Infodemiology and Infoveillance
Internet-based syndromic surveillance

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OAHPP Syndromic Surveillance Workshop 30-Mar-2009
Ontario Agency for Health Protection and Promotion

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Why Syndromic Surveillance?

• “The fundamental objective of syndromic surveillance is to identify illness clusters early, before diagnoses are confirmed and reported to public health agencies, and to mobilize a rapid response, thereby reducing morbidity and mortality.” (Kelly J. Henning, MMWR 2004, http://www.webcitation.org/5fde6JBKx)
“before diagnoses are confirmed”

In reality, many syndromic surveillance systems tap into clinical data - we know little what is going on at people’s home when they first notice symptoms, before they see/call a doctor.
I have an idea -- let’s start thinking outside the box”
What is the first thing many people do before they see a doctor (or call Telehealth Ontario), or take OTC medicines?
Before seeing/calling a doctor many people do this:
Surveillance of citizen self-assessments & status updates

Information seeking (web clickstream, etc.)
Over the counter and prescription medications
School and work absenteeism
Nurse triage telephone calls

Data types

Biological sensors

Physician office visits
EMS activity
ED visits, Hospitalizations

Orders
Laboratory tests

Preliminary diagnoses

Diagnoses

Additional evaluation

Confirmed diagnoses

Timeline

Exposure
Symptom onset
Health behavior
Healthcare encounter
Medical evaluation
Initial findings
Final diagnosis

Incubation Period

Health and healthcare behaviors

Diagnostics

Syndromic Surveillance

Adapted from Mandl 2007
The notion of “infodemiology”


The science of distribution and determinants of disease in populations

Epidemiology → Public Health Professionals

Policy Makers → Public Health Interventions

Policy Decisions

Population Health Status

Information & Communication patterns

“Infodemiology”

the epidemiology of information

Describing and analyzing information & communication patterns and its relationship to population health status
The premise

“The Internet has made measurable what was previously immeasurable: The distribution of health information in a population, tracking (in real time) health information trends over time, and identifying gaps between information supply and demand. “

Eysenbach G. Infodemiology. Proc AMIA Fall Symp 2006
“Infodemiology”
the epidemiology of information

Describing and analyzing health information & communication patterns (e.g. on the Web)
for public health purposes

Demand Metrics (search & navigation)

Supply Metrics (what’s published)

Gunther Eysenbach
J Med Internet Res 2009;11(1):e11
Infoveillance

= “using infodemiology data for surveillance purposes”

Eysenbach G
Infodemiology and Infoveillance: Framework for an Emerging Set of Public Health Informatics Methods to Analyze Search, Communication and Publication Behavior on the Internet
J Med Internet Res 2009;11(1):e11
URL: http://www.jmir.org/2009/1/e11
doi: 10.2196/jmir.1157
Infovigil
- an infoveillance prototype
Centre for Global eHealth Innovation, Toronto, in collaboration with OAHPP
Two examples

Demand-based infoveillance: Google
Supply-based infoveillance: Twitter
Demand-based infoveillance

Google searches

flu

powered by Google™
Infodemiology: Tracking demand for health information for syndromic surveillance

Eysenbach G. Infodemiology. Proc AMIA Fall Symp 2006
Correlation clicks vs next wk cases

Eysenbach G. Infodemiology. Proc AMIA Fall Symp 2006
Correlation sentinel physicians ILI reports vs next wk cases

Flu cases nxt week vs ILI

\[ R^2 = 0.5604 \]

Eysenbach G. Infodemiology. Proc AMIA Fall Symp 2006
A comparison of model estimates for the mid-Atlantic region (black) against CDC-reported ILI percentages (red), including points over which the model was fit and validated.

J Ginsberg et al. Nature 2009
doi:10.1038/nature07634
Supply-based infoveillance

Example: Twitter status updates

QuickTime™ and a decompressor are needed to see this picture.
What are you doing?

Getting headache, also some fever, think I am getting sick

Latest: @Berci @sheff TEDMED looks great but $4000 reg fee isn't for academics :-) about 4 hours ago

@epatientdave RT @mvolpe: In Toronto? Want to chat marketing? I'm speaking at SMX Analytics in TO this week and would love to meet some new friends

7 minutes ago from TweetDeck

@shockema I'd rather pick up the 10 lbs. of thawed dog dung by hand from my backyard than grade. (Guess what I did yesterday in the nice weather?)

15 minutes ago from TweetDeck

@shockema I absolutely loathe grading! (I really think the way it's typically done is immoral.)

17 minutes ago from TweetDeck

@enygma hmmm, Open Source Bridge looks pretty cool

23 minutes ago from Spaz


24 minutes ago from web
Realtime results for "i have fever"

L_i_2: sucks to be me. I have fever! Ugh... I'm listenin to gaga... 😊
about 8 hours ago from web - Reply - View Tweet

sammnmendes: im not good i have fever
about 13 hours ago from web - Reply - View Tweet

plizzo: I hate being sick. I have fever and a bad headache...
1 day ago from EventBox - Reply - View Tweet

devilvata: Doing better today. Sinus infection is getting better. Slept most of the day yesterday with some very odd dreams. I have fever dreams.
2 days ago from multwitter - Reply - View Tweet

rebecca1wu: my first time calling in for a sick day for the past six months that I've been working... because I have fever. 😞
2 days ago from web - Reply - View Tweet

jPivera010: I have fever! (36.3°C)!!
2 days ago from Tootsie - Reply - View Tweet

vaemors: @mrobb: Yeah but I have fever... must be recover for tomorrow *^*
2 days ago from web - Reply - View Tweet

AsefKchNinja: I have fever and I lost my voice! Right before spring break. I'm being punishment 😞
2 days ago from TwitterForPC - Reply - View Tweet

ambo: Done working for the night... back to the same old tomorrow morning & all freaking weekend.... & I have fever by the way- feel fine though?
2 days ago from TwitterForPC - Reply - View Tweet

CameronLady: At home. Sick. Nap time. I have fever. I also want food.
3 days ago from twitterpie - Reply - View Tweet

O_o: I have fever now 😞
4 days ago from web - Reply - View Tweet
Realtime results for cough near:toronto within:15mi

DJThorntn: @BradInToronto Best Thing Ever when you need to stop a nagging scratchy cough.
Toronto, ON (43.647000, -79.384)
44 minutes ago from TweetDeck · Reply · View Tweet · Show Conversation

JuliaBreton: Just had a cough drop that makes your mouth numb - horrific experience mimicking the dentist...who likes those things??
Toronto
about 2 hours ago from web · Reply · View Tweet

87 Winkler: Back from the Dr. I have a cough @Carolyn has tennis elbow
Toronto
about 4 hours ago from web · Reply · View Tweet

poDIt: FB John has taken his Tylenol and is off to cough at rude people at the farmer's market. http://f.ly/an.uk/7Pe
Toronto
about 4 hours ago from twitterfeed · Reply · View Tweet

Procthy: @polturnerwerty puking 4 year olds, never fun. glad to hear he is feeling better. my four year old has a cough out come the inhalers.
Toronto
about 6 hours ago from web · Reply · View Tweet · Show Conversation

Nouraz: Probably gonna have to go to the doctors cuz of this cough. Shit.
Toronto
about 16 hours ago from twitterific · Reply · View Tweet

TeamBE: Damn! cough took out my voice so I couldn't record...and lost out on an opportunity...DAMN DAMN DAMN!
Toronto
about 16 hours ago from web · Reply · View Tweet

Nouraz: Jeeze. Cough is driving me nuts.
Toronto
1 day ago from TweetDeck · Reply · View Tweet

maloimbitser: @cryst0066 Hey, so I start work & I'll finally meet you Monday!
Realtime results for sick

7 more results since you started searching. Refresh to see them.

ATLBEATBATTLE: headache, headcold, sick n da head...need a nap!
less than 20 seconds ago from 7TweetDeck · Reply · View Tweet

kraitweets: brooklyn botanic garden conservatory out my window, not feeling
manhattan-sick at all!
less than 20 seconds ago from TwitterGadget · Reply · View Tweet

Laegpilant: today's been a shitty day... 8 hours shift, so freaking sick, starts
closing, not in LA for the biggest hit concert and on so much more. ...
less than 20 seconds ago from web · Reply · View Tweet

CindyWMorrison: @wrigley a strep strain resistant to meds?! Say it isn't so! How
long has she been sick? Poor thing! That's horrible!
half a minute ago from SocialStapa · Reply · View Tweet · Show Conversation

MTA, NYC: http://bit.ly/HlJg (was) UPDATED: QNS, F train, Sick Customer: F
train service has resumed with residual delays. http://mta.info/mtadelay (was)
half a minute ago from twitterfeed · Reply · View Tweet

Sk eligible: powers activated

operator@ @agony I'm calling I sick so you don't et sick
half a minute ago from TwitterBerry · Reply · View Tweet

Moxiesoda: So sick of snow. Been out shoveling snow on to my driveway.
half a minute ago from web · Reply · View Tweet

mrch2020: Daniel, you sick for making twitter sound dirty. Thank you very much.
Chris, you suck too. That is all.
half a minute ago from twitterific · Reply · View Tweet

aconsecrets: Slick Puppies "War". http://hwt.fm/15505
half a minute ago from web · Reply · View Tweet
Realtime results for #sick

_1r_: Good morning. F**k. Have a running nose and I am coughing. Getting #sick ?
about 13 hours ago from TwitterForDesktop - Reply - View Tweet

strebel: Moved from the bed to the couch. #sick
about 18 hours ago from TwitterForDesktop - Reply - View Tweet

keithrobinson: Taking it easy at home ... stupid cold #sick
about 18 hours ago from web - Reply - View Tweet

twista: dextromorphan-acetaminophen-phenergan-pharmacal-propoxyphene-paracetamol. #sick
sleep-deprived #struggling #unsynchronized.
about 19 hours ago from web - Reply - View Tweet

borning: Taking misery to an all new level. Super congested & even my ears is full up. #sick
about 19 hours ago from TwitterForDesktop - Reply - View Tweet

lonnybov: there is no cow bell big enough to cure my fever right now. #sick
about 21 hours ago from web - Reply - View Tweet

Loseman: paul blart mall cop - really bad movie. you need a real story to make a
good movie. #sick of bad movies#
1 day ago from web - Reply - View Tweet

darren: @sophistication why did i hear “i am face” at the end of that spot? #sick
1 day ago from iVentureBox - Reply - View Tweet - © Show Conversation

keithrobinson: I’ve got like half a cold, not enough to stop me or anything, just a tad
annoying. #sick
1 day ago from TweetDeck - Reply - View Tweet

keithrobinson: @sabian ex: a guy wrote he was #sick . He then got a tweet from a
cold and flu company “Sorry to hear your sick here’s a coupon for NyQuil”.
1 day ago from TweetDeck - Reply - View Tweet - © Show Conversation
<table>
<thead>
<tr>
<th>TAGS</th>
<th>PEOPLE</th>
<th>TEXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>#earthhour</td>
<td>mathjibson: Did Julie look me? #Earthhour? about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#followfriday</td>
<td>manamae: #FollowFriday! Very! on #followfriday! LOLL about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#tctc</td>
<td>noonhup: #earthhour is a test run for their socialbot updates, tweeting in the dark, cold and insensible, winning at MotherEarth. #tctc about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#f1</td>
<td>kerriyng: @OBamapresser. Couldn’t believe they cut away from the press conference this morning #f1 about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#mwv2</td>
<td>codew2: #mwv2 far cry map editor would so fuckckkking pump every game in the world if it had about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#fb</td>
<td>wafizh82: Sitting at the Betty Brinn Children’s Museum with the two loves of my life. I love my sweetie! #fb about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#joopbandfilms</td>
<td>impactVilla: See all the results of the #joopbandfilms game at Or do your own! You funny people... about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#gov20camp</td>
<td>harvins: size matters @mobaplace #gov20Camp about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#bcrn2</td>
<td>twase_dg: LQ! Wünsche allen noch einen schönen Abend beim #bcrn2 - wie gekern noch wird sehr lang. Wir bedenken... about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#voteearth</td>
<td>cindyh: “Now it’s dark.” - Frank Beauch - #earthhour #voteearth about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#pycon</td>
<td>far on: In John Wayne A. #mycol openspace at 3 pm (about 25 min) #pycon about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#quote</td>
<td>anttatan: RT @stotlesslo: RT @HemaiRadio: The Universe has infinite solutions, but you have to ask for solutions, not problems #tto #tto #tto about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#cdigita109</td>
<td>davideiras: @redigita109 @crowdemonster guys who penso, atrevem-se a donar-los aquest poder, si realmente som 20% podem que tem por de fechar? about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#wam09</td>
<td>#wam09: Legislation in Congress to make sure Net Neutrality will be law. Need to push Democrats as well as Republicans. #wam09 about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#jobs</td>
<td>jobs_use: The 100 Best Resources for an Online Job Search via @InterviewBest #jobs #jobs #jobs about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#d2daily</td>
<td>gp332: Mist @AndyFlanagan at #2010daily sadly. Was he great? about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#hrs</td>
<td>cthohnni: Oakland school board to change the name of school to #BarackObama Academy on his 64th day in office #TCTC about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#go20</td>
<td>olivjason: @BarackO2Olmay. I was wondering exactly the same thing. seemed very low. something to do with #go20 about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#teaparty</td>
<td>mason: There’s nothing wrong with the people who voted for Obama that becoming taxpayers won’t cure. #teaparty #teaparty #teaparty about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#fedw</td>
<td>blairwaver: Fedw Não esquece da voz última viral de T. Motila no Youtubes. about an hour ago</td>
<td></td>
</tr>
<tr>
<td>#tweetmyjobs</td>
<td>tiny_trch_energy: General Engineer Energy Manager #RichmondVA #EnergyJobs about an hour ago</td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Rate</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>chicken pox</td>
<td></td>
<td></td>
</tr>
<tr>
<td>feeling ill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>flu</td>
<td></td>
<td></td>
</tr>
<tr>
<td>food poisoning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>headcold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sore throat</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
@jillianlillian Zicam doesn't speak lolcat, but it does provide coupons to the sick! http://cli.gs/MhhUhS

@money Sounds like you're on the right track! Here's a Zicam coupon for next time: http://cli.gs/MhhUhS
9:46 AM Mar 27th from web in reply to money

@LaneEllen Glad to hear it!
9:45 AM Mar 27th from web in reply to LaneEllen

@spudhat1 That's no fun...have you heard of Zicam? Homopathic, and sometimes you will be tweeted a coupon: http://cli.gs/MhhUhS
9:44 AM Mar 27th from web in reply to spudhat1

@KateHarding Sounds great! Don't forget a coupon next time: http://cli.gs/MhhUhS
9:52 PM Mar 26th from web in reply to KateHarding

@msamelson Thanks for the support!
4:01 AM Mar 26th from web in reply to msamelson

@suchpretty You sound like you could use some Zicam, stat: coupon? http://cli.gs/MhhUhS
2:48 PM Mar 26th from web in reply to suchpretty

@LucyOnDvA We hope so too; check out Zicam! http://cli.gs/MhhUhS
4:06 PM Mar 26th from web in reply to LucyOnDvA

@Beersandeve Happy to hear it, thanks!
3:56 PM Mar 25th from web in reply to Beersandeve
Get a coupon

Fill out the form below and we’ll give you a downloadable .pdf coupon that you can print right now.

Enter your first name: *

Enter your last name: *

Enter your email: *

☐ Yes! Contact me with any news, updates, or special offers.

Remember me

We will not sell or distribute any of your personal information to any outside organization.

Submit
Syndromic Surveillance 2.0

Actively involving the public
City or Zip Code: m4l3y7

Number of days ago sickness began: 1

- Runny nose (Stuffy nose/Sneeze/Allergies)
- Cough (Sore throat)
- Fever (Chills)
- Head ache (Dizzy)
- Muscle ache (Body ache/Tired)
- Stomach ache (Diarrhea/Nausea/Vomit)

More Symptoms?

Age

Male  Female

More Details


Posted By: Anonymous
Age: 44
Gender: Male
Start date of sickness: Mar 15, 2009
Symptoms: Fever Chills Head ache
Dizzy
Comments:

Tell a friend

Flag this post as spam

0 Comment(s)
Internet (Twitter/Google)-based surveillance esp. appropriate for

- Symptoms which are **noticable** for the consumer (and bothersome enough to microblog about it or search information)
- Conditions with long lag time between **preclinical** symptoms and presentation at Emergency Department / Physician
- Symptoms in **younger** people (18-55 yrs)
- Can obtain **further information** (ask about other symptoms) through rapid online questionnaire and/or direct consumer to interventions
Real outbreak or “epidemic of fear”?

Other traditional surveillance data

Real epidemic

Public Health response to suspected outbreak

Infoveillance Data

Epidemic of fear

Public Health response to surge in information needs

Even in the absence of any predictive value for outbreaks data can be used:
-to improve health communication
-Learn about population behavior + knowledge
-Build consumer health vocabulary

Duct tape sales rise amid terror fears
From Jeannie Neesun
CNN
Tuesday, February 11, 2000 Published: 7:30 PM EST (00:30 GMT)
WASHINGTON (CNN) -- Americans have apparently heeded the U.S. government's advice to prepare for terror attacks, emptying hardware store shelves of duct tape.
Infoveillance

• Applicable for infectious diseases

• But also for chronic conditions (monitor misinformation, consumer information needs, information gaps)
QuickTime™ and a decompressor are needed to see this picture.
Editorial

Infodiemilogy and Infoveillance: Framework for an Emerging Set of Public Health Informatics Methods to Analyze Search, Communication and Publication Behavior on the Internet

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Abstract

Infodiemilogy can be defined as the science of distribution and determinants of information in an electronic medium, specifically the Internet, or in a population, with the ultimate aim to inform public health and public policy. Infodiemilogy data can be collected and analyzed in near real time. Examples for infodiemilogy applications include the analysis of queries from Internet search engines to predict disease outbreaks (e.g., influenza), monitoring peoples’ status updates on microblogs such as Twitter for
Questions / Discussion points

• **Application Areas**: For which conditions (concepts) is “infoveillance” useful?
  – Which keywords/syndromes should we monitor?
  – What further information should we gather (rapid questionnaires)?
  – Who are the primary users for this system?
Infovigil
- an infoveillance prototype
Centre for Global eHealth Innovation, Toronto
QuickTime™ and a decompressor
are needed to see this picture.

“Your proposal is innovative. Unfortunately, we won’t be able to use it because we never tried it’s something before.”
Count what is countable, measure what is measurable. What is not measurable, make measurable.

[Galileo Galilei]
QuickTime™ and a decompressor are needed to see this picture.

Thanks for your attention!
Thank you!

Gunther Eysenbach MD MPH

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www.jmir.org
Twitter: eysenbach
HealthMap
Global disease alert map

[Map interface with various disease alerts and country-specific information]
Something else to consider…
Toronto tops the Twittersphere

MATT HARTLEY
Globe and Mail Update
December 23, 2008 at 11:25 AM EDT

Toronto is the Twitter capital of the Great White North and home to one of the largest collections of Twitter users in the world, according to a new report from market tracking firm HubSpot Inc.

In the company's quarterly "State of the Twittersphere" report, Toronto places eighth on a list of the Top 30 locations on Twitter, based on the supplied biographical information of Twitter users, while Canada ranks No. 13.

London tops the list, followed by the United States generally, then San Francisco, New York and Chicago.

Internet Links
• Follow us on Twitter: Get the latest updates from @GlobeTech
• Globe Technology
• Tech Gift Guide: Searching for the perfect gadget: Dozens of gizmos and games reviewed

The popularity of Twitter – a micro-blogging service which allows users to update their status, create friend lists and post mini messages limited to 140 characters or less using either a computer or a cellphone – has exploded in 2008, with the service's user base jumping 600 per cent this year.

The power of the service's Toronto user base as on display earlier this month when an ad hoc group of

http://www.webcitation.org/5feNVCZnv
Accuracy of IP geolocation

- 98% accuracy on country-level
- Within-country accuracy:

<table>
<thead>
<tr>
<th>Countries</th>
<th>Correctly Resolved Within 25 Miles of True Location</th>
<th>Incorrectly Resolved More Than 25 Miles from True Location</th>
<th>Not Covered on a City Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>87% (87%)</td>
<td>12%</td>
<td>1%</td>
</tr>
<tr>
<td>Canada</td>
<td>82% (82%)</td>
<td>17%</td>
<td>1%</td>
</tr>
<tr>
<td>China</td>
<td>77% (79%)</td>
<td>22%</td>
<td>1%</td>
</tr>
<tr>
<td>Korea, Republic of</td>
<td>71% (82%)</td>
<td>16%</td>
<td>13%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>46% (60%)</td>
<td>30%</td>
<td>24%</td>
</tr>
<tr>
<td>United States</td>
<td>81% (85%)</td>
<td>15%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Source: GeoIP, http://www.webcitation.org/5TIPdsZ5m