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# Overview of Syndromic Surveillance: Systems and Uses

Presentation to CSTE Methods Subcommittee  
November 16, 2017

Robert Mathes (rmathes@health.nyc.gov)  
Bureau of Communicable Disease  
New York City Department of Health and Mental Hygiene

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## Overview:

**Syndromic surveillance (generally)**

**What are the specific systems**

**How it's used**

**Caveats**

**Informing public health action**

# ... syndromic surveillance uses routine, pre-existing, non-diagnostic data such as emergency department visit chief complaint...

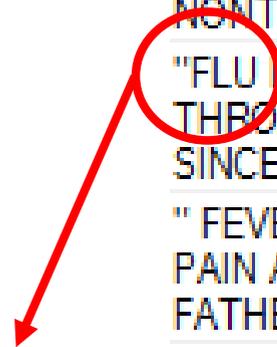
	Chief complaint	Date of visit	Time of ED visit	Sex	AGENUM	dbxcd9	DISPO
7304	THROAT PAIN COUGH	03/19/16	16:57	F	16	J02.9	DISCHARGED
7305	URI	03/19/16	16:57	F	0	J069	DISCHARGED
7306	GENERALIZED WEAKNESS	03/19/16	16:57	M	82		ADMIT
7307	BRAMPING LOWER ABD 2 WKS@R1030@ LOWER AB	03/19/16	16:57	F	31	R1030 R110 F17200	DISCHARGED
7308	HAS A COLD	03/19/16	16:57	F	4	B34.9	DISCHARGED
7309	INTOX	03/19/16	16:57	M	48	F19.10	DISCHARGED
7310	SPITTING BLOOD@R042@ K21	R05 03/19/16	16:58	F	66	R05 K219 R042	DISCHARGED
7311	F329 F329	03/19/16	16:58	M	53	F329	DISCHARGED
7312	HIGH FEVER	03/19/16	16:58	F	8	B34.9	DISCHARGED
7313	W-BLACK STOOL	03/19/16	16:58	M	43	K52.9	DISCHARGED
7314	LFT EAR INFECTION	03/19/16	16:58	F	79	H60.90	DISCHARGED
7315	BACK PAIN	03/19/16	16:58	F	75	D649   I10   M545	DISCHARGED
7316	FEER SINCE YESTERDAY, SORE THROAT COUGH	03/19/16	16:58	M	5		DISCHARGED
7317	BODY BACK PAIN@R100@	03/19/16	16:58	F	56	R1084 R100	DISCHARGED
7318	LOW BACK PAIN	03/19/16	16:58	M	70		MISSING
7319	HYPOGLYCEMIA	03/19/16	16:59	F	81		DISCHARGED
7320	SHOULDER PAIN, NONTRAUMAT@M255M25511 M25	03/19/16	16:59	F	55	M25511 M25511	DISCHARGED
7321	"FLU LIKE SYMPTOMS, SORE THROAT AND LEFT SHOULDER PAIN SINCE YESTERDAY", AN EMPLOYEE	03/19/16	16:59	F	45		DISCHARGED
7322	" FEVER X 2 DAYS AND ABDOMINAL PAIN AND VOMITED 1 X TODAY" PER FATHER	03/19/16	16:59	M	5		DISCHARGED
7323	DIARRHEA FOR 5 DAYS , VOMITING , AS PER MOTHER " TODAY HE IS VERY WEAK "	03/19/16	16:59	M	1	790.8	DISCHARGED
7324	NOT FEELING WELL	03/19/16	16:59	M	0	R50.9	ADMIT

# ... to categorize health care encounters into syndromes...

	Chief complaint	Date of visit	Time of ED visit	Sex	AGENUM	ddbxcd9	DISPO
7304	THROAT PAIN COUGH	03/19/16	16:57	F	16	J02.9	DISCHARGED
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7317	BODY BACK PAIN@R100@	03/19/16	16:58	F	56	R1084 R100	DISCHARGED
7318	LOW BACK PAIN	Influenza-like illness			70		MISSING
7319	HYPOGLYCEMIA				81		DISCHARGED
7320	SHOULDER PAIN, NONTRAUMAT@M255M25511 M25	03/19/16	16:59	F	55	M25511 M25511	DISCHARGED
7321	"FLU LIKE SYMPTOMS, SORE THROAT AND LEFT SHOULDER PAIN SINCE YESTERDAY" AN EMPLOYEE	03/19/16	16:59	F	45		DISCHARGED
7322	" FEVER X 2 DAYS AND ABDOMINAL PAIN AND VOMITED 1 X TODAY" PER FATHER	Vomit			5		DISCHARGED
7323	DIARRHEA FOR 5 DAYS , VOMITING , AS PER MOTHER " TODAY HE IS VERY WEAK "				Diarrhea		
7324	NOT FEELING WELL	03/19/16	16:59	M			

# ...using text processing algorithms...

LOW BACK PAIN	03/19/16	16:58	M	70	
HYPOGLYCEMIA	03/19/16	16:59	F	81	
SHOULDER PAIN, NONTRAUMAT@M255M25511 M25	03/19/16	16:59	F	55	M25511 M25511
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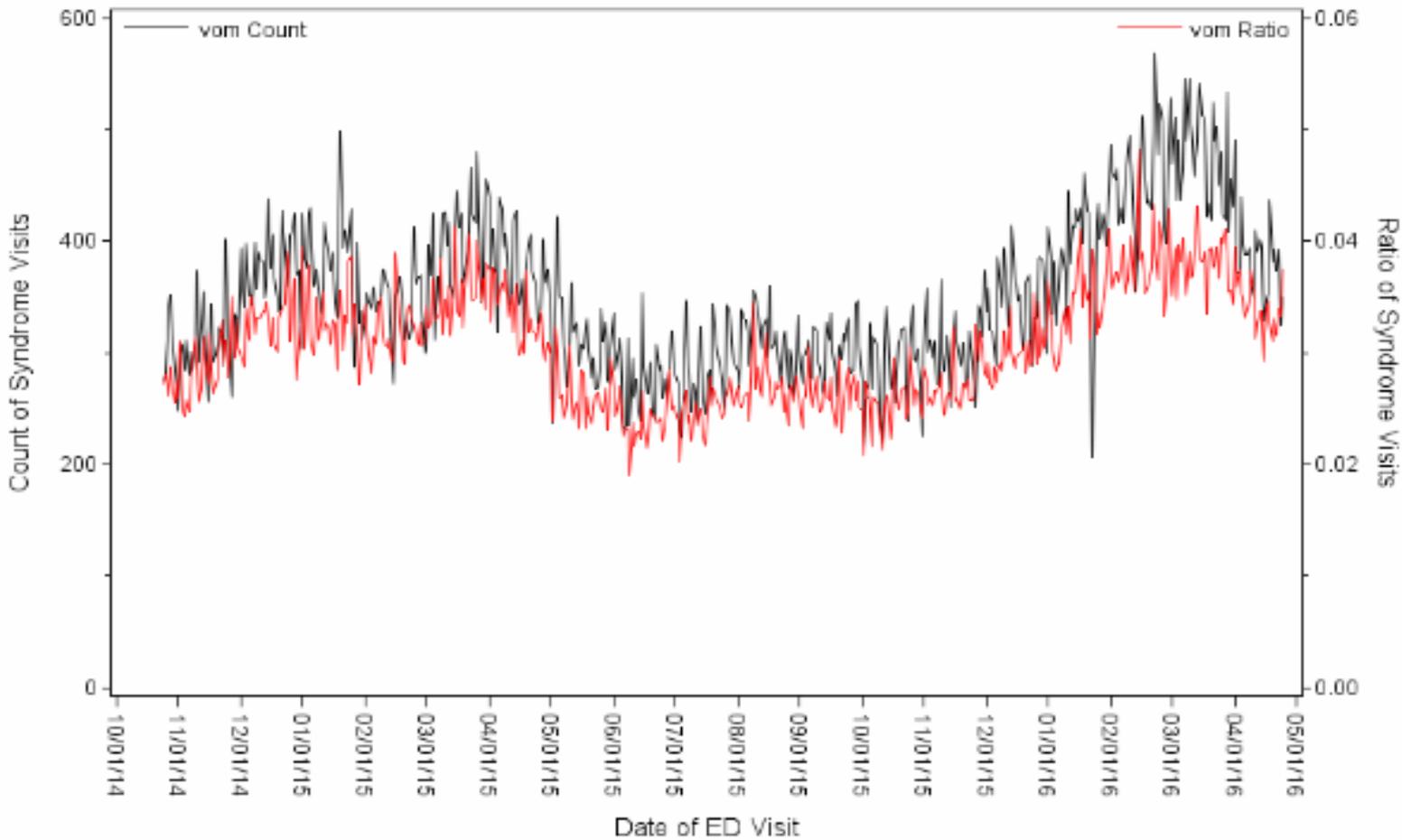
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%Macro Flu;
IF(INDEX(CC,"FLU") AND INDEX(CC,"STOMA")=0 AND INDEX(CC,"INTEST")=0) OR
 (INDEX(CC,"VIRAL") AND (INDEX(CC,"INF") OR INDEX(CC,"SYN") OR INDEX(CC,"ILL")))) OR
/*ICD9 suggestion:*/ (%ccscanstatement(487) or
/*ICD10 suggestion:*/ %ccscanstatement(J09X1) or %ccscanstatement(J10) or %ccscanstatement(J11))) and
INDEX(CC,"FLUI")=0 AND INDEX(CC,"FLUS")=0 AND INDEX(CC,"FLUT")=0 AND INDEX(CC,"FLUX")=0 AND INDEX(CC,"VACC")=0 AND
INDEX(CC,"VAX")=0 AND INDEX(CC,"IMM")=0 AND INDEX(CC,"IMZ")=0 AND INDEX(CC,"INJ")=0 AND INDEX(CC,"SHOT")=0 AND INDEX(CC,"SHT") = 0)
    THEN FLU=1;
    ELSE FLU=0;
%Mend;

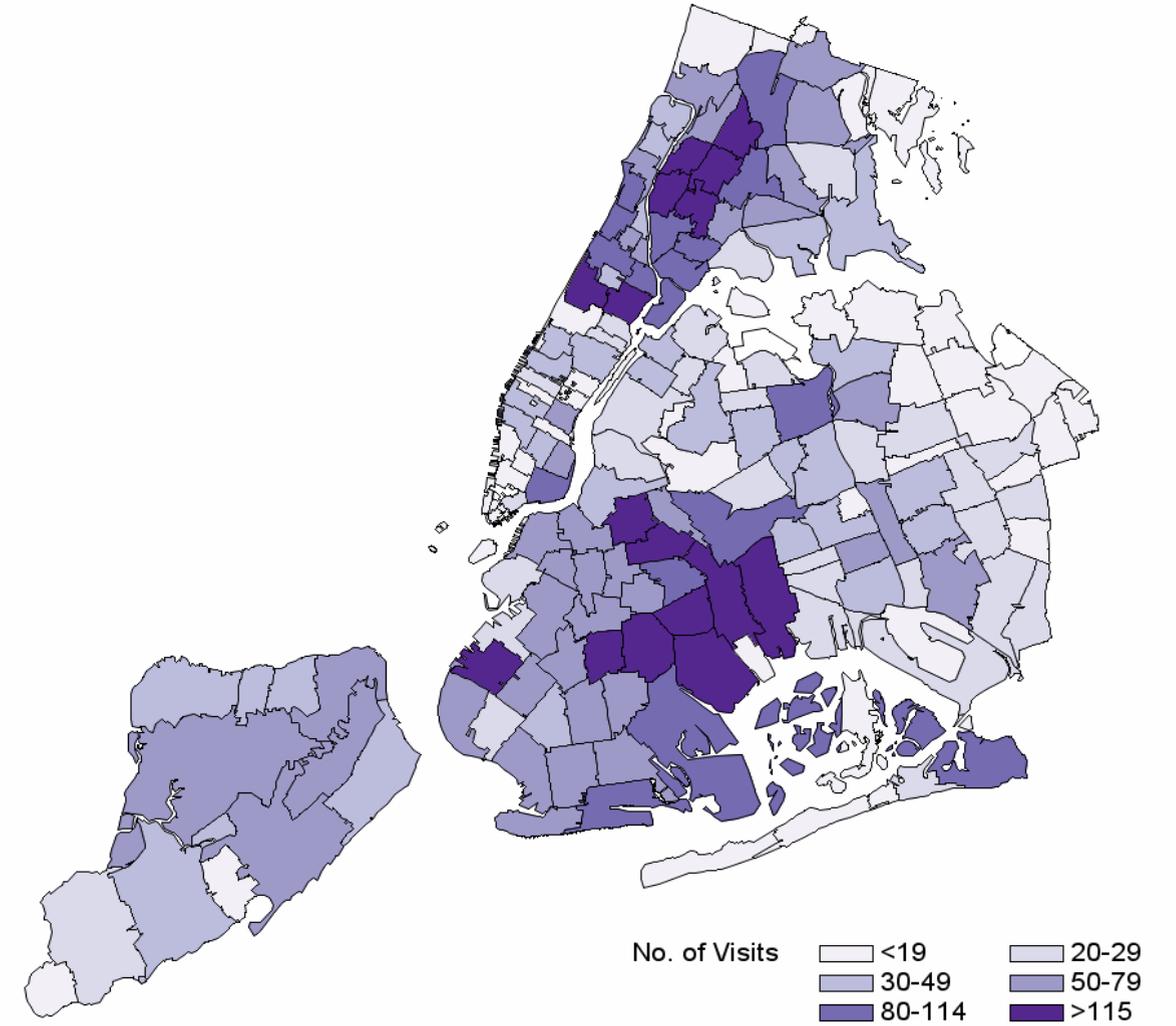
```

# ...and look for patterns...

Vomit Syndrome Visits to NYC Emergency Departments  
Oct 25, 2014 - Apr 24, 2016

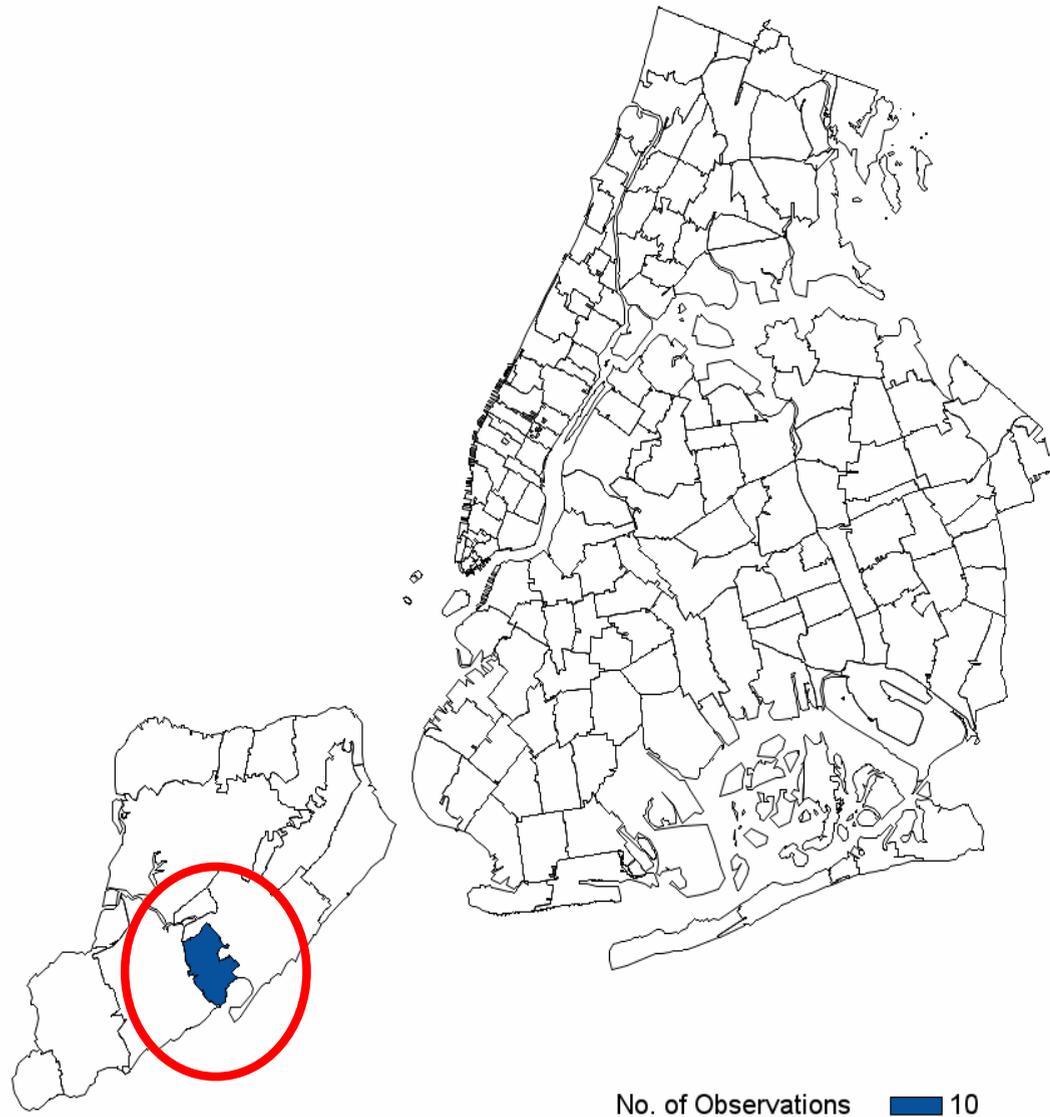


ED Visits by ZIP Code



# ...and clusters

Zip Codes in Vomit Signal: Counts



	Chief complaint	Date of visit	Time of ED visit	Sex	AGENUM	ddxcd9	DISPO
1	*****   CHIEF COMPLAINT QUOTE: PER EMS, PATIENT HAS BODY PAIN, NAUSEA, VOMITING, WEAKNESS, AND CANT HOLD HIS URINE FOR 2 DAYS.	03/27/16	12:01	M	85	A41.9 N12 R39.9	ADMIT
2	*****   CHIEF COMPLAINT QUOTE: ABDOMINAL PAIN, NAUSEA, DIZZINESS, VOMITING THAT STARTED TODAY SUDDENLY.	03/27/16	15:23	F	59	K56.69 R10.84 R1	ADMIT
3	*****   CHIEF COMPLAINT QUOTE: "HE WAS DIAGNOSED WITH GALLSTONES 3 DAYS AGO AND WAS PRESCRIBED PERCOCET FOR PAIN, BUT SINCE YESTERDAY HE HAS BEEN FEELING "FULLNESS, VOMITING, AND HAS NOT HAD A BM	03/27/16	09:30	M	71	K57.90 K59.00 K8	DISCHARGED
4	CHIEF COMPLAINT QUOTE: C/O N/V AND WEAKNESS SINCE YESTERDAY	03/28/16	11:41	F	73	E87.6 K52.9 R11.	ADMIT
5	CHIEF COMPLAINT QUOTE: PATIENT COMPLAINS OF MID ABDOMINAL PAIN THAT STARTED AROUND 1 AM, PATIENT VOMITED X 3	03/28/16	06:13	F	62	E87.6 K85.9 R10.	ADMIT
6	CHIEF COMPLAINT QUOTE: "I HAVE REALLY BAD PAIN IN MY STOMACH FOR 3 DAYS, IT FEELS LIKE BAD GAS CRAMPS". DENIES N/V/D	03/28/16	15:49	M	54	K57.92	DISCHARGED
7	CHIEF COMPLAINT QUOTE: ABD PAIN STATES "I VOMITED 26 X LAST NIGHT"	03/28/16	17:44	M	62	F10.239 R10.9	ADMIT
8	CHIEF COMPLAINT QUOTE: RUQ PAIN ONSET LAST NIGHT 9PM AFTER EATING. PATIENT DENIES N/V/D- HX OF SIMILAR SITUATION. TOOK TIZANIDINE AND MOTRIN 930. WITH NO RELIEF. STATES IT USUALLY HELPS HIS PAIN	03/28/16	02:41	M	47	K82.8 R10.9 R79.	DISCHARGED
9	CHIEF COMPLAINT QUOTE: C/O ABDOMINAL PAIN WITH VOMITING X 3 DAYS	03/28/16	09:21	M	80	R10.13	DISCHARGED
10	DIZZINESS,VOMITING	03/28/16	18:22	M	63	R11.10 R42	ADMIT

# Where syndromic has been useful

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## Outbreak/event **detection**

- Localized cluster or spike of syndrome visits

# Where syndromic has been useful

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## Situation **awareness** during an unfolding event

- Pandemic H1N1
- Hurricane Sandy
- Heat waves

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- Influenza
- Winter gastroenteritis
- Asthma

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## Timely **identification** and **monitoring** of changing or emerging trends

- Drug overdose
- Hospital utilization

# What syndromic surveillance does not do

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Does not tell you if a person actually has a disease

- no corresponding laboratory data

Does not replace traditional disease surveillance

# Public Health Syndromic Surveillance Systems



# Syndromic systems

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## System

Emergency department

## What to analyze

Chief complaint  
Diagnosis code (ICD-10)

## Utility

Outbreak detection  
Situation awareness  
Expected trends  
Emerging trends

# The ED surveillance system is the most robust

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Data is real time

Data collected

- Date, time, hospital, date of birth, gender, ZIP code, **chief complaint**, **diagnosis code (ICD-10)**, disposition
- Body temperature, oxygen saturation, recent international travel, nurse triage notes

Syndromes: respiratory, ILLI, diarrhea, vomit, asthma, bioterrorism agents, heat, carbon monoxide exposure, etc.

# Syndromic systems

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System	What to analyze	Utility
Emergency department	Chief complaint Diagnosis code (ICD-10)	Outbreak detection Situation awareness Expected trends Emerging trends
911 calls	Call type	Outbreak detection

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911 calls	Call type	Outbreak detection
Pharmacy sales	Drug name	GI illness Influenza surveillance

# Syndromic systems

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Emergency department	Chief complaint Diagnosis code (ICD-10)	Outbreak detection Situation awareness Expected trends Emerging trends
911 calls	Call type	Outbreak detection
Pharmacy sales	Drug name	GI illness Influenza surveillance
School nurse visits	Reason for visit	Outbreak detection Expected trends

# Syndromic systems

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Emergency department	Chief complaint Diagnosis code (ICD-10)	Outbreak detection Situation awareness Expected trends Emerging trends
911 calls	Call type	Outbreak detection
Pharmacy sales	Drug name	GI illness Influenza surveillance
School nurse visits	Reason for visit	Outbreak detection Expected trends
Urgent care	Chief complaint Diagnosis code (ICD-10)	?????

# Syndromic platforms

System	Software	User needs	Pros	Cons
Homegrown	SAS and/or R	IT (to set up data transfer) Extensive coding experience Knowledge of statistics	Most control over data and systems Highly customized Personal relationship with providers	Labor intensive
ESSENCE	None	Some coding experience helpful (SQL or R) Some statistics	Built in QA Dashboard visuals Many analytic options CDC support National level system	Less customizable Less control over data
Other external software (e.g. EpiCenter)	None	Interpretation of reports	Least labor intensive Can be customized based on needs	Yearly fee Less control over data

# Staffing

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Staff are mostly MPH level, some PhD

- Epi/biostats background

We look for analysts who have multiple years of experience with SAS and/or R

Knowledge of statistical analysis is useful, especially:

- Time series
- Cluster detection

But curiosity may be the most important thing of all!

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# How is syndromic used every day?

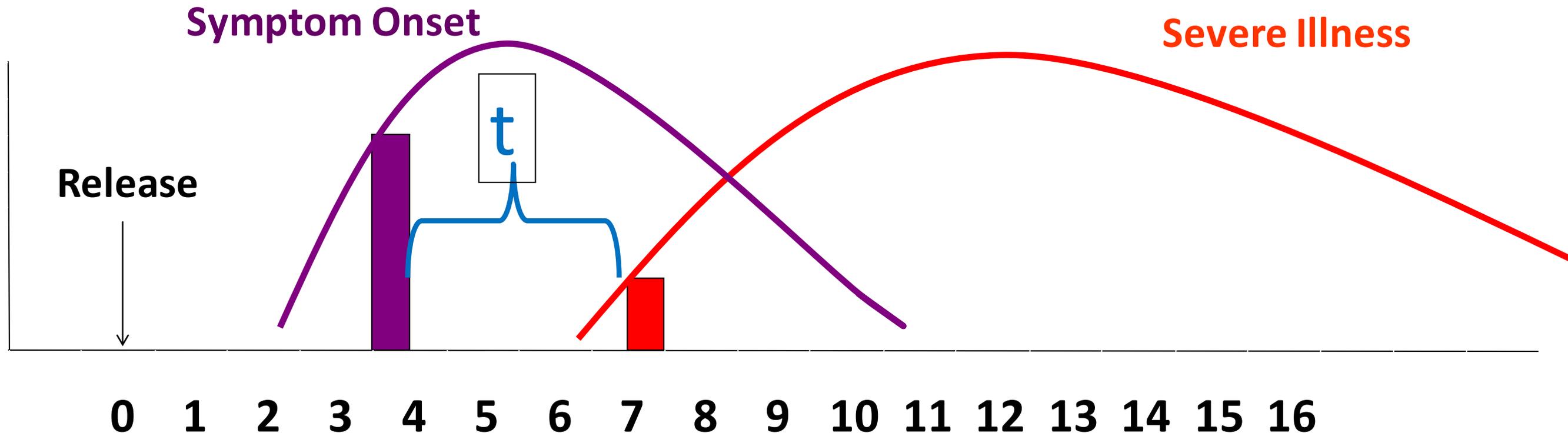
# It was originally designed for early detection of bioterrorism and outbreaks

Early focus was on investigating statistical signals



# By capturing mild symptoms before more serious manifestations

Number of Cases



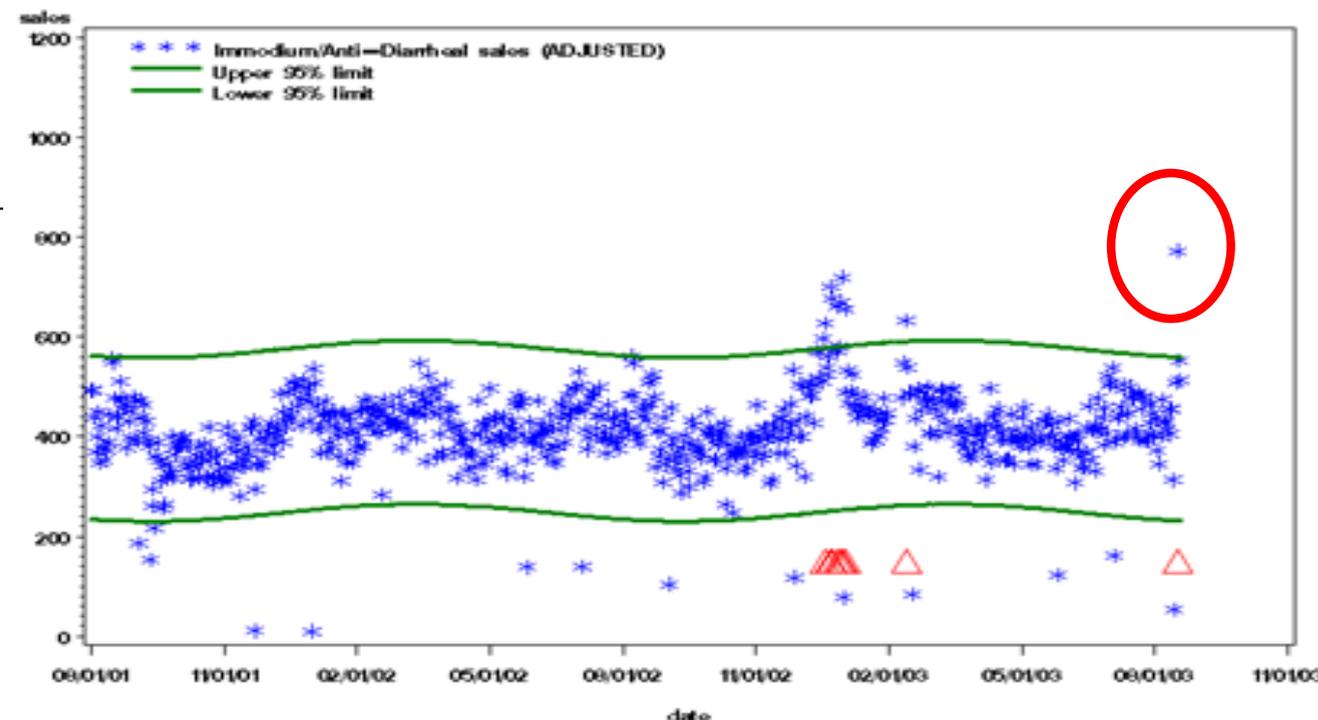


# Blackout, 2003

Both OTC and ED signaled after the blackout in August 2003

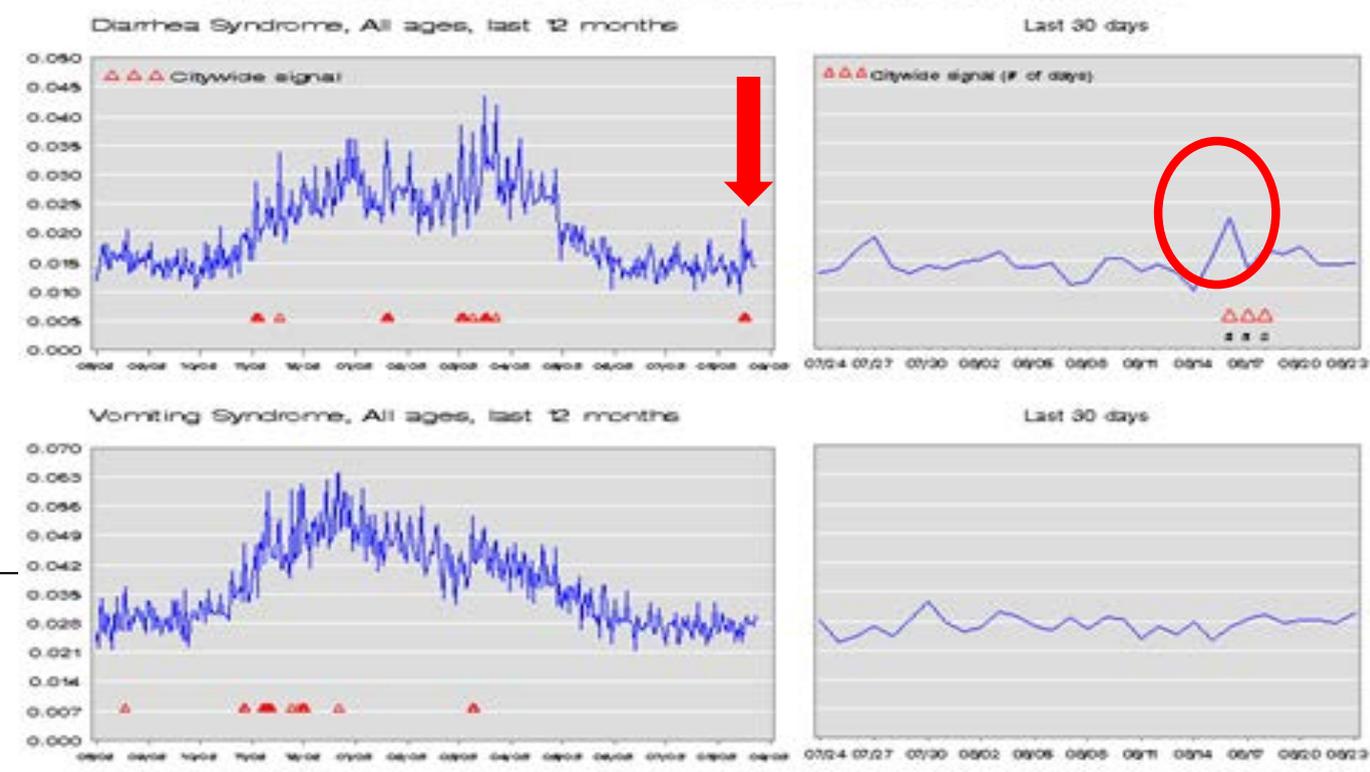
Alerted to diarrheal disease that was not due to any single agent

No other methods detected this outbreak



NYC DOHMH Communicable Disease Program

## NYC Emergency Department Surveillance Citywide trends in the ratio of syndrome visits to other visits through Aug 23, 2003



NYC DOHMH Communicable Disease Program, 08AUG03

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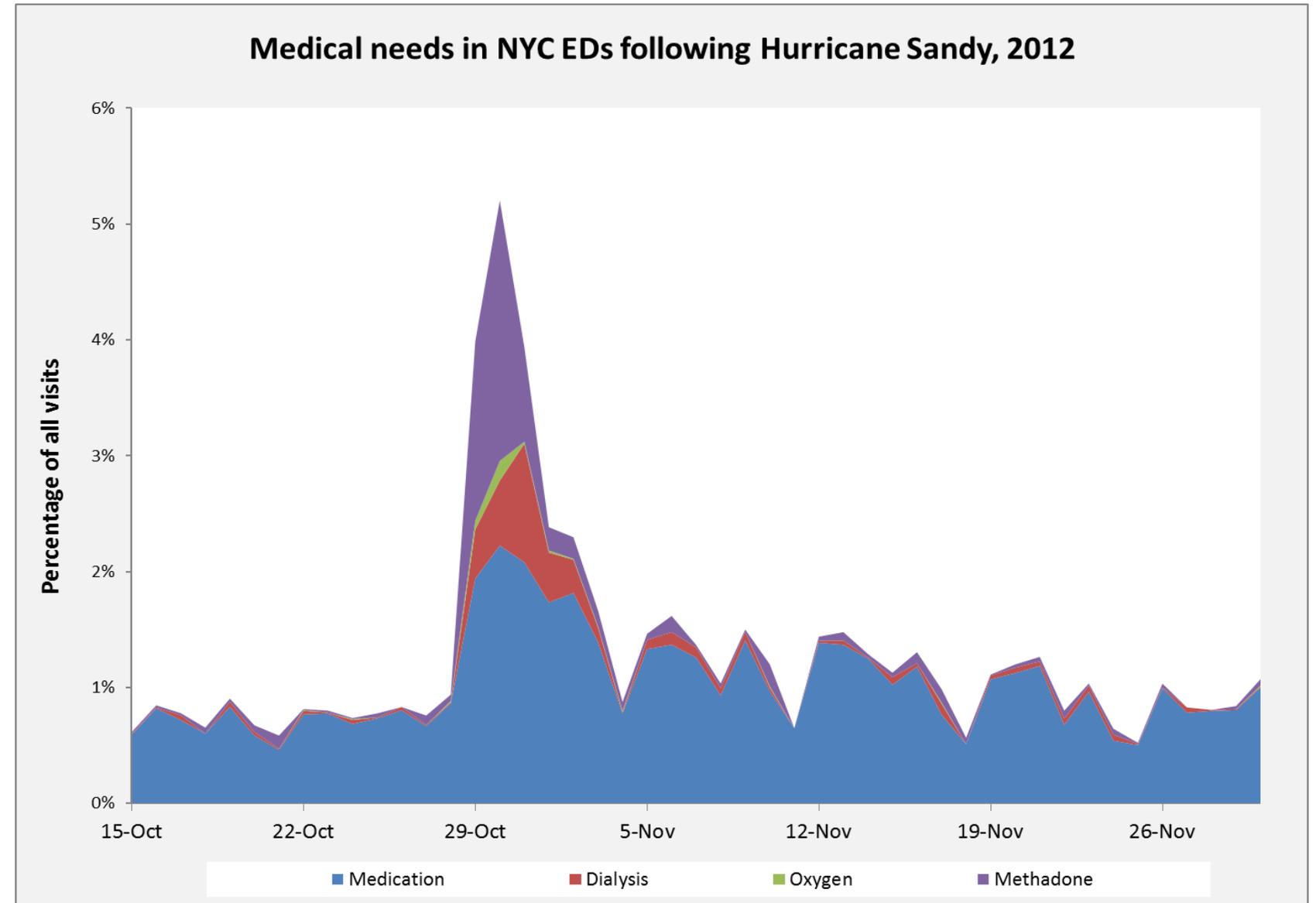
**However the focus has shifted from event detection to situation awareness and tracking disease outbreaks**

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**We've found it useful during emergency or mass gathering events when no other timely data source exists**

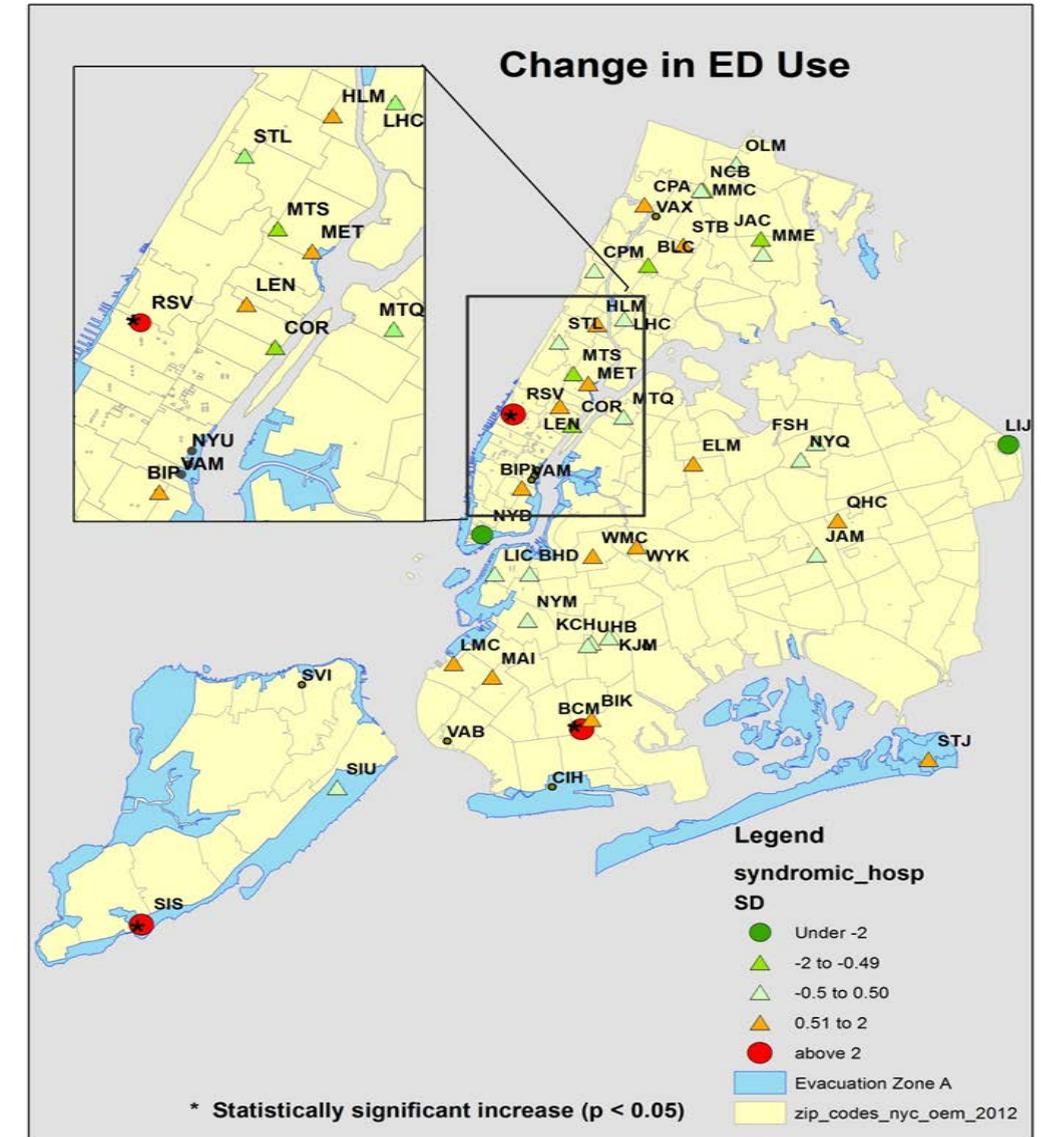
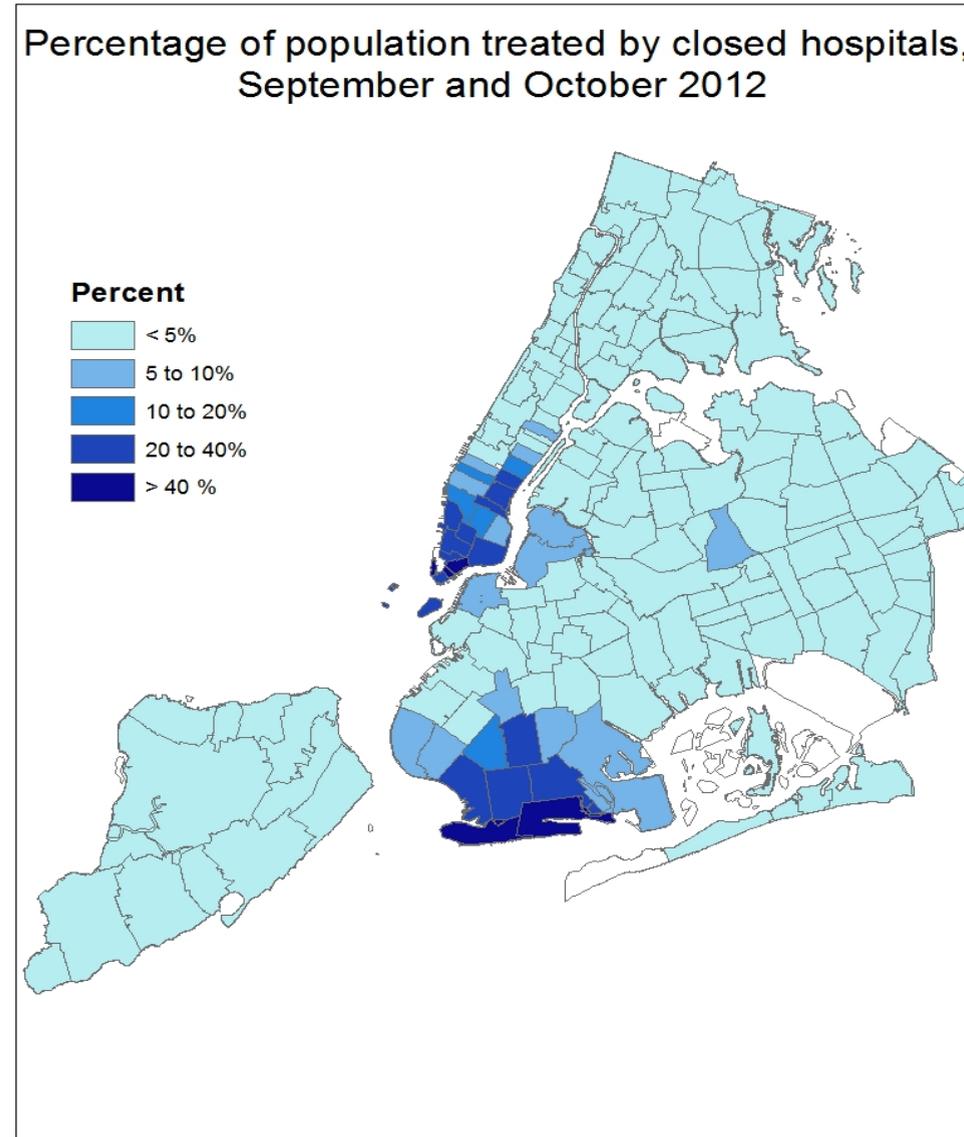
# For example, during Hurricane Sandy...

We saw a large increase in people visiting the ED for medical needs



# ...and especially after

We also tracked how ED utilization patterns changed because of hospital closures



November 28, 2012

# Hypothermia and Carbon Monoxide Poisoning Cases Soar in City After Hurricane

By SHERI FINK

The number of cold-exposure cases in New York City tripled in the weeks after Hurricane Sandy struck compared with the same period in previous years, the health department reported in an alert to thousands of doctors and other health care providers on Wednesday.

And even though power and heat have been restored to most of the city, there are still thousands of people living in the cold, the department said.

The department warned health care providers that residents living in unheated homes faced “a significant risk of serious illness and death from multiple causes.”

The number of cases of carbon monoxide exposure, which can be fatal, was more than 10 times as high as expected the week of the storm and 6 times as high the next week, reflected in greater numbers of emergency department visits. Calls to the city’s poison center also increased, health officials said.

And as temperatures dip, health officials said the cold could lead to other health problems, including a worsening of heart and lung diseases and an increase in anxiety and depression.

“My bigger concern is what happens in the future as we get closer to winter in the next four weeks,” Dr. Thomas A. Farley, the city’s health commissioner, said in an interview. “There are probably about 12,000 people living in unheated apartments right now.”

Between Nov. 3 and 21, more than three times as many people visited emergency rooms for cold exposure as appeared during the same time periods from 2008 to 2011, the health department said. The storm hit on Oct. 29.

It took days before many elderly and disabled residents, trapped in cold, dark apartments without working elevators or phones, were visited by emergency responders and health workers. Some went to emergency rooms.

Dr. Farley said prolonged exposure to cold even slightly below room temperature could be deadly, and he urged residents of unheated apartments to consider relocating. He said they could find help by calling 311.

The alert said residents in cold apartments should wear layers of dry, loosefitting clothing. They should not use ovens or portable gas heaters because of the risks of fire and carbon monoxide.

The statistics were collected through a system that gathers major complaints daily from most of the city’s hospital emergency departments. The number of hypothermia cases reported to the system since the storm is 65, but that is considered an undercount.

Health department officials said the figure also did not reflect the much larger number of people whose underlying heart and lung problems had worsened in cold environments. An increase in asthma attacks, heart attacks and stroke would be more difficult to detect immediately. Officials said both the very young and older people, as well as people with chronic diseases, mental illness and substance use, were most at risk.

Dr. Farley said the increase in hypothermia cases was greatest immediately after the hurricane and during the cold period around the northeaster on Nov. 7.

Some people exposed to cold were treated at Staten Island University Hospital. “Our initial cases were people immersed in water, most in the process of being rescued,” said Dr. Brahim Ardolic, chairman

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# Identifying and tracking expected events is another strength

# Allergy season

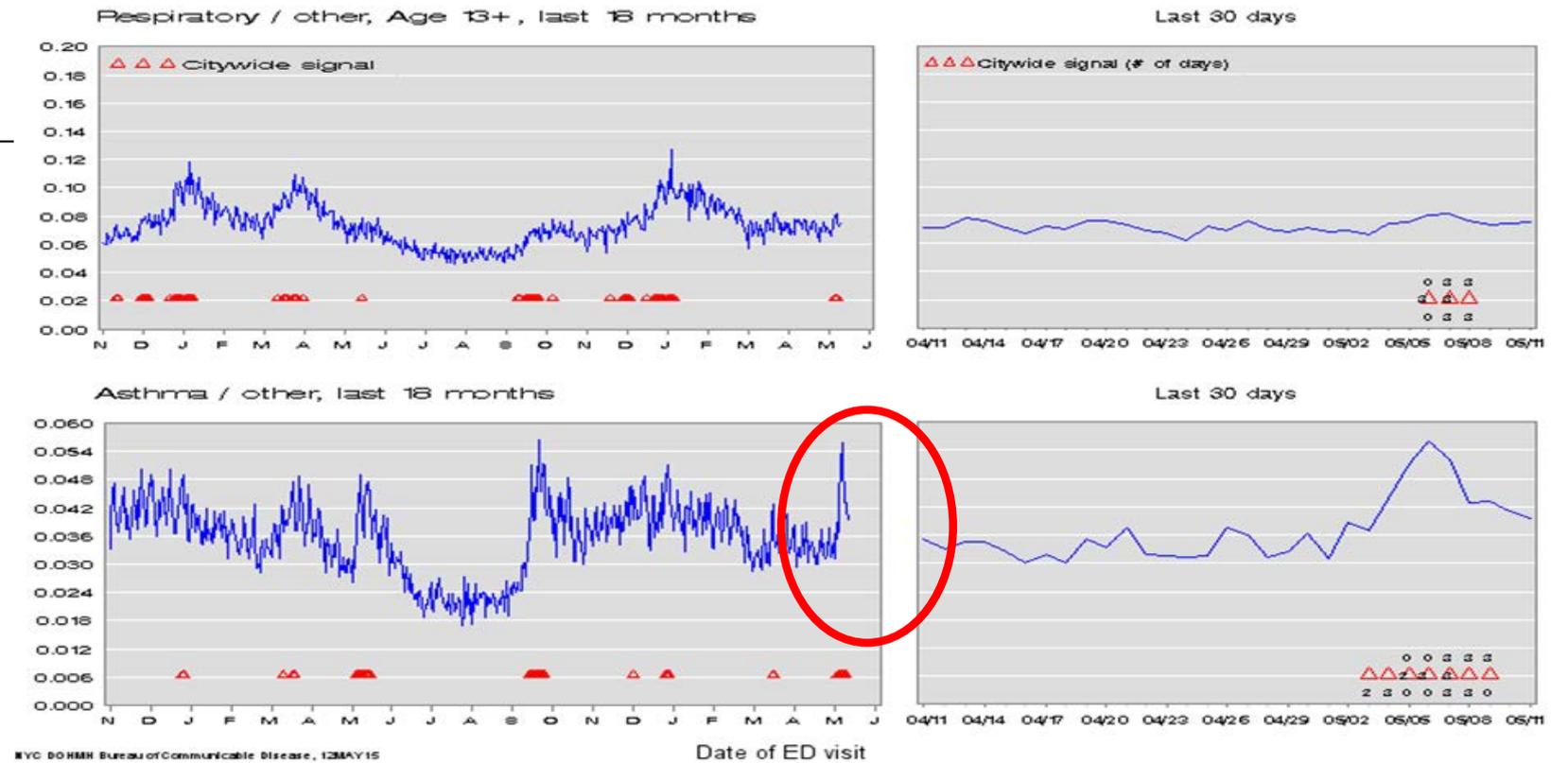
Track asthma ED visits and allergy OTC sales

What is the timing and magnitude?

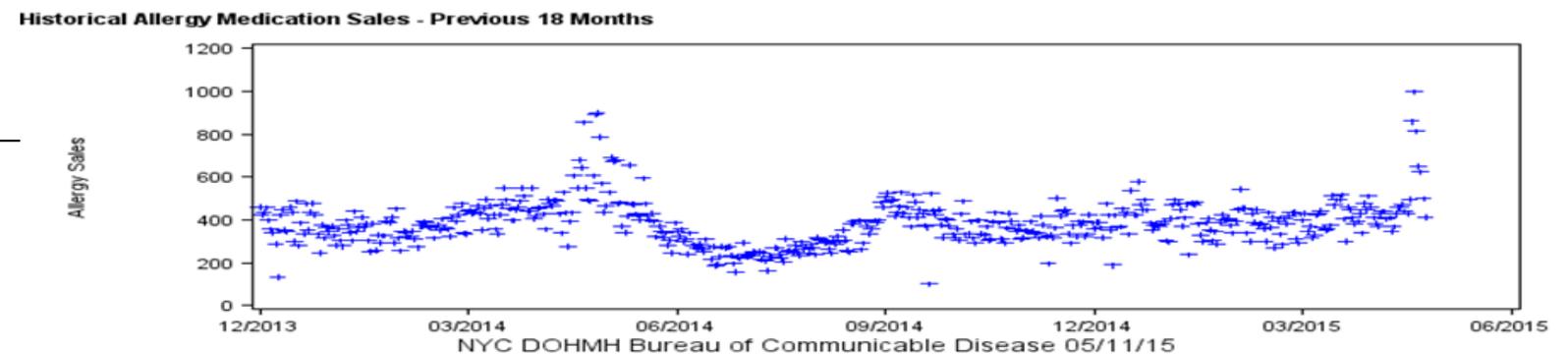
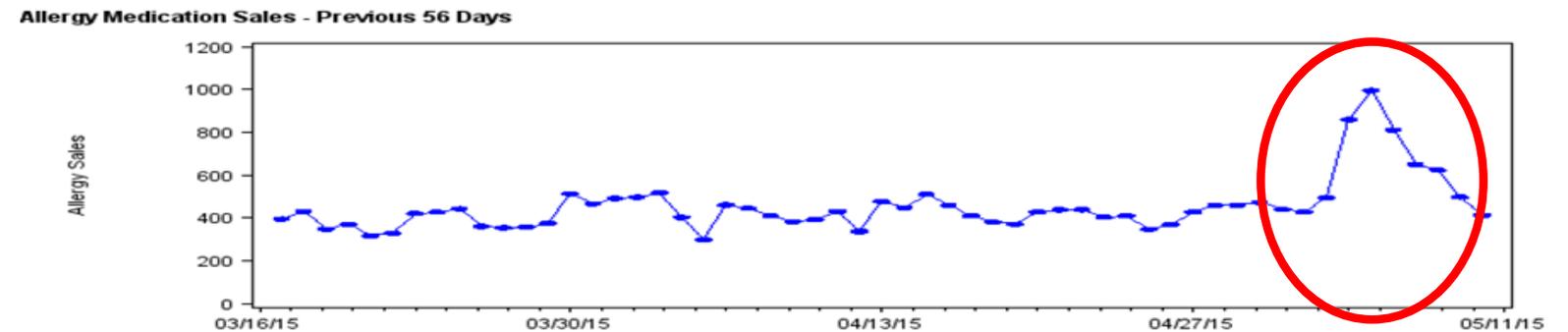
This helps determine if and when to send out

[HAN](#)

## NYC Emergency Department Surveillance Citywide trends in the ratio of syndrome visits to other visits through May 11, 2015



## NYC Surveillance for Allergy OTC Sales through 05/11/15



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# And finding things that are unexpected

# Monitoring new and unusual words

Obs	word	arch13_count	arch13_mean	mean_adj	Count_111014	ratio_111014
1	FDNY	808	2.21	2.21	52	23.49
2	COMMUNICABLE	32	0.09	1.00	16	16.00
3	AMP	97	0.27	1.00	10	10.00
4	MENINGITIS	496	1.36	1.36	11	8.09
5	SMOKED	337	0.92	1.00	7	7.00
6	TRANSCARE	127	0.35	1.00	7	7.00
7	VOMMIT	9	0.02	1.00	7	7.00
8	3D	378	1.04	1.04	7	6.76
9	12C	34	0.09	1.00	6	6.00
10	12D	26	0.07	1.00	6	6.00
11	K2	41	0.11	1.00	6	6.00
12	LATE	273	0.75	1.00	6	6.00
13	UNIT	181	0.50	1.00	6	6.00
14	WEAKNES	236	0.65	1.00	6	6.00
15	EPILEPSY	841	2.30	2.30	13	5.64
16	TRAFFIC	555	1.52	1.52	8	5.26
17	2WKS	714	1.96	1.96	10	5.11
18	12A	28	0.08	1.00	5	5.00
19	3M	29	0.08	1.00	5	5.00
20	ASTHMATICUS	321	0.88	1.00	5	5.00
21	CARPAL	277	0.76	1.00	5	5.00
22	FVR	272	0.75	1.00	5	5.00
23	IDEACION	272	0.75	1.00	5	5.00
24	PLEURISY	332	0.91	1.00	5	5.00
25	PVB	361	0.99	1.00	5	5.00
26	SCH	102	0.28	1.00	5	5.00
27	SINAI	192	0.53	1.00	5	5.00

Counts all words/ICD 10 codes and compares to baseline mean. List ranks words by highest count to mean ratio

Can be used for routine and emergency situation awareness

Can detect things that are unusual or not normally monitored

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**Though not often used, can identify specific cases**

# Squirrel Attacks in Prospect Park Lead to Worry of Rabies

By KHORRI ATKINSON and SEAN PICCOLI JULY 23, 2017



RELATED COVER.  
GLOBAL HEALTH  
Rabies Death  
APRIL 20, 2015

RECENT C

Report of aggressive squirrel in Brooklyn park

Focus was to identify and vaccinate

Report of jogger who was attacked – no additional info

Used syndromic to identify case, follow up with ED

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**However, syndromic data is tricky ...**

# In New York, On Alert for Bioterrorism City's Tracking System Is Viewed as a Model

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By Ceci Connolly Washington Post Staff Writer

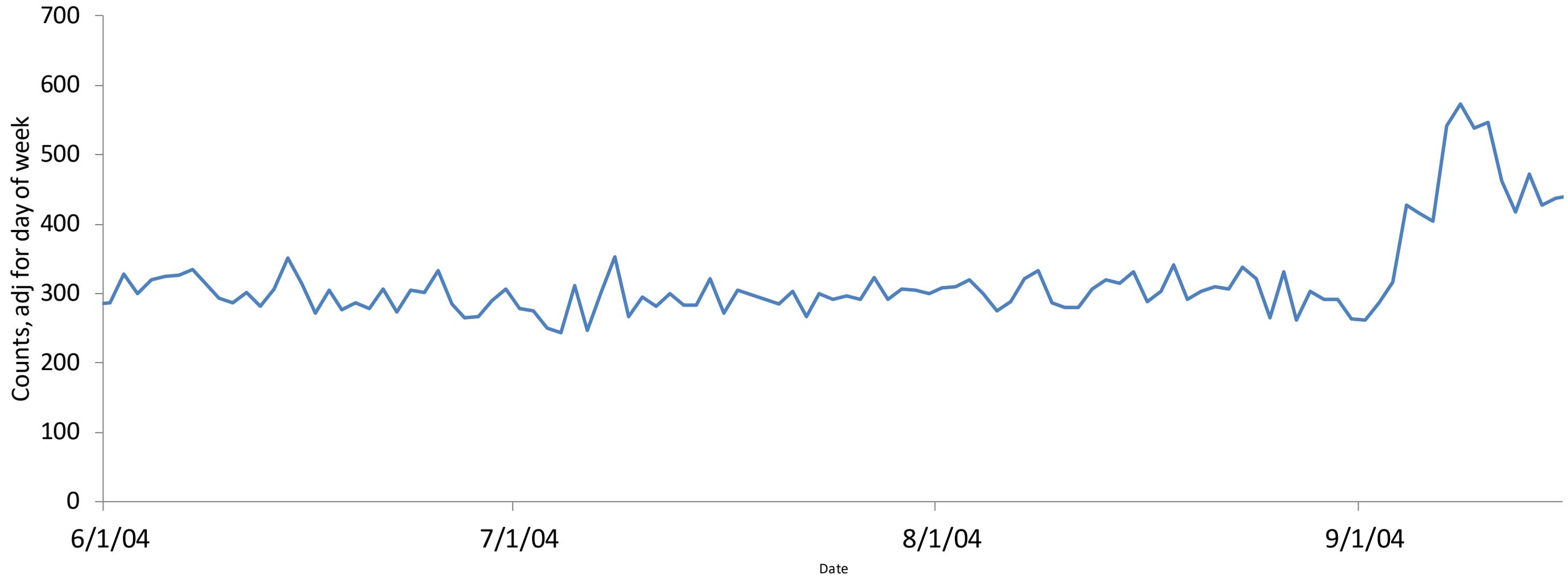
Saturday, November 24, 2001; Page A01

NEW YORK -- After some 300,000 Milwaukee residents were infected in 1993 with cryptosporidium, a parasite that can cause severe intestinal illness, New York added a diarrhea surveillance program that tracks lab results and pharmacy sales. The first clue in Milwaukee, said Marcelle Layton, assistant commissioner of health in New York, was an uptick in purchases of Kaopectate.

*One Monday morning a few winters ago, Layton's team arrived at work to see a similar increase in sales of Imodium, another anti-diarrheal medication. "It turns out Imodium had been a sponsor of the Super Bowl that weekend," Layton said, laughing in retrospect. "I now know more about pharmaceutical marketing than I ever expected."*

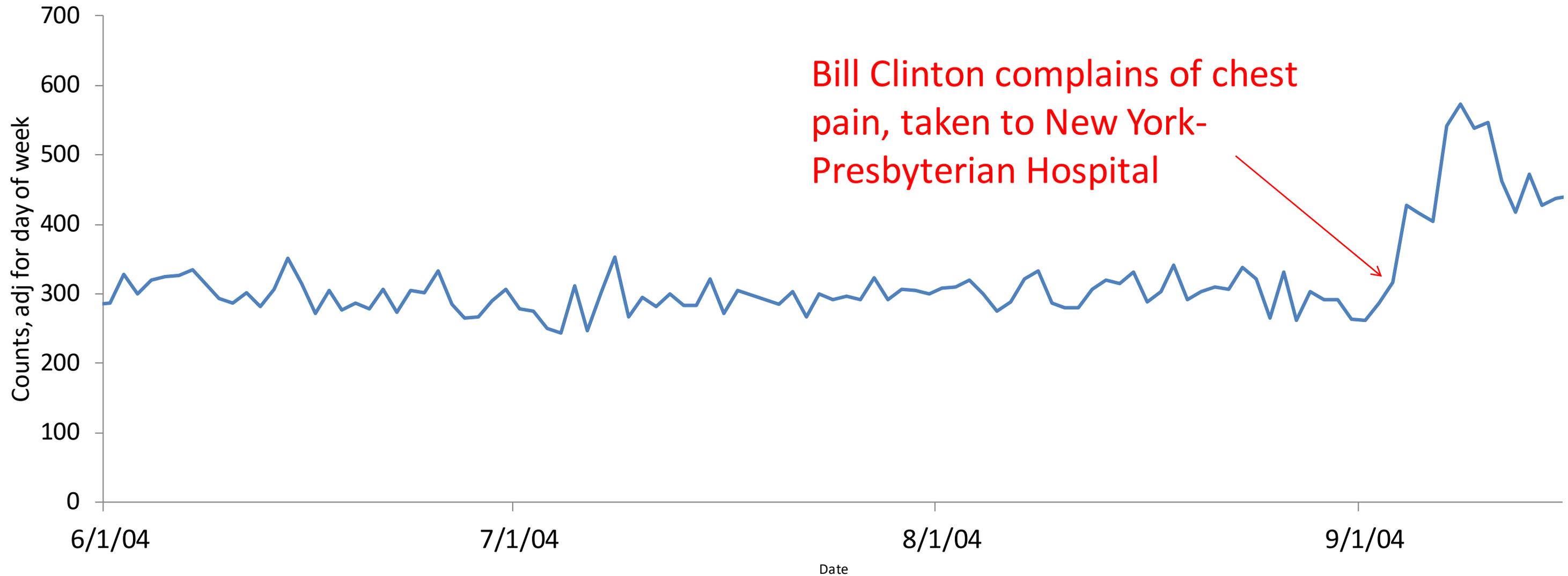
# Name that event...

## Emergency Department visits for 'Chest Pain', Age >=18



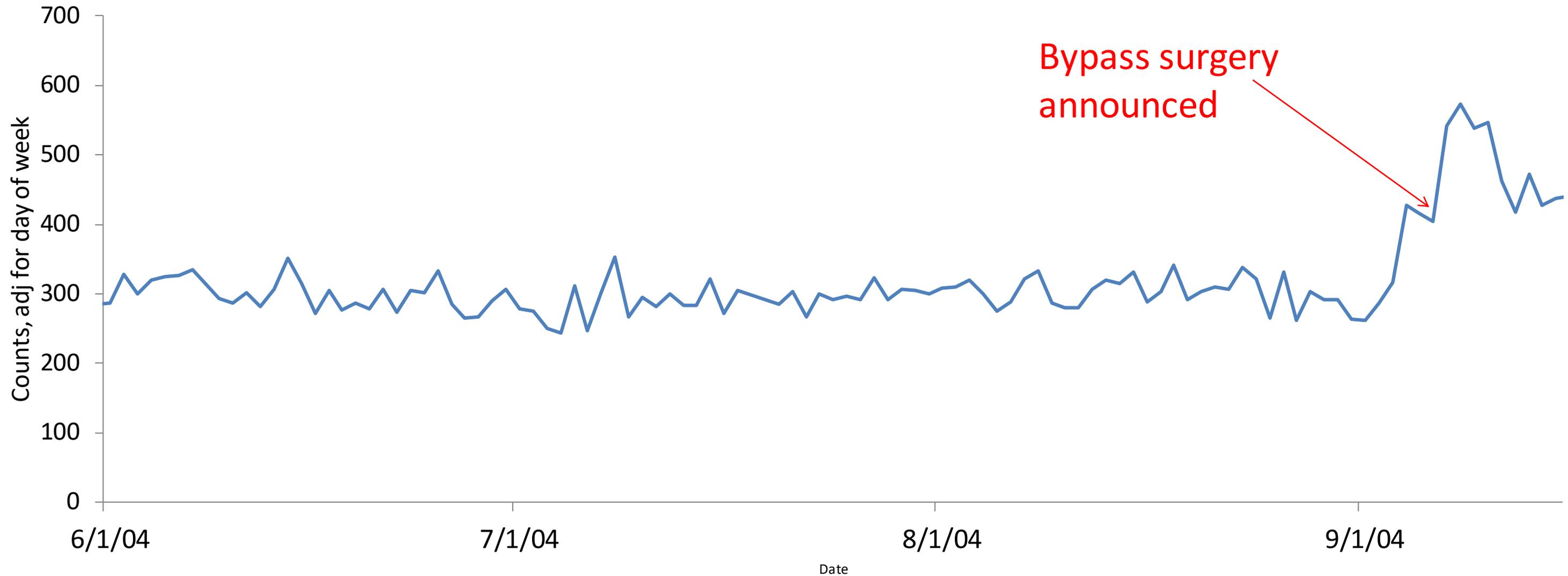
# Name that event...

## Emergency Department visits for 'Chest Pain', Age >=18



# Name that event...

## Emergency Department visits for 'Chest Pain', Age >=18



# What this tells us

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Trends can be affected by:

- increased awareness/reporting
- media
- worried well

Syndromic data is noisy!

Specific disease finding is difficult

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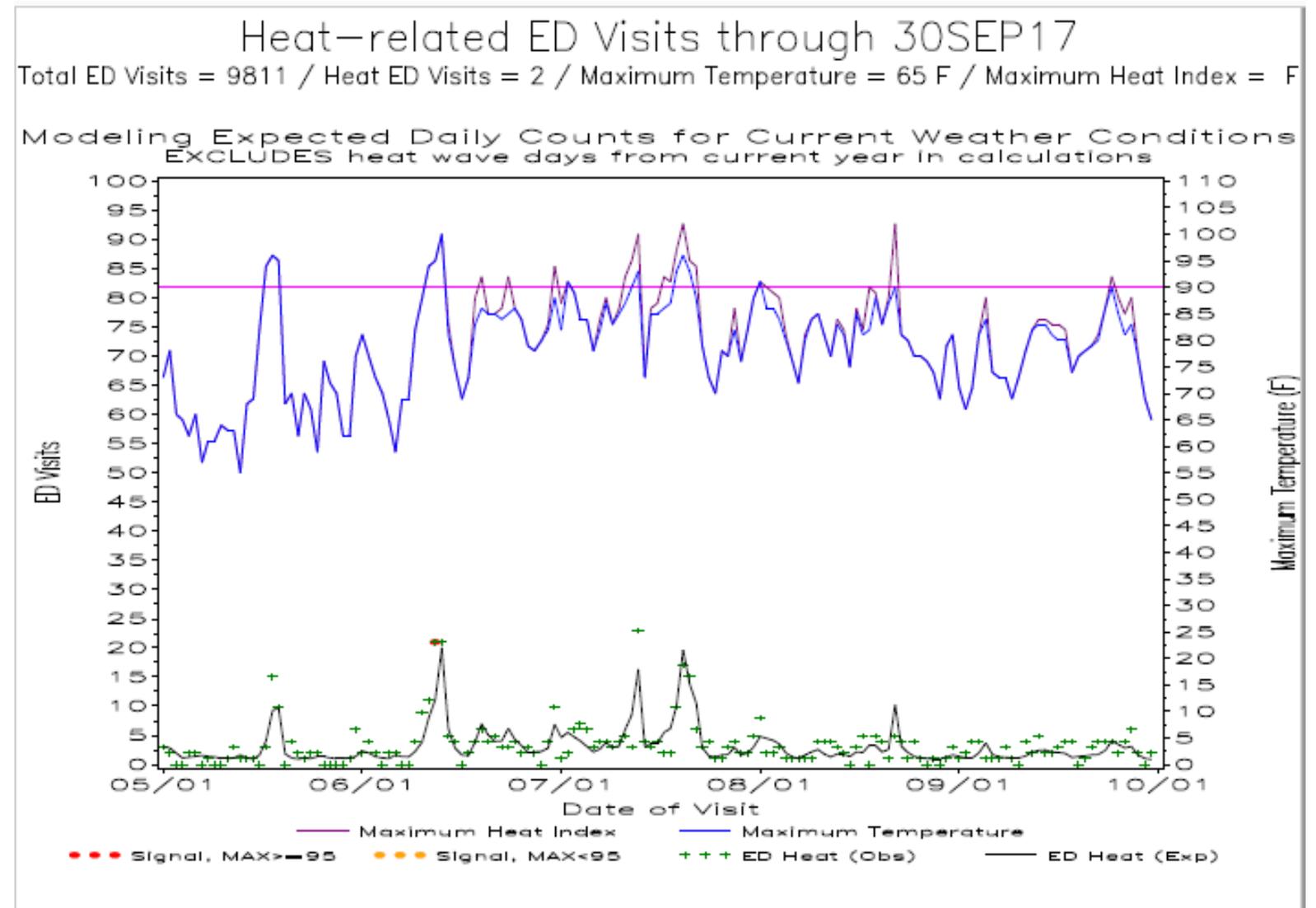
# Can syndromic inform public health action?

# Data inform city during heat waves

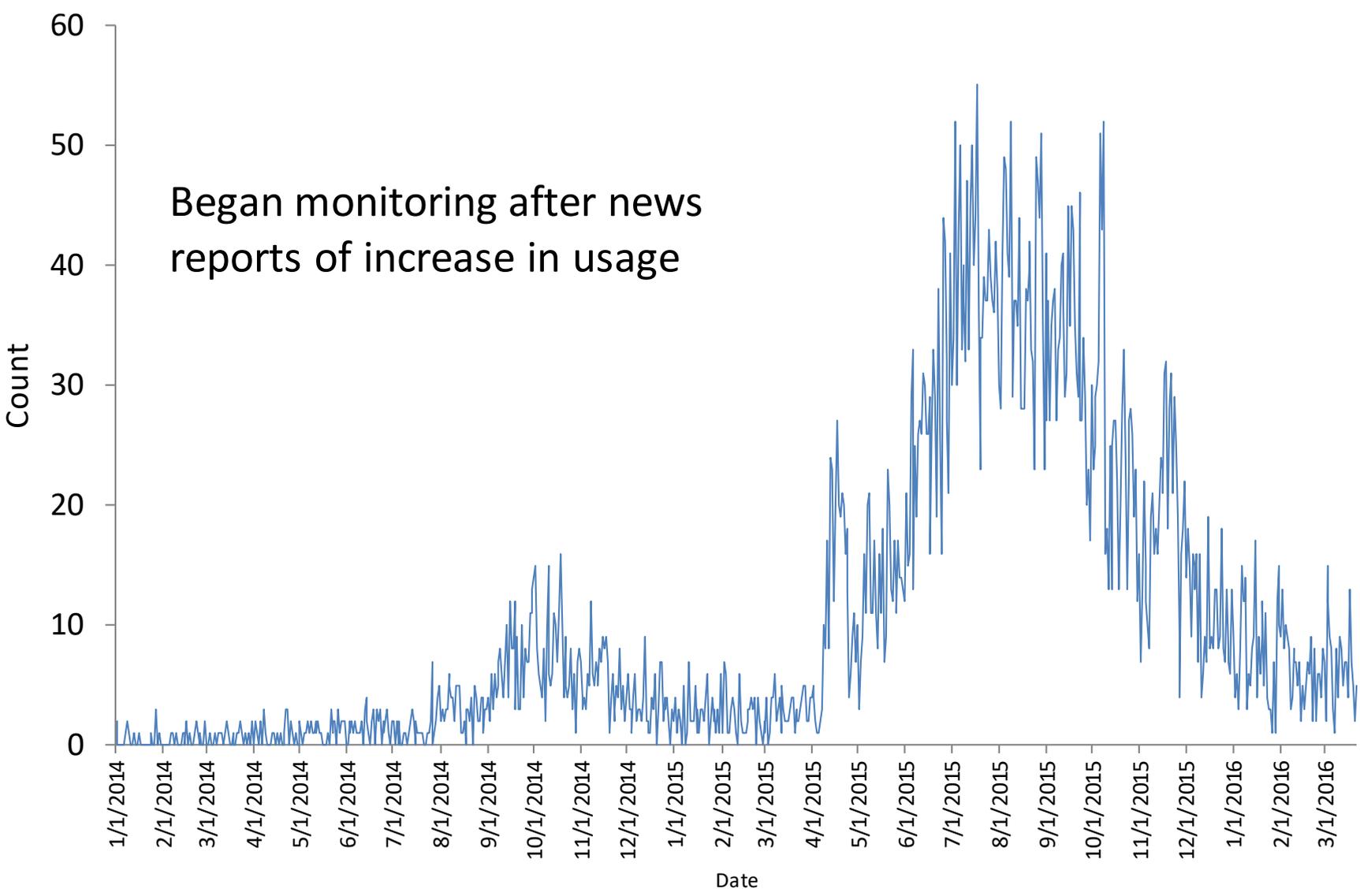
Track heat-related ED visits during heat waves

Data used during emergency calls to provide real time situation awareness

This helps determine where in city help is needed



# Share hotspots of synthetic cannabinoid use with city officials

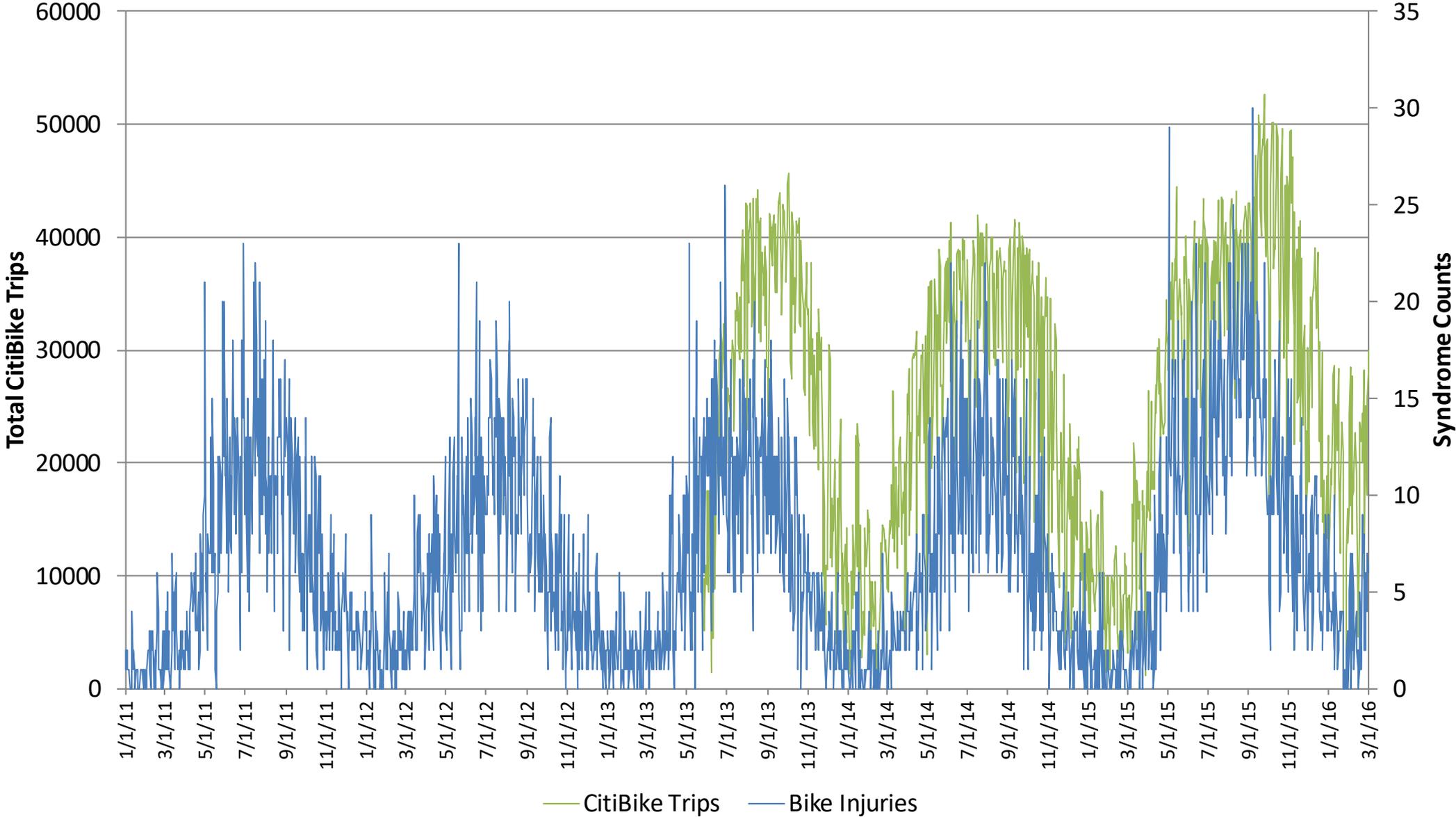


Track areas of the city where we see more K2 related ED visits

Share with city officials

Target stores in hotspot areas

# Did the introduction of CitiBike increase bike-related injuries?



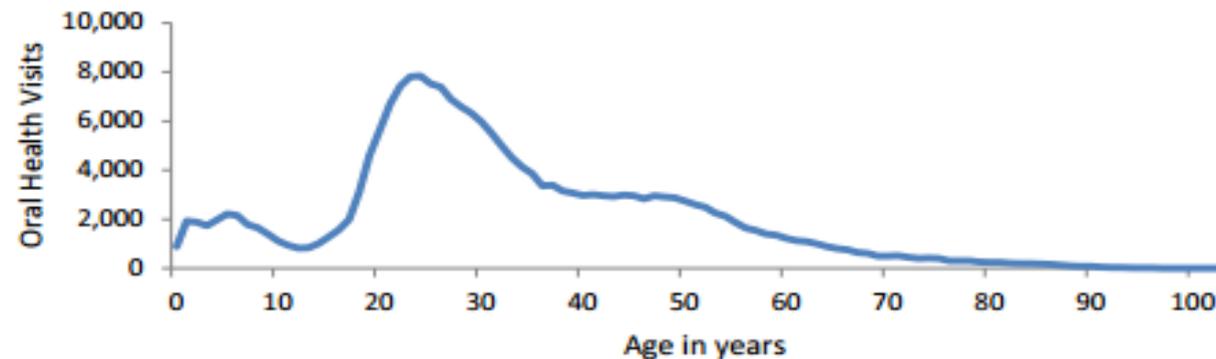
Bike-related injuries to the ED did not largely increase following the introduction of CitiBike in NYC

# Do people use the ED for preventable oral health care?

## Adults made over 180,000 preventable oral health visits to emergency departments from 2009 to 2014 in New York City

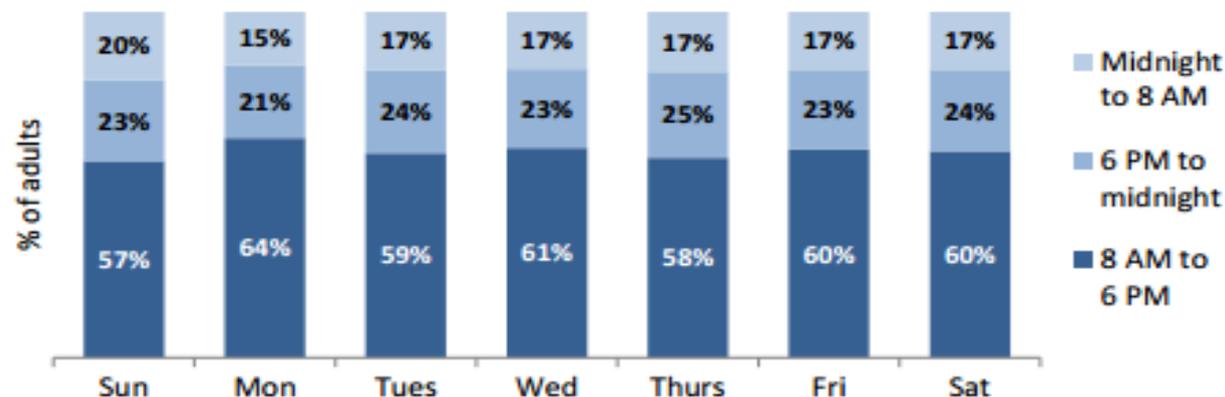
- Among all ED visits made from 2009 to 2014 in NYC, 1% (874 per 100,000) were identified as being preventable oral health visits.
- One in three (33%) preventable oral health visits were made by adults ages 21 to 30.
- Visits were more likely to be made by male (52%) than female (48%) adults.

Emergency department oral health visits by age, New York City, 2009-2014



Source: NYC DOHMH Syndromic Surveillance Unit, 2009-2014

## Emergency department oral health visits by day of week and time of day among New York City adults, 2009-2014



Source: NYC DOHMH Syndromic Surveillance Unit, 2009-2014

- Among adults, the majority (60%) of weekday dental ED visits occurred from 8 AM to 6 PM, when dental offices were open.
- In 2010 and since 2012, more preventable oral health visits were seen among adults in the July to September quarters compared with the other quarters within the same year.

Found ~1% of all ED visits were for preventable oral health care

EDs rarely have dentists on staff and thus are not good sources of care for underlying oral health problems

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# Ongoing projects

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# Measure changes in access to care

*Potential changes to ACA may affect utilization and who accesses care*

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# Does emergency department utilization change after introduction of urgent care centers?

# In summary

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## **Pulse of the city's health**

Provide trends of infectious and non-infectious disease

Assurance (e.g. that nothing is going on)

Reinforce public health messages

## **Able to provide timely information**

Emergencies (H1N1, Sandy)

- especially when no other data source exists

## **The use of this data is ever expanding!**

# Questions?



## NYC DOHMH Syndromic Group

Ramona Lall  
Robert Mathes  
Hilary Parton  
Sophie Rand  
Jessie Sell  
Priscilla Wong