
The RODS System

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Source Project

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Disclosure

- Minority interest in General Biodefense, LLC
- Training courses, technical support, and installs of public health surveillance systems

Evaluation Framework vs. the RODS Story

Robinson Crusoe Story

Shipwreck

Robinson

Deserted island

“Man versus Nature”



Robinson Crusoe after application of the Soviet framework

Shipwreck →

Robinson →

→ Peninsula

President of the House committee

Two party members

Trade union representative

Activistka to collect party dues

The masses (proletariat)

????

“How the Soviet Robinson was Written,”
Ilf and Petrov 1933

The RODS Technology Dissemination Story

February 2002, demonstrated at Olympics how to obtain hospital data in real time. Generalizable solution.

4/02 tried to disseminate it through a technology partner

12/02 tried to disseminate by giving it away for free

2003

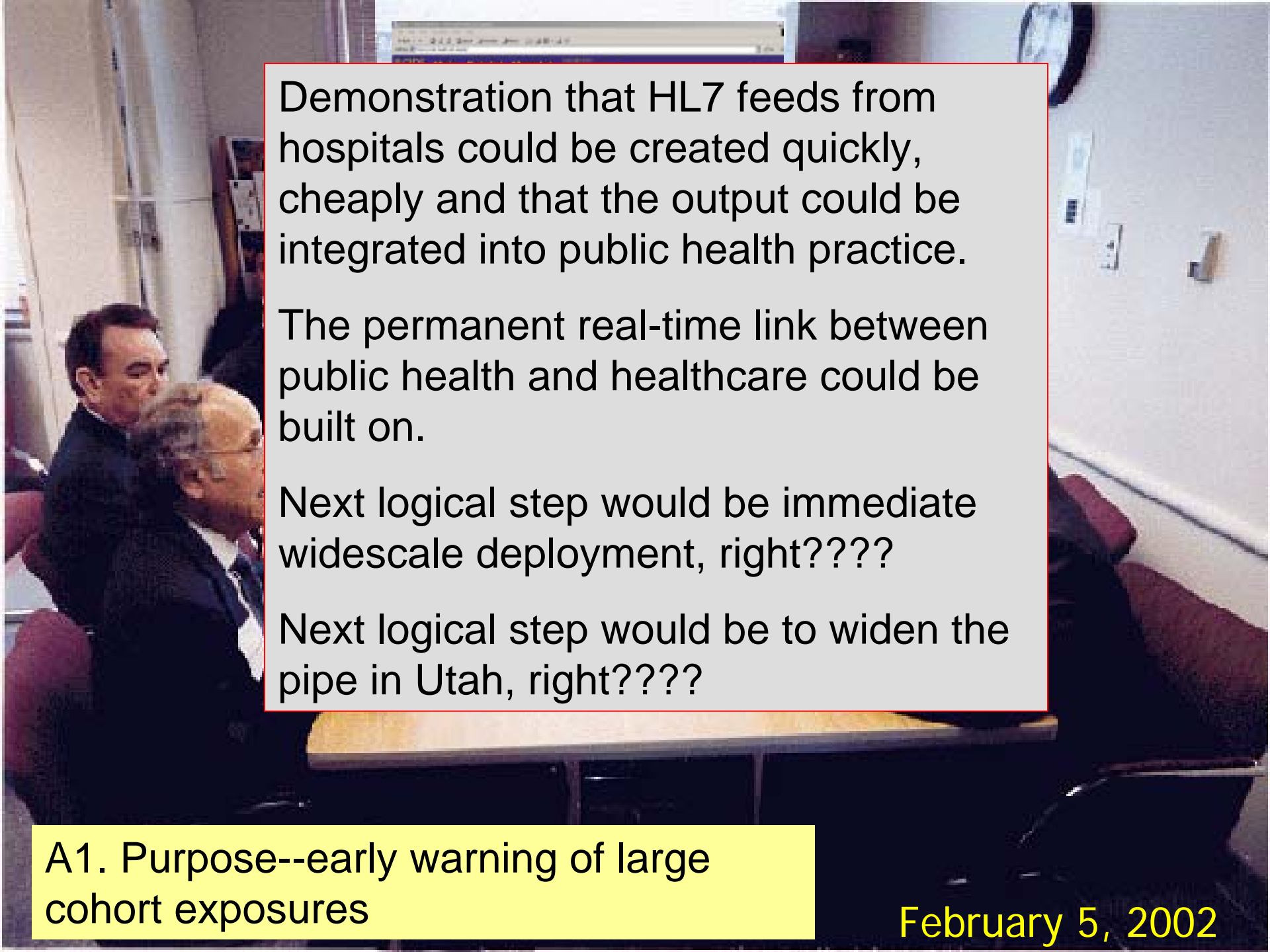
Found that ASP model removed a lot of barriers

Ongoing validation studies

Realized that data access was a huge barrier-> NRDM

September 2003 RODS Open Source Project

“Dissemination of new medical technology known to take decades. We might profitably focus on the question of what to do to speed things up”



Demonstration that HL7 feeds from hospitals could be created quickly, cheaply and that the output could be integrated into public health practice.

The permanent real-time link between public health and healthcare could be built on.

Next logical step would be immediate widescale deployment, right????

Next logical step would be to widen the pipe in Utah, right????

A1. Purpose--early warning of large cohort exposures

February 5, 2002

The RODS System: How it Works

- Emergency room registration systems capture chief complaints at time of registration--as part of normal workflow-- electronically
- The registration computer transmits chief complaints as HL7 messages to other computers in the health system via an HL7 message router
- The HL7 message router can de-identify these messages and transmit them via the Internet to a health dept
- ...in real time.



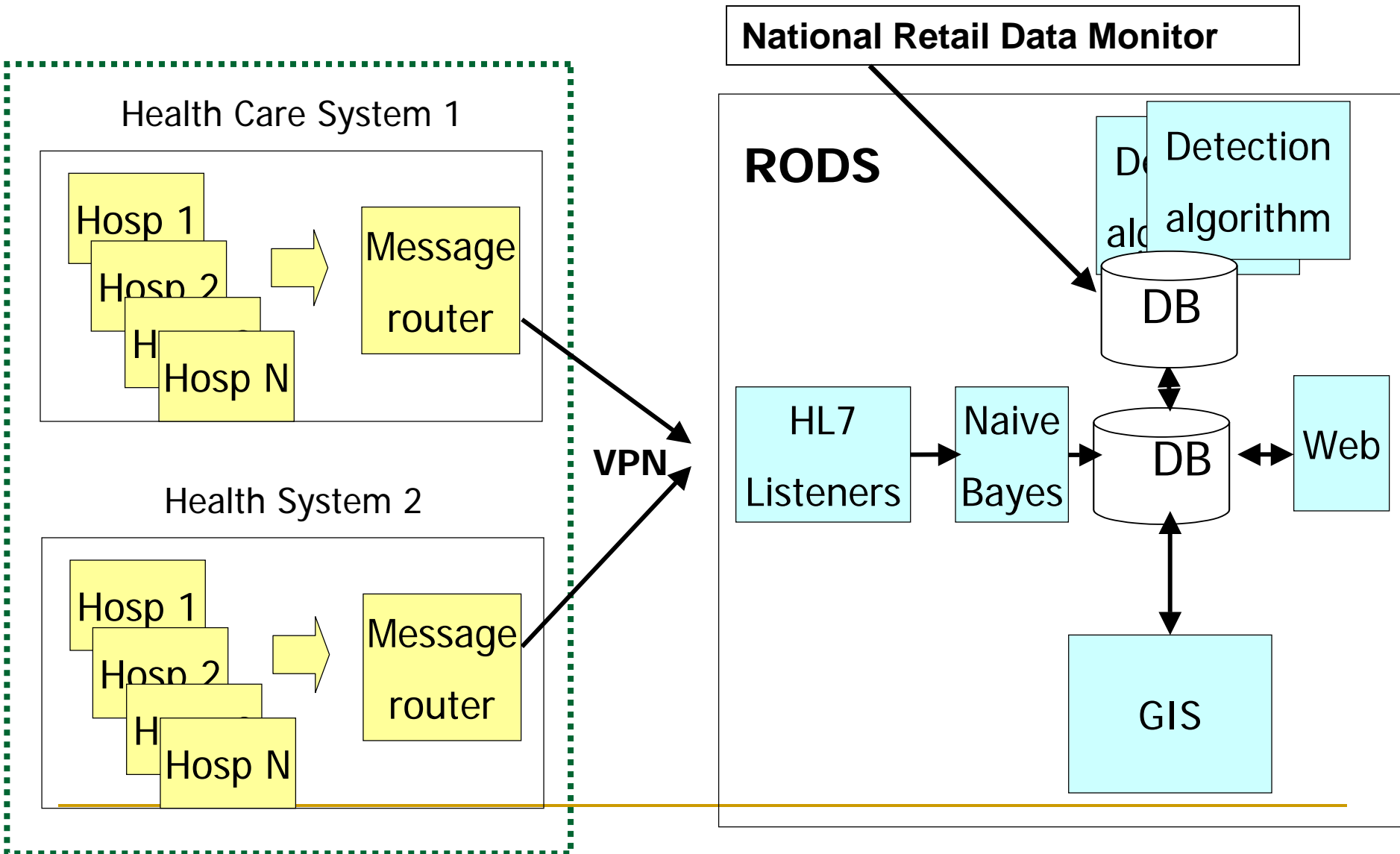
Example HL7 Message (Admission, Discharge, Transfer Message) from an Emergency Department

```
MSH|^~\&||xxx||RODS|20020224^A04|2002022XX  
XXXXXX|P|2.3<CR>  
PID||||^84204|||<CR>  
PV1|E|||98765432|||  
||200202151830||<CR>  
DG1|||SORE THROAT, COUGH<CR>  
IN1|||||^^^  
84056<CR>  
<ETX>
```

Annotations in the image:

- Zip code**: Callout pointing to `^A04` in the MSH header.
- Visit date and time**: Callout pointing to `200202151830` in the PV1 segment.
- Free-text chief complaint**: Callout pointing to `SORE THROAT, COUGH` in the DG1 segment.

Data Flow in the RODS System



Naive Bayes Text Classifier

Maps free-text chief complaint to one of seven prodrome categories (or an eighth category—none)

"N/V/D"

Chief complaint **Naive Bayes Classifier**

$$P(\text{Respiratory}|\text{NVD}) = .05$$

$$P(\text{Botulinic}|\text{NVD}) = .001$$

$$P(\text{Constitutional}|\text{NVD}) = .01$$

$$P(\text{GI}|\text{NVD}) = .9$$

$$P(\text{Hemorrhagic}|\text{NVD}) = .001$$

$$P(\text{Neurologic}|\text{NVD}) = .001$$

$$P(\text{Rash}|\text{NVD}) = .001$$

$$P(\text{None}|\text{NVD}) = .036$$

GI prodrome

Output

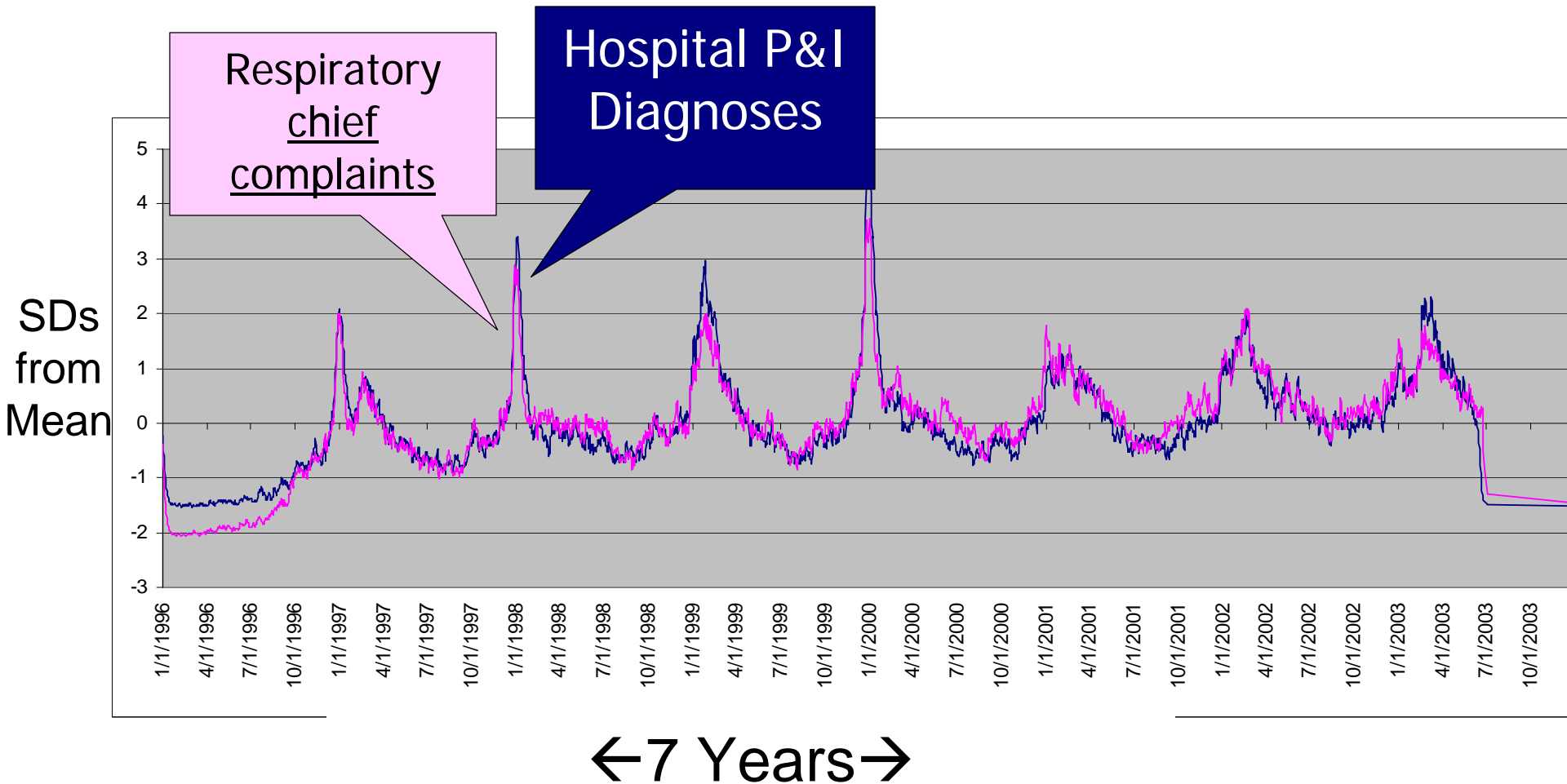
Validation: Naïve Bayes vs. UDOH Manual ED log review

Sensitivity, specificity and likelihood ratio positive (LR+) measurements for the CoCo classifier using the Utah Department of Health emergency department gold standard.

CoCo Syndrome	UDOH Syndrome	Sensitivity	Specificity	LR+
Respiratory	Respiratory infection with fever*	0.52	0.89	5
Gastrointestinal	Gastroenteritis without blood	0.71	0.90	7
Encephalitic	Meningitis / encephalitis	0.47	0.93	7
Rash	Febrile illness with rash*	0.50	0.99	56
Botulinic	Botulism-like syndrome	0.17	0.998	104

*Required documentation of fever in the patient record.

Detecting Respiratory Outbreaks by Monitoring Chief Complaints



Web Interfaces

Address <https://rods.bmi.pitt.edu/slc/main.html>

Go Lin

RODS UTAH **Main Epiplot Mapplot**

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Center for Biomedical Informatics
University of Pittsburgh

System Message Log

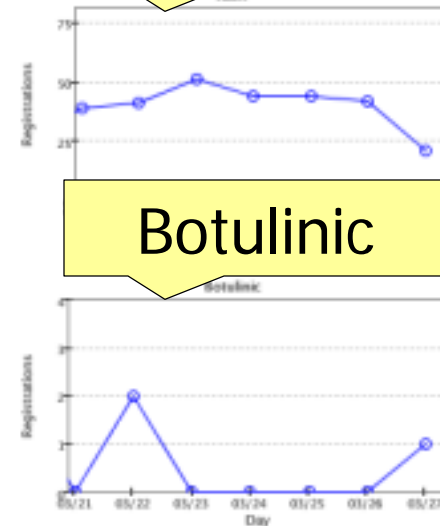
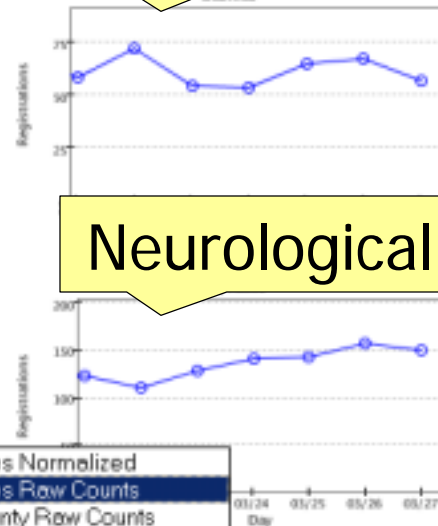
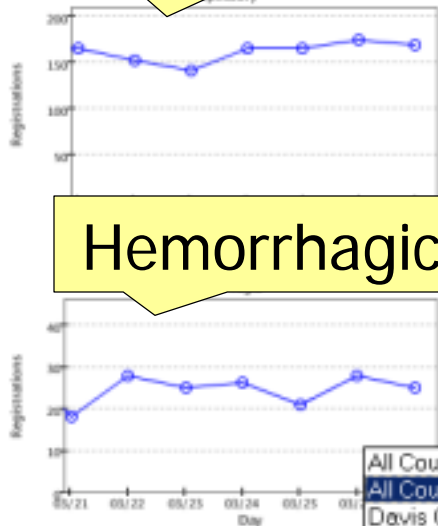
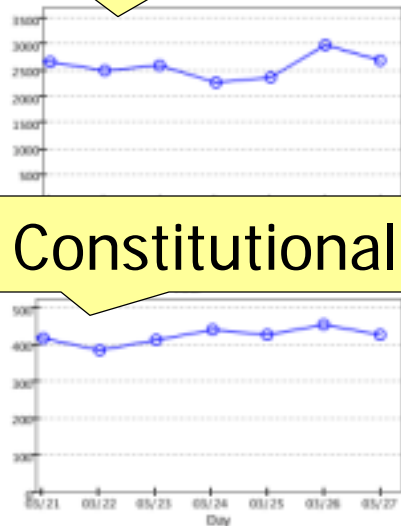
03/03/2002 06:21 - Hemorrhagic Alarm in All by RLS where count 33 exceeded 29.343
19/02/2002 20:43 - Viral Alarm in Morgan by RLS where count 7 exceeded 6.69

All visits

Respiratory

GI

Rash

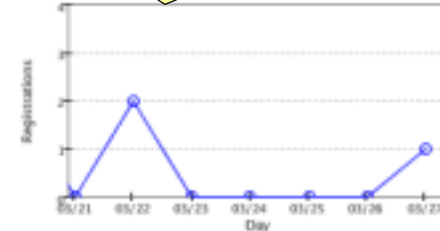
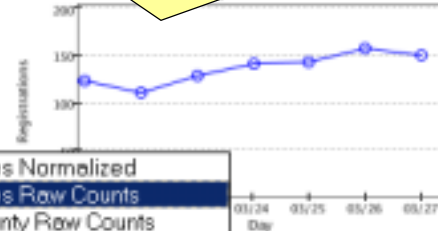
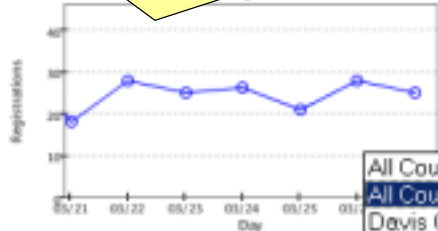
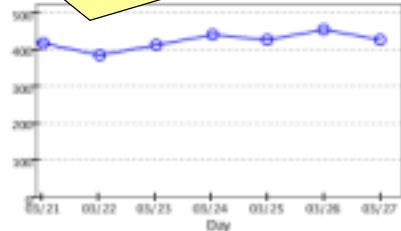


Constitutional

Hemorrhagic

Neurological

Botulinic

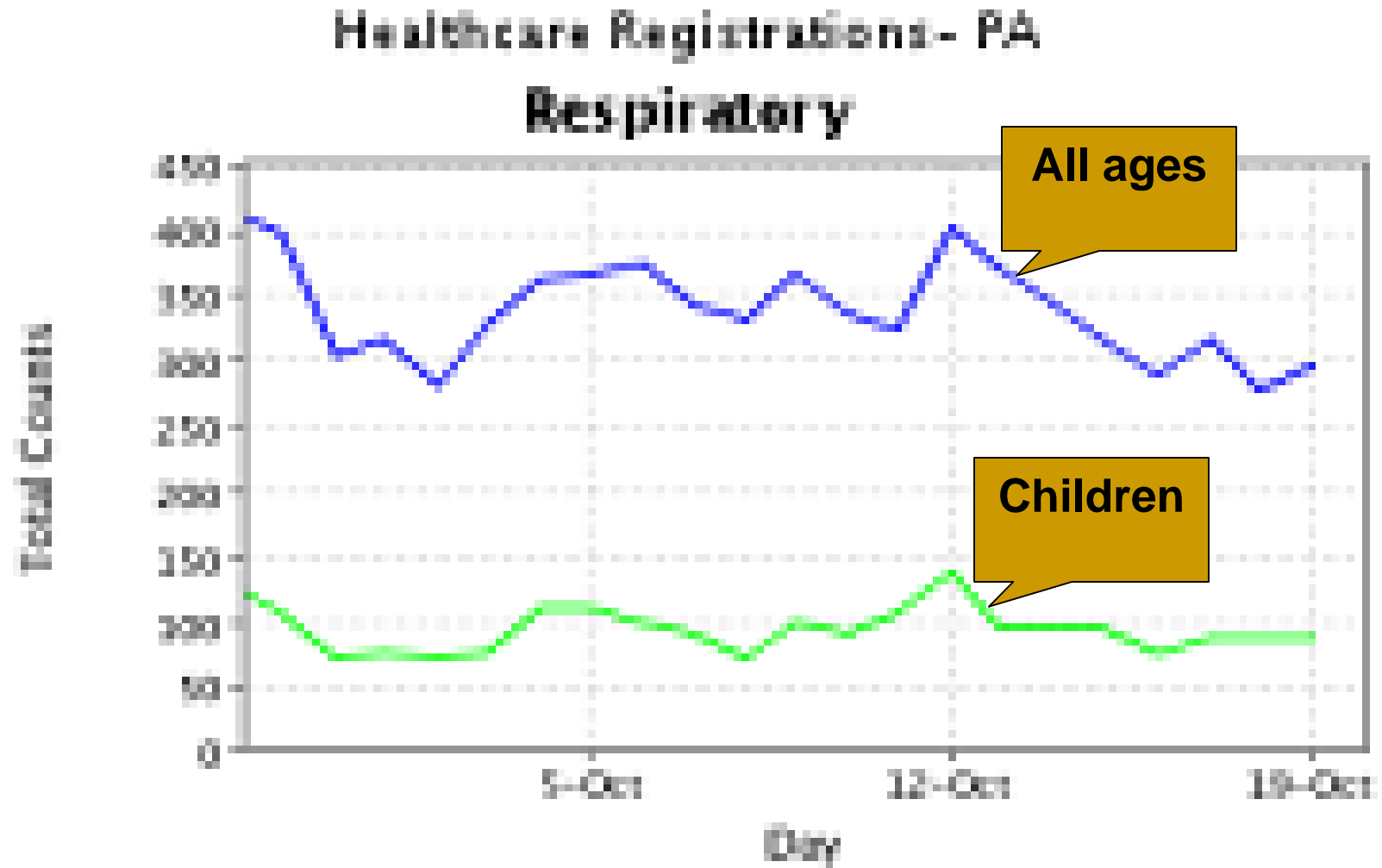


- All Counties Normalized
- All Counties Raw Counts
- Davis County Raw Counts
- Salt Lake County Raw Counts
- Utah County Raw Counts
- Morgan County Raw Counts
- Summit County Raw Counts
- Wasatch County Raw Counts
- Weber County Raw Counts

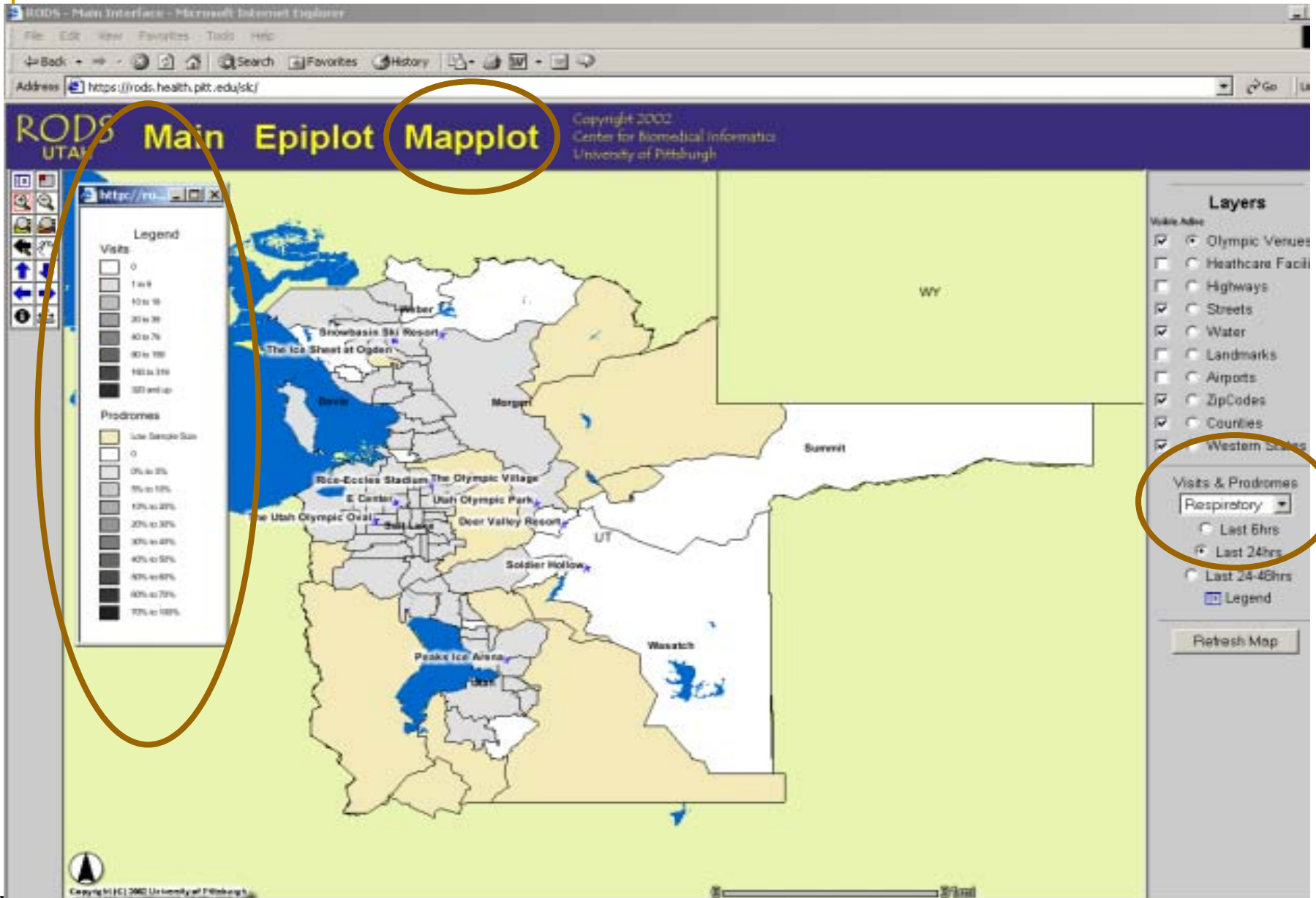
Note: Graphs

A3. Operation: How it works

Web Interfaces



Web Interfaces



Algorithms Used or in Development

Bill Hogan

Method	Application
BARD (Bayesian Airborne Attack)	Airborne Attack
PANDA 1	Complex times series w priors
PANDA 2 (Massive Multi-source fusion)	One Bayes Net node per member of population
SS1: Oscan Fast Scan Statistic	Robustly significant overdense di
SS2: Oscan Oriented Regions	Robustly significant overdense di
SS3: Historical Model Scan Stat.	Combine 1000s of zipcode-specific
SS4: Bayes Net in Scan Statistics	Looking for multiattribute patterns
Wavelets time-series monitoring	Multi-scale univariate timeseries prediction
WSARE 2.0 (Recent patterns)	What's strange about recent events
WSARE 3.0	WSARE with baseline modeled by
Numerous conventional time series algorithms	Includes Wavelet, HMM, Cusum, RLS, SA Serfling

**Dan Pelleg
(poster session)**

**Weng Keen Wong
(Talk)**

Rich Tsui

Details of these methods and bibliography available from "Summary of Biosurveillance-relevant statistical and data mining technologies" by Moore, Cooper, Tsui and Wagner. Downloadable (PDF format) from www.cs.cmu.edu/~awm/biosurv-methods.pdf

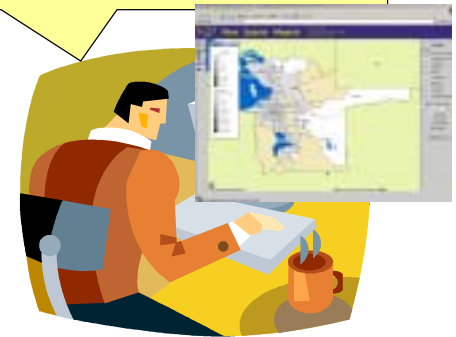
Alert Communication

Alert is triggered when

- pred. err ≥ 2.3 STD
- $p < 0.05$



RODS response person



Respiratory scare 7/18/03

Reminder: ADL will never ask you for your password or billing information.

Subj: **FW: EpiAlert Respiratory in Washington, PA**
Date: 7/18/2003 8:06:04 PM Eastern Standard Time
From: [Redacted]
To: [Redacted]
Sent from the Internet [\[Details\]](#)

> -----
> From: rods@www.rods.pitt.edu[SMTP:RODS@WWW.RODS.PITT.EDU]
> Sent: Friday, July 18, 2003 8:05:31 PM
> [Redacted]
> Subject: EpiAlert Respiratory in Washington, PA
> Auto forwarded by a Rule
>
 EpiAlert Report in Washington, PA

Date: 2003-07-18
Prodrome: Respiratory in Washington, PA
Observed normalized count: 27.556 (62.0/225.0)
Threshold normalized count: 16.13 (7.6/07)
Last two months plot: https://www.rods.pitt.edu/rods2/1.6/servlet/drawCount?start=1048205105508&end=1058573105508&minutes=1080&alarmDate=2003-07-18&state_ID=0&mfst=3&county=63&count=120&name=Washington



Washington, PA

Healthcare registrations

- All Visits
- Botulinic
- Constitutional
- Gastrointestinal
- Hemorrhagic
- Neurological
- Rash
- Respiratory

Realtime OTC

- Antidiarrheal
- Antifever adult
- Antifever pediatric
- Bronchial

remedies

- Chest rubs
- Cold relief adult

liquid

- Cold relief adult tablet

tablet

- Cold relief pediatric liquid

pediatric liquid

- Cold relief pediatric tablet

pediatric tablet

- Cough syrup adult liquid

liquid

- Cough adult tablet

pediatric liquid

- Cough syrup

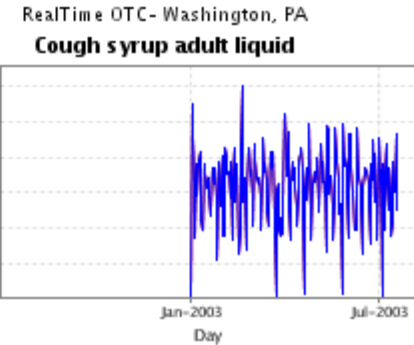
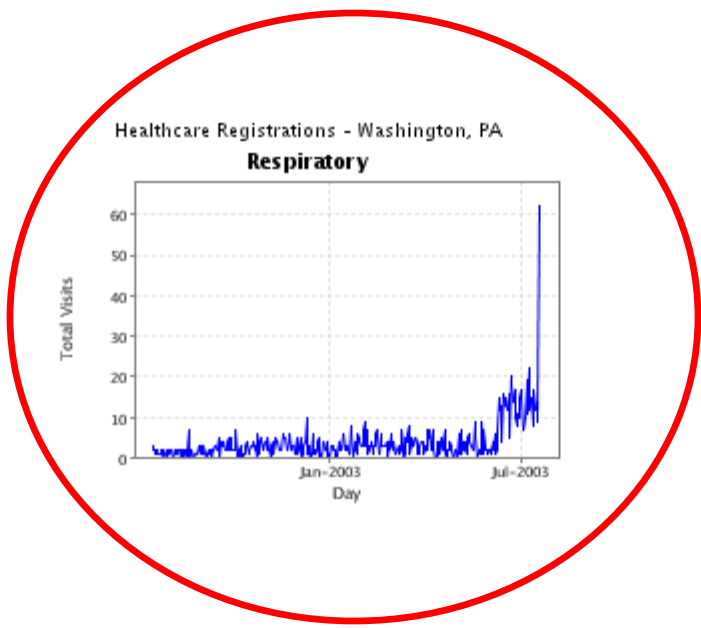
pediatric liquid

- Electrolytes

pediatric liquid

- Hydrocortisones

internal



Counts

Non-promotion sales All sales

Date Admitted	Age (Years)	Gender	Home Zipcode	Chief Complaint
2003-07-18 17:39:00.0	30	F		POSS CARBON MONOXIDE EXPOSURE
2003-07-18 17:37:00.0	0	M		CARBON MONOXIDE EXPOSURE
2003-07-18 17:34:00.0	0	M		CARBON MONOXIDE EXPOSURE
2003-07-18 17:33:00.0	0	M		POSSIBLE CARBON MONOXIDE POISONING
2003-07-18 17:31:00.0	0	F		POSS CARBON MONOXIDE EXPOSURE
2003-07-18 17:29:00.0	0	M		CARBON MONOXIDE EXPOSURE
2003-07-18 17:28:00.0	0	M		POSS CARBON MONOXIDE EXPOSURE
2003-07-18 17:28:00.0	0	F		POSSIBLE CARBON MONOXIDE POISONING
2003-07-18 17:25:00.0	0	M		POSS CARBON MONOXIDE EXPOSURE
2003-07-18 17:18:00.0	10	M		POSS CARBON MONOXIDE EXPOSURE
2003-07-18 17:18:00.0	0	M		CARBON MONOXIDE EXPOSURE
2003-07-18 17:17:00.0	20	F		CARBON MONOXIDE EXPOSURE
2003-07-18 17:13:00.0	0	M		CARBON MONOXIDE EXPOSURE
2003-07-18 17:11:00.0	0	M		POSSIBLE CARBON MONOXIDE POISONING

Enter Network Password [?] [X]

 Please type your user name and password.

Site: mars.upmc.edu

Realm: Patient Record Query

User Name:

Password:

Save this password in your password list

2003-07-18 17:10:00.0	0			KPOSURE
2003-07-18 17:08:00.0	0			KPOSURE
2003-07-18 17:04:00.0	0			KPOSURE
2003-07-18 17:01:00.0	0			KPOSURE
2003-07-18 16:59:00.0	0			NOXIDE POISONING
2003-07-18 16:58:00.0	0			KPOSURE
2003-07-18 16:57:00.0	0			KIDE EXPOSURE
2003-07-18 16:56:00.0	0			NOXIDE POISONING
2003-07-18 16:55:00.0	0			KPOSURE
2003-07-18 16:54:00.0	0			KPOSURE
2003-07-18 16:52:00.0	30			KIDE EXPOSURE

Electronic medical record of one patient

The screenshot displays the MARS System interface within a Microsoft Internet Explorer browser window. The title bar reads "UPMC Version of the MARS System - Microsoft Internet Explorer". The main content area shows a patient's emergency room report for 02/02/02. The report includes patient information, a warning about confidentiality, and detailed clinical notes under sections like "ATTENDING PHYSICIAN ADDENDUM:", "REVIEW OF SYSTEMS:", "PHYSICAL EXAMINATION:", and "IMPRESSION:". A right-hand sidebar contains "EMR Navigation Windows" with a "Category Selection" list and "ER Reports" for the patient.

UPMC Version of the MARS System - Microsoft Internet Explorer

mars

WARNING! You must protect this document as confidential medical record information

New Pat Help

EMR Navigation Windows

Category Selection

- HP [History/Physical](#)
- DS [Discharge Summar](#)
- ER [Emergency Room](#)
- RAD [Radiology](#)
- SP [Surgical Patholo](#)
- PGN [Progress Note](#)
- LETT [Letter](#)
- LAB [Laboratory](#)
- LABSS [Spread Sheets](#)
- MICRO [Microbiology](#)

ER Report 4: 02/02/02 Emergency Room

Format for Printing

NAME [REDACTED]
IDNO [REDACTED]
SUBTYPE [REDACTED]
DOCTOR [REDACTED]
PROCEDURE BY ... [REDACTED]

ATTENDING PHYSICIAN ADDENDUM:

This a patient that I examined here for complaints of diarrhea with the resident. Confirmed the history and physical with the resident and examined here by myself. [REDACTED] has got loose stools for a couple days. Her husband has had a similar illness and it is not improving. She feels she is able to keep up with p.o. liquids has got poor appetite. No nausea. No vomiting.

REVIEW OF SYSTEMS:

Otherwise negative for me.

PHYSICAL EXAMINATION:

I find the woman's temp at 36.6, initial triage pulse is 104, when I examine her is 88, 20, pressure 128/palp. She is normocephalic. Eyes anicteric. Neck supple. Bilateral breath sounds clear. Abdomen is a bit obese. Nontender. No focal tenderness, guarding, or rebound. Back nontender. Rectal is per the resident and did not suggest blood. She is neurologically intact. Skin is warm and dry.

IMPRESSION:

Multiple loose stools consistent with a diarrheal illness. No vomiting. She is taking p.o. She does not appear clinically dehydrated. Recommended that we check a potassium given her use of Laxix and this was ordered. Also, gave her some fluids while we were waiting. She was given some symptomatic treatment which will continue as an outpatient. Unfortunately, due to a lab error, the potassium was hemolyzed and the patient did not wish to wait for a redraw potassium. She was satisfied with her care at that point and wished to follow up with her own PCP. She is, therefore, discharged in good condition with diagnosis of diarrhea.

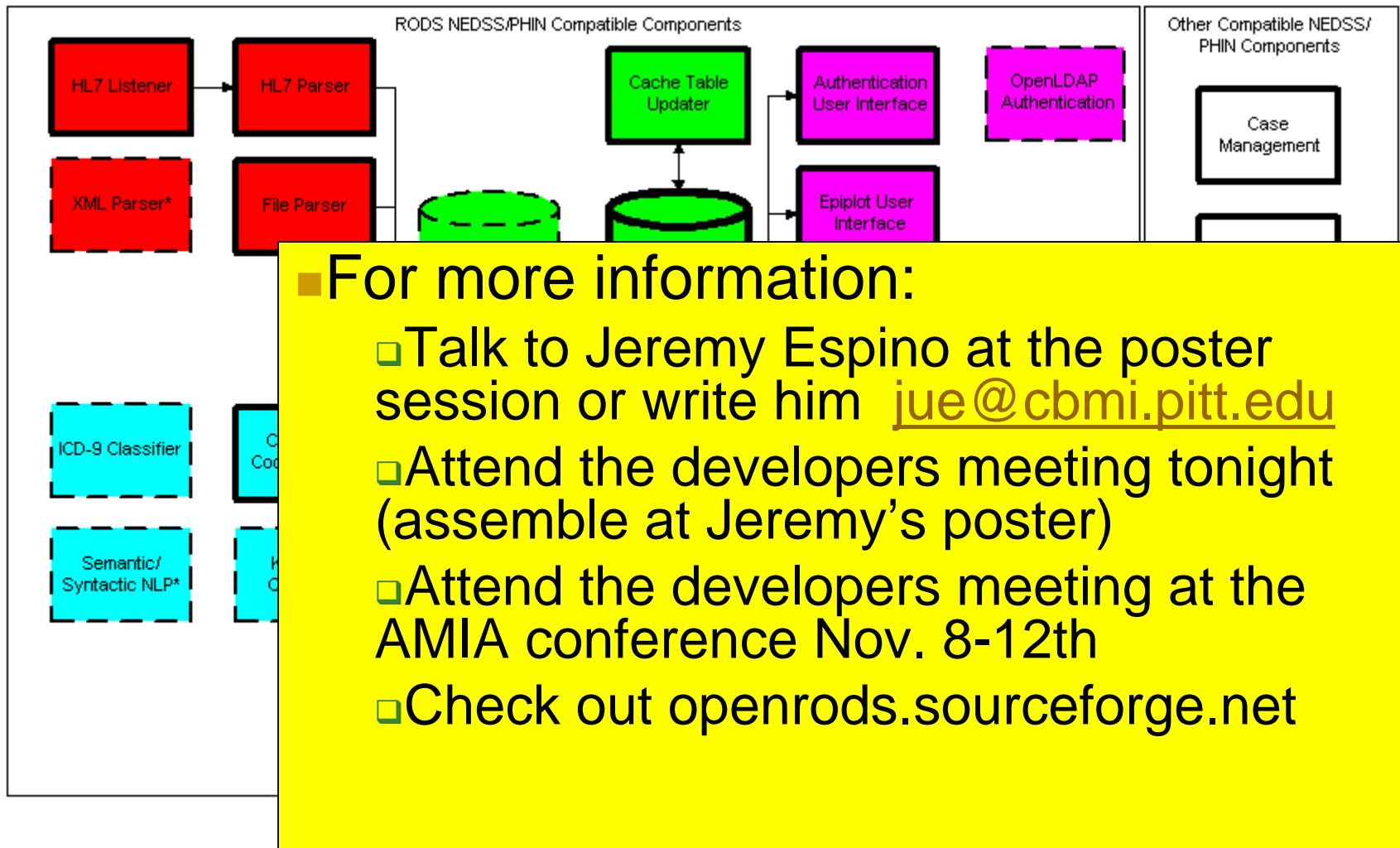
ER Reports

- PSH 02/02/02
- PSH 02/02/02
- PSH 01/09/02
- PSH 01/09/02
- PSH 05/02/01
- PSH 04/18/01
- PSH 04/18/01
- PSH 12/20/99
- PSH 02/15/99
- PSH 02/15/99
- PSH 06/03/97
- PSH 06/03/97
- PSH 03/28/97
- PSH 05/03/96
- PSH 08/07/95
- PSH 11/20/94
- PSH 11/25/94

RODS Open Source Project

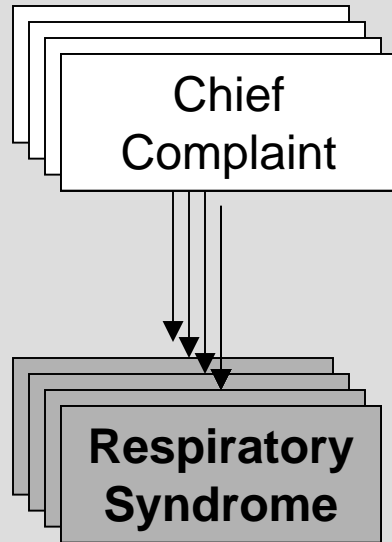
- What is open source?
- Why open source?
 - One word → Linux (and freedom from monopolistic practices)
 - Also, open source may catalyze rapid growth of a critical mass of
 - Software developers
 - Consultants and companies that install and maintain
 - Users
- What does the software do?
 - Syndromic surveillance following PHIN standards
 - Collects and analyzes multiple data types e.g., OTC and clinical

Modular Design: Actual and Planned



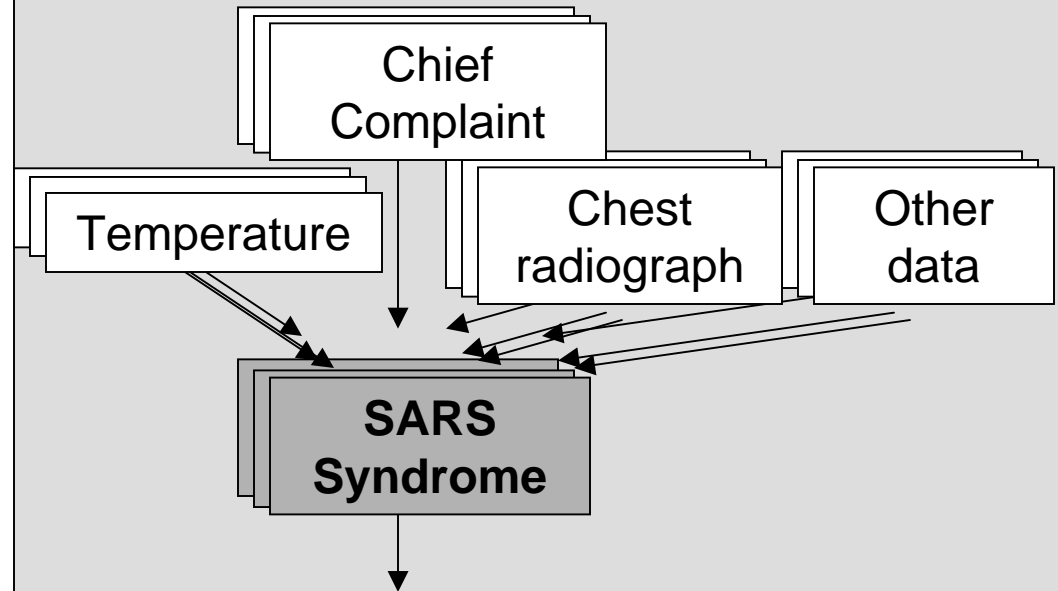
Future Direction

What we do now



Spatial and temporal analysis to detect overdensity of cases in a zip code or larger region

Where we are going



Spatial, temporal, and other clustering analysis to detect overdensity of cases
In a building, on a hospital floor, in a household or family, in a workplace
(e.g., a mail handling facility)

Lessons Learned

- “Free-text chief complaints” is a good place to start
- (OTC is an even better place to start)
- ASP is the way to go
- You need strong leadership. With it
 - HL7 interface - two days
 - Network connection - one week
 - Data sharing agreement < 6 weeks
- Team up with medical computer scientists and computer scientists if you can.
- We have removed every barrier we can
- It is up to you to connect hospitals
- If there was an emergency, it could happen in six weeks

**Medical Computer
Scientist
(aka Medical
Informatician)**

**Computer
Scientist**



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- Commonwealth of Pennsylvania
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- AHRQ
- National Library of Medicine

Personnel

Wendy Chapman PhD

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Per Gesteland MD

William Hogan MD MS

Judith Hutman

Oleg Ivanov MD MPH

Lili Ma

Andrew Moore PhD

Robert Olszewski PhD

Hoah Su

Cleat Szczepaniak

Weng Keen Wong

For more information...

Other presentations:

Weng Keen Wong (WSARE algorithm)

Per Gesteland (Data Agreement negotiations)

Paper: Tsui et al, *Technical Description of RODS: A Real-time Public Health Surveillance System*, JAMIA, Sept. 2003;10(5) 399-408

Open Source Project: openrods.sourceforge.net

Utah Validation Study: Per.Gesteland@ihc.com

How the Soviet Robinson was Written: translation on request

Talk to us here!

Jeremy Espino (Open Source Project)

Judith Hutman (Laboratory Administrative Director, ASP Services)

Rich Tsui, Bill Hogan, Dan Pelleg, Weng Keen Wong

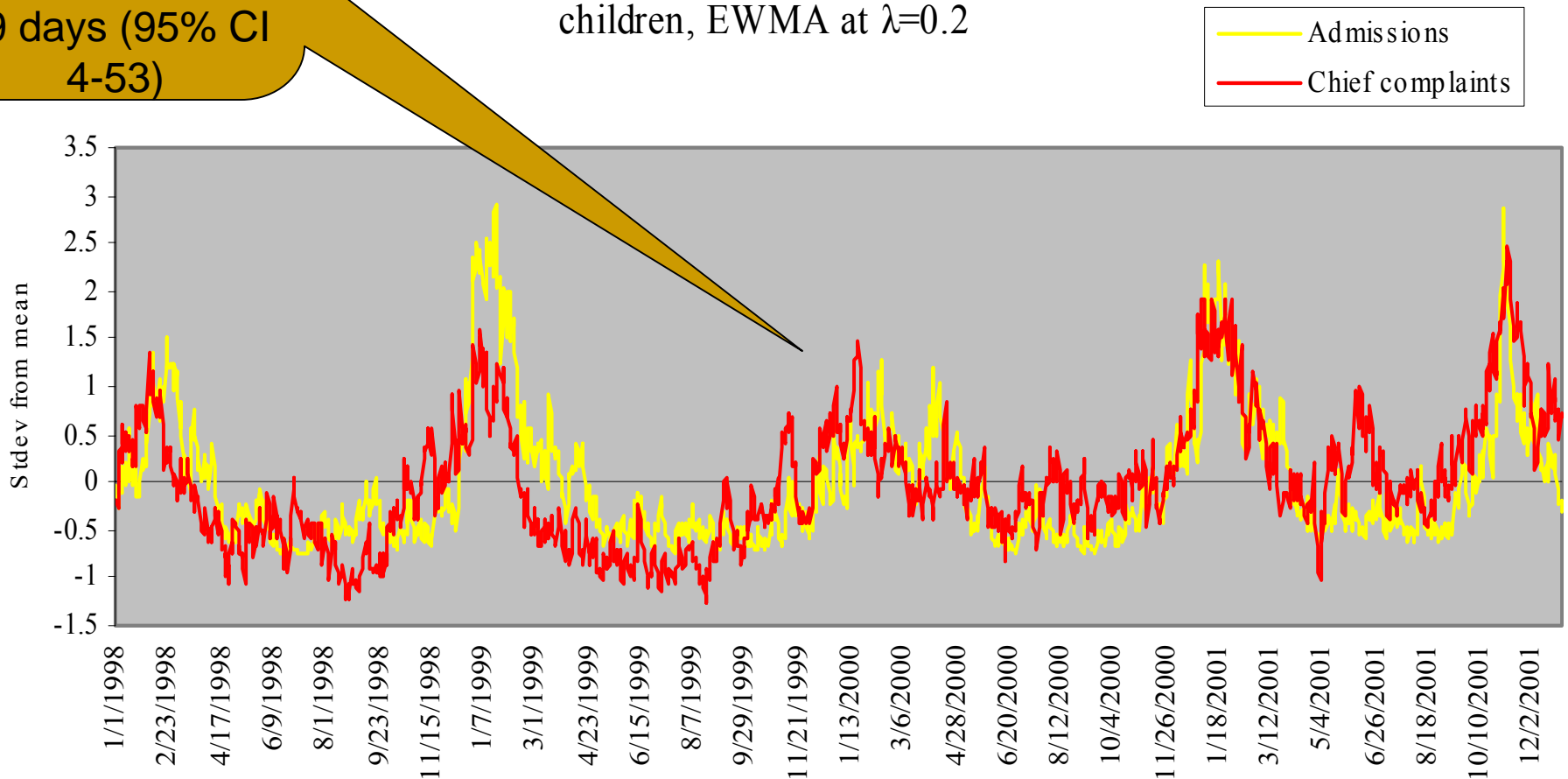
Evaluation guidelines

- System description (purpose, stakeholders, operation- including standards/security)
- Outbreak detection (timeliness, validity)
- Experience (Usefulness, Flexibility, Acceptability, Portability, Stability, Costs)
- Conclusions and Recommendations

GI Chief Complaints and GI Diagnoses in

Detection from
CCs precede
that from
admissions by
29 days (95% CI
4-53)

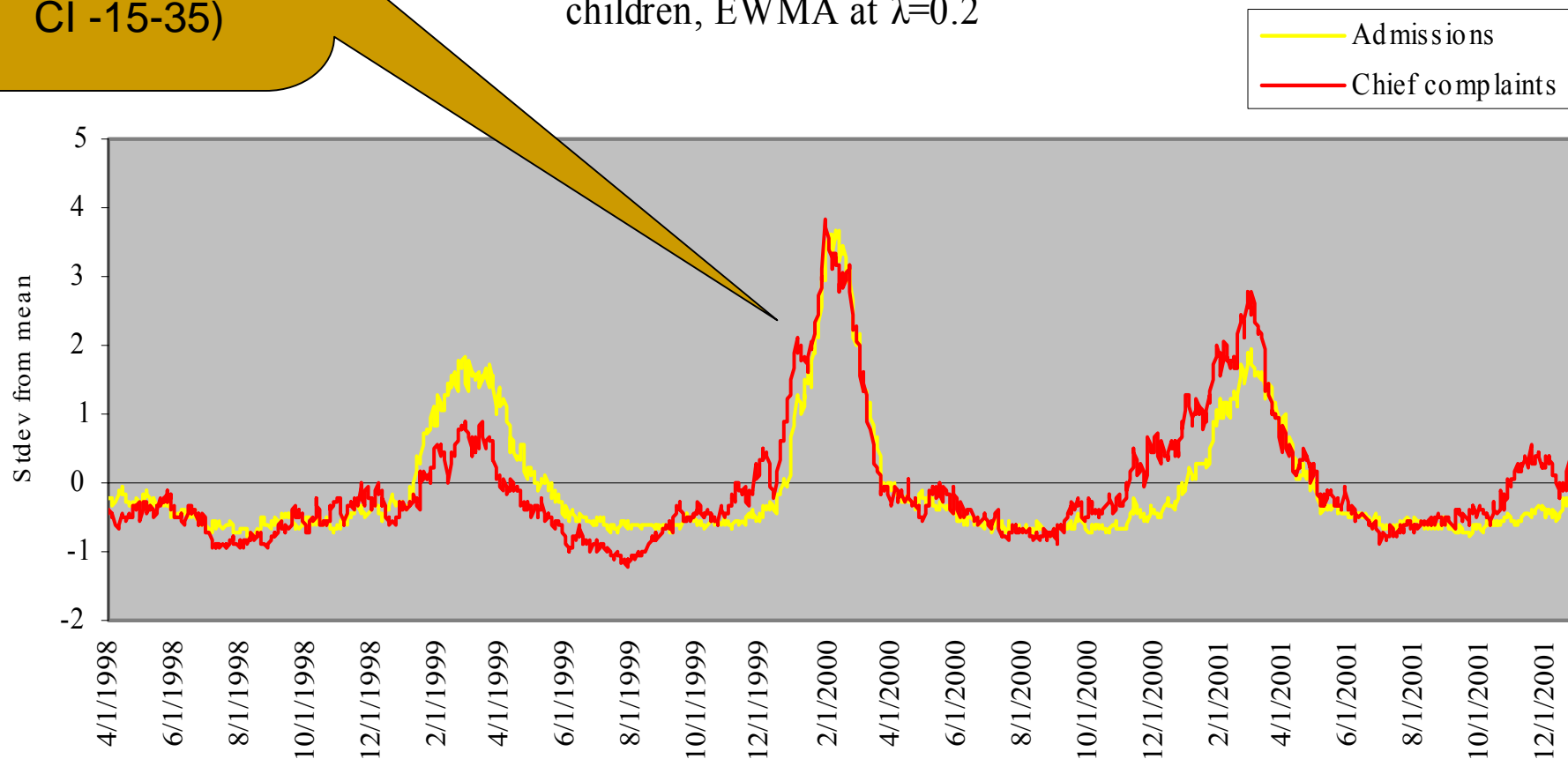
Gastrointestinal illness admissions and chief complaints,
children, EWMA at $\lambda=0.2$



Detecting Respiratory Outbreaks in Children by monitoring Chief Complaints

Detection from
CCs precede that
from admissions
by 10 days (95%
CI -15-35)

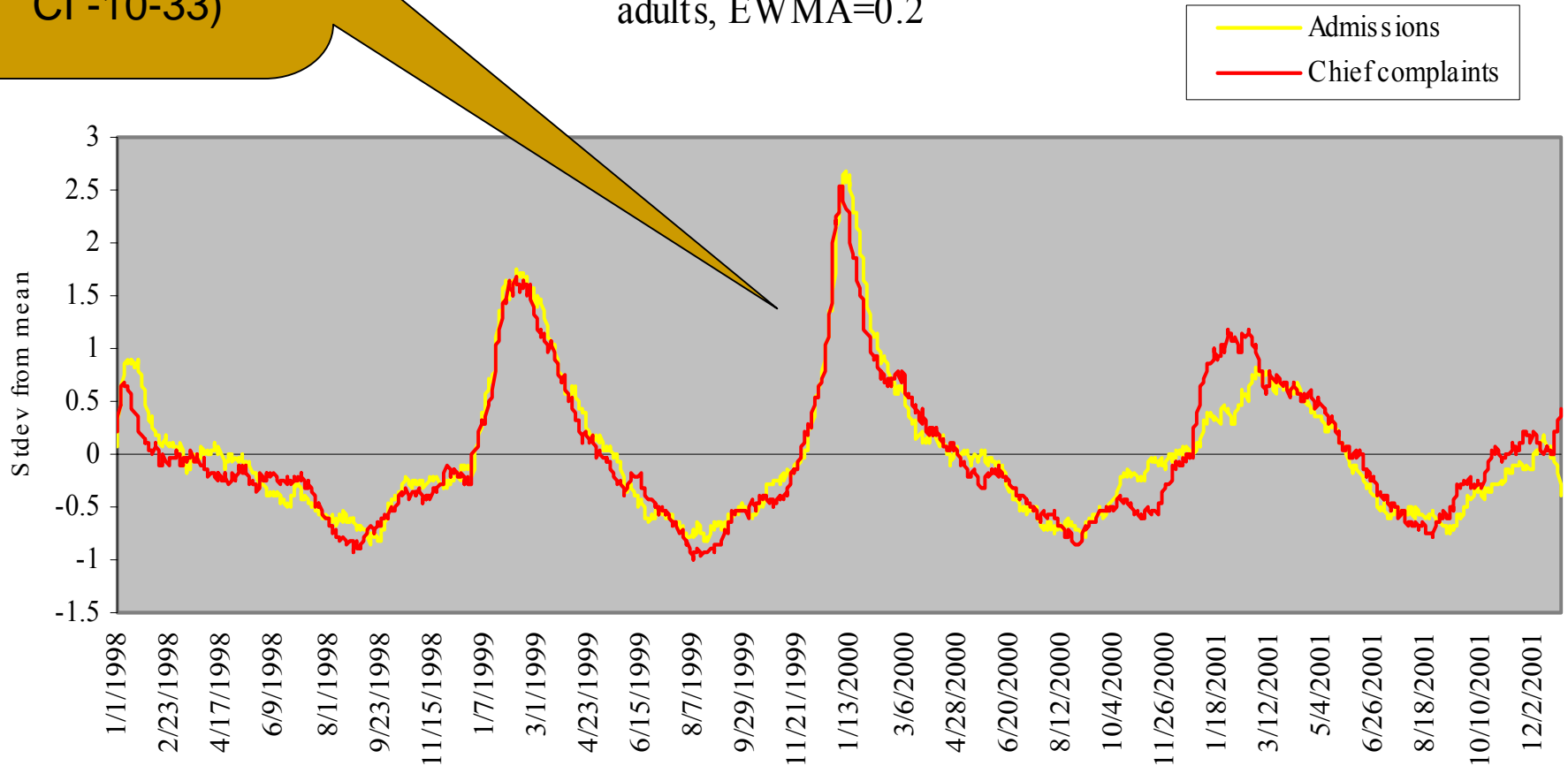
Respiratory illness admissions and chief complaints,
children, EWMA at $\lambda=0.2$



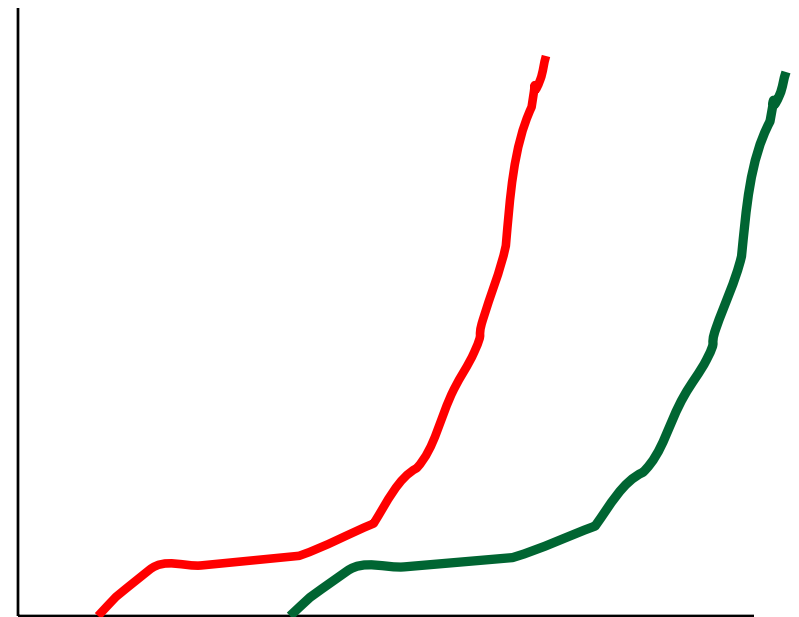
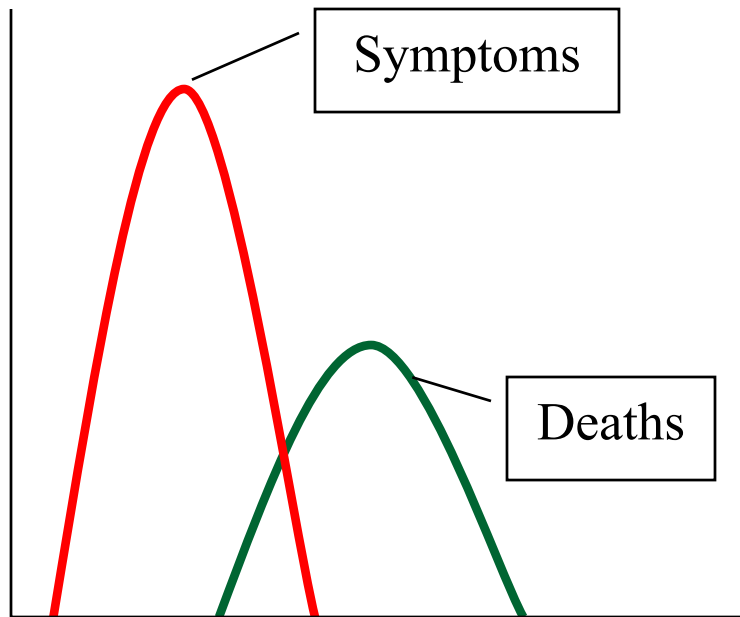
Detecting Respiratory Outbreaks in Adults by monitoring Chief Complaints

Detection from CCs precede that from admissions by 11 days (95% CI -10-33)

Respiratory illness admissions and chief complaints, adults, EWMA=0.2



Two Key Patterns of Concern



Cohort exposure:
Air, food or water
contamination

SARS Pattern:
Contagious diseases