HealthMap: Novel Sources of Information on Emerging Biological Threats

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Newsweek
SARS
What You Need to Know
The New Age of Epidemics
Potential of Digital Disease Detection

- SMS Messaging
- Micro Blogging
- Social Networking
- Internet Searching
- Emailing
- Internet Chatting
- Blogging
- Online News Reporting
- Video/Radio Reporting
- Health Expert Reporting

epidemic curve
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

- Outbreak start
- Outbreak discovery
- Public communication

$\Delta t_1$, $\Delta t_2$
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

Year of Outbreak Start

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

World Bodies (UN, WHO, FAO, OIE)

1. Public
2. Public health practitioners
3. Healthcare workers, Clinicians
4. Ministry of Health
5. Digital Disease Detection

Digital Disease Detection
The Rise of Digital Disease Detection
The HealthMap System
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

**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
  - Area 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 Centers 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
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...

Tags: Dengue, Pakistan, flood, mosquitoes

Comments
precisely placed in locations
resulting in alerts per day
the number of public and private sources we use to access more than 50,000 sites 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

4800 disease patterns

220 species

Case and Death Counts
Bayesian Filtering

Breaking News
Warning
Old News
Context
Not disease related

91% accuracy
Articles are categorized using more than 19 million phrases with 91% accuracy.

Bayesian Filtering

Warning

Breaking News

Old News

Context

Not disease related
La Jornada

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

La funcionaria de La Gloria informó que el raro padecimiento ha afectado a 60 por ciento de sus tres mil habitantes con infecciones respiratorias.
Global spread of H1N1 with informal sources

Participatory Epidemiology
Next Generation Public Health: Artificial Artificial Intelligence

community input

post to public

review

notify contributor

aggregate
Outbreaks Near Me
Direct Reporting
Is a Swine Flu Outbreak Coming? Ask Your iPhone

By Bryan Walsh
HealthMap
Outbreaks Near Me

Location, preferences

Relevant real-time alerts

2. 26-year-old falls victim to H1N1 in Mass.
   8/17/09 8:43 PM
   3 hours 39 min 26 sec ago (NECN: Boston, Mass.) - The H1N1 flu is dominating news headlines today.
   Massachusetts is reporting its 11th swine flu death, as Boston Mayor Tom Menino looks to prepare for a possible resurgence of the virus this fall. Boston

3. West Nile virus found in Boston
   8/13/09 10:18 PM
   By Stephen Smith, Globe Staff For the first time this summer, West Nile virus has been detected in mosquitoes in Boston, city health authorities said today.
   The infected insects were discovered in Jamaica Plain.
Human Report

Animal Report

Previous Report

Enter an email address to view past submissions
> 100k downloads
Android
Potential for increased global coverage
HealthMap Hotline

919-MAP-1-BUG (627-1284)
Leave a voicemail or Send SMS
Reporting through the website

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

**Provide an eyewitness report**
(something you personally know or heard about)

- **Headline:** Dead crows in park
- **Disease:** Undiagnosed
- **Location:** Park, Town 1, State A
- **Email:**
- **Description:** Dozens of dead crows.

Submit  Cancel

Or

**Share a news report**
(a news article you read online)
Submit a disease report:

Headline: 

Disease: Please select a disease

Location: 

Description:

Upload a related photo (optional): Choose File

Email: 

By submitting, you agree to the Terms of Submission.

Submit
Worldwide User Submitted Reports
iPhone Submissions vs CDC sentinel surveillance

R² = 0.74
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

- 23 Apr - PRO> Undiagnosed deaths - Thailand (06): (CM)
- 21 Apr - PRO/MBDS> Undiagnosed deaths - Thailand (05): Chiang Mai
- 20 Apr - PRO/EDR> Undiagnosed deaths - Thailand (05): (CM)
- 19 Apr - Mystery Thai illness strikes another tourist - World - Canoe.ca
Validating Undiagnosed Events by Mobile Phone

Geo-localized push messages → Validate event
Flu Near You
Influenza in the US
Flu Activity in Your Area

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

Week ending: 1/15/2012

User contributed data: (colors determined by current week of data)
- Green: No symptoms reported
- Yellow: Some symptoms reported
- Red: At least 1 person with ILI

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

Legend:
- No Report
- No Activity
- Sporadic
- Local
- Regional
- Widespread

Map data ©2012 Europa Technologies, Google, INEGI, Tele Atlas - Terms of Use
Age Distributions

Users

Household members
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?
- [ ] Fever
- [ ] Cough
- [ ] Sore throat
- [ ] Shortness of breath
- [ ] Chills/night sweats
- [ ] Fatigue
- [ ] Nausea or vomiting
- [ ] Diarrhea
- [ ] Body aches
- [ ] 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
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?
- [ ] Fever
- [ ] Cough
- [ ] Sore throat
- [ ] Shortness of breath
- [ ] Chills/night sweats
- [ ] Fatigue
- [ ] Nausea or vomiting
- [ ] Diarrhea
- [ ] Body aches
- [ ] Headache

What was your highest temperature measured?
- [ ] less than or equal to 99.9°F
- [ ] Not measured

What day did you start feeling ill?

October 2011

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Why Flu Near You?

Centers for Disease Control

Google Flu Trends
Twitter
Haiti in Cholera
Cholera Surveillance in Haiti
HealthMap Pilot, Haiti
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

_Yowinwinnie Sore throat
less than a minute ago via txt

MelissaPinkette tof RT @Tunji_O: So Lil John finally got a sore throat, I guess life can be fair, YEAHHHHHHHHHH !!!
2 minutes ago via UberSocial

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

paperclipsars 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®

heidiglamiuupsu @mdotperiod @heidiglamiuupsu 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

njnwantha Symptoms and treatment of sore throat
http://twitter.com/484Mar
2 minutes ago via web
Twitter as a predictor of influenza-like illness

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
Using Social Media to Build an Epidemic Curve

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 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.

201,002 HITs available. View them now.
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 with malaria?

- Yes
- No

3. Please check all that apply.

- Sleep under a bednet
- Use mosquito repellent

3. Please enter your current city:

4. Please enter your current 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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