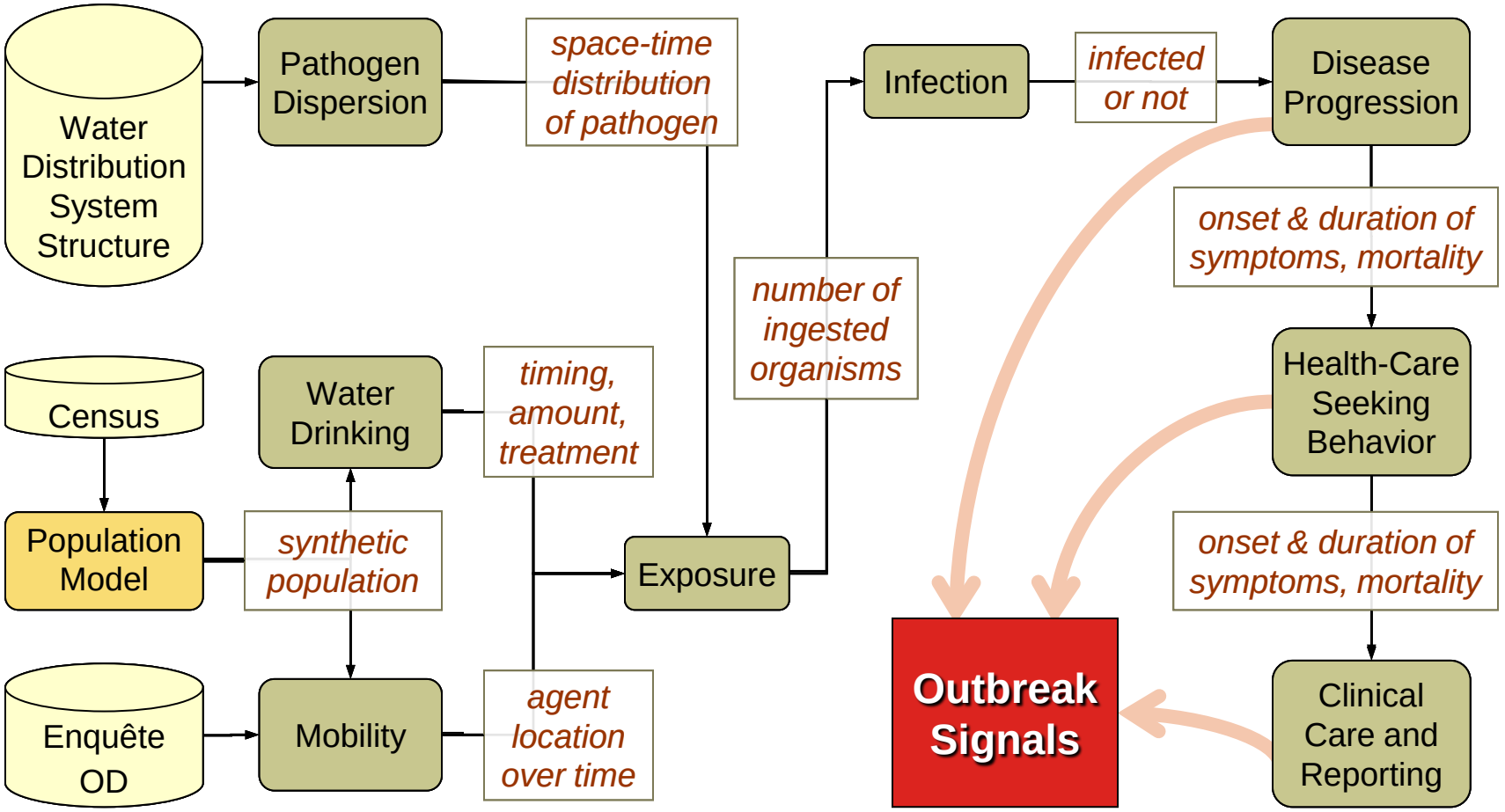
2004-01 to 2004-01



LOW Person-to-Person Transmission

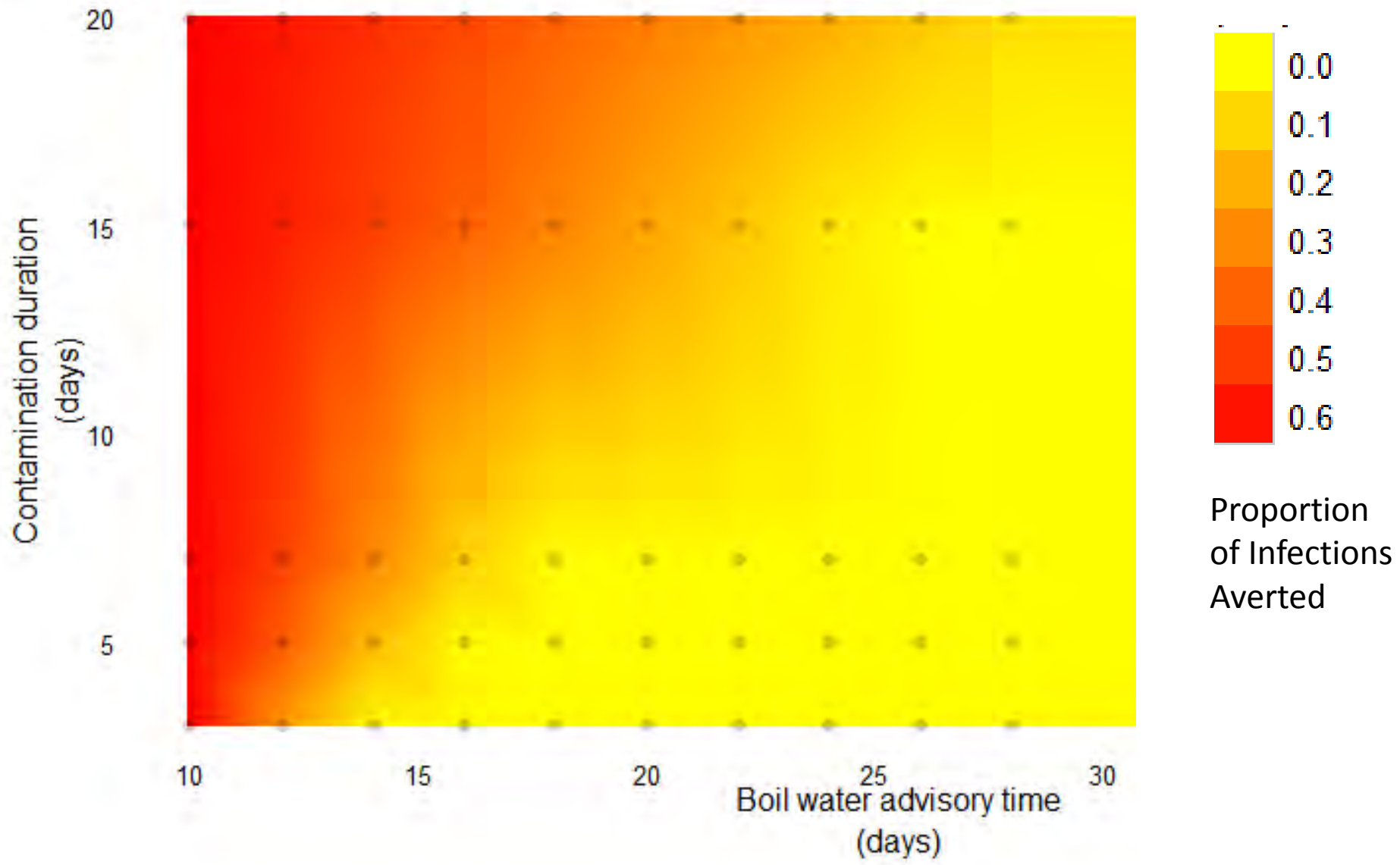
Diagnostic Test Evaluation Approach

Simulation for Integrated Evaluation



Okhmatovskaia A, Verma AD, Barbeau B, Carriere A, Pasquet R, Buckeridge DL (2010). A Simulation Model of Waterborne Gastro-Intestinal Disease Outbreaks: Description and Initial Evaluation. AMIA Annual Symposium.

Evaluating Impact – Infections Averted



Pattern Analysis Summary

- Context is moving from single time series to rich, multi-dimensional data sets
- Innovations in analytical methods
  - Automated temporal analysis
  - Space—time analysis more complicated
  - High-dimensional methods in other disciplines
- Methods and tools needed for integration
- Training programs needed desperately

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