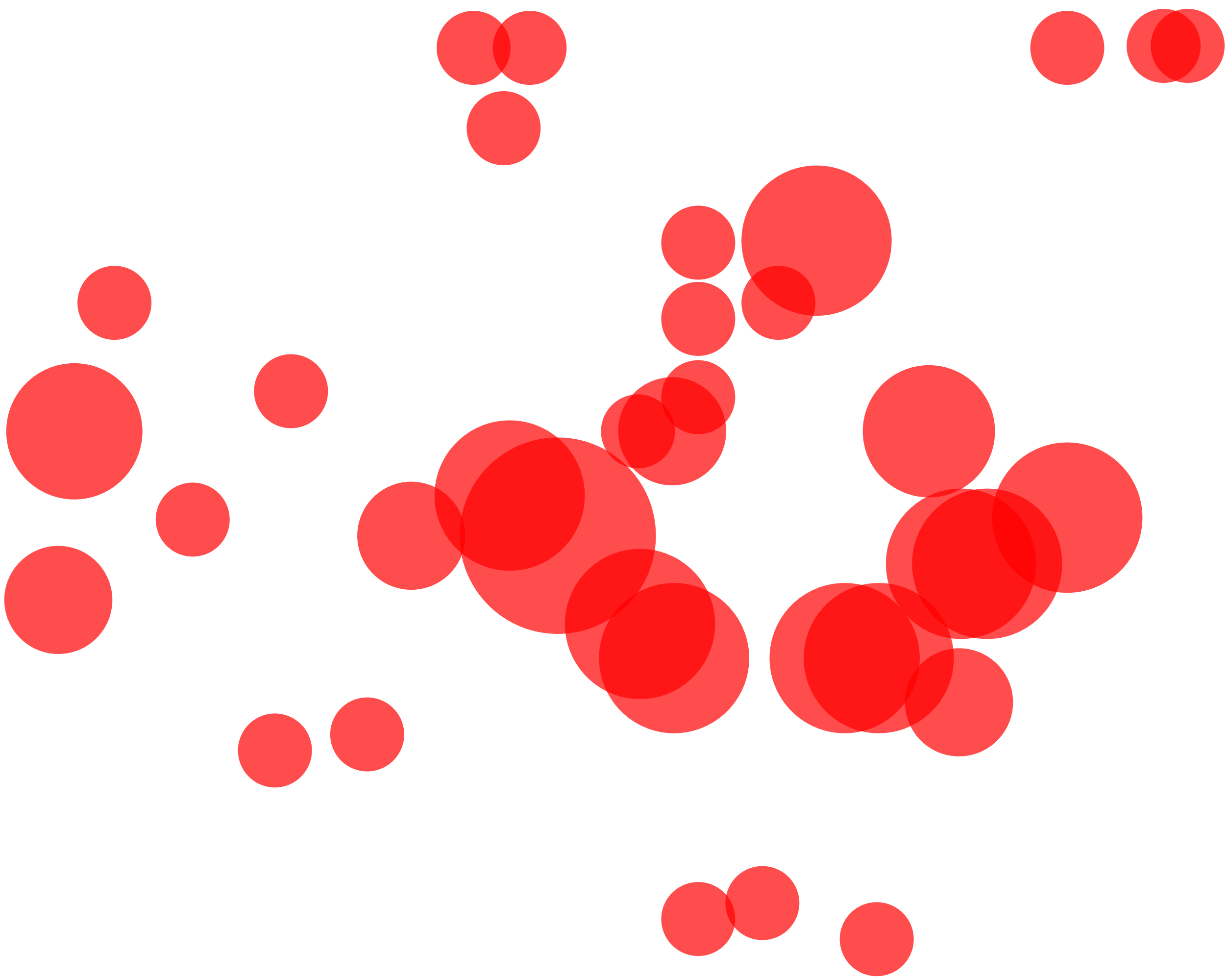
Mapping *Crisis*

Joseph Pavey



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INTRODUCTION

Humankind has always experienced crisis. Sickness and disease have plagued our lives and led to countless deaths for as long as human beings have walked the earth. But recent advances in geo-information systems, data aggregation, and mobile communications technology are helping us invent systems to better track and respond to outbreaks of disease. Technologies as simple as SMS are making it easy and inexpensive for individuals everywhere to provide on-the-ground updates. In addition, sophisticated online platforms are able to intercept this data in real-time, providing context and clarity to help health officials and emergency workers make critical decisions regarding response.

This powerful combination of what writer Steven Johnson calls, "...bottom up intelligence and top down distribution..." has the power to save lives.[1] It is one of the most profound ways in which communications technology can help change our world. And it is a field in which innovations have only just begun.

THE LONDON CHOLERA OUTBREAK OF 1854

In the late summer of 1854, the Soho district of London experienced a sudden rash of deaths due to cholera. Over the course of ten horrific days more than 600 people in the small West End neighborhood died from the disease. To this day, it is still considered the worst outbreak of cholera the United Kingdom has ever experienced.[2]

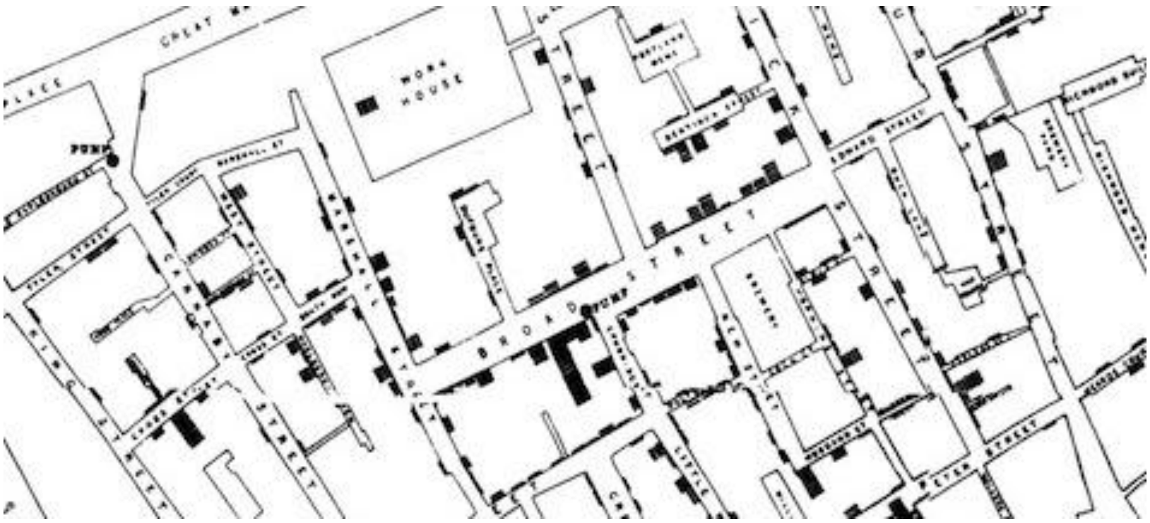
At the time of the outbreak it was widely believed that cholera was an airborne sickness. The outbreak occurred in one of the poorer districts in London, and most people blamed the deaths on pollution.

Physician and medical theorist John Snow believed differently. Based on evidence from previous epidemics, he was convinced that bacteria in contaminated water transmitted cholera. In the days immediately following the outbreak Snow set out to prove his theory.

It took more than just a simple sample from the water supply for Snow to isolate the cause of the plague. A great deal of medical detective work, aided by some of the most sophisticated methods of gathering and analyzing data available at the time, finally confirmed his hypothesis.

The British government had been tracking the names of deceased citizen since as far back as the 1600s. But it was only in the mid-1840s that they expanded their records to include variables such as the parish where the deceased had lived, and their cause of death. The office of Registrar-General collected this data and released it every seven days in a record called Weekly Returns.[3]

By the time of the 1854 outbreak, the information available from these Weekly Returns was rich enough that Snow could track who was dying from cholera, where they lived, and where they had died. Snow took these statistics and laid them on top a map of London. Doing so showed him that a majority of the deaths had occurred in a small area of the neighborhood that drew its water from a single source: a pump located on Broad Street.



The handle was removed from the pump after Snow’s discovery, blocking the neighborhood’s ability to draw water from the contaminated supply. New reports of cholera slowed, and then eventually stopped. Through the patient analysis of John Snow, London’s cholera epidemic of 1854 became what may have been the first outbreak of disease effectively neutralized by the science of analytics.[4]

AGGREGATING HEALTH DATA ONLINE

In the 150 plus years following those harrowing days in London, advances in communications technology have continually improved the ability of health officials to gather data about global health epidemics. However, it is the massive increase in connectivity provided by the Internet and the World Wide Web that has lead to some of the biggest advancements thus far.

In 1997, the Public Health Agency of Canada launched an early prototype of a tool that would help change the face of disease awareness. The Global Public Health Intelligence Network, or GPHIN, was an online early warning system for tracking outbreaks of disease worldwide. This sophisticated software engine crawled news feeds in Arabic, English, French, Russian, Chinese, and Spanish, filtering data for new reports of disease. Any relevant information it discovered was forwarded to

GPHIN workers who could then analyze the data for accuracy. The filtering system was highly automated, enabling nearly real-time parsing of reports from a staggering number of sources.[5]

Before 2002, the United Nations received all its information about infectious diseases from the World Health Organization. By 2003, 75% of that information was coming from GPHIN.[6] Then came the SARS incident. In late 2003, GPHIN was able to accurately detect a SARS outbreak in the Guangdong region of China nearly three full days before the World Health Organization. Experts around the world took notice.[7]

In a field where early detection and quick response could mean the difference between containment and global pandemic, GPHIN's success stood out as a huge achievement in both health and information technologies. A success that caught the attention of people in both industries, and inspired a man whose life's work spanned both fields to take these ideas even further.

A Passionate Plea

The Technology Entertainment and Design conference (aka TED) is a gathering of intellectuals, artists, and technologists, held annually in California. At the 2006 conference, Dr. Larry Brilliant was awarded a prize for his lifetime of achievements in the field of epidemiology. Brilliant has spent his life on projects as varied as preventing blindness in Asia and Central America, to helping co-found the Well, an early online community. Brilliant is best known for his leadership on a massive project in India in the 1970s that helped eradicate small-pox.[8]

In a passionate twenty-minute presentation, Brilliant implored the crowd at TED to "...build a powerful early warning system to protect our world from some of its worst nightmares."[9] For Brilliant, the solution presented by GPHIN was too limited. The fact that the reports it flagged still needed to be sifted through one by one limited the speed and functionality of the system. Plus, GPHIN was accessible only to experts, and lacked data visualization tools to help lend context to the mass of data it gathered. What GPHIN offered was doubtlessly a better system than anything that had come before it. But in a world where information was rapidly becoming both participatory and open, GPHIN felt like a throwback to the Web 1.0 era.

During a 2006 interview with Wired magazine, Larry Brilliant further described his vision for what a future health monitoring system might look like: "I envision a kid (in Africa) getting online and finding that there is an outbreak of cholera down the street. I envision someone in Cambodia finding out that there is leprosy across the street."[10]

It is not hard to hear echoes of John Snow's 1854 cholera map in Brilliant's dream of freely available, geo-visualized health information. But the scale of Brilliant's vision would be unimaginable to the

Victorian era doctor. As extraordinary as it might seem, at the time Brilliant plead his case at TED, work had already begun on a project that closely resembled it.

ACROSS THE MAP

Launched in September of 2006, just 7 months after Brilliant’s TED appearance, the website HealthMap.org is a system for tracking epidemics that addresses some of the shortcomings of GPHIN. The site’s engine crawls the WHO database, Google News feeds, and medical discussion forums for relevant data. Instead of merely forwarding a string of emails when stories are flagged, HealthMap sorts information into categories based on keywords and displays the data on an interactive world map. Users of the site can drill down through the data into categorical displays that group related alerts, disease specific information, and chronological timelines.[11]

Equally important, HealthMap is accessible to anyone with a connection to the World Wide Web. John Brownstein, a professor at Harvard Medical School, and co-founder of HealthMap.org, describes the philosophy behind the platform: "The idea of HealthMap is to get filtered, valuable information to the public and public health community in one freely available resource.”[12]

The HealthMap application pushes the boundaries of real-time disease tracking beyond the previous benchmarks achieved with GPHIN. Its automated search system works by crawling information from a great number of vetted sources of information including news aggregators like Google News, professionally curated emailing lists such as ProMED-mail, and health related RSS feeds. More traditional sources of health data such as the World Health Organization database are also input. This system has proven highly reliable, and highly effective. Between October 2006 and November

2007, HealthMap.org processed over 35,749 alerts regarding activity in over 202 countries and semiautonomous territories.[13]

But the populist ethos of HealthMap's model for visualizing information does not carry over into its aggregation scheme: 92.8% of its data still comes from major news sources.[14] If Larry Brilliant is right, and the mantra for these services needs to be "...early detection, early response..."[15] a more useful filtering system may be one that that incorporates data submitted by trained individuals operating in the field as well.

Disease epidemics frequently start in Africa and Asia. In these areas the key to getting health information faster will come from solutions that close the "last mile" gap. In other words, by building data gathering systems that can accurately and effectively monitor activity in small villages and rural areas that have not traditionally been well connected to regional hospitals.

Many of these places have relatively low Internet penetration. Therefore communications sources outside of the Internet need to be looked to for both finding and distributing this information. Fortunately, in recent years, a number of new tools have arrived that allow for this kind of aggregation.

MOBILE TOOLS FOR GATHERING DATA

Mobile phones have been rapidly adopted worldwide, with over 5.6 billion subscriptions estimated to be active by the end of 2010. In the same time frame, mobile penetration is expected to reach 68% overall in the developing world. This statistic is somewhat skewed by high adoption rates in Asia and the Pacific Rim regions. But even in Africa, where communication networks are still very limited, penetration is expected to reach 41% by this time.[16] In places where computers and laptops are scarce, and landlines nearly non-existent, mobile phones are heavily relied upon for distance communication.

For this reason, any health-watch platform tracking activity in low resource environments could benefit from incorporating SMS messages from trusted sources as one of the indicators in their data aggregation strategy. One of the most popular and flexible systems for gathering and organizing such messages is FrontlineSMS.

FrontlineSMS is a freely available, open-source system for collecting, distributing, and organizing text messages in a computer database. Cambridge, UK programmer Ken Banks first conceived the software in 2005.[17] FrontlineSMS allows messages to be sent from any handset and received using either a GSM modem, or an SMS enabled phone tethered to a PC. This SMS to PC functionality offers users a flexible system for organizing, filtering, and integrating messages into databases or software applications. Since the system does not require an Internet connection to work it is especially well suited for use in countries with limited Internet access.

The open-source nature of the FrontlineSMS software has led to a number of specialized implementations targeting specific needs. Among these is the recently released FrontlineSMS:Medic. This distribution of the platform gives community health workers a fast and easy way to send and receive medical information from remote locations.

Earlier this year, the team behind FrontlineSMS:Medic extended the functionality of their platform with a beta software plug-in they call PatientView. The PatientView plug-in gives users the ability to categorize patient information into forms via text message. These forms can then be submitted back to regional health centers where the information can submitted directly to an Internet or GSM modem connected PC. This allows information to be submitted to experts quickly, and over long distances, in a format that can more easily be searched and managed.[18]

In the half a decade since its 2005 launch, the FrontlineSMS platform has been used for such diverse purposes as elections monitoring in the Philippines and disaster relief in Chile, to distributing weather information to farmers in Mongolia. One of the most high profile implementations has been its use in combination with the Kenyan software platform Ushahidi.[19]

TESTIMONY FROM THE CROWD

Sometimes it takes a tragedy to inspire a great idea. The creation of the Ushahidi is one such case. During the days immediately following the Kenyan presidential election of December 28, 2007, the country was in crisis. The outcome of the election was in dispute, resulting in a wave of politically motivated violence that spread across the nation. With a government blackout placed on mainstream news, Kenyan native Ory Okolloh decided to use her blog as a way to reroute information around the embargo.

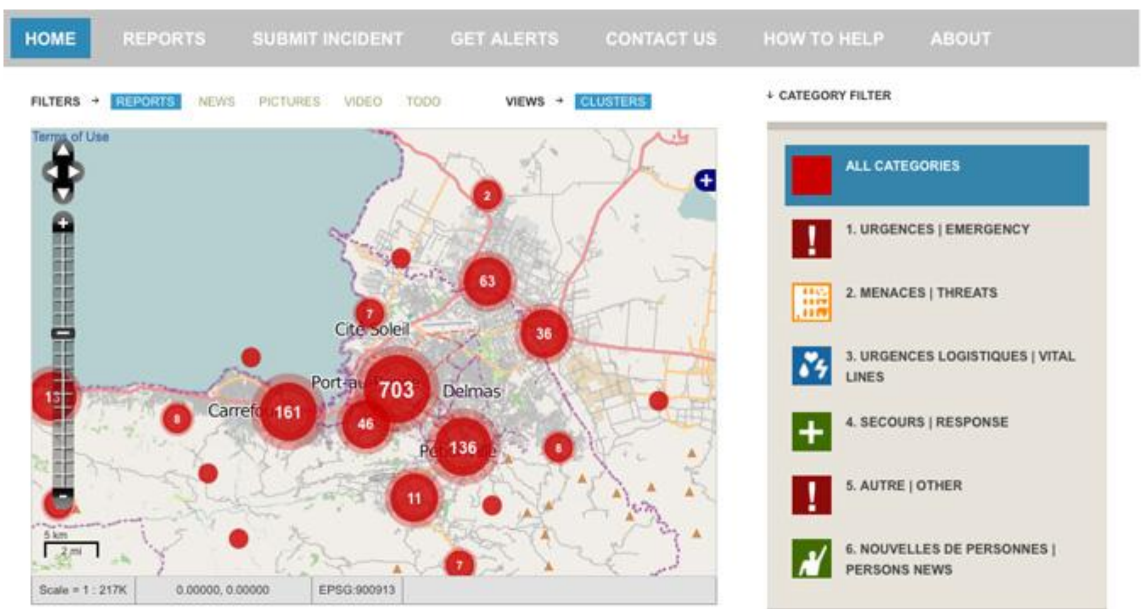
Okolloh initially updated her website with information from reports by rival political parties. But when she asked for individuals to send her their own stories and reports, her website became a rallying point for concerned Kenyans around the world. Almost immediately Okolloh became inundated with stories from citizen journalists eager to share first hand experiences and spread awareness about the situation on the ground. The mass of information Okolloh received quickly became too much for her to parse through alone.[20]

Overwhelmed by the response, Okolloh put a post up on her website to find people interested in helping create a central repository where the information she was receiving about the crisis could be collected and plotted on a map. Her request was simple and informal: “...any techies out there willing to do a mashup of where the violence and destruction is occurring using Google Maps?”[21]

Her request did not go unanswered, and within three days of her original post, the first version of this new site went live.[22]

Okolloh named the site Ushahidi, a Swahili word meaning witness or testimony. The site leveraged the open APIs of FrontlineSMS and Google Maps to allow reports sent via text message to be uploaded to the site and displayed geographically. Ushahidi became instrumental in helping bring attention to the crisis in Kenya, and Okolloh and her collaborators went on to form a non-profit organization that continued to develop Ushahidi for public use. The platform has since been used for collecting and visualizing data for purposes as diverse as mapping crime incidents in Georgia, reporting incidents of child abuse in Benin, and wildlife tracking in Kenya.[23]

But it was in 2010 during the aftermath the earthquake in Haiti that Ushahidi came of age. On January 12th, only two hours after the 7.0 magnitude earthquake took place, Ushahidi's Haiti crisis map went live. Volunteers at Tufts University in Boston worked for days on end gathering



information to help save lives.

An SMS code, 4636, was set up to receive incoming messages. Since cellular tower triangulation is often inaccurate, users were asked to send text messages containing "need and address." (Straw, 2010) Volunteers would map the coordinates and push this information to aid groups like the Red Cross who could assist.[24]

Over the 25 days following the earthquake the volunteer team had mapped over 2,500 individual reports, and saved hundreds, if not thousands of lives.[25] This marked the single most extensive use of Ushahidi to date. The implementation is still in use nearly a year later, helping track areas where specific supplies are needed, and to monitor and broadcast health reports related to the subsequent cholera outbreak.

On November 1, 2010, Patrick Meier, Director of Crisis Mapping at Ushahidi, launched a program titled Universities for Ushahidi.[26] In June of 2011, this initiative intends to hold week- long training sessions where ten students from developing nations around the world will learn how to deploy the Ushahidi platform themselves. After returning home from their training, these students are expected to organize response teams in their home countries. In the event of necessity, these teams will be ready to deploy the Ushahidi platform. Gathering data and directing response is a critical line of defense in severe situations.

Ushahidi's ability to gather information and help respond to complex and dangerous situations has proven to be highly effective. In an effort to make it even easier for individuals to use and deploy the platform quickly, the team behind the original software recently launched Crowdmap, a cloud-based service for setting up new instances of Ushahidi. The team is currently hard at work on SwiftRiver, an open-source tool they believe will help users validate and manage real-time data intercepts.[27]

A TWO WAY STREET

In addition to its effectiveness in gathering data, another feature of SMS that makes it ideal during disasters and outbreaks is its ability to act as a two-way communication system. This capability to push messages to the public is essential in spreading awareness about SMS driven emergency response campaigns. It is also important to the process of gathering information in cases where details remain ambiguous. During the incident in Haiti, when incoming messages did not contain specific enough location data, volunteers could reply directly to the sender from within the Ushahidi software, requesting more specific information.[28]

This ability to broadcast messages has continued to be important long after the initial search and rescue efforts have completed. When a cholera epidemic broke out in Haiti months after the earthquake, local cellular networks, in conjunction with the Red Cross, sent free text messages to people in the affected regions. These messages provided descriptions of cholera symptoms, and information regarding on contaminated water supplies.[29]

Conversely, in situations where the spread of disease is widely misunderstood, short educational messages could be sent out explaining facts about the disease in question. This kind of information push could be used to help stop panic and reduce mass hysteria.

Unlike radio and television broadcasts, which have been the traditional method for sending emergency information, SMS does not require having the intended audience's attention at a specific moment. If your radio isn't on and tuned to the right channel, you can miss an important announcement when it is broadcast. With SMS, the message is waiting for you to read the next time you pick up your phone.

A Blueprint for Accelerating Awareness

Each of the tools and systems outlined above offer unique strengths. The question then becomes, how could these tools be coordinated to improve aggregation of public health information in the developing world where it is needed most?

FrontlineSMS:Medic and its ability to format data from simple text messages represents an innovative solution towards closing the "last mile" information gap. It gives trained community health workers who work in hard to reach rural areas, a fast and inexpensive way to transmit data across long distances.

Besides just the increase in speed, the standardization of the data set is also critical. In situations such as identification of symptoms associated with infectious disease, this formatting could allow data to be more easily shared with health officials and knowledge workers upstream. Reports could be analyzed faster and compared or combined with other data sets to look for patterns.

Similar to *Universities for Ushahidi*, a program could be set up to train hospital employees and community health workers to use FrontlineSMS:Medic. Health workers in the field could submit medical information via text messaging into a FrontlineSMS database stored at a central hub such as a regional hospital. Hospital workers could then perform a secondary verification on the information to ensure validity, or request further information, also via text, all from the FrontlineSMS software. Disease related data could then be entered into a regional instance of Ushahidi, giving it geographic context.

Information from these regional sources could be shared with global organizations like HealthMap, and the WHO, which would allow the medical reports gathered from the field to be quickly incorporated into the aggregation schemes that are already taking place. This could make it easier and faster to spot the kinds of trends that lead to awareness of outbreaks.

Once a trend is identified in an area, information regarding how to avoid contamination could be pushed out to the crowd via SMS. Again the ubiquity of mobile phones makes text messaging a cheap and inexpensive alternative means for sending emergency messages to the general public. If used in concert with traditional messaging channels such as TV and radio, this could lead to improved awareness during crisis situations.

It is important to note that disease diagnostics require a high level of expertise. Therefore any system for aggregating health diagnostics should always require reports to be submitted by trained medical professionals. This is why the community health workers who serve in these hard to reach regions would be the lynchpin of such a system. Though the technology would help increase the speed and dissemination of the data, it is the trained professionals who would makes the system a success.

To see how this might work, let's return to our earlier example of the London cholera outbreak. In this case, information about deaths caused by the disease was only circulated every seven days in the Registrar-General's Weekly Returns. But what if attending physicians had been able to push information instantly to a platform that supported open reference and geo-visualization? Not only would health officials have been able to see what was happening in hours rather than days, but the visual analysis provided could have helped them connect the dots faster as well.

Once conclusions regarding the cause of cholera had been reached, an SMS alert could have been

broadcast to those who were in areas susceptible to infection. This message could contain information educating those in the area on how to avoid infection. Online maps highlighting the area of the outbreak could continue to receive up to date information provided through a broad set of channels. Using tools that are widely available, and relatively simple by today's standards, it is possible that hundreds of lives could have been saved.

CONCLUSION

Air travel, and international trade have made our world smaller. With each passing year, what happens in one part of the world has a greater effect on what happens in another, and public health is no exception. Today, none of us can afford to sit idle, ignoring disease outbreaks a half a world away.

Thankfully, innovations in Internet communications technologies and mobile phones have also given us the ability to shrink space. By finding new ways to use the communication tools we already have, and empowering a larger number of individuals to submit health reports, we have the potential to build a rich ecosystem for coordinating against the spread of disease.

Doing so will require collaboration between governments, regional health providers, international health organizations, cellular service providers, and small and large software developers around the world. This is no easy feat, but projects like Ushahidi, HealthMap, and FrontlineSMS prove that developing these integrated systems is not only possible, but that it is already happening. By working together to integrate these systems, our ability to innovate scalable solutions can outpace the ability of disease to spread and to evolve.

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