

Timely detection of localized excess influenza activity across multiple data streams

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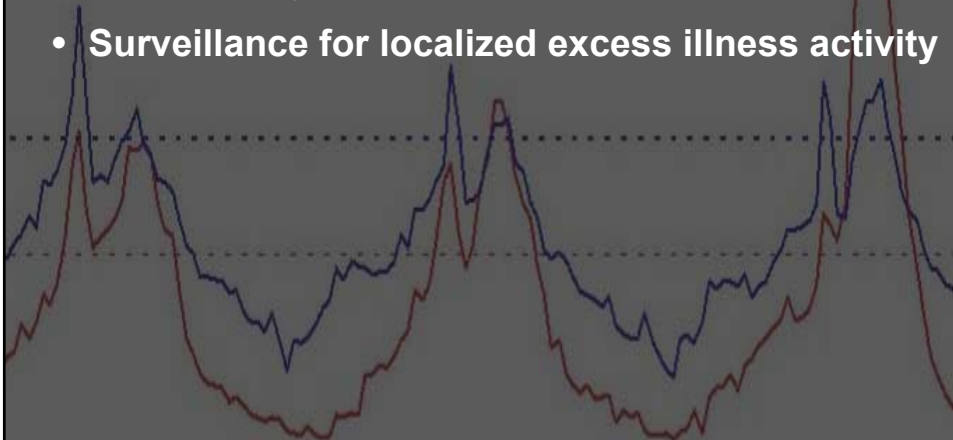
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Influenza Seasonality

- Strong temporal pattern
- Not spatially uniform
- Surveillance for localized excess illness activity



Multi-Stream Surveillance

- Health care systems routinely generate multiple data streams
- No single data stream optimal
- Multi-stream surveillance could improve cluster detection



Objective

To compare the performance of ten types of electronic clinical data for timely detection of localized excess activity throughout the 2007/08 influenza season in northern California

Study Population



- Integrated health care delivery system
- 3.3 million members
- Central Valley and San Francisco Bay
- Of 18 medical centers, 12 electronically recorded patient temperature



Available Data Streams

Data stream	Explanation	Temporal data element
AC±F	Influenza-like illness in ambulatory care	Encounter
AC+F	" with fever	
ED±F	Influenza-like illness in emergency department	
ED+F	" with fever	

Available Data Streams

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ED±F	Influenza-like illness in emergency department	
ED+F	" with fever	
Admissions	Pneumonia or influenza hospital inpatient admissions (text strings)	Admission
Discharges	Same as above, but with a primary discharge diagnosis of pneumonia or influenza (ICD-9 codes)	

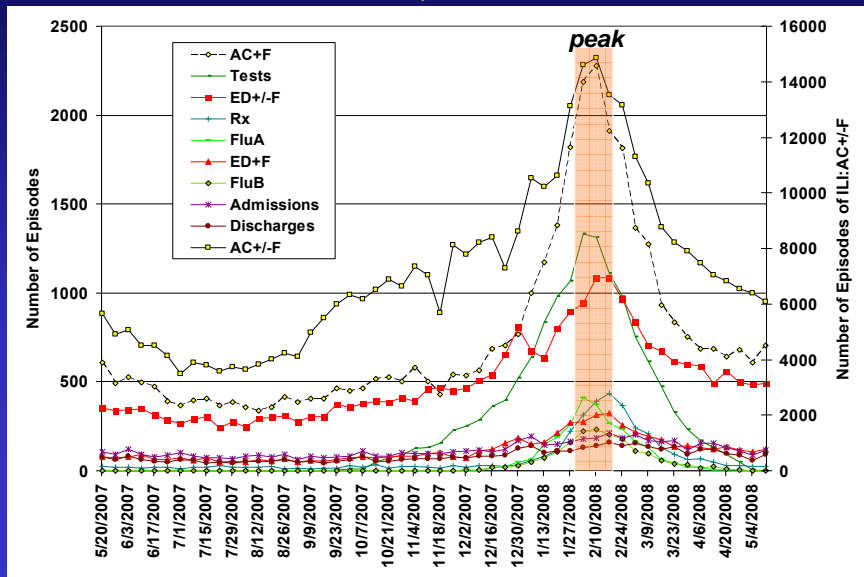
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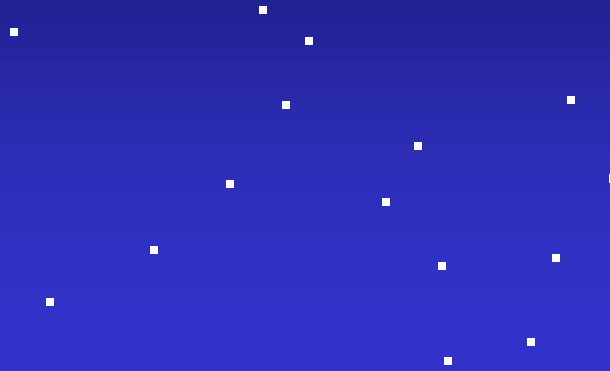
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Tests	RT-PCR tests ordered	Specimen collected
FluA	RT-PCR tests positive for influenza type A	
FluB	" B	

Weekly episodes of influenza-associated data streams, 5/20/07-5/17/08



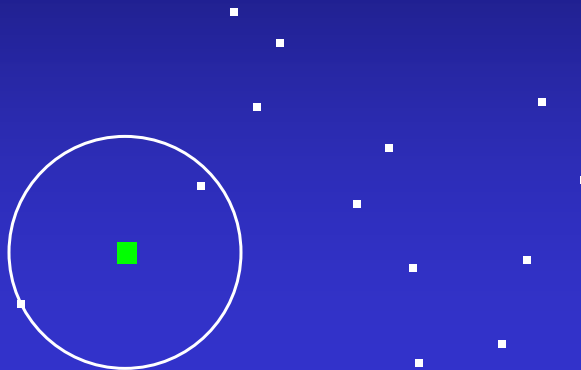
Scan Statistic

- Are there excess cases in any particular zip code or set of zip codes?



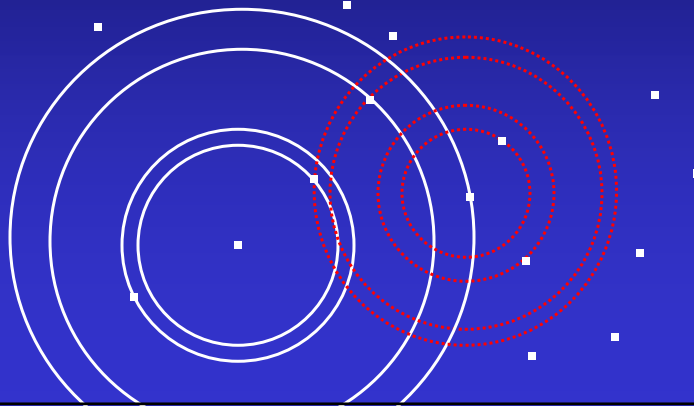
Scan Statistic

- Are more cases observed than expected, inside vs. outside the circle?



Scan Statistic

- Repeat for all possible clusters
 - Can be centered on any zip code
- To add time, imagine stacking maps
 - Cylindrical potential clusters



Compare cylinders:

- Identify cylinder with maximum likelihood

Inference:

- Generate random replicas of the dataset
- Monte Carlo hypothesis testing: compare most likely clusters in real and random datasets

Space-Time Permutation Scan Statistic: Properties

- Adjusts for purely geographical or purely temporal variation
- Simultaneously tests for outbreaks of any size at any location
- Accounts for multiple testing
- SaTScan™ (www.satscan.org)

Space-Time Permutation Scan Statistic: Analysis Options

- Retrospective
 - Once
 - Using all data available
 - Identify most unusual clusters during study period
- Prospective
 - Daily, for early detection
 - Using data available as of each surveillance day
 - Identify most unusual cluster each day

Credible Influenza Cluster #1: Centroid in Bay Area

Data Stream	Cluster Duration	# of zip codes	Obs	Exp	Obs/Exp	p-value
AC+F	12/7-1/3	58	710	557	1.3	0.0003

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AC+F	12/7-1/3	58	710	557	1.3	0.0003
Tests	12/8-1/2	94	506	385	1.3	0.0003
AC±F	12/15-1/5	19	1,620	1,387	1.2	0.001

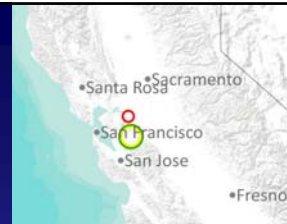
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AC±F	12/15-1/5	19	1,620	1,387	1.2	0.001
ED+F	12/11-12/25	10	13	3	4.79	n.s.
ED±F	12/16-12/26	69	313	248	1.3	n.s.
FluA	12/17-12/30	9	6	0.81	7.4	n.s.

Credible Cluster Characteristics

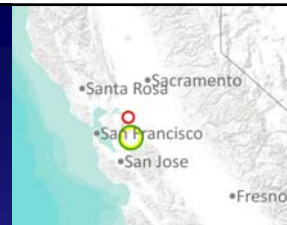
- Detection at $p < 0.005$ by ≥ 3 streams
- Excess risk in ≥ 4 streams
- Occurrence when $> 5\%$ specimens statewide tested positive

Prospective Detection of Cluster #1



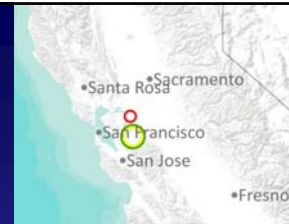
	# of days after 1 st signal that each data stream signaled						
	AC+F	AC±F	ED+F	ED±F	Rx	Tests	FluA

Prospective Detection of Cluster #1



	# of days after 1 st signal that each data stream signaled						
Min. RI (years)	AC+F	AC±F	ED+F	ED±F	Rx	Tests	FluA
1							
2							
5							
10							
25							

Prospective Detection of Cluster #1



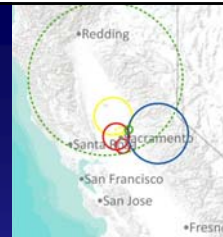
Min. RI (years)	# of days after 1 st signal that each data stream signaled						
	AC+F	AC±F	ED+F	ED±F	Rx	Tests	FluA
1	-	0	-	-	-	0	-
2	-	0	-	-	-	-	-
5	-	2	-	-	-	-	-
10	-	14	-	-	-	-	-
25	-	14	-	-	-	-	-

Prospective Detection of Cluster #2



Min. RI (years)	# of days after 1 st signal that each data stream signaled						
	AC+F	AC±F	ED+F	ED±F	Rx	Tests	FluA
1	-	28	-	-	0	4	-
2	-	28	-	-	0	4	-
5	-	28	-	-	5	4	-
10	-	28	-	-	5	4	-
25	-	28	-	-	5	4	-

Prospective Detection of Cluster #3



Min. RI (years)	# of days after 1 st signal that each data stream signaled						
	AC+F	AC±F	ED+F	ED±F	Rx	Tests	FluA
1	2	0	21	8	21	6	13
2	2	0	22	8	-	6	14
5	4	1	22	9	-	7	-
10	4	1	22	9	-	7	-
25	4	2	22	9	-	7	-

Prospective Detection of Cluster #4



Min. RI (years)	# of days after 1 st signal that each data stream signaled						
	AC+F	AC±F	ED+F	ED±F	Rx	Tests	FluA
1	-	24	-	41	-	0	4
2	-	25	-	-	-	-	10
5	-	25	-	-	-	-	10
10	-	25	-	-	-	-	11
25	-	25	-	-	-	-	11

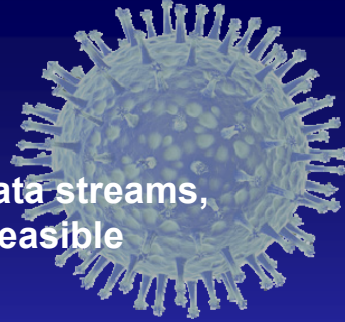
Summary of Prospective Analyses

- AC±F and Tests signaled during all 4 clusters
 - Most timely for 3 clusters
- Rx most timely for one cluster
- FluA also had timely signals
- Not reliable: ED+F, ED±F, hospital admissions and discharges, and FluB
- When fever included in ILI definition for AC or ED, signals were delayed or missed

Limitations

- No external gold standard for credible influenza activity
- One health care system, one state, one influenza season

Conclusions



- Using only 3 of 10 available data streams, timely prospective detection feasible
 - AC±F, Tests, and Rx
- AC streams more useful than ED streams
- Inform selection and development of data for enhanced public health surveillance
 - Univariate or multivariate methods
- Additional research needed to confirm which data streams most promising

Extra Slides

ILI Syndromic Definition

- At least one of the following respiratory symptoms:

079.3	RHINOVIRUS INFECT NOS
079.89	OTHER SPECIFIED VIRAL INFECTION
079.99	UNSPECIFIED VIRAL INFECTION
460	NASOPHARYNGITIS, ACUTE
462	PHARYNGITIS, ACUTE NOS
464.00	LARYNGITIS, AC.W/O OBSTRU
464.01	LARYNGITIS, AC.W/OBSTRUCT
464.10	TRACHEITIS W/O OBSTRUCTIO
464.11	AC TRACHEITIS W OBSTRUCT
464.20	LARYNGOTRACHEITIS W/O OBS
464.21	AC LARYNGOTRACH W OBSTR
465.0	LARYNGOPHARYNGITIS, ACUTE
465.8	URI, OTHER MULT. SITES
465.9	URI, ACUTE NOS
466.0	BRONCHITIS ACUTE
466.19	BRONCHIOLITIS DUE OTHER ORG'S

478.9	RESPIRATORY TRACT DISEASE
480.8	VIRAL PNEUMONIA NEC
480.9	PNEUMONIA, VIRAL
481	PNEUMOCOCCAL PNEUMONIA (L
482.40	STAPH PNEUMONIA NOS
482.41	PNEUMONIA, STAPHYLOCOCC. A
482.49	OTH STAPH PNEUMONIA
484.8	PNEUM IN INFECT DIS NEC
485	BRONCHOPNEUMONIA ORGANISM
486	PNEUMONIA, ORGANISM NOS
487.0	INFLUENZA WITH PNEUMONIA
487.1	INFLUENZA W/OTH. RESP. MA
487.8	INFLUENZA W/OTHR MANIFEST
784.1	PAIN IN THROAT
786.2	COUGH

- And either:
 - Measured fever of at least 100 F (in temperature field of database)
 - 780.6: fever (if and only if no valid temperature of any magnitude)

Space-Time Permutation Scan: Parameters

SaTScan™ (www.satscan.org)

- Surveillance period: 9/30/07-5/17/08
- Historical period: 5/20/07-9/29/07
- Episodes (i.e., repeat visits excluded)
- Max. temporal scanning window: 7 days
- Max. circle size: 50% of the population
- Adjusts for day of week-by-space interaction
- No. Monte Carlo replications: 9,999

