

HealthMap: Novel Sources of Information on Emerging Biological Threats

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Boston Children's Hospital

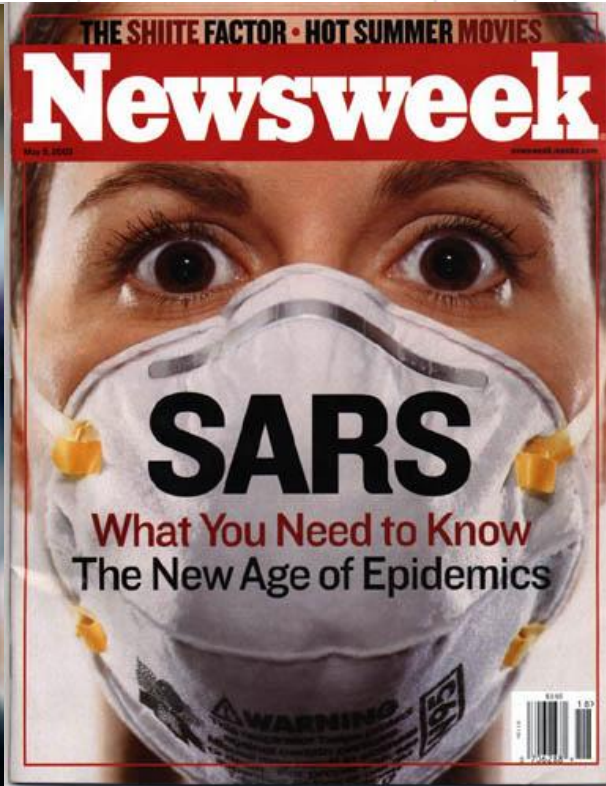
jane.huston@childrens.harvard.edu

(857) 218-4079



Guangzhou Baiyunshan Pharmaceutical Co.

(Public Shenzhen: 000522.SZ)



Potential of Digital Disease Detection





Emerging and re-emerging infections, 1996-2010

Cryptosporidiosis

Human Monkeypox

E.Coli O157

Venezuelan Equine Encephalitis

Dengue Haemorrhagic Fever

Ebola Haemorrhagic Fever

Marburg Haemorrhagic Fever

Ross River Virus

Hendra Virus

Reston Virus

West Nile Virus

Legionnaire's Disease

Severe Acute Respiratory

Syndrome (SARS)

Malaria

Typhoid

Cholera

BSE

Lassa Fever

Yellow Fever

Lyme Borreliosis

Echinococcosis

Diphtheria

Influenza A (H5N1)

Nipah Virus

RVF/VHF

O'Nyong-Nyong Fever

Buruli Ulcer

Multidrug Resistant Salmonella

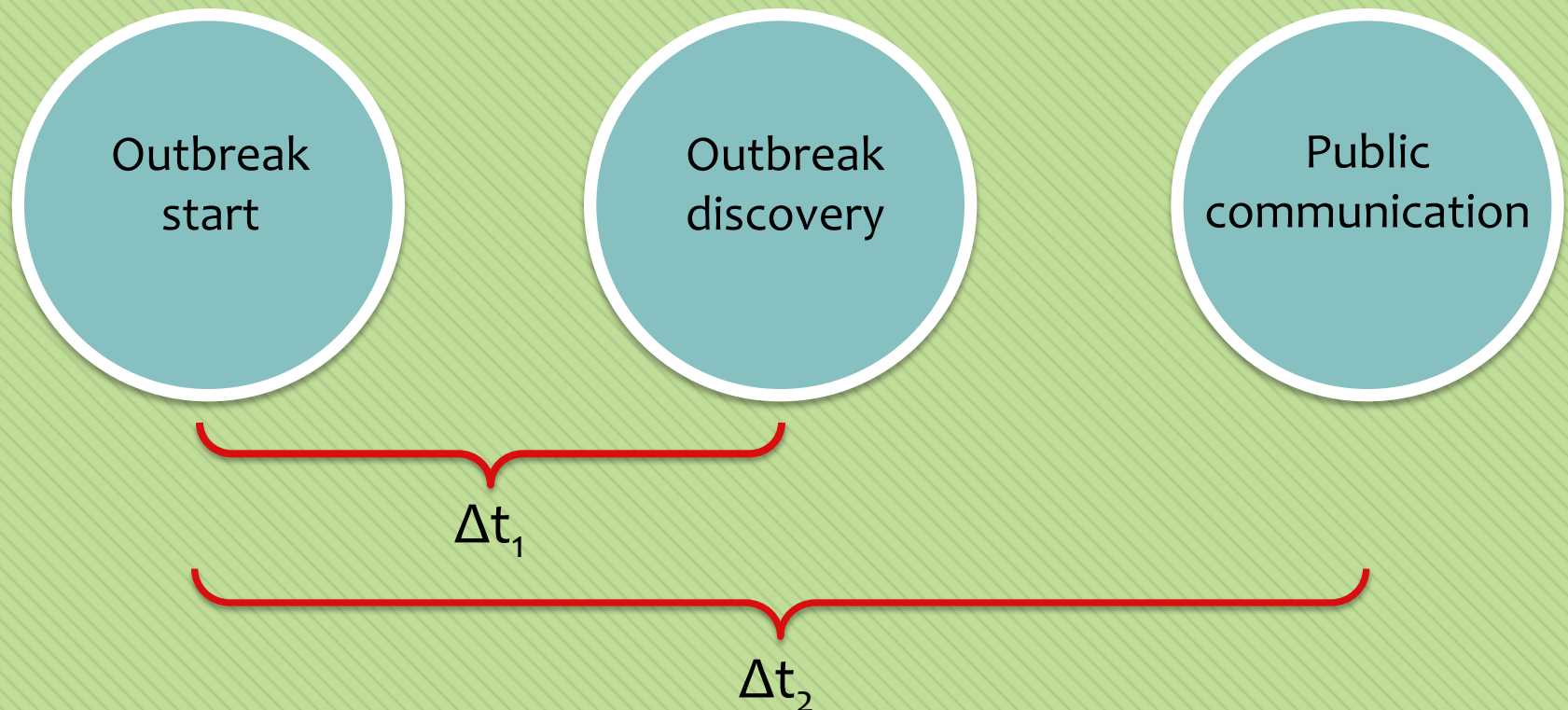
nvCJD

Outbreak Database (1996-2009)

- **Disease / Location**
- Date of onset of risk factor
- Date of local mass gathering
- Date of associated wildlife outbreak
- Date of exposure
- Date of symptom onset
- Date of outbreak start
- Date of hospitalization or medical visit
- Date of outbreak detection
- Date of death
- Date of laboratory confirmation
- Date of announcement by a local
- Date of any earlier mentioned report
- Date of ProMED, GPHIN, HealthMap reports
- Date of WHO notification
- Date of DON report (official)
- Date of mass immunization campaign
- Date of implementation of vector control)
- Date of declaration of an epidemic raised
- Date of declaration of end of epidemic

Global Surveillance Capacity Assessment

Characterize global spatial-temporal trends in the timeliness of outbreak detection and reporting



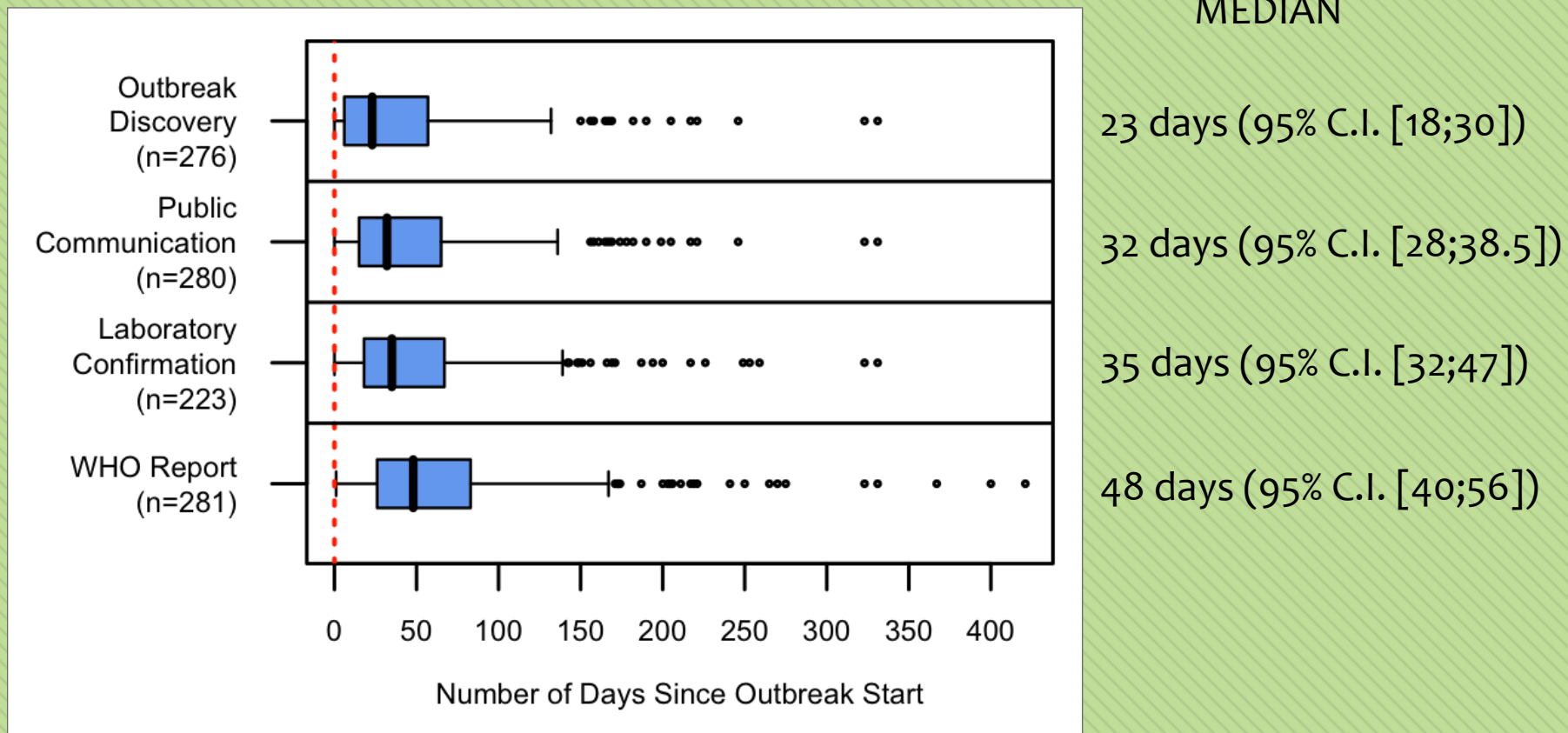
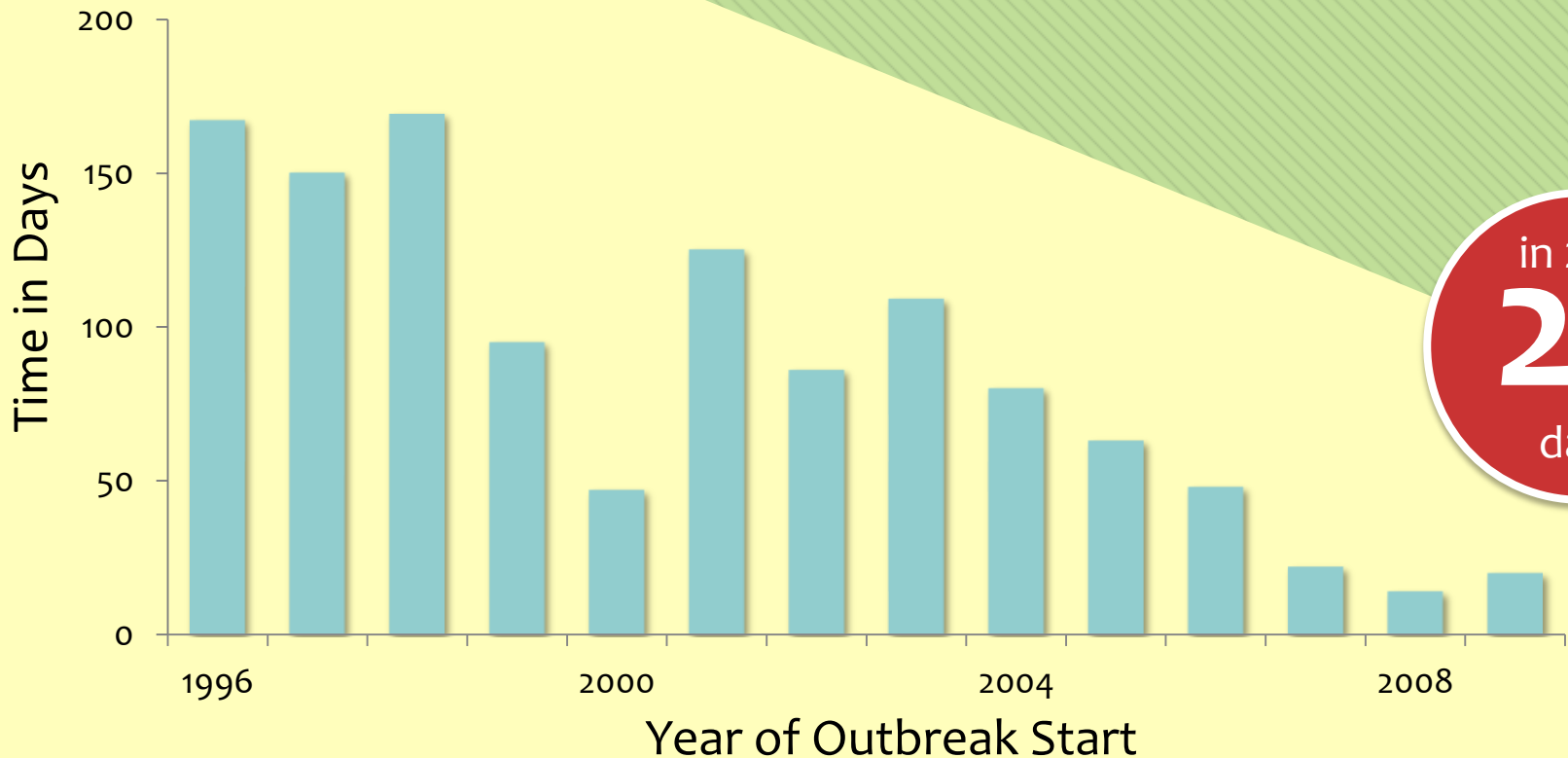


Figure 2 . Boxplots of the median time (and inter-quartile range) between outbreak start and various outbreak “milestones” for a set of WHO-confirmed outbreaks during 1996-2009.

Number of days from outbreak start to outbreak discovery

in 1996
167
days



in 2010
20
days

Traditional Public Health Reporting

1 →



Public

2 →

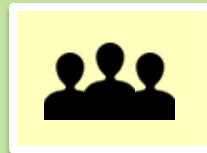


Public
health
practitioners

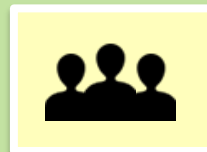


Healthcare
workers,
Clinicians

3 →



Local
Officials



Labs

4 →



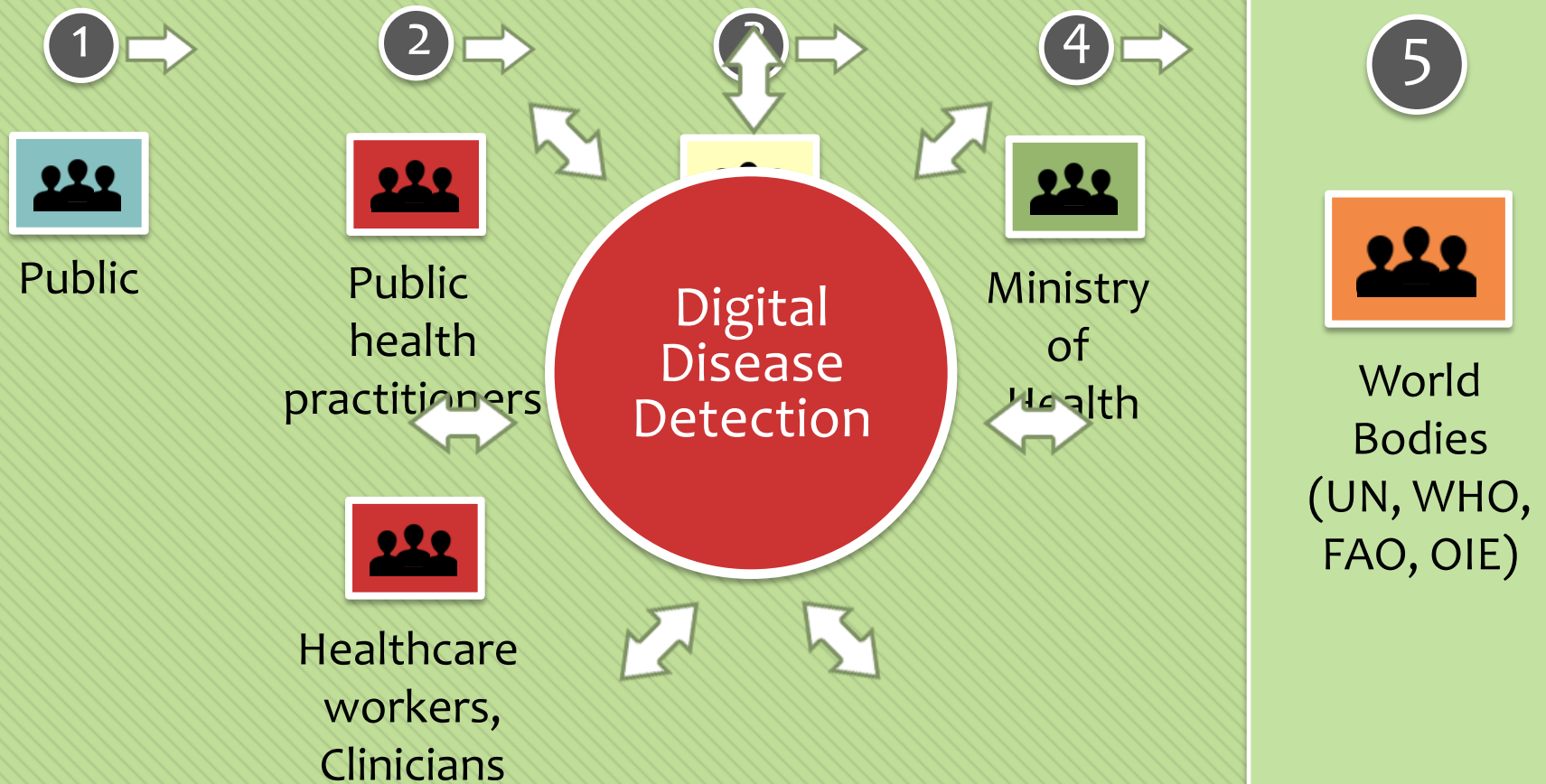
Ministry
of
Health

5

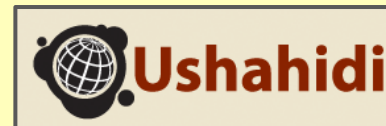
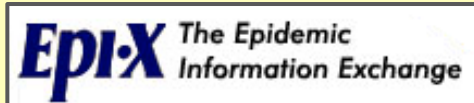


World
Bodies
(UN, WHO,
FAO, OIE)

Traditional Public Health Reporting



The Rise of Digital Disease Detection



The HealthMap System



Global

Local

News

About

Projects

Mobile

Donate

Feedback

English

Search disease or location

GO Advanced Search

Display Options:



Outbreak Missing?
Add it to the map

Quick Views

Map data ©2011 Geocentre Consulting, MapLink, Tele Atlas - [Terms of Use](#)

Activity Index

Low High

Country level Province or local level

Alerts from past week

Avian Influenza (past month)

Drought in Africa 2011

673 Alerts Now Showing

Date: 12 Sep - 20 Sep | Diseases: all | Places: all | Sources: all | Categories: all

Source	Date	Summary	Disease	Location	Cases	Deaths	Significance
	19 Sep	PAKISTAN - Epidemics of cholera and denque fever after floods ... - ...	Cholera	Pakistan			☆☆☆☆☆ 1 vote
	19 Sep	Confirmed Foot and mouth disease in San Pedro, Paraguay - cattle	Foot and Mouth	Paraguay			☆☆☆☆☆ 1 vote
	19 Sep	Food poisoning at the Galaxy	Foodborne Illness	Macau			☆☆☆☆☆ 1 vote
	19 Sep	PRO/MBDS> Avian influenza - MBDS region (12): Cambodia / Banteay	Avian Influenza	Phum Ta Pho, Khétt Bântéay Méan Choây, Cambodia			☆☆☆☆☆ 1 vote



Global

Local

News

About Projects Mobile Donate Feedback

Current location: Boston, Massachusetts, United States : radius 50 miles

Change: zip, city, state or province GO

Outbreaks Near Me

Disease alerts within 50 miles of Boston, Massachusetts, United States in the past month.



Vectorborne

Sep 16
Swampscott, Massachusetts, United States
[Mosquito Samples Test Positive for West Nile Virus](#)

Sep 15
Georgetown, Massachusetts, United States
[West Nile found](#)

Sep 14
North Andover, Massachusetts, United States
[West Nile Virus found in North Andover](#)



Environmental

Sep 3
Plum Island, Massachusetts, United States
[Some Plum Island beaches still closed - The Daily News of Newburyport](#)

Sep 3
New Bedford, Massachusetts, United States
[Algae prompts health](#)



Respiratory

Sep 18
Methuen High School, Massachusetts, United States
[High School Student Diagnosed With Tuberculosis - Boston News Story - WCVB Boston](#)

Aug 30
Boston
[Swine Flu H1N1 -- Boston, Massachusetts](#)



Submit an Alert

Outbreak missing from this map? [Add a news article, or your own eyewitness report](#) to the map.

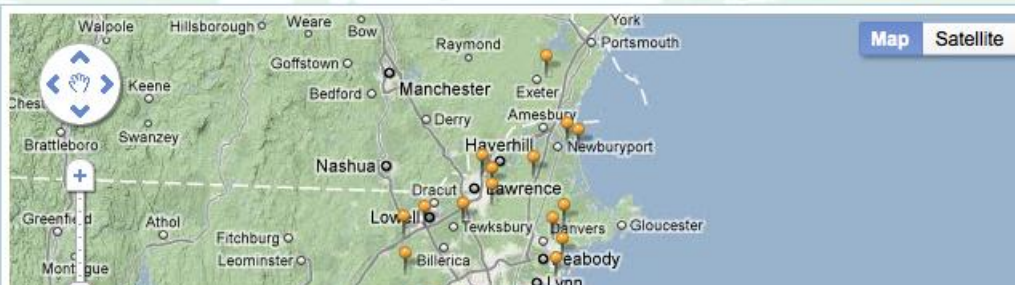
Customized Email Alerts

[Log in](#) or [sign up](#) to get customized email alerts for your location!

Local Public Health Links

- [Massachusetts Department of Public Health](#)
- [Rhode Island Department of Health](#)
- [Boston Public Health Commission](#)
- [United States Agency for Toxic Substances and Disease Registry](#)
- [United States CDC Travellers' Health](#)
- [United States Centres for Disease Control and Prevention](#)
- [United States Chemical Safety and Hazards Investigation Board](#)
- [United States Department of Agriculture](#)
- [United States Environmental Protection Agency](#)
- [United States Food and Drug Administration](#)
- [United States Food and Drug Administration Recalls](#)
- [United States Food Safety and Inspection Service](#)

Regional Disease Map View





Global

Local

News

About

Projects

Mobile

Donate

Feedback

Search: Enter keywords



THE DISEASE DAILY

Sep 19, 2011



Dengue Plagues Pakistan's Most Populous Province Sep 16, 2011



More than 5,000 dengue cases and 17 deaths have been reported in Pakistan, with 4,400 of those cases and 12 of the deaths occurring in Punjab province where just over half of the country's...

[Denque, Pakistan, flood, mosquitoes](#)

0 Comments

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- [Emerging Disease](#)
- [One Health: Human-Animal Intersections](#)
- [Veterinary](#)
- [Neglected Tropical Disease](#)
- [Vaccine Preventable](#)
- [Outbreaks 101](#)
- [Announcements](#)

Recent Comments

★ Today's Most Popular

👁 Most Viewed Articles



Vaccine Preventable

Imported Poliovirus Leaves 1 Dead in Xinjiang, China Sep 9, 2011

On August 31st, we reported that four children were diagnosed with polio in Xinjiang, China, a country that had been polio-free for eleven...



[wild polio virus, China, vaccination](#)

News

Salmonella and suing: Del Monte sues FDA and state health authority over salmonella outbreak investigation Sep 9, 2011

In an unprecedented act, Del Monte Fresh Produce N.A., Inc. filed a lawsuit against the Food and Drug Administration on August 22. The food...



News

World Cup Fever - Rugby World Cup 2011 Sep 8, 2011

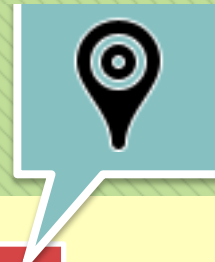
Rugby fans from around the world are flocking to New Zealand for the 2011 Rugby World Cup (RWC), and HealthMap is watching for outbreaks of...





in 15
languages
every hour
24/7





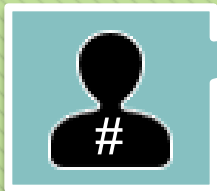
Typhoid cases in Mufulira have

reached 2,227 with health authorities

calling for increased efforts to prevent

new infections in Mupambe

Township





10,500
locations



220
species



4800
disease patterns



Case and
Death Counts

Bayesian Filtering

with
91%
accuracy

Breaking News

Warning

Old News

Context

Not disease related



Bayesian Filtering



Articles are categorized using more than **19 million phrases**

with
91%
accuracy

Breaking News



Warning



Old News

Context

Not disease related





Influenza A (H1N1) Reports

Source

Informal Sources (Media)
 Official Sources (ie: CDC, WHO)

[All HealthMap Sources »](#)

Category

Ruled Out
 Suspected Cases
 Suspected Deaths
 Confirmed Cases
 Confirmed Deaths

Zoom to country

[Mexico](#)

Zoom to: [N. America](#) [S. America](#) [Europe](#) [Africa](#) [Mideast](#) [Asia](#) [Australia](#) [World](#) Full Screen

La Gloria, Perote, Veracruz de Ignacio de la Llave, Mexico

Apr 1, 2009, Suspected Deaths: 2

[Veracruz: reporta agente municipal extraño brote](#)
 ...

Apr 1, 2009, Suspected Cases: 1800

Map | Satellite | Earth | **Terrain**



Influenza A (H1N1) Virus, 2009 — Online Monitoring

John S. Brownstein, Ph.D., Clark C. Freifeld, B.S., and Lawrence C. Madoff, M.D.

[Portada](#) | [Edición impresa](#) | [Especiales](#) | [Multimedia](#) | [Servicios](#) | [Escribanos](#)

Usted está aquí: [Portada](#) → [2009](#) → [04](#) → [01](#) → [Veracruz: reporta agente municipal extraño brote epidémico que ha cobrado dos vidas](#)

Veracruz: reporta agente municipal extraño brote epidémico que ha cobrado dos vidas

[Enviar esta página a alguien](#)
[Imprimir esta página](#)

La funcionaria de La Gloria informó que el raro padecimiento ha afectado a 60 por ciento de sus tres mil habitantes con infecciones respiratorias



Influenza A (H1N1) Reports

Source

Informal Sources (Media)
 Official Sources (ie: CDC, WHO)

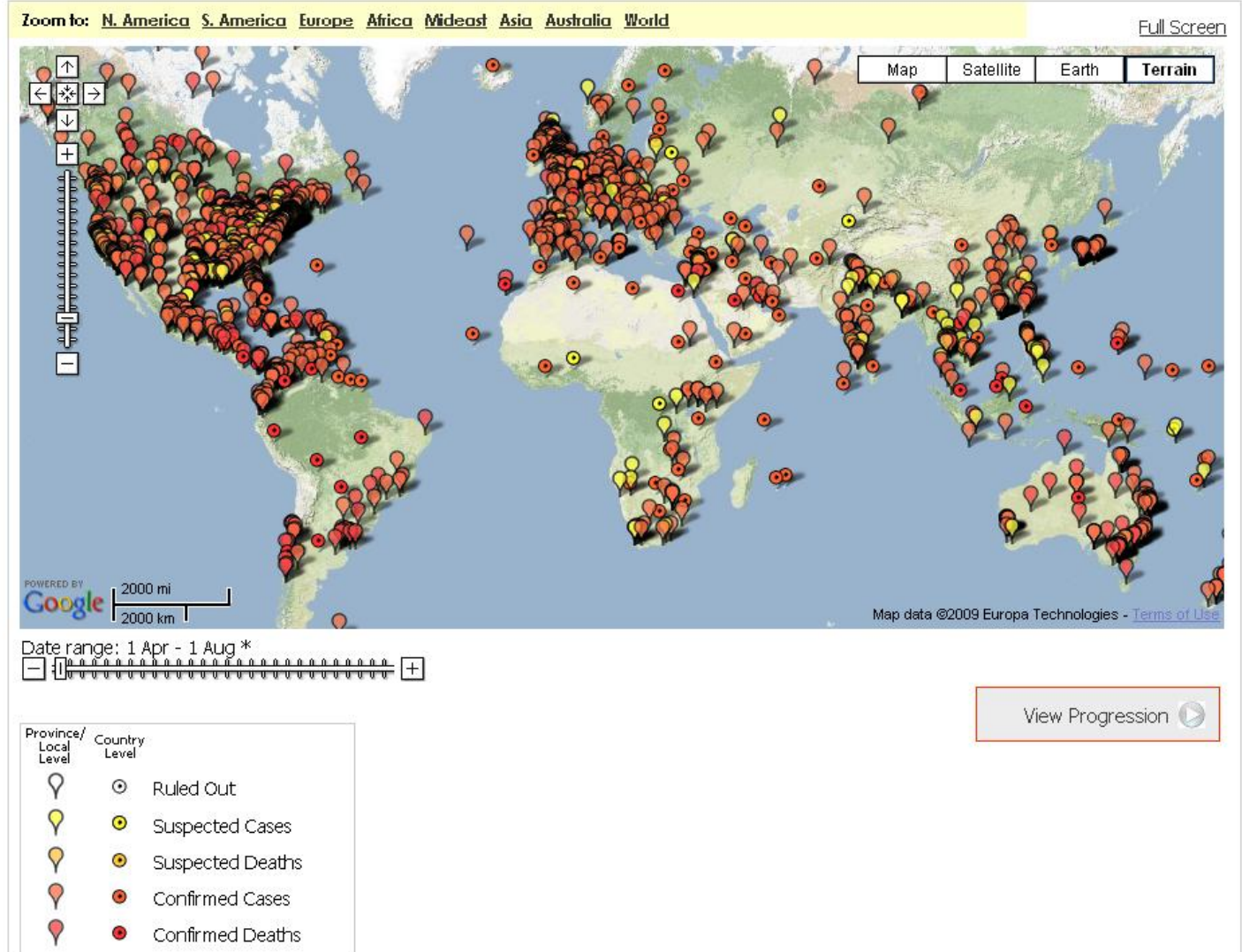
[All HealthMap Sources >>](#)
[View H1N1 on HealthMap >>](#)

Category

Ruled Out
 Suspected Cases
 Suspected Deaths
 Confirmed Cases
 Confirmed Deaths

Zoom to country

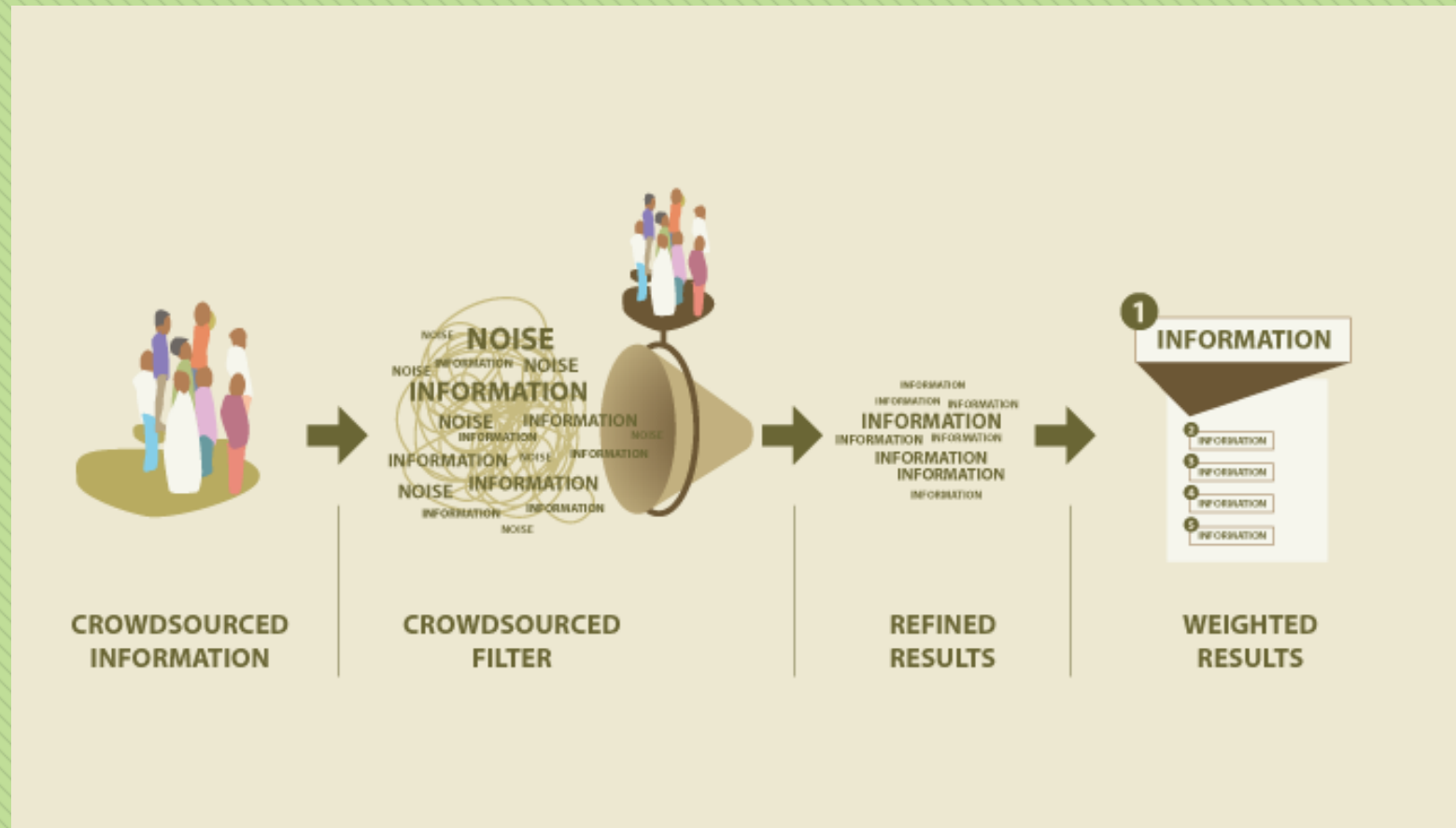
- [Afghanistan](#)
- [Albania](#)
- [Algeria](#)
- [American Samoa \[USA\]](#)
- [Antigua & Barbuda](#)
- [Argentina](#)
- [Australia](#)
- [Austria](#)
- [Azerbaijan](#)
- [Bahrain](#)
- [Bangladesh](#)
- [Barbados](#)
- [Belarus](#)
- [Belgium](#)



J.S. Brownstein, C.C. Freifeld, and L.C. Madoff (2009) [Influenza A \(H1N1\) Virus, 2009 - Online Monitoring](#), New England Journal of Medicine

Official data is obtained from CDC and WHO daily Influenza A (H1N1) updates. Informal data sources are a subset of reports from the [HealthMap](#) database. The case numbers shown are cumulative counts. HealthMap is a public website bringing together disparate data sources to achieve a unified view of the current global state

Participatory Epidemiology



Next Generation Public Health: Artificial Artificial Intelligence



1408		getoid56789@yahoo.com		2009-10-17 20:01:29	a mom and 2 kids have h1n1 in kyle SD	2 kids in their teens and a mom worse. The kids are in good st recovering. It was later for her be hospitalized for the disease
1402	✓	m23@gmx.us	33,790, -89.613	2009-10-17 18:22:40	its here	
1406		jarrodbrown1@gmail.com	41,275, -111.953	2009-10-17 18:17:08		Swine flu Gibbs residence
1405	✓	jarrodbrown1@gmail.com		2009-10-17 18:14:59		Swine flu Gibbs residence
1404	✓	wicajosh@btinternet.com	53,500, -1.060	2009-10-17 16:36:58	!! omg	Mum and son feel very bad
1403	✓	sinneakypete@yahoo.com	40,559, -74.169	2009-10-17 15:33:36	women has swine flu in Staten Island	Two women at least in Staten dose out to her fearing an out
1402	✓	kuwcu5dfgrjzobskwdjhdn	39,909, -86.393	2009-10-17 14:06:20		Jdxyjdjlkhdhkhjgdjgdjgjhrehndjgkjkjkjgdhdndryjrh
1401	✓	wakawak4@gmail.com	33,645, -112.075	2009-10-17 11:05:57		

Page 10

review

post to public



notify contributor



aggregate

Outbreaks Near Me

Direct Reporting



TIME
IN PARTNERSHIP WITH **CNN**

Wednesday, Sep. 09, 2009

Is a Swine Flu Outbreak Coming? Ask Your iPhone

By Bryan Walsh



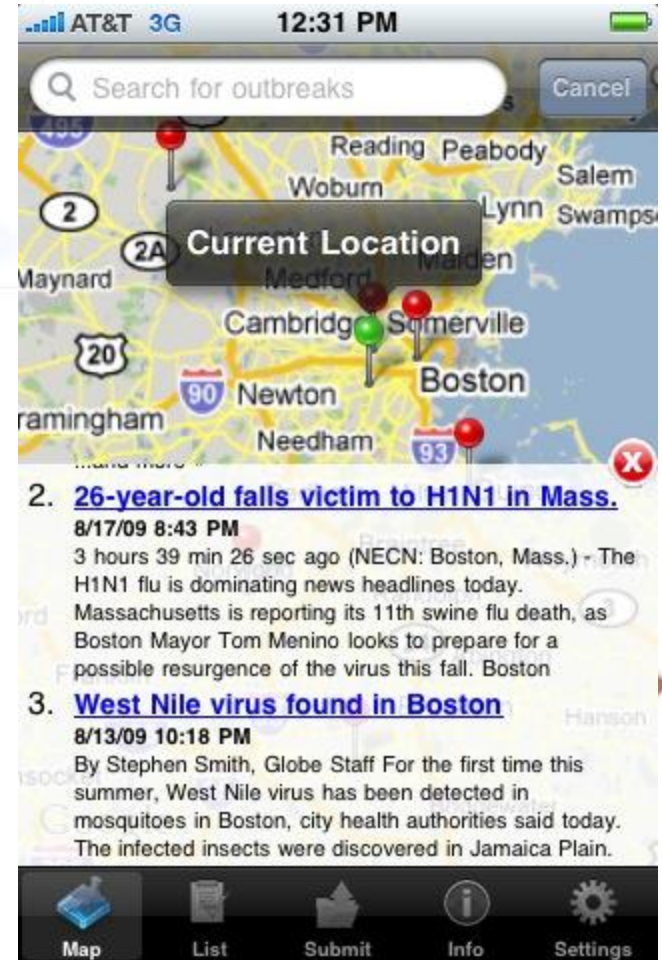
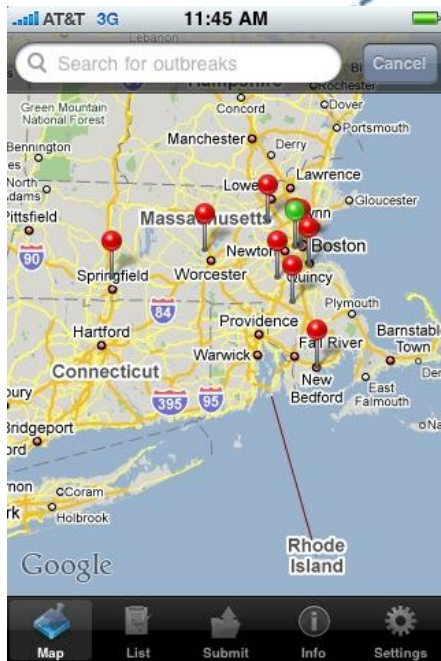
HealthMap

Outbreaks Near Me

Location,
preferences



Relevant real-
time alerts



HealthMap

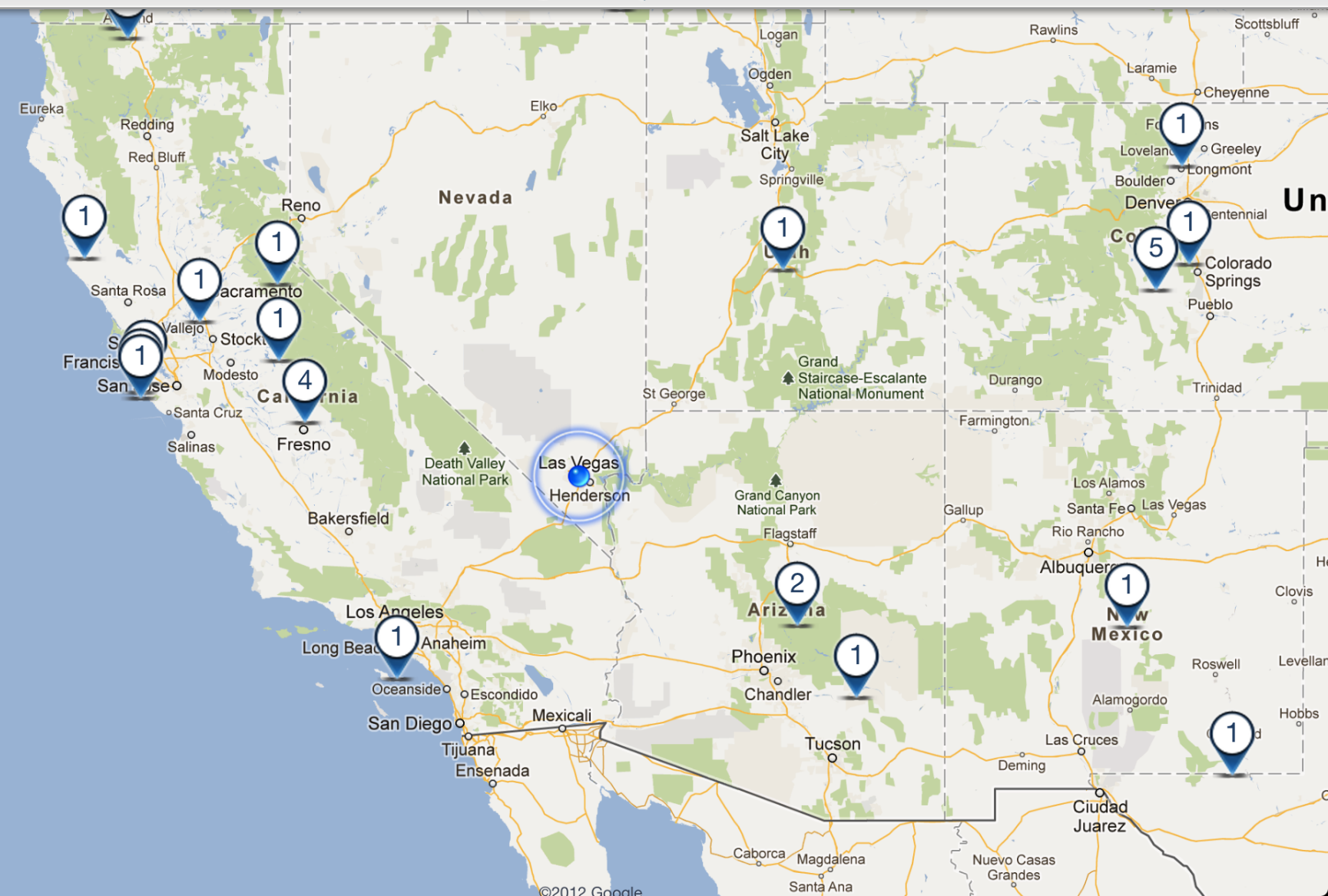
Map View


List View


News

About

Submit




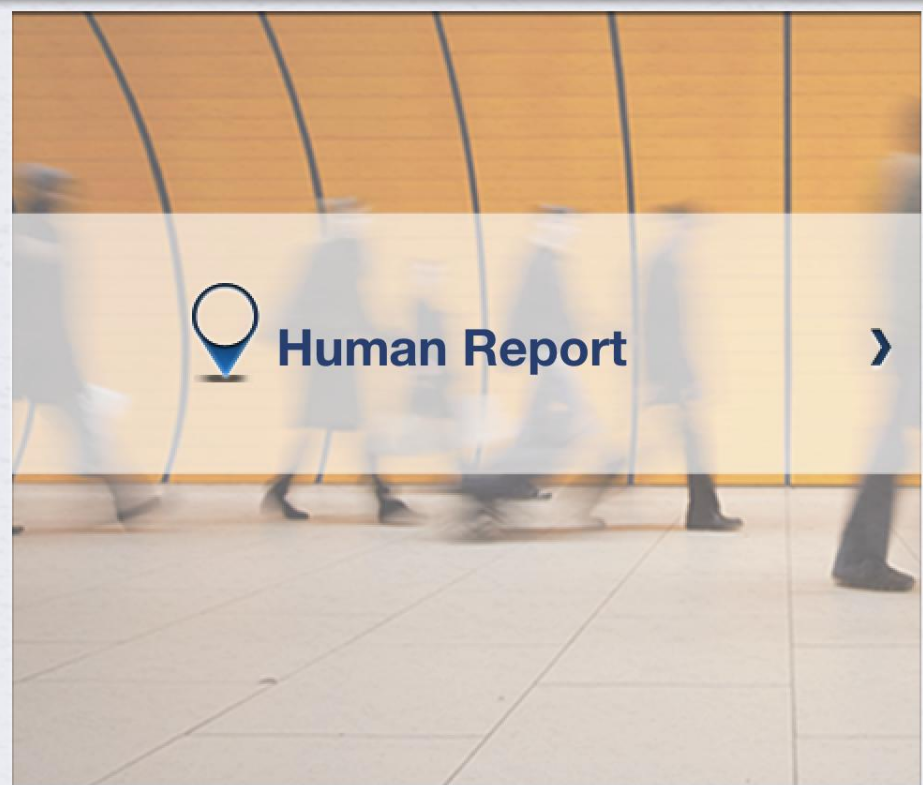
 Map View

 List View

 News

 About

 **Submit**



Human Report



Animal Report



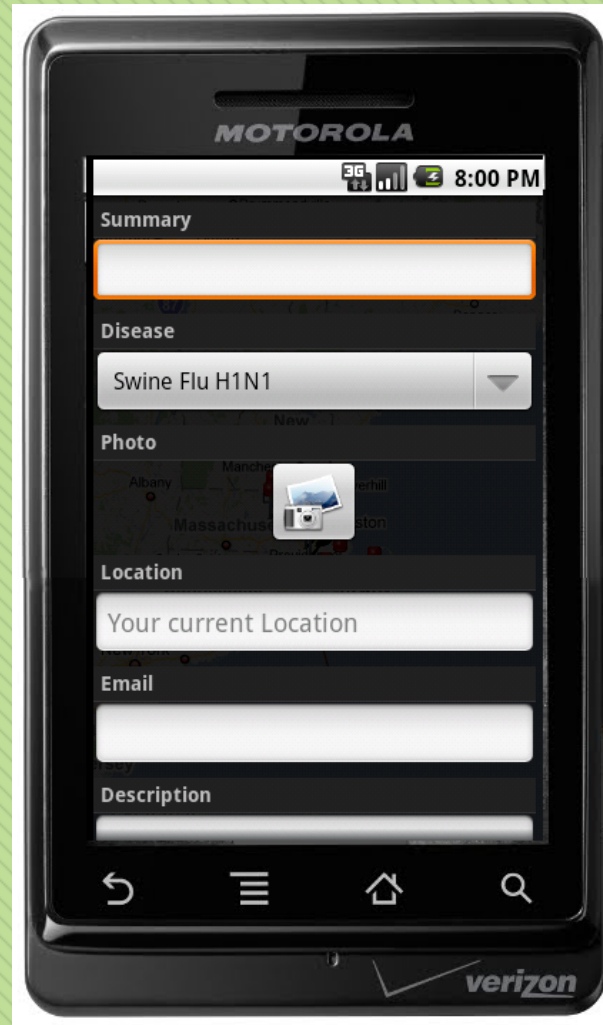
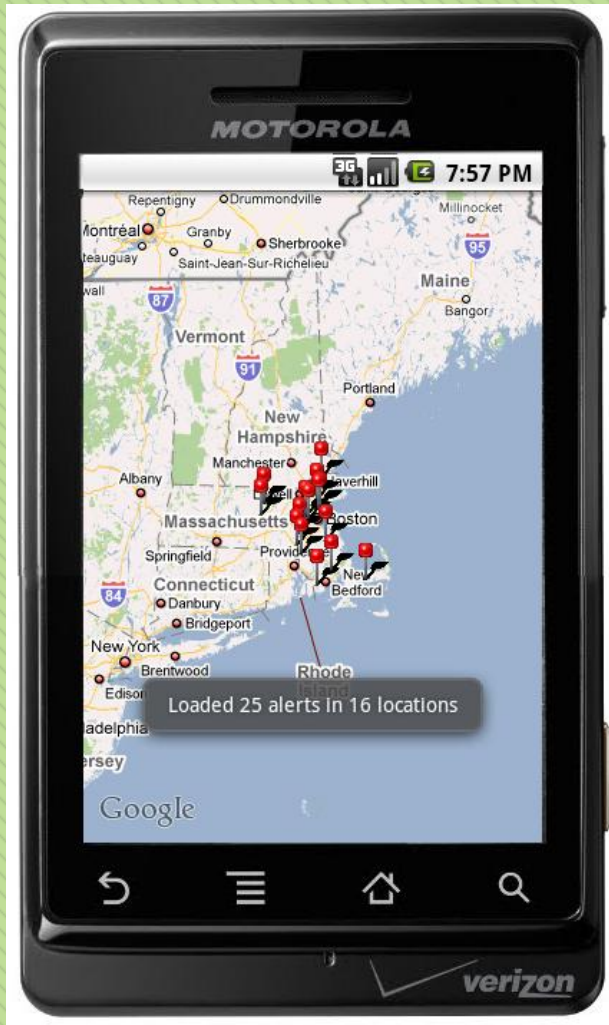
Previous Report

**Enter an email address to
view past submissions**

> 100k downloads



DFIDD DOES



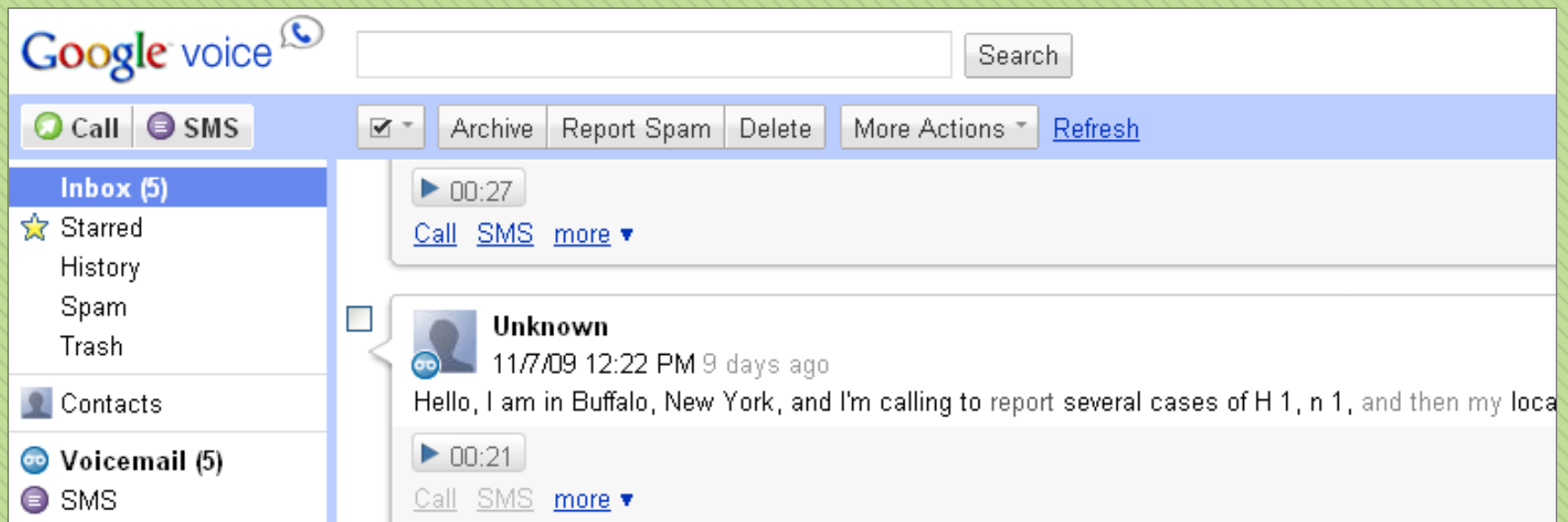
Android

Potential for increased global coverage



HealthMap Hotline

919-MAP-1-BUG (627-1284)
Leave a voicemail or Send SMS



The screenshot displays the Google Voice interface. At the top left is the "Google voice" logo. To its right is a search bar with a "Search" button. Below the logo are "Call" and "SMS" buttons. A navigation bar contains a checkmark icon, "Archive", "Report Spam", "Delete", "More Actions", and "Refresh". A left sidebar lists "Inbox (5)", "Starred", "History", "Spam", "Trash", "Contacts", "Voicemail (5)", and "SMS". The main area shows two messages. The first is a voicemail with a duration of 00:27 and options for "Call", "SMS", and "more". The second message is from an "Unknown" sender, dated "11/7/09 12:22 PM 9 days ago", with a duration of 00:21 and similar options. The message text reads: "Hello, I am in Buffalo, New York, and I'm calling to report several cases of H 1, n 1, and then my loca".

Reporting through the website

Outbreak Missing? Help us by adding it to the map.



Online Form



Email



Voice or Text



SmartPhone App

Provide an eyewitness report

(something you personally know or heard about)

Headline:

Disease:

Location:

Email:

Description:

Or

Share a news report

(a news article you read online)



OutbreaksNearMe



[My Alerts](#) | [All Alerts](#) | [Submit a Report](#) | [Settings](#) | [Invite](#) | [About](#)

Submit a disease report:

Headline:

Disease:

Location:

Description:

Upload a related photo (optional): No file chosen

Email:

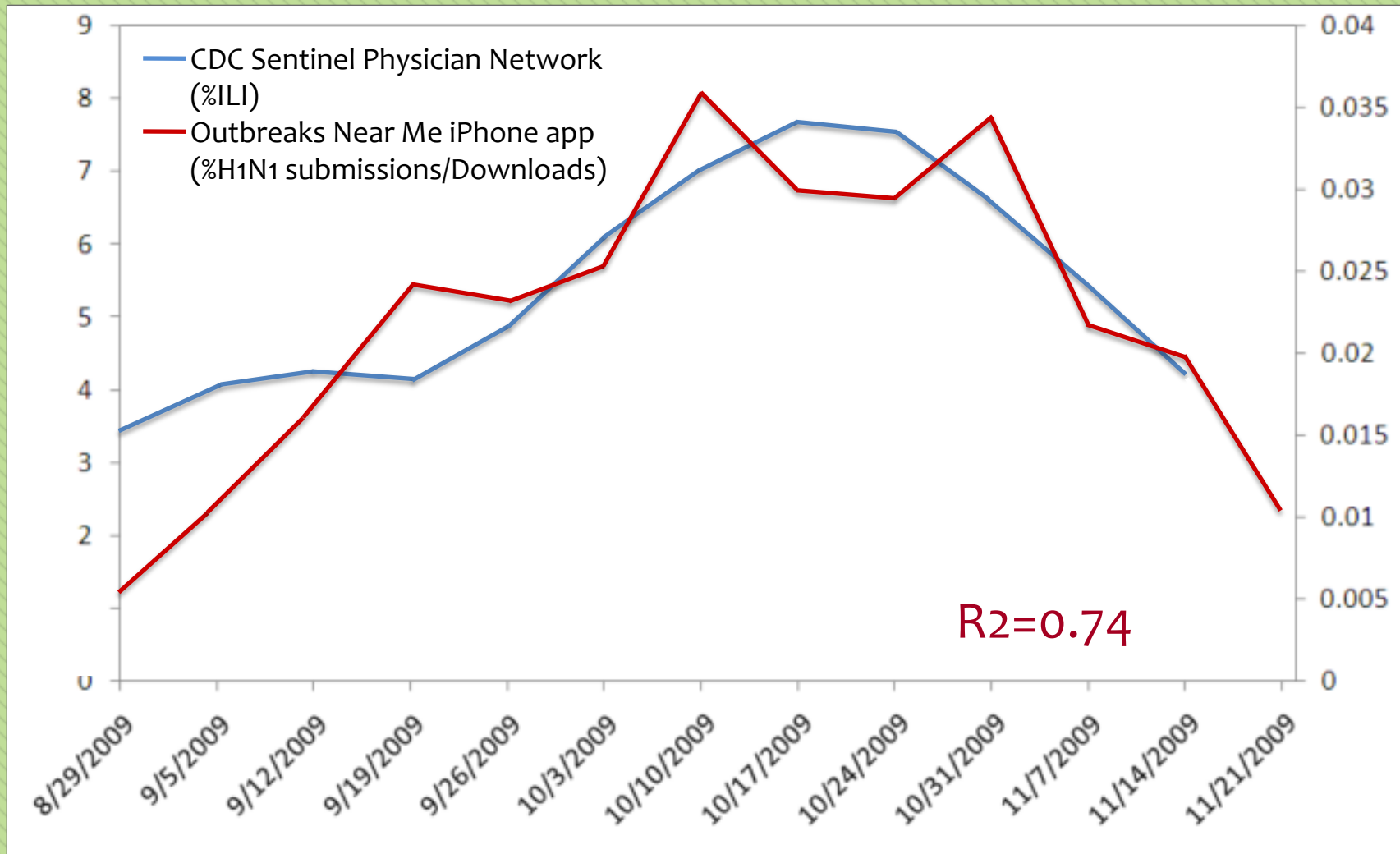
By submitting, you agree to the [Terms of Submission](#).



Worldwide User Submitted Reports



iPhone Submissions vs CDC sentinel surveillance



Future of Outbreaks Near Me Mobile

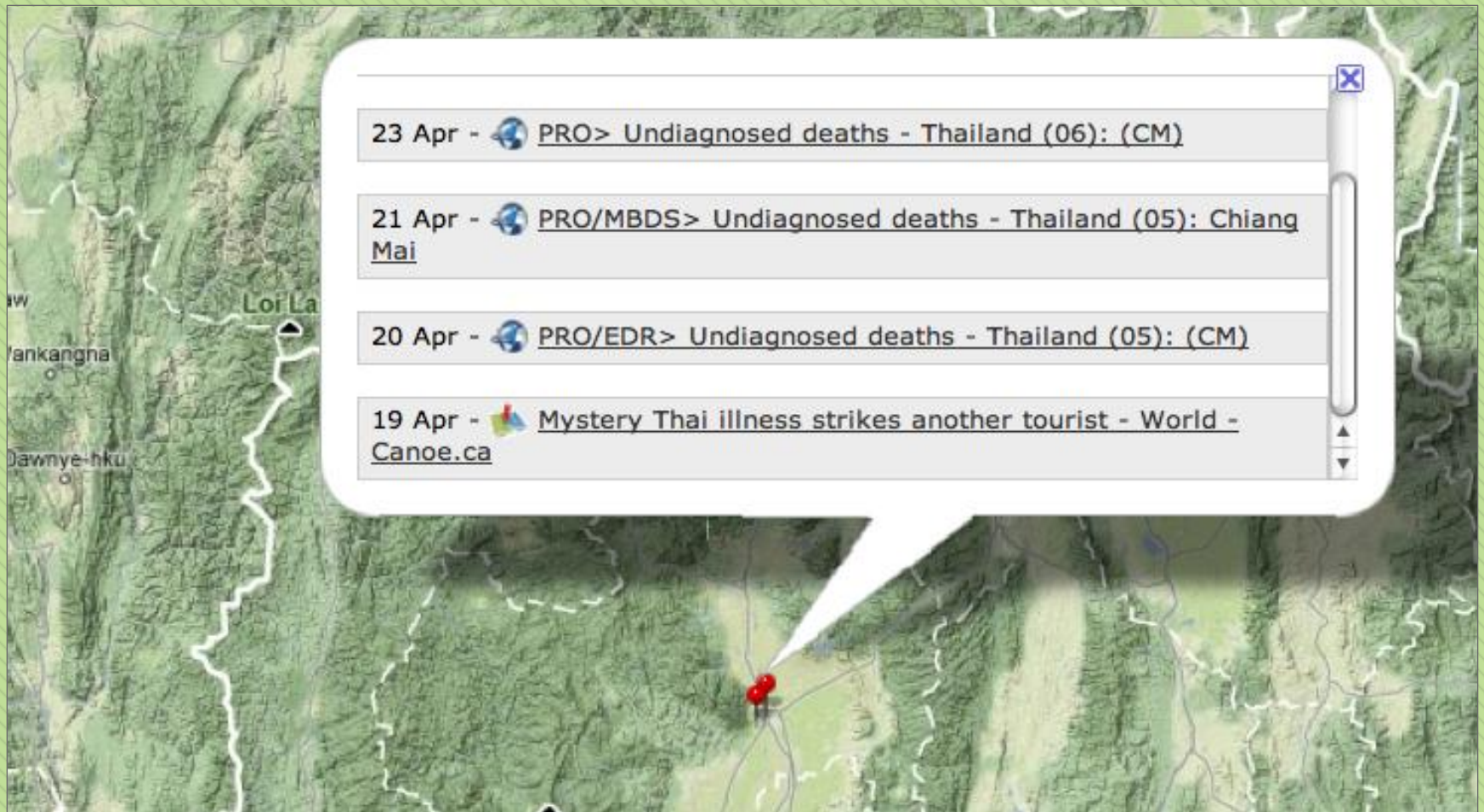


- Engaging the users through recognition
- Providing key public health messaging
- Improved visualization
- And building a disease detective network...

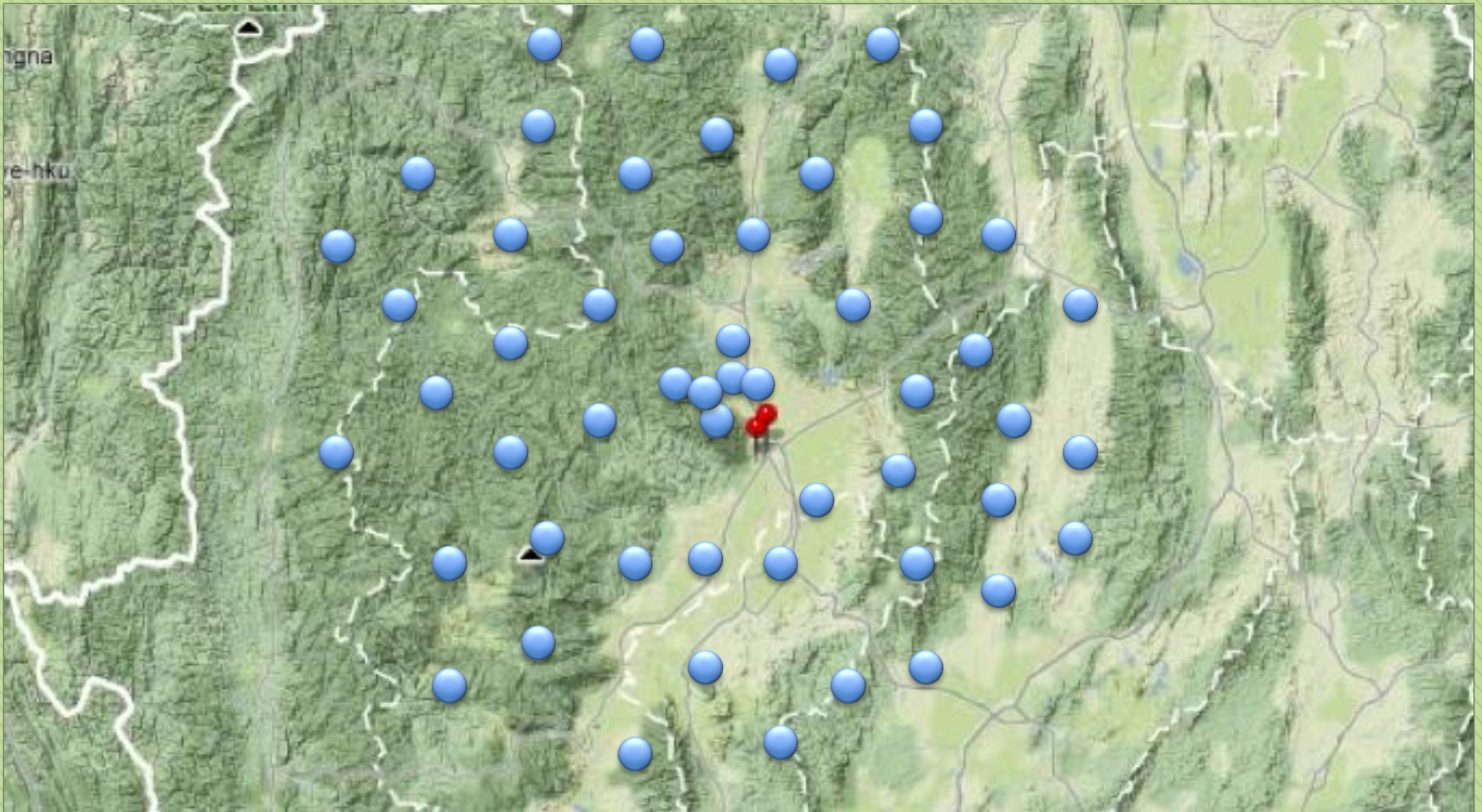
Undiagnosed Events in HealthMap



Validating Undiagnosed Events by Mobile Phone



Validating Undiagnosed Events by Mobile Phone



Geo-localized push messages → Validate event

Flu Near You

Influenza in the US

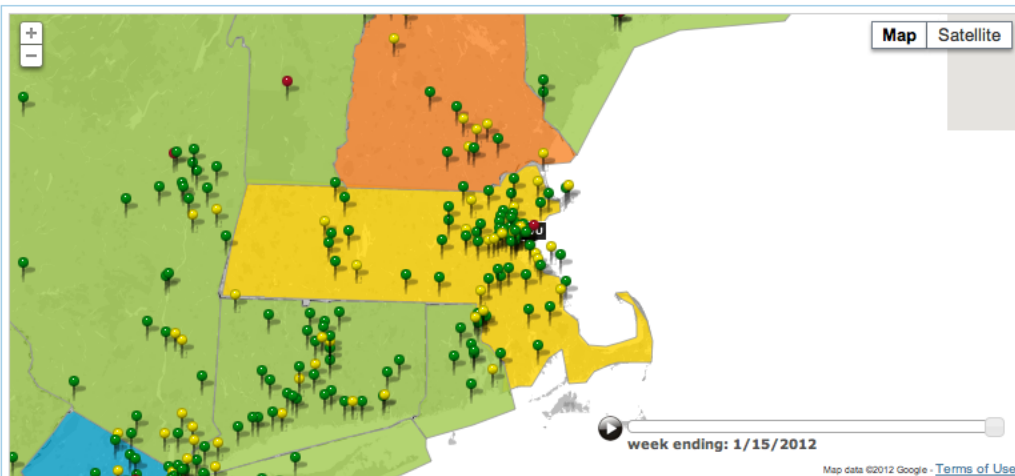
flu near you 
do you have it in you?





Flu Activity in Your Area

User submitted flu reports in Boston, Massachusetts, United States in the past month.

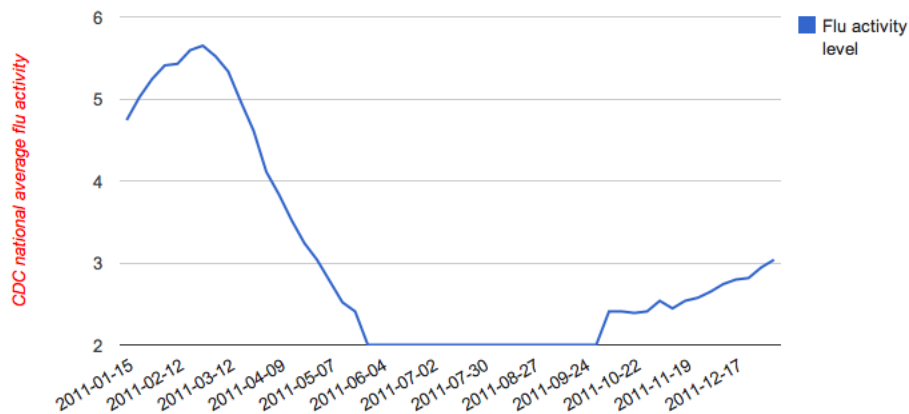


User contributed data: (colors determined by current week of data)

No symptoms reported
 Some symptoms reported
 At least 1 person with ILI

Additional flu data:
 User Contributed Flu Activity
 CDC Flu Activity
 Google Flu Trends ILI

No Report
 No Activity
 Sporadic
 Local
 Regional
 Widespread



Share Flu Near You: [f](#) [t](#) [g+](#) [e](#) [m](#)

do you have it in you?

685 Reports in MA

since start of 2011 flu season

- 151 Reported symptoms
- 534 Reported no symptoms

Get Vaccinated!

Please consult with your healthcare provider about vaccinations.

You can get your flu vaccine at any of these locations:

CVS/pharmacy
2 CENTER PLAZA, BOSTON, MA, 02108
(617) 523-3653

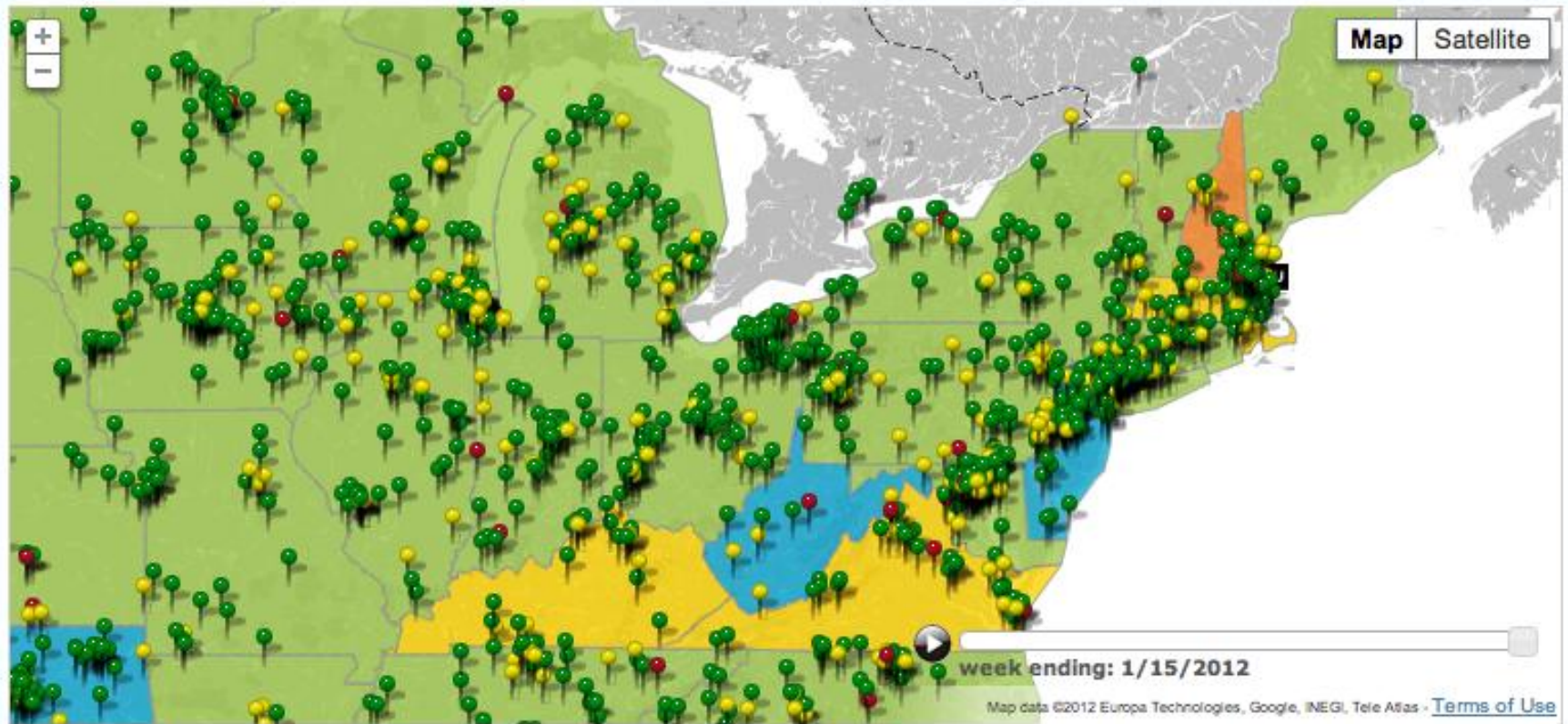
CVS/pharmacy
333 WASHINGTON STREET, DOWNTOWN CROSSING, BOSTON, MA, 02108
(617) 742-0783

Rite Aid Pharmacy
100 CAMBRIDGE ST STE102, BOSTON, MA 02114
(617) 367-4704

CVS/pharmacy
55 SUMNER STREET, BOSTON, MA, 02114

Flu Activity in Your Area

User submitted flu reports in Boston, Massachusetts, United States in the past month.



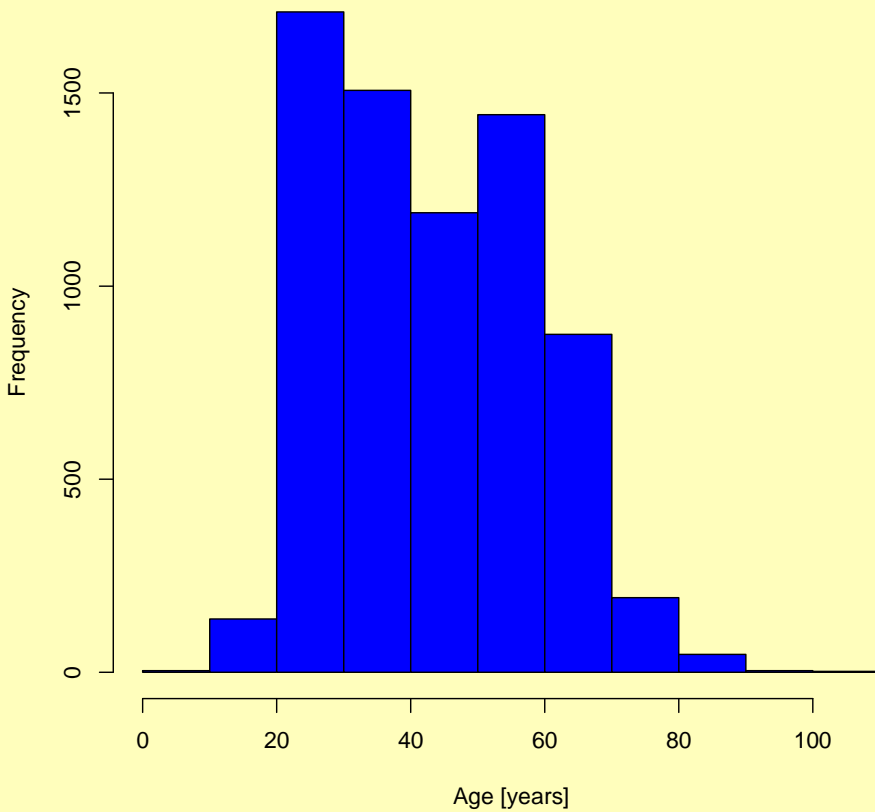
User contributed data: (colors determined by current week of data)

No symptoms reported Some symptoms reported At least 1 person with ILI

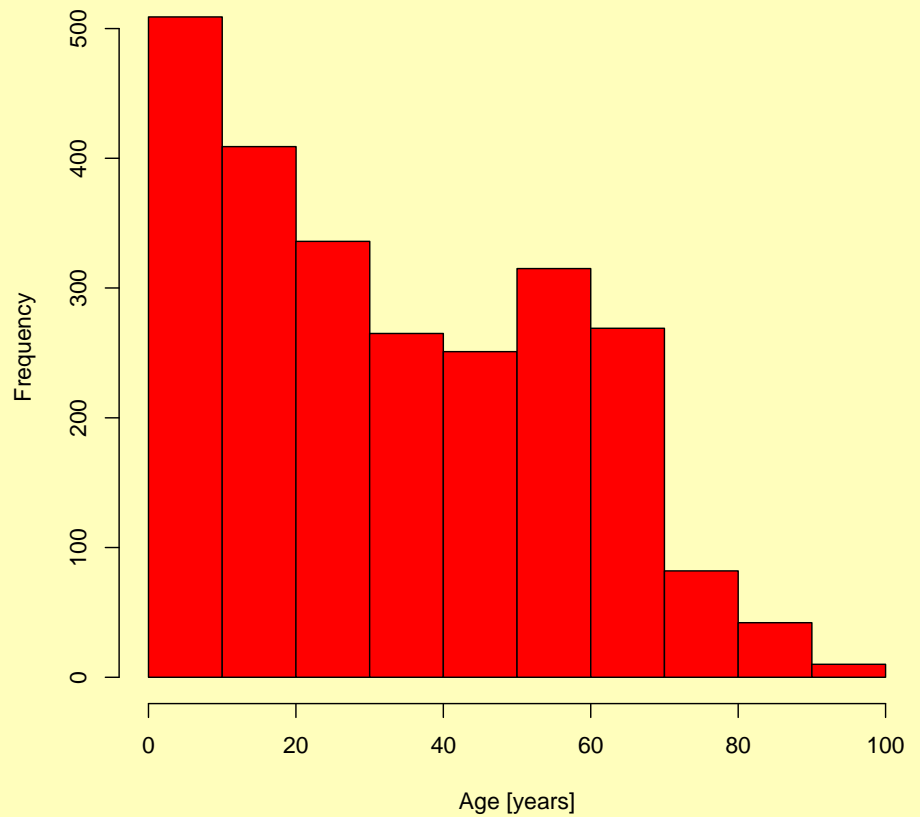
Additional flu data: User Contributed Flu Activity CDC Flu Activity Google Flu Trends ILI

No Report No Activity Sporadic Local Regional Widespread

Age Distributions



Users



Household members

Initial Form

Report Your Health Status

Thank you for registering for the Flu Near You project! Now it's time to start your first survey.

United States in the past month.

Map Satellite

What symptoms have you experienced in the past week?

<input type="checkbox"/> Fever	<input type="checkbox"/> Fatigue
<input type="checkbox"/> Cough	<input type="checkbox"/> Nausea or vomiting
<input type="checkbox"/> Sore throat	<input type="checkbox"/> Diarrhea
<input type="checkbox"/> Shortness of breath	<input type="checkbox"/> Body aches
<input type="checkbox"/> Chills/night sweats	<input type="checkbox"/> Headache

I did not have any of the listed symptoms

Did you receive the flu vaccine after July 31, 2011?

Yes No Don't know

Did you receive the flu vaccine last year (between July 31, 2010 - July 31, 2011)?

Yes No Don't know

Submit

week ending: 10/22/2011

Map data ©2011 Google - Terms of Use

Form after illness indication

Report Your Health Status

Thank you for registering for the Flu Near You project! Now it's time to start your first survey.

What symptoms have you experienced in the past week?

<input checked="" type="checkbox"/> Fever	<input type="checkbox"/> Fatigue
<input type="checkbox"/> Cough	<input type="checkbox"/> Nausea or vomiting
<input type="checkbox"/> Sore throat	<input type="checkbox"/> Diarrhea
<input type="checkbox"/> Shortness of breath	<input type="checkbox"/> Body aches
<input type="checkbox"/> Chills/night sweats	<input type="checkbox"/> Headache

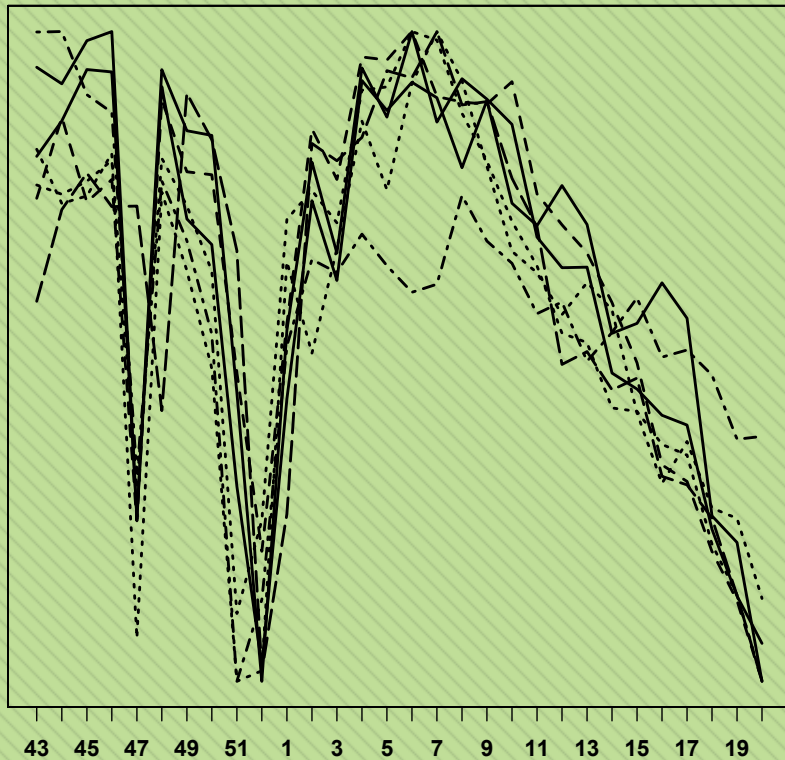
What was your highest temperature measured?

Not measured

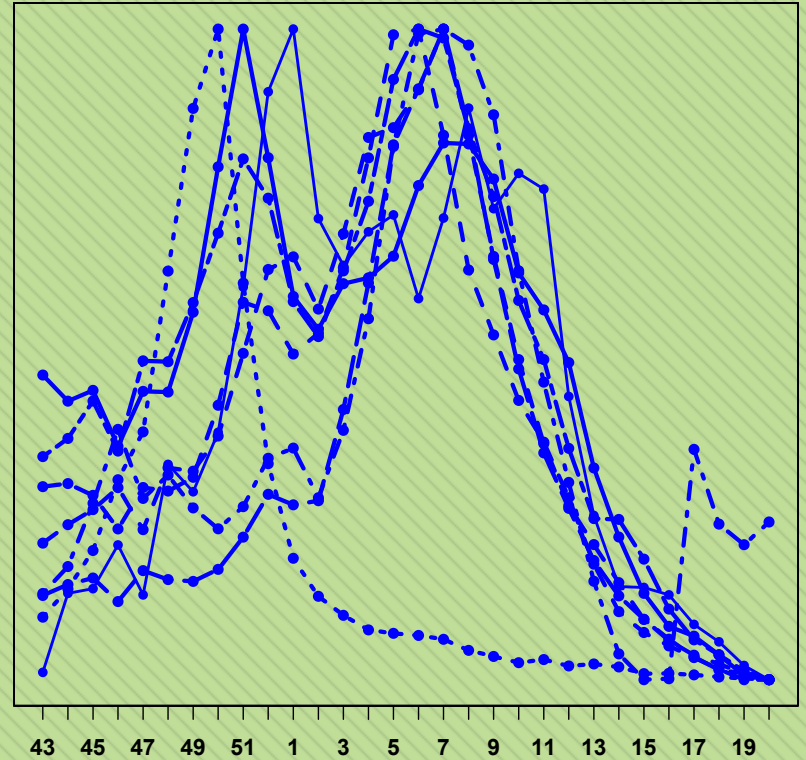
What day did you start feeling ill?

October 2011						
Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Why Flu Near You?



Centers for Disease Control

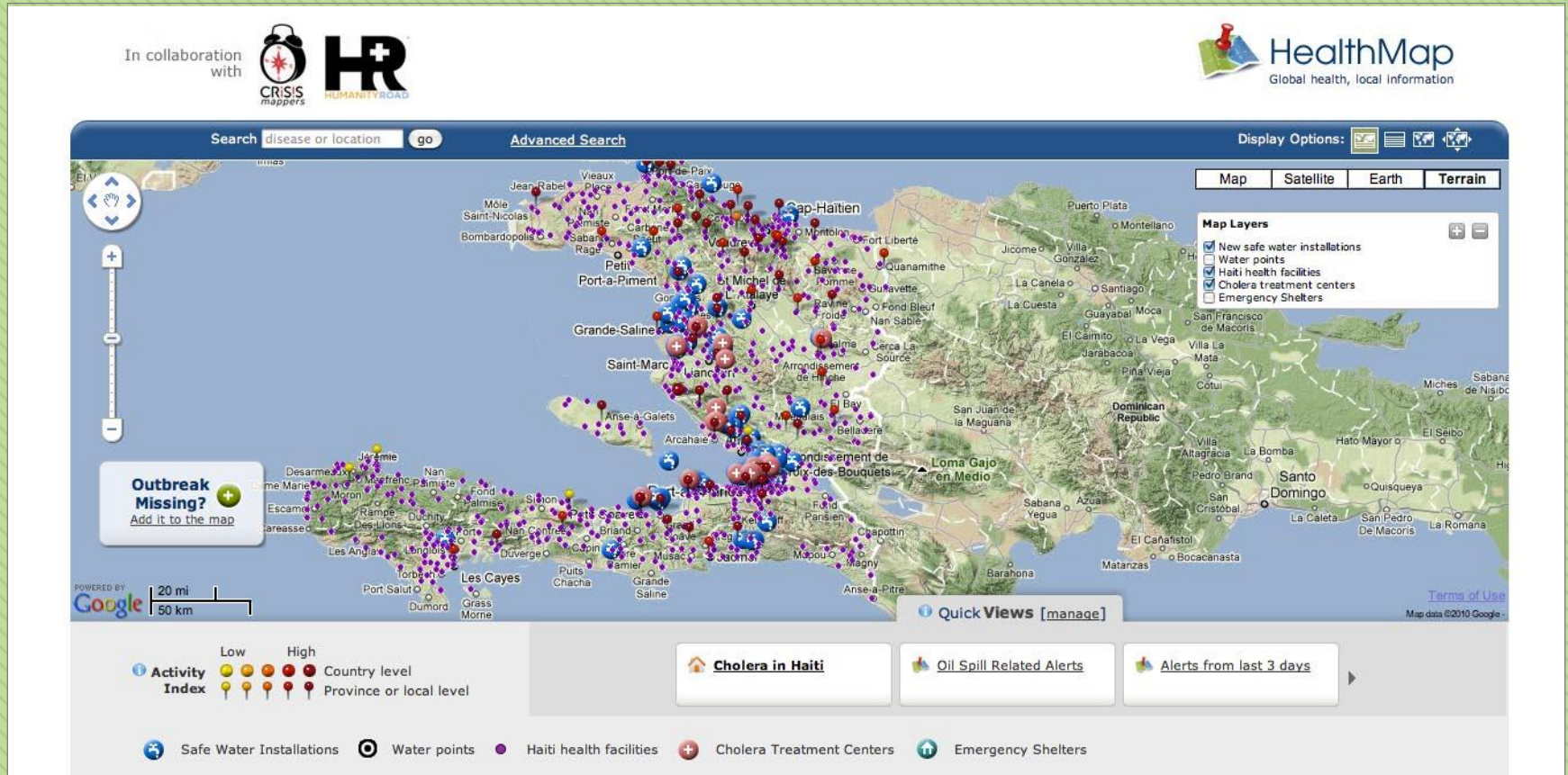


Google Flu Trends

Twitter

Haiti in Cholera

Cholera Surveillance in Haiti





9:31 AM 67% 900

healthmap.chp.org/~chelleid/da/pap/dep... Google

OutbreakMD Report

Existing reports: 0

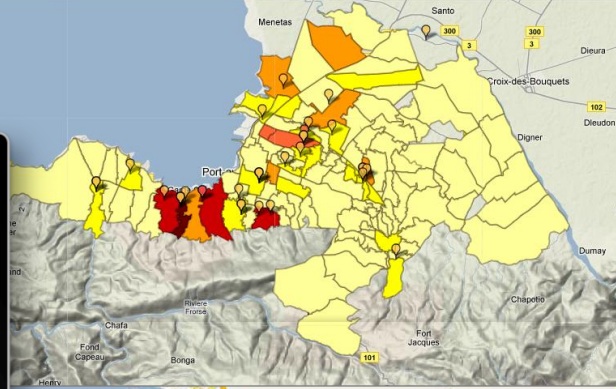
PI initials/ID:

Date:

Location:

Choose disease category:

- Malaria**, Malaria
 - Rapiq test
 - Smear positive
- Typhoid**, Typhoid
 - Perforation
 - fever
 - abdominal pain
 - clinical perforation
 - Titer positive
 - fever
 - abdominal pain
 - Syndrome
 - fever
 - abdominal pain
 - Malaria negative
- Meningitis**, Meningitis
 - fever
 - altered mental status
 - neck stiffness
 - HIV positive
 - HIV negative
- Tuberculosis**, Tuberculosis
 - cough
 - fever
 - weight loss x 3 wks or greater
 - CXR c/w TB
 - AFB positive
 - AFB negative
- HIV**, HIV
 - new diagnosis
 - severe throat pain
- Diphtheria**, Diphtheria
 - fever
 - + neck swelling and throat membranes
 - neck swelling



HealthMap Pilot, Haiti



sore throat

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Search tip

Use an at-sign (@) immediately before a username to find mentions of (and replies to) a user. Example: [@mashable](#) will find tweets referencing the user "mashable".

Realtime results for sore throat



lovelylibra84 Has a fever of 101, **sore throat**, runny nose, and a headache.... Sheesh, this being sick sh*t, is for the birds :(
 less than 20 seconds ago via Twitter for BlackBerry®



RiosBia I hate being sick, arghhh this **sore throat**!!!!...
 half a minute ago via web



_Yowinnie **Sore throat**
 less than a minute ago via txt



MelissaPinkette lol RT [@Tunji_O](#): So Lil John finally got a **sore throat**, I guess life can be fair, YEAHHHHHHHHH !!!
 2 minutes ago via ÜberSocial



AustinKirkland Woke up with a **sore throat** and stuffy nose. **Lame.**
 2 minutes ago via Twitterrific



paperclipears lolol my **throat** needs to go fuck off and stop being **sore.**
 2 minutes ago via web



claireduff90 agghhhh **sore throat** :(
 2 minutes ago via web



DiLaNnSeNn Biggest headache and **sore throat** :(
 3 minutes ago via Twitter for BlackBerry®



heidiglamluvvsu [@mdotperiod](#) [@heidiglamluvvsu](#) I'm feeling fine just no voice and a SUPER **sore throat**! How are u missy?> truly blessed- u goin NAACP Awards?
 3 minutes ago via web



njuwantha Symptoms and treatment of **sore throat**
 [http://twurl.nl/8474ac](#)

New to Twitter?

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A #NewTwitter

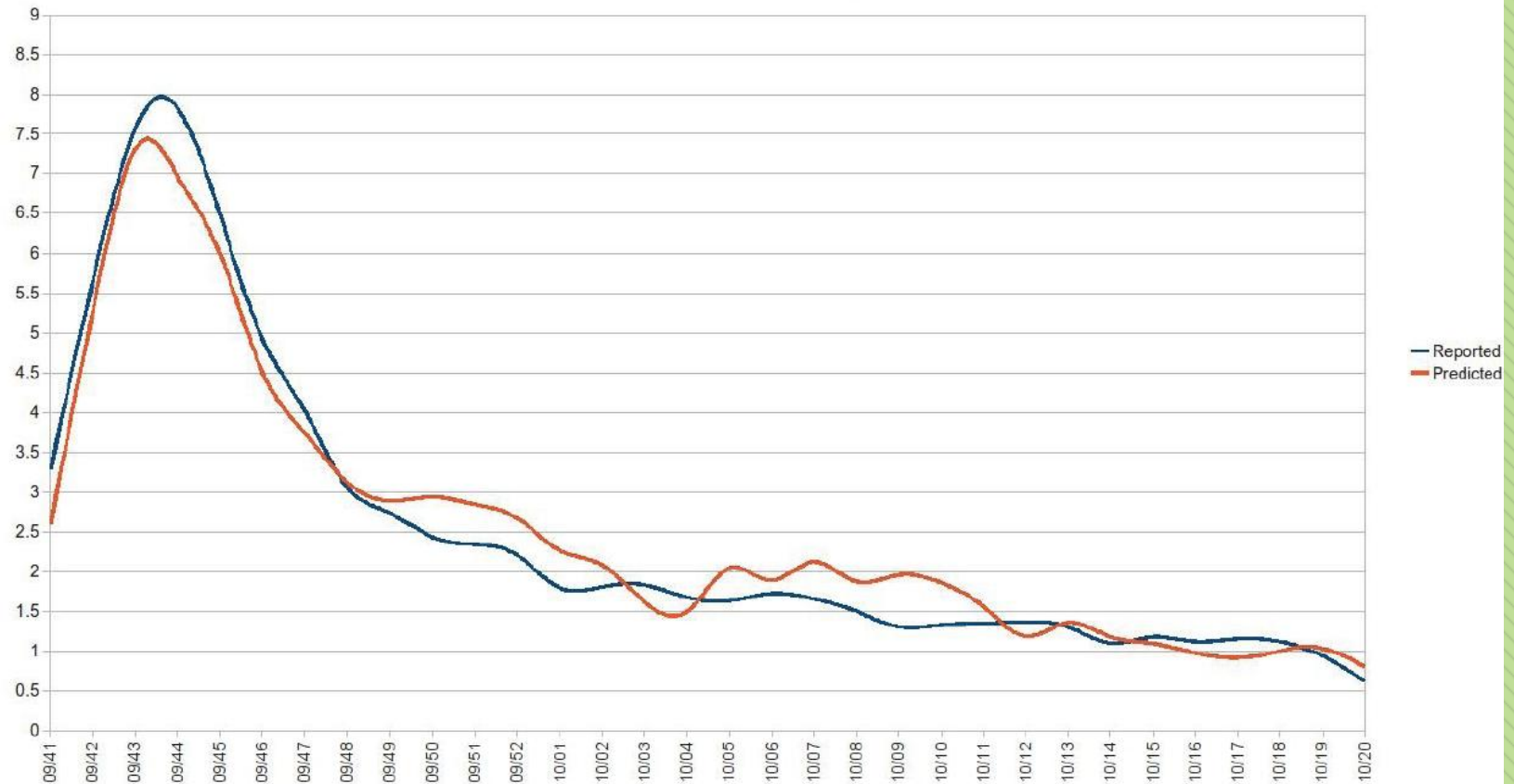
[Catch a glimpse](#) of the new Twitter.com.



Twitter as a predictor of influenza-like illness

Reported vs. Predicted Weekly ILI%

Flu Season 2009-2010 - Region 2



Out-of-sample Prediction ~ error avg=0.37%, min=0.01%, max=1.25%. Std=0.26%

Alessio Signorini. University of Iowa



Ameliebaron Amélie Baron

La journée avait si bien commencé, collègues de [#RFI](#) primés...
mais épidémie de choléra officialisée en [#Haiti](#).

21 Oct



wyclef Wyclef Jean

My visit to Sant Nicolas hospital in Saint Marc, As haiti is still
fighting Cholera <http://plixi.com/p/53255834>

27 Oct



jacquiecharles Jacqueline Charles

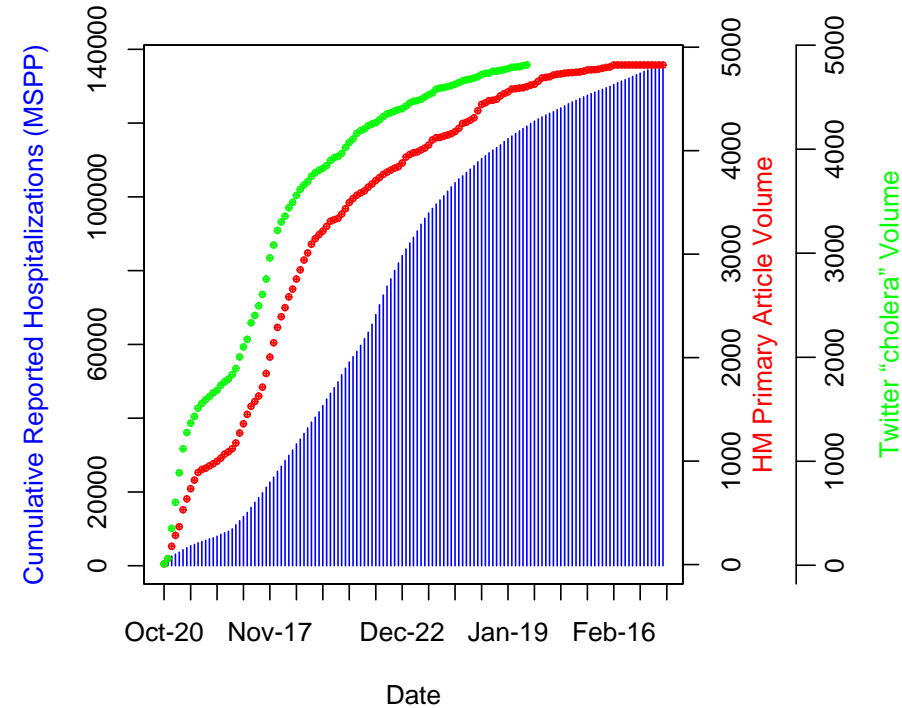
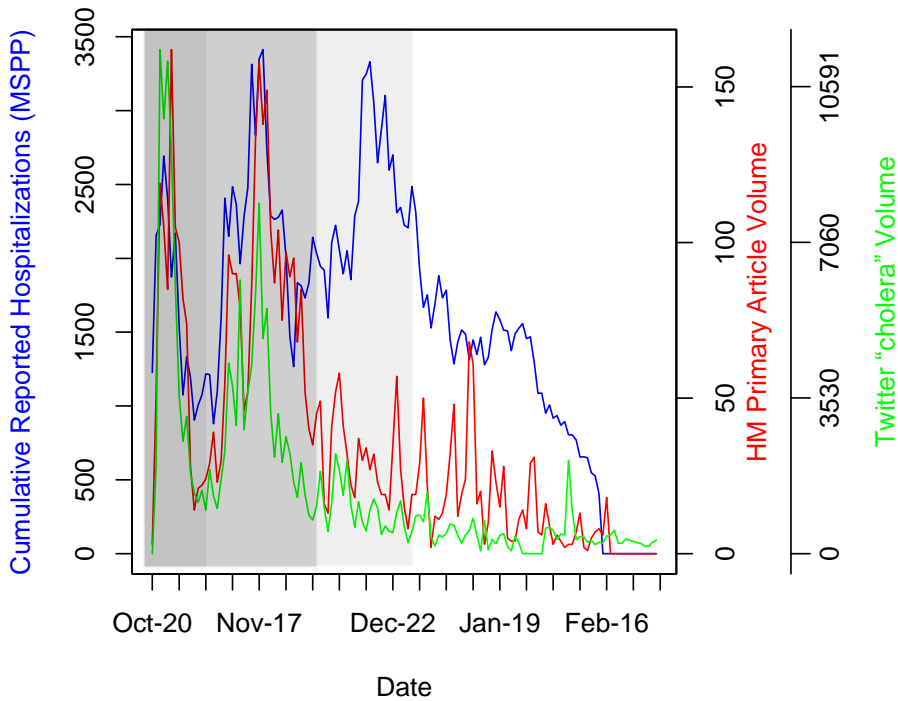
Sitting w/a father who just lost his 7-year-old to cholera. Reality
still has not hit

30 Oct



twitter

Using Social Media to Build an Epidemic Curve

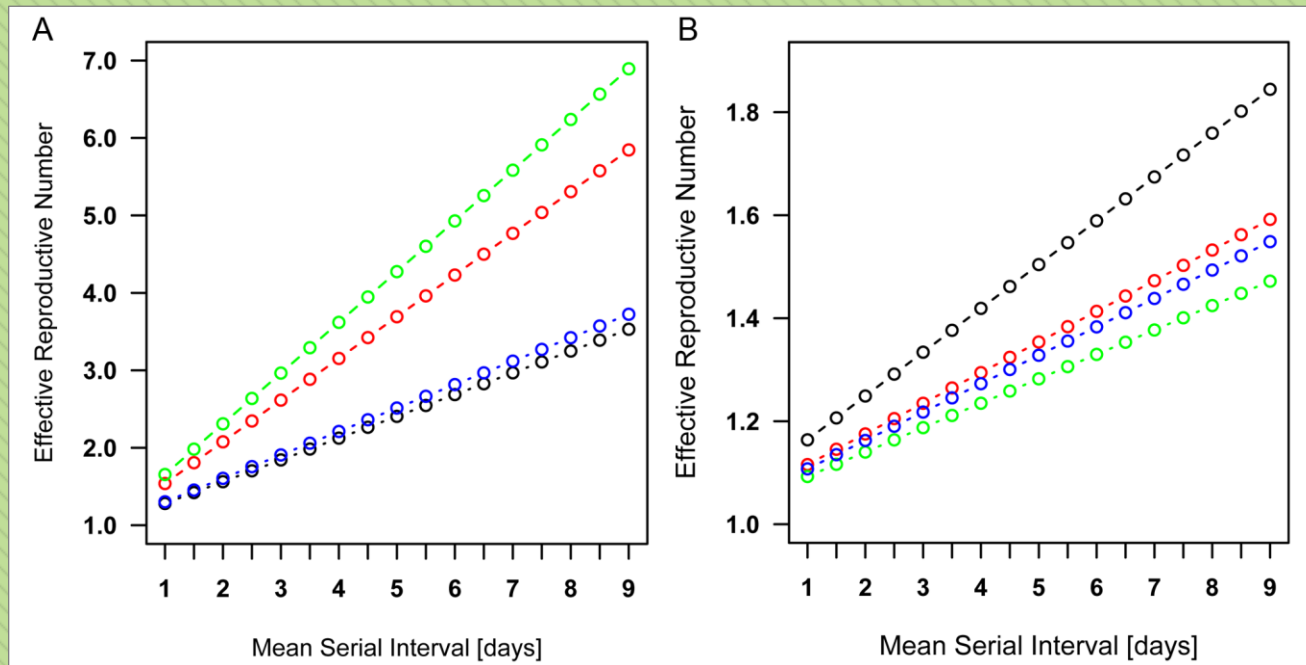


Chunara et al. 2012. American Journal of Tropical Medicine and Hygiene.

Estimate Reproductive Number (R_0)

Phase 1: Informal sources 1.54-6.89 compared to official sources 1.27-3.72

Phase 2: Informal sources 1.04-1.51 compared to official sources 1.06-1.73



Case counts

Hospitalizations

HealthMap

Twitter

Mechanical Turk

Malaria in India

Mechanical Turk

Mechanical Turk is a marketplace for work.

We give businesses and developers access to an on-demand, scalable workforce. Workers select from thousands of tasks and work whenever it's convenient.

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As a Mechanical Turk Requester you:

- Have access to a global, on-demand, 24 x 7 workforce
- Get thousands of HITs completed in minutes
- Pay only when you're satisfied with the results



India Malaria HIT

How are you feeling?

Please answer the following questions about any recent symptoms and malaria prevention habits.

1. Have you recently experienced any of the following symptoms? Please check all that apply.

- Fever Weakness Nausea Aches
- Chills Severe fatigue Vomiting Muscle pain
- Sweats Enlarged spleen Dry cough Back pain

If you are experiencing a symptom other than the ones listed above, including 'no symptoms', please indicate it here.

2. Were you recently diagnosed?

- Yes
- No

3. Please check all that apply:

- Sleep under a bednet
- Use mosquito repellent

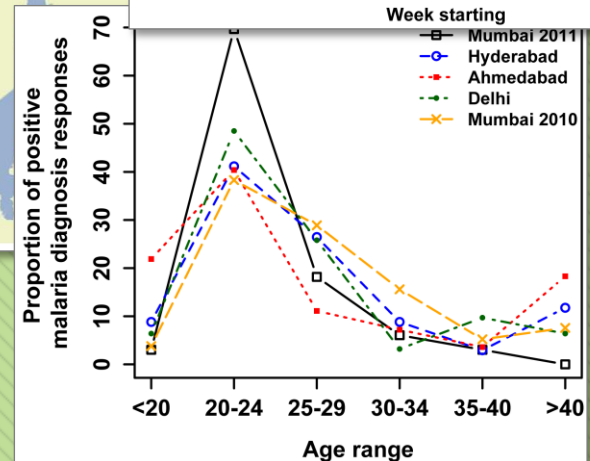
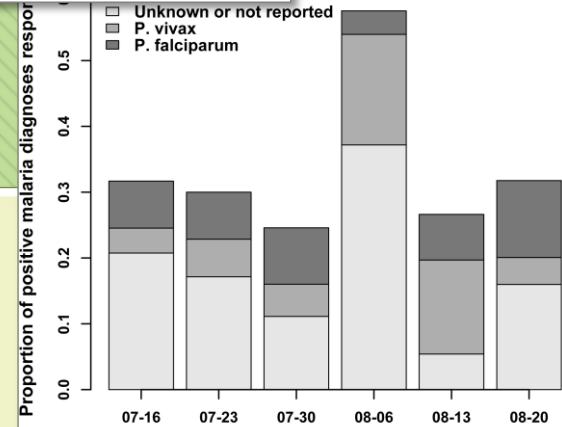
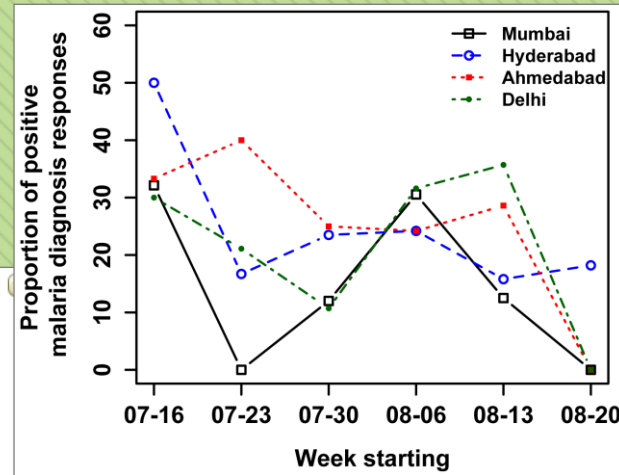
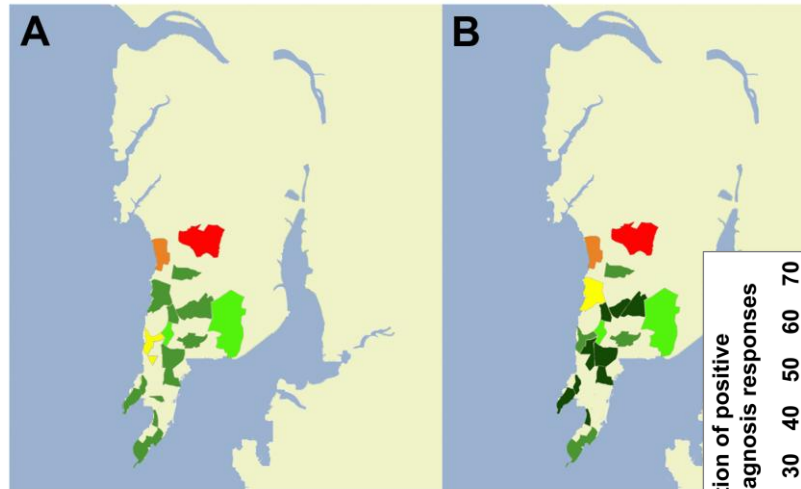
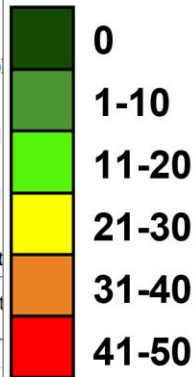
3. Please enter your current age:

4. Please enter your current city:

City:

State:

Please provide any comments you may have below, we appreciate your input!



Conclusions

- Value in the fusion and visualization of distributed electronic resources (online epidemic intelligence, social networks, mobile technology)
- Novel Internet-based collaborative systems can play an important complementary role in gathering information quickly and improving coverage and accessibility.
- These early efforts at tapping the power of digital tools demonstrate important steps in improving health systems as well as engaging the public as participants in the public health process.

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