

A dark blue world map with numerous small, light blue dots scattered across the continents, representing global monitoring of vaccination conversations. The dots are more densely clustered in North America, Europe, and parts of Asia.

Vaccine Sentimeter:

Global monitoring of vaccination conversations

Chi Bahk, MPH
VP Operations

epidemico

| Disclosures

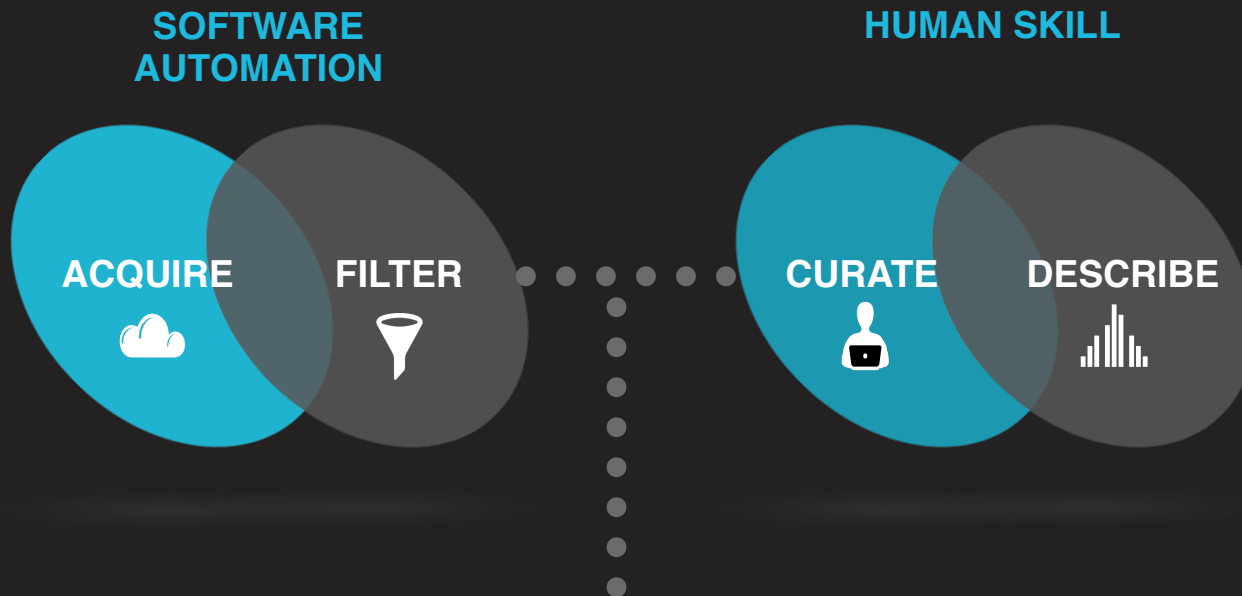
- This research was funded in part by Sanofi Pasteur.
- This research was conducted in partnership with ProMED-Mail and Sanofi Pasteur.
- Epidemico commercializes the information technology aspects of this research.

Goals

- Build a publicly available online tool to facilitate real-time monitoring of vaccine confidence
 - To be used by public health professionals
- Assess utility of the tool

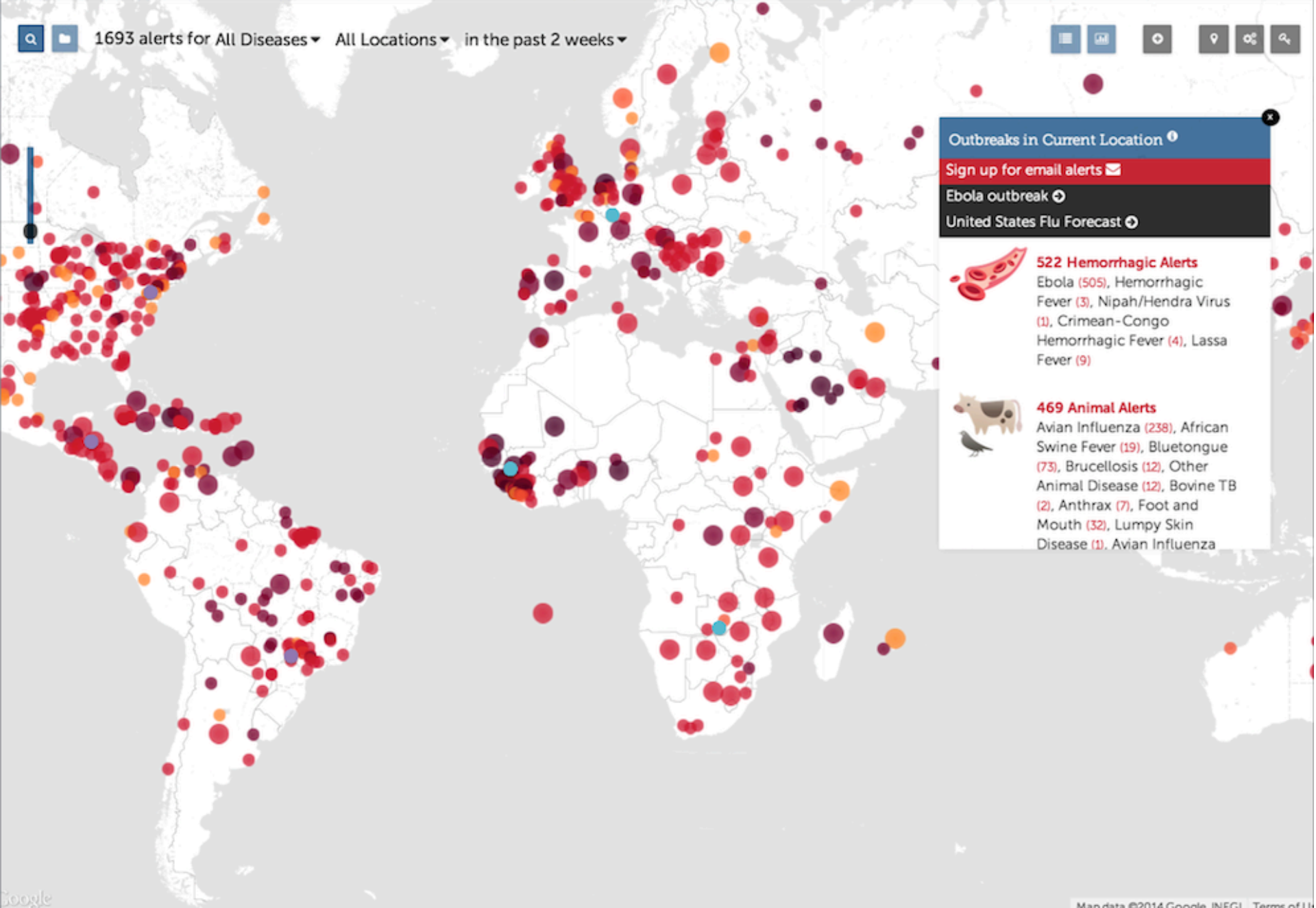
Technology

Analyzing social media relies on machine- and human-dependent processes.



Improve data tools for efficiency

Natural language processing (NLP) and machine learning tools can assist in reducing human burden.



Outbreaks in Current Location ⓘ

Sign up for email alerts ✉

Ebola outbreak ↻

United States Flu Forecast ↻



522 Hemorrhagic Alerts

Ebola (505), Hemorrhagic Fever (3), Nipah/Hendra Virus (1), Crimean-Congo Hemorrhagic Fever (4), Lassa Fever (9)



469 Animal Alerts

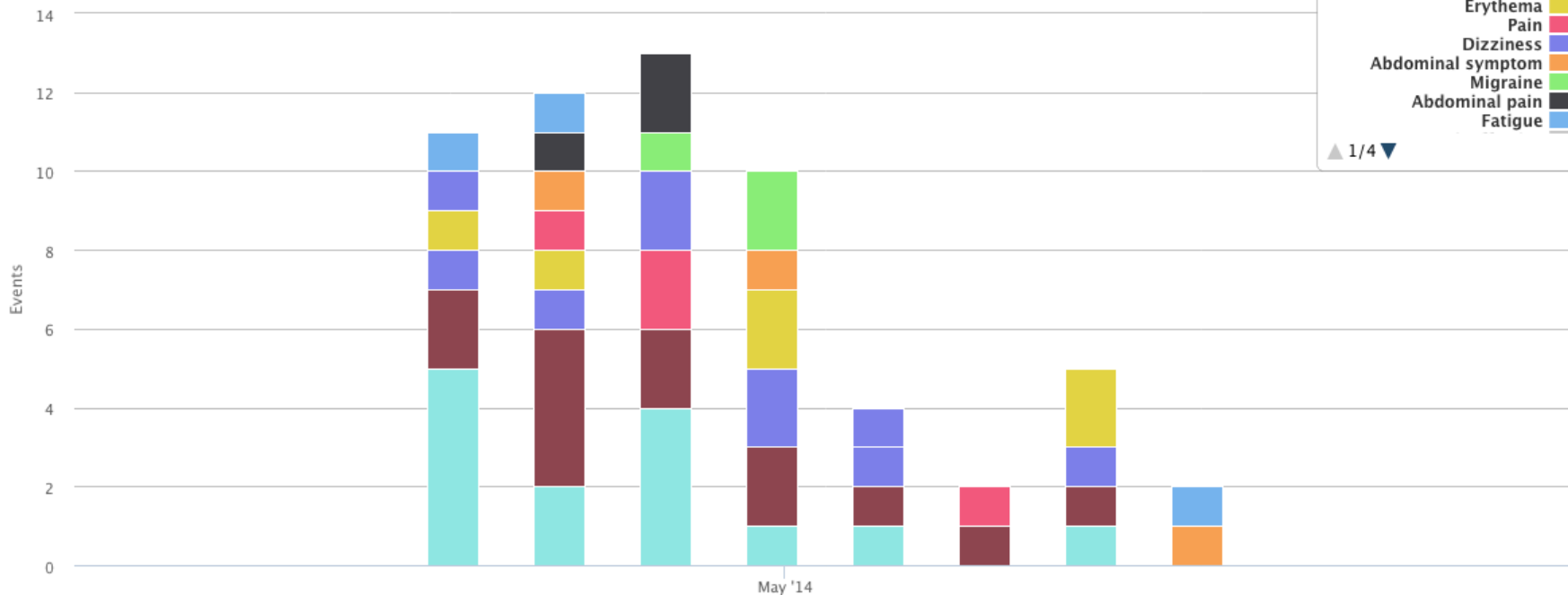
Avian Influenza (238), African Swine Fever (19), Bluetongue (73), Brucellosis (12), Other Animal Disease (12), Bovine TB (2), Anthrax (7), Foot and Mouth (32), Lumpy Skin Disease (1), Avian Influenza





Events

per week



Twitter

Facebook

Forums

Export

Contextualize

Hide

Post

Search post texts

or set filters »

Date

Indicator

Actions



First day on # Tecfidera . Four hours in and face is tingling . I'll take it over stomach issues any day! #sideeffects #facetingling #MSisBS

05/31/2014

0.77979



Having a nasty relapse ATM. Woke up this morning from being on steroids for 5 days. Skin and subcutaneous tissue disorders - Erythema (referring to Tecfidera).

05/26/2014

0.9906



...took the evening # Tecfidera an hour later than normal and am up with side effects . I look like a lobster . #MsSucks

05/26/2014

0.82486



@user the Tecfidera acne is AWFUL and nothing works on it :(

05/20/2014

0.90057



Applications of Core Technology

Domains:

infectious disease,
drug side effect,
vaccine sentiment,
hospital sentiment,
supply chain issues



Geography:

global coverage,
experience in 15
languages



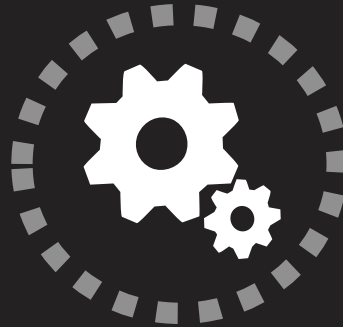
Data sources:

mainstream news,
social media,
publications,
crowdsourced



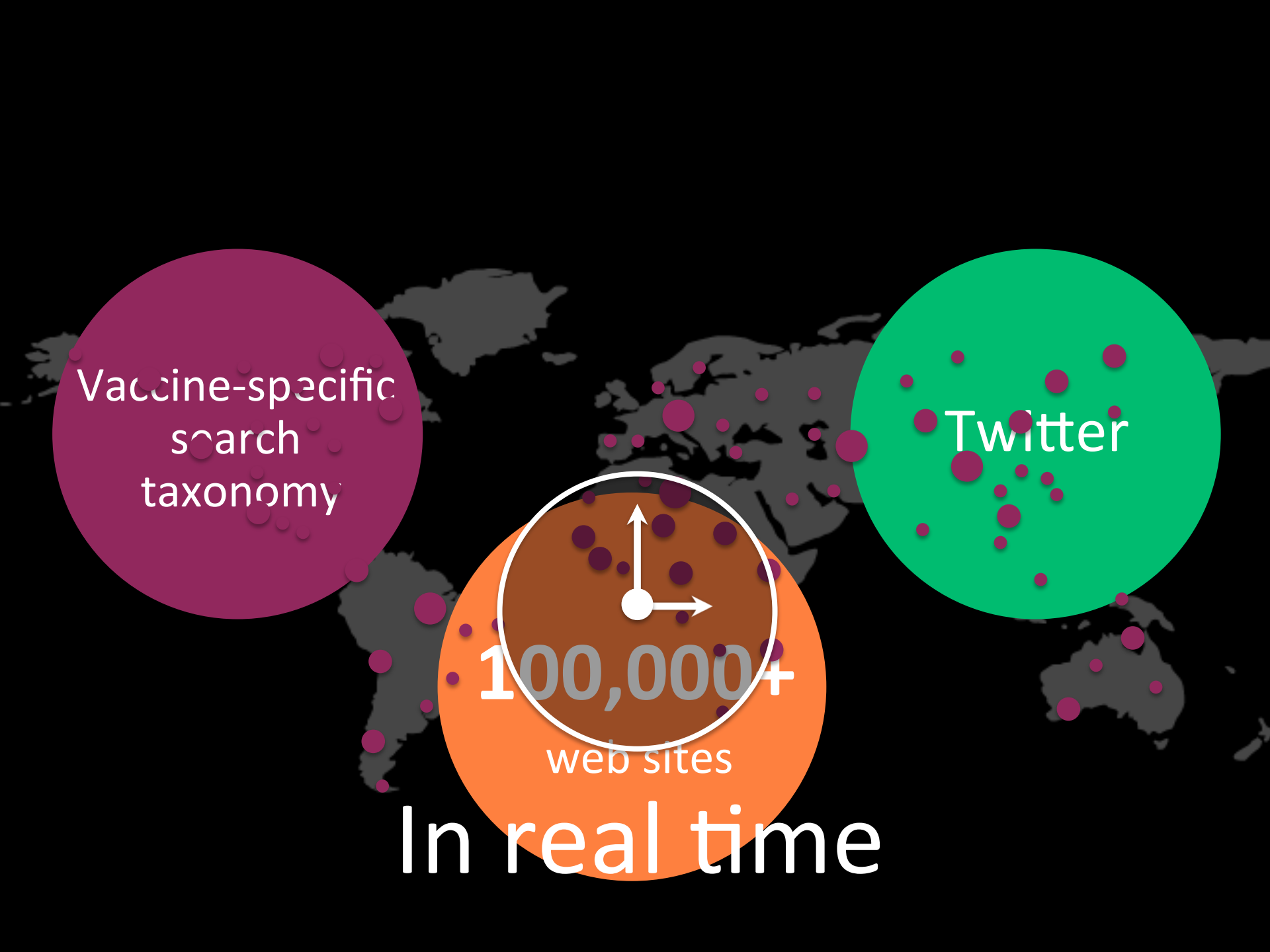
Output:

real-time dashboard,
data API,
periodic report



Application: Vaccine Sentimeter





Vaccine-specific
search
taxonomy

Twitter



100,000+
web sites

In real time



Wednesday, November 26, 2014



Fox6news.com

“They’ve Been Robbed of Their
Womanhood” – Local **Milwaukee** Media
Covers **Gardasil Vaccine** Injuries



if you'd ever HAD shingles, you'd realize that death isn't that bad of an option... Avoid this hell with the shingles vax #vaccineswork

Sentiment = 0.80



would NOT recommend the new meningitis
vaccine literally cannot move arm without
wanting to cry

Sentiment = -0.875

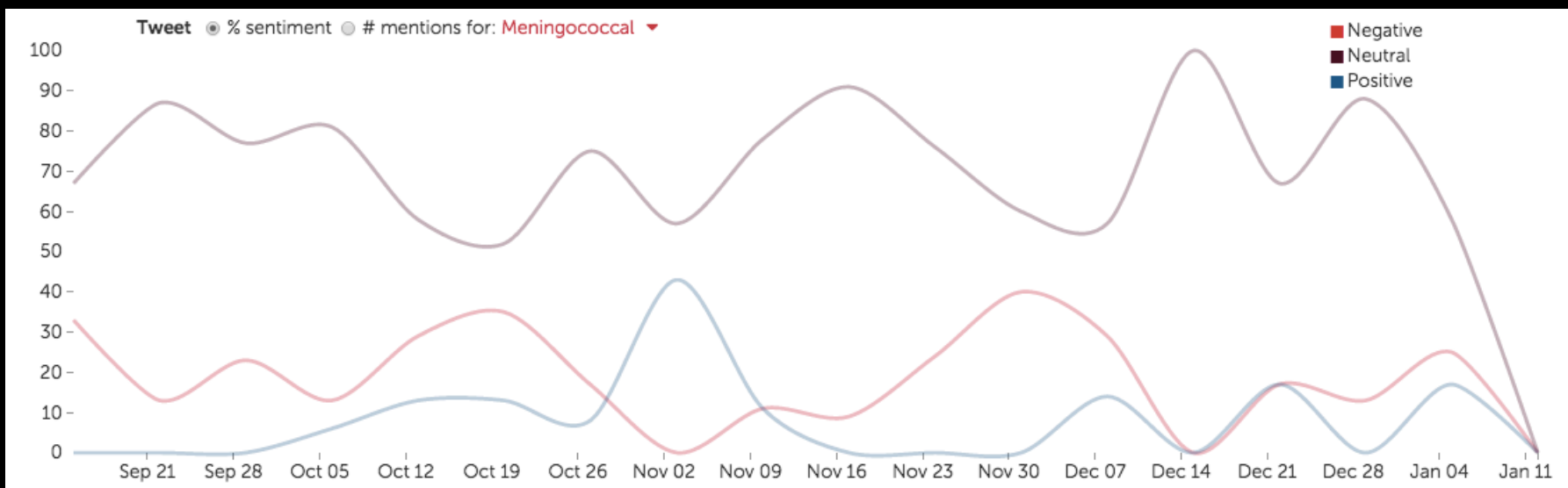
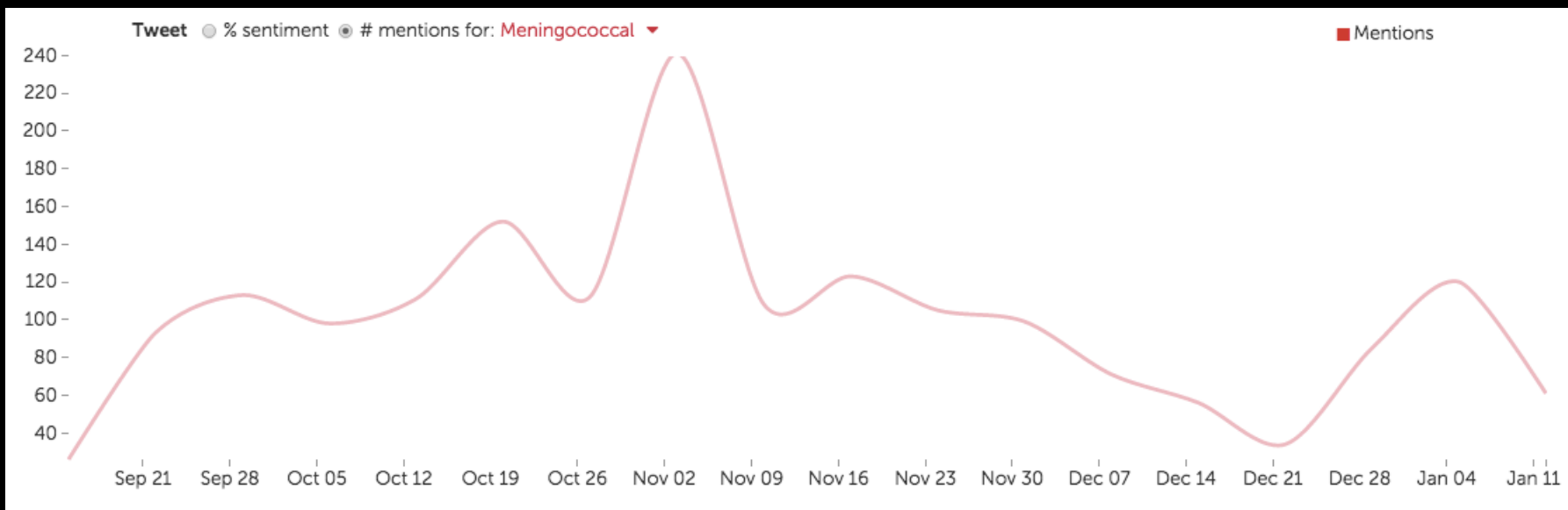


Categories

- AEFI (Autism, death, general, Immune System, Mild, Miscarriage, Narcolepsy, Neurological damage, Paralysis, Fertility, Fever, Seizures...)
- Beliefs (Conspiracy theory, Philosophical, Religious, Socio-cultural)
- Contamination
- Cost
- Disease Burden
- High Profile Individual
- Lack of Awareness/Information
- Mass campaign
- Motives (Business, Political)
- New product
- Outbreaks
- Programmatic error/issue/conflict
- Recommendations (by HCW, by health organization, by journalist, by lay person, by parent, by religious leader)
- Supply
- Vaccine refusals

Date	Summary ▼	Vaccine	Category	Sentiment	Location
2014-11-21	"Robbed of Their Womanhood": Teens After Human Papillomavirus (HPV ... - Center for Research on Globalization	HPV	AEFI - Fertility	Negative	United States
2014-11-18	They've Been Robbed of Their Womanhood Local Milwaukee ...	HPV	AEFI - Fertility, AEFI - General, Motives - Business, Beliefs - Conspiracy theory	Negative	United States
2014-11-10	Mass sterilization: Kenyan Doctors Find Anti-fertility Agent in UN ...	Tetanus/NOS	Beliefs - Conspiracy theory, Beliefs - Religious, Fertility, Programmatic Error/Issue/Conflict	Negative	Kenya
2014-11-19	Zoster Vaccination in Patients with Rheumatoid Arthritis: Time to Change the ... - HCPLive	Shingles	Research, Recommendation by HCW	Positive	United States
2014-11-20	Yemen concludes children's vaccination campaign - Al-Shorfa	Measles/NOS, Rubella/NOS, Polio/NOS	Mass Campaign, Strategy - Delivery	Positive	Yemen
2014-11-14	Yellow Fever Vaccine - Only One Dose Required for Immunity - AllAfrica.com	Yellow Fever	Recommendation - Policy, Vaccine Effectiveness	Positive	Cameroon
2014-11-24	WSU students asked to have mumps vaccination - KXLY Spokane	MMR	Recommendation by HCW	Positive	Washington State, United States
2014-11-19	Wrangling over life-saving meningitis vaccine may cost hundreds of children's lives - The Independent	Meningococcal	Programmatic Error/Issue/Conflict, New Product, Recommendation - Policy, Cost	Positive	United Kingdom

Vaccination conversations on Twitter are visualized by mentions and sentiment trends over time



Uptick in mentions and positive sentiment attributed to Meningitis Now campaign

Meningitis Now calls on Government to stop vaccine delay

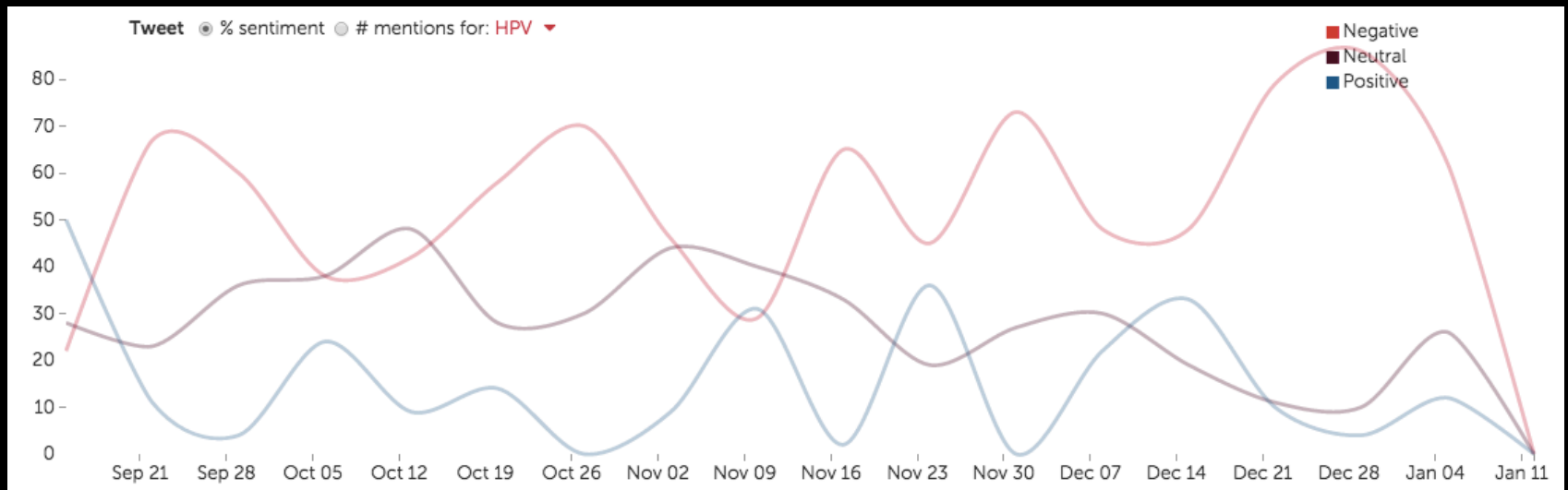
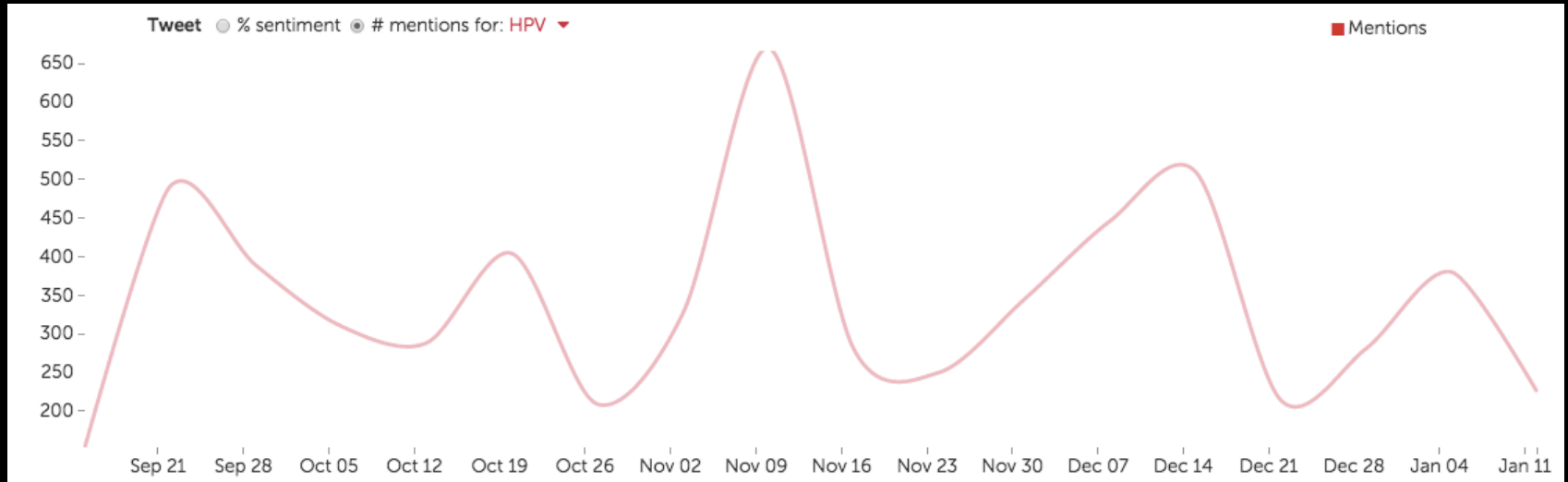


Stroud MP Neil Carmichael with Meningitis Now Young Ambassadors Chloe Stuart and Mollie Gobey from Bridgewater in Somerset

First published Wednesday 5 November 2014 in News



Public perception of HPV vaccine is captured in high # mentions and in high % of negative sentiment



By Chi Y. Bahk, Melissa Cumming, Louisa Paushter, Lawrence C. Madoff, Angus Thomson, and John S. Brownstein

Publicly Available Online Tool Facilitates Real-Time Monitoring Of Vaccine Conversations And Sentiments

ABSTRACT Real-time monitoring of mainstream and social media can inform public health practitioners and policy makers about vaccine sentiment and hesitancy. We describe a publicly available platform for monitoring vaccination-related content, called the Vaccine Sentimeter. With automated data collection from 100,000 mainstream media sources and Twitter, natural-language processing for automated filtering, and manual curation to ensure accuracy, the Vaccine Sentimeter offers a global real-time view of vaccination conversations online. To assess the system's utility, we followed two events: polio vaccination in Pakistan after a news story about a Central Intelligence Agency vaccination ruse and subsequent attacks on health care workers, and a controversial episode in a television program about adverse events following human papillomavirus vaccination. For both events, increased online activity was detected and characterized. For the first event, Twitter response to the attacks on health care workers decreased drastically after the first attack, in contrast to mainstream media coverage. For the second event, the mainstream and social media response was largely positive about the HPV vaccine, but antivaccine conversations persisted longer than the provaccine reaction. Using the Vaccine Sentimeter could enable public health professionals to detect increased online activity or sudden shifts in sentiment that could affect vaccination uptake.

Two Cases Studies

1. July 11, 2011 publication of a story in the *Guardian*, a British national daily newspaper, about a fake vaccination campaign orchestrated by the CIA in Pakistan
 - VS data from May 2012 to May 2014
 - 5,964 relevant mainstream media reports and 39,308 relevant tweets



EXHIBIT 1

Mainstream Articles And Tweets About Polio Vaccine In Pakistan Per Month, May 2012–May 2014



SOURCE Vaccine Sentimeter (Note 4 in text). **NOTES** Twitter data for May–September 2012 were unavailable. CIA is Central Intelligence Agency. WHO is World Health Organization.

Two Cases Studies

2. December 4, 2013 episode of *Katie*, the US television personality Katie Couric's show on the ABC network, titled "HPV Vaccine Controversy"
 - VS data from November 2013 to Jan 2014
 - 160 relevant mainstream media reports and 1,534 tweets



EXHIBIT 2

Mainstream Articles And Tweets About Human Papillomavirus (HPV) Vaccine Per Week, August 2013–July 2014

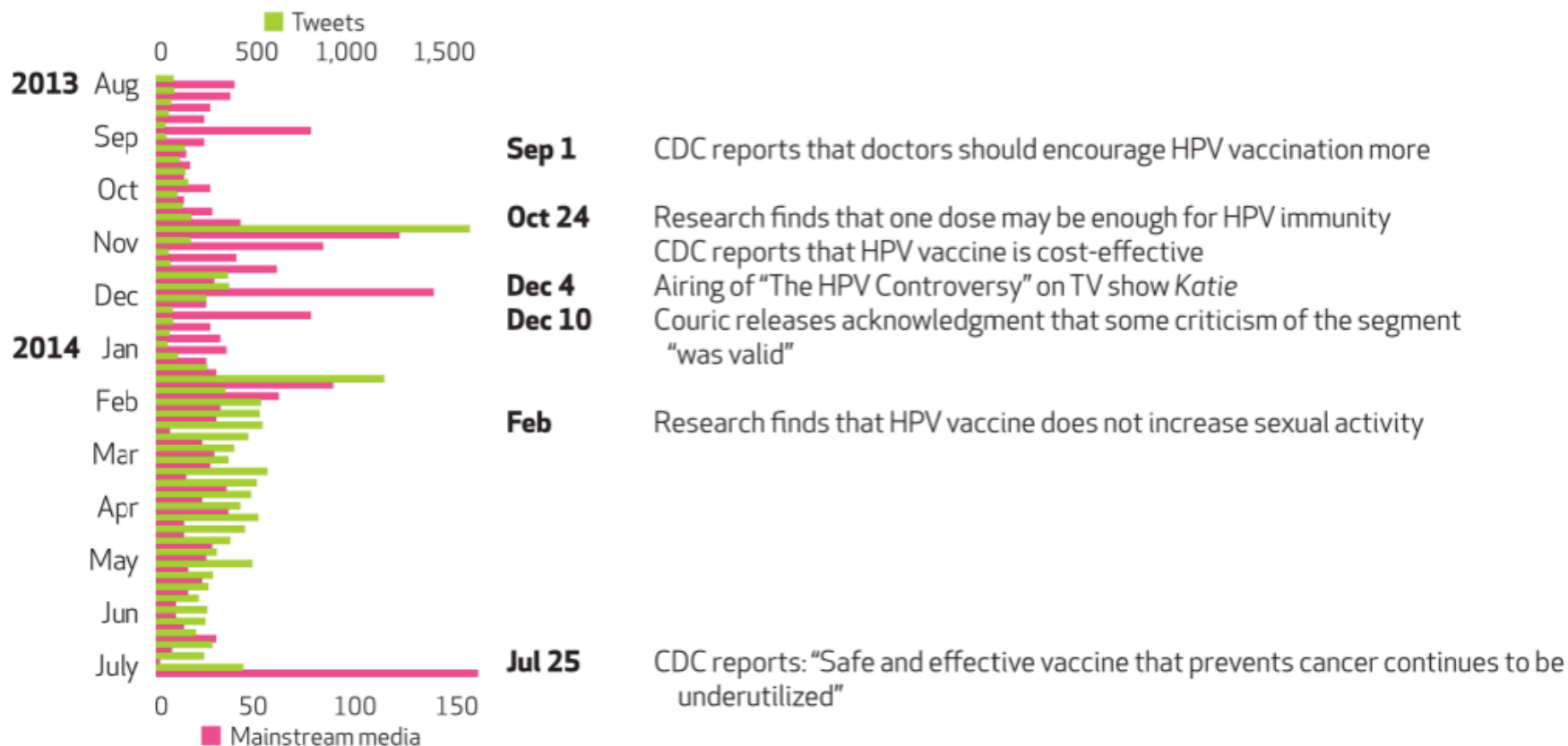
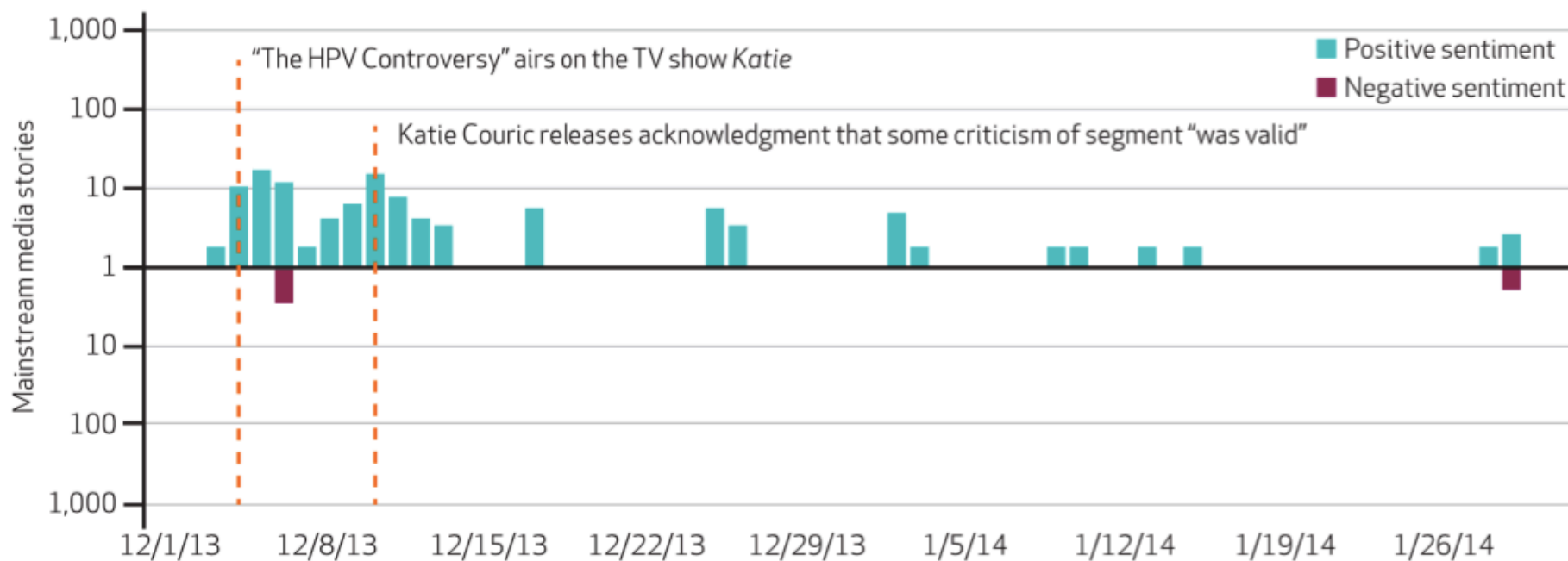


EXHIBIT 3

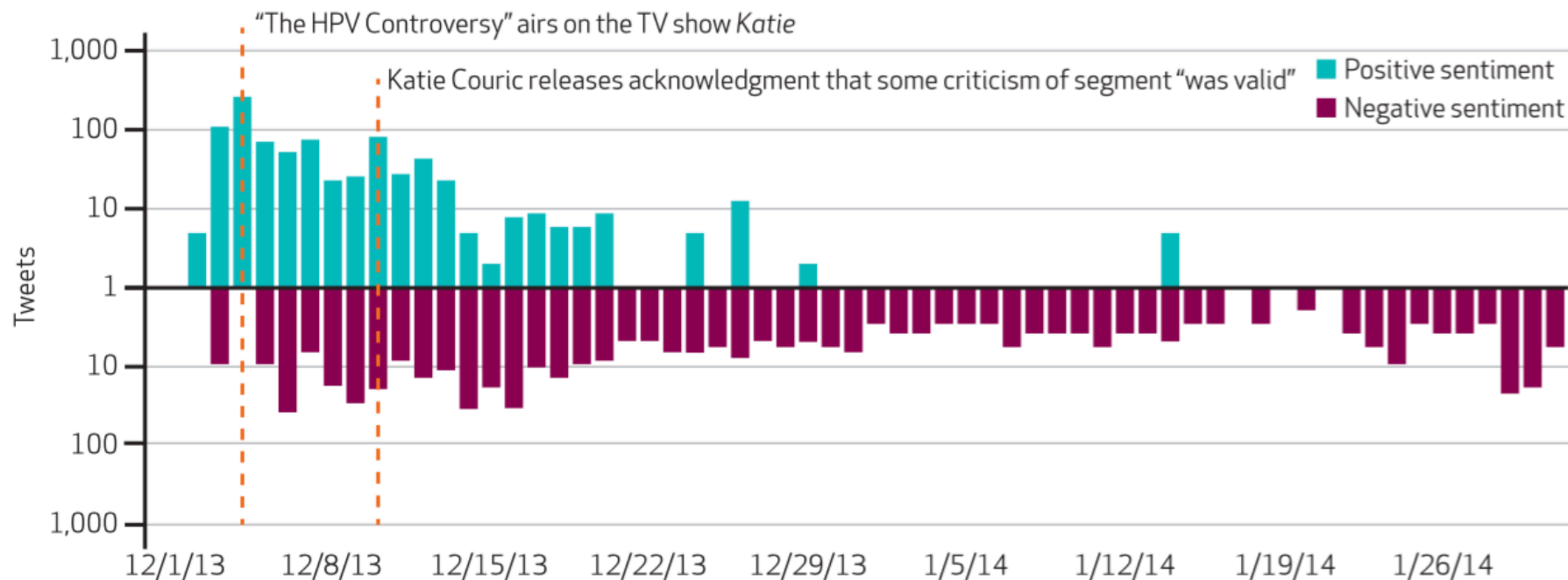
Volume And Sentiment Of Mainstream Media Activity Referencing Broadcast Of “HPV Vaccine Controversy” Segment, Per Day, December 2013–January 2014



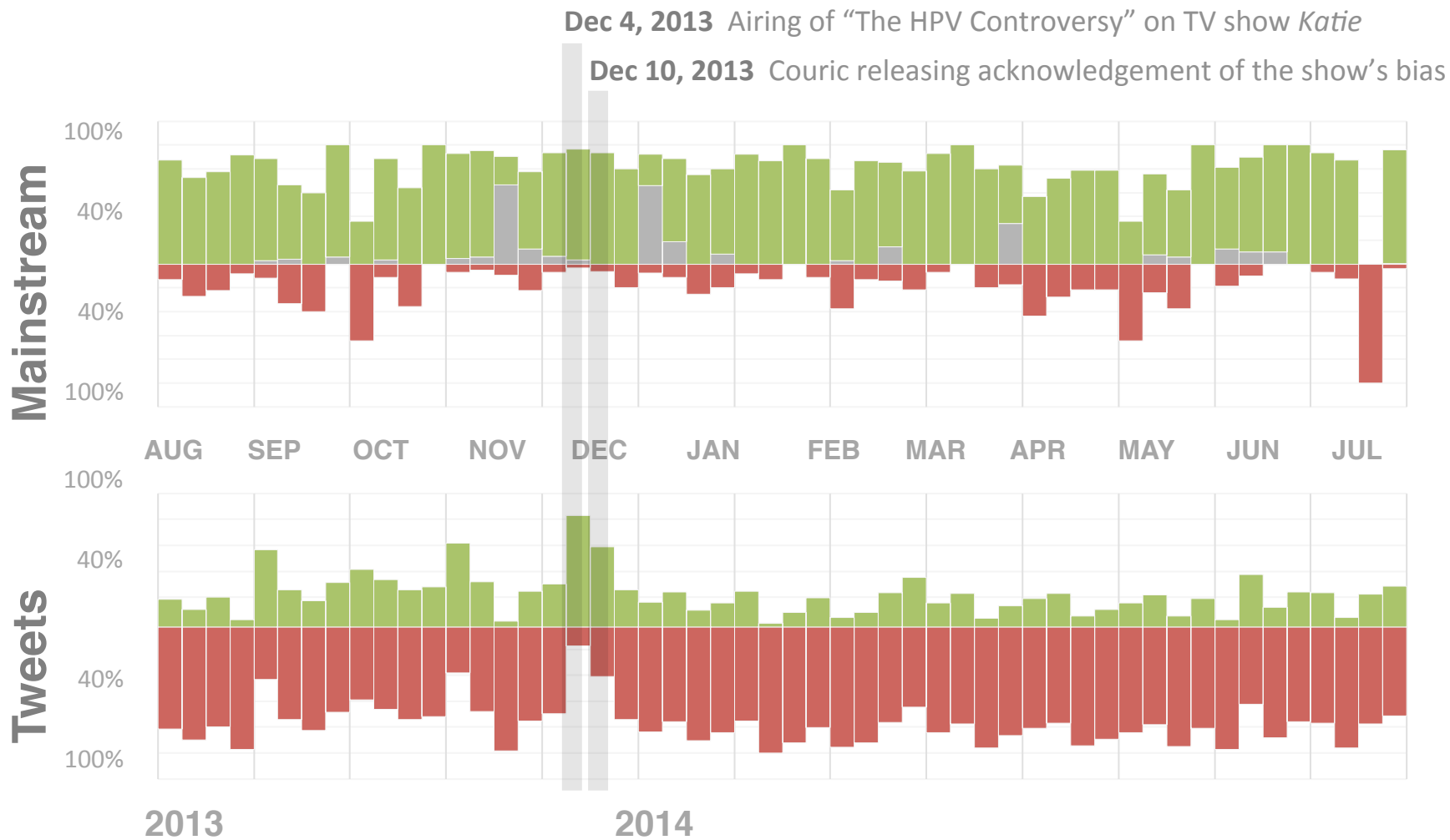
SOURCE Vaccine Sentimeter (Note 4 in text). **NOTE** The y axis uses a log scale.

EXHIBIT 4

Volume And Sentiment Of Tweets Referencing Broadcast Of “HPV Vaccine Controversy” Segment, Per Day, December 2013–January 2014



SOURCE Vaccine Sentimeter (Note 4 in text). **NOTE** The y axis uses a log scale.



Discussion Points

- Can detect signals that may relate to vaccination uptake
- Can help anticipate, understand, and respond to the public's questions and concerns
- Important differences between mainstream and social media
- Additional work to be done:
 - additional data sources
 - overlay downstream factors
 - increased/improved automated processing
 - sustained operation of tool

QUESTIONS?

