A Social Media-based Participatory Epidemiology Approach for Infectious Disease Prevention (VBDP) in South Asia

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Abstract—Every year millions of people in south Asia and other tropical regions face the threat of vector-borne infectious diseases such as Malaria and Dengue. Existing prevention strategies use principles of epidemiology and health communication separately, despite the fact that new technological capabilities may enable us to integrate the two disciplines. This paper describes an ongoing effort in Singapore that plans to integrate hotspot mapping, civic engagement and health communication to extend the boundaries of participatory epidemiology in VBD prevention. We chronicle the research that informed our approach, present the conceptual underpinnings from a participatory epidemiological lens, and describe the challenges and opportunities encountered. It is our hope that, when actualized, this trans-disciplinary model integrating insights from public health, communication and sociology will provide a holistic solution for policymakers and health prevention agencies tackling VBD threats in south Asia.

Keywords: Malaria/Dengue, mHealth, Participatory

I. INTRODUCTION (HEADING 1)

Despite improvements in countries like India and Vietnam, Malaria threatens the lives of no less than 1,322 million people in the south-east Asian (SEA) region [1]. In Singapore, Dengue continues to threaten lives despite a steady drop in cases since 2005’s dramatic outbreak of nearly 14,000 cases [2]. As public health authorities work towards solutions to efficiently manage the vector-borne disease scenario, it is remarkable that social media is used to a bare minimum in a region known for its technological prowess. In India, health authorities inform how authorities from public health, communication and sociology will provide a solution for policymakers and health prevention agencies tackling VBD threats in south Asia.

The use of information and communication technologies (ICTs) in public health has rapidly proliferated over the last two decades given the deep penetration of the Internet and mobile phones in both developed and developing countries. The nature of use, however, has differed depending on the region and problem context. In developed countries such as the US, that face a burden of lifestyle chronic diseases such as obesity and cancer, ICTs have been used as for designing and testing educational and behavioral interventions and delivering remote care through telemedicine[3]. At a systemic level, ICTs have been deployed in the design of health information management systems giving rise to the study of disciplines such as clinical informatics and patient informatics. Developing regions such as Africa and Asia are rife with infectious and communicable diseases, and issues related to maternal and child health. In these resource-limited settings, ICTs (mainly mobile phones) have been used largely for the purposes of data collection, surveillance and mobile-based telemedicine [4]. In contrast, their application in behavioral and/or educational interventions has been largely limited. Interventions that straddle the individual, community and system levels are rare despite the numerous affordances of mobile phones and social media.

Vector-borne infectious diseases present us an opportunity to creatively address this gap because of the nature of their transmission and preventive strategies that are required for their management and control. Let us take the case of Malaria. Malaria is a life-threatening disease caused by parasites (called Plasmodium) that are transmitted to people through bites of infected mosquitoes (called Anopheles), and is preventable. It is known that Anopheles mosquitoes usually bite at night and transmission is closely related to climatic conditions such as rainfall, temperature and humidity. Anopheles breeding sites can range from small puddles of water to construction sites, pots and vessels. We also know that Malarial symptoms, such as fever, headache, chills and vomiting, usually surface 10-15 days after the
infective mosquito bite. The best treatment upon Malarial diagnosis is Artimesinin-based Combination Therapy (ACT), although evidence of resistance have been reported. Such a scenario presents core needs for two main stakeholder groups. The public health authorities need a system that:

a) empowers them with apriori outbreak information to facilitate early preparedness for preventive actions;

b) receives ongoing/dynamic information from the citizens so as to monitor the disease spread in real-time; and

c) allows them to educate citizens in order to promote practice of preventive behaviors and, respond to specific informational requests from the general public.

The general public needs a system that:

a) alerts them about potential outbreaks in their area/vicinity;

b) allows them to interact with authorities and share information about any outbreak-related issue; and

c) receive authentic information from authorities about what preventive actions to take; and

d) allows them to share information with members in their informal social networks.

We propose that an emerging and relatively virgin approach called participatory epidemiology (PE) that can guide future solutions to Malaria/Dengue prevention in Southeast Asia. We commence by presenting a brief background and organizing principles of PE. Later, we present ongoing work in Singapore that is anchored in PE approaches to develop a tripartite interactive system called MoBuzz.

At a basic level, PE denotes the use of local, on-ground intelligence to gather information and track the spread, causes and effects of diseases. The PE concept was most famously popularized by Catley and Mariner’s work in East Africa where they employed qualitative community-based approaches to derive animal health status from local farmers [5]. However, the rapid proliferation of the Internet and mobile phones has transformed the PE landscape in the ensuing years. As is shown by initiatives such as FrontlineSMS and Ushahidi [6], disease surveillance, health monitoring and information sharing can now be digitally integrated and helped to link disparate stakeholders such as health authorities, health providers and the general public.

Pe Louisiana et al. (2012) [7] tested an online initiative where respondents reported their experiences with Malaria through Amazon.com’s Mechanical Turk for an incentive of $0.02 and concluded that “micro-monitoring and online reporting are a rapid way to solicit malaria, and potentially other public health information”. The Program for Monitoring Emerging Diseases (http://www.promedmail.org) provides an online reporting system and rapid information dissemination related to infectious disease outbreaks. In this sense, participatory epidemiology also denotes employing participatory methods – those nested in, and involving communities – to collect epidemiological data. The other key principle includes the use of participatory mapping techniques in order to inform prevention activities.

II. MOBUZZ – EXTENDING THE PE CONCEPT

We propose that the conceptual capabilities of PE can be extended to provide holistic preventive solutions for Malaria/Dengue if mobile phones and social media were to be integrated into the conceptual matrix. We propose MoBUZZ, an integrated mobile and desktop-based health risk communication system that is built upon PE principles but extends its reach to provide an interface between citizens and health authorities, and customized health messages to enhance preventive behaviors and health awareness. Our system – currently in the prototyping stage – comprises three main components: predictive surveillance; civic engagement and health communication. Figure 1 represents informational inputs from, and outputs for the citizens, government and health organizations.

<table>
<thead>
<tr>
<th>Input</th>
<th>Citizens</th>
<th>Government</th>
<th>Health Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia information of feedback on breeding sites, complaints, SOS and symptoms</td>
<td>Environmental information from meteorological department</td>
<td>Real-time patient information during peak outbreak seasons</td>
<td></td>
</tr>
</tbody>
</table>

Output

<table>
<thead>
<tr>
<th>Output</th>
<th>Citizens</th>
<th>Government</th>
<th>Health Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual representation of Dengue spread</td>
<td>Visual representation of Dengue spread to inform prevention and control activities</td>
<td></td>
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<tr>
<td>Periodic alerts</td>
<td>Real-time information to monitor disease spread and incidence</td>
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<tr>
<td>Tailored health communication messages</td>
<td>Informational tools to communicate with key audiences</td>
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<tr>
<td>Social networking tools to communicate with citizens and government</td>
<td>Potential tools to integrate and leverage from/with other disease management teams</td>
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Figure 1: Information Framework for MoBuzz

A. Predictive Surveillance

Let’s take Singapore as an example of a city plagued by Dengue. The intention is to develop a color-coded early warning system that displays Dengue hotspots by generating predictive maps (see Figure 2) made available to both health authorities and the public on mobile devices. Raw weather-related information such as rain, temperature and humidity is processed using predictive disease modeling that feeds into an automated system which generates predictive maps of Dengue hotspots.

Figure 2: Dengue hotspots in Singapore
What distinguishes this project from other similar crowd sourcing and crowd informatics platforms is the integration of a disease modeling and simulation component. In this component, we build a hierarchy of spatio-temporal epidemic models. In the simplest of these models, we have a human population density that is averaged over time but not space, and a dynamic mosquito population, i.e. mosquitoes move around in the spatial grid. Susceptible humans \( S(x, y, t) \) can be infected by infected mosquitoes \( i(x, y, t) \), while susceptible mosquitoes \( s(x, y, t) \) can then be infected by infected humans \( I(x, y, t) \). Humans who recover from the infection \( R(x, y, t) \) then become immune to further infection. Infected mosquitoes do not recover, and die at the same rate as uninfected mosquitoes. These are replaced by new mosquitoes that are susceptible. In our simulations, we can control how fast the mosquitoes move, how easy it is for mosquitoes to infect humans, and how easy it is for humans to infect mosquitoes. We then measure from our simulations the spatial extent of infected mosquitoes. This defines the human population that is at risk of infection, which provides more policy-relevant information than the actual incidences of infected humans. As more data becomes available, either through the public health agencies or through crowdsourcing, we will refine the epidemic model to incorporate influences from meteorological factors like temperature and rainfall, as well as anthropogenic factors like changes in demographics and land use. For policy makers and crowd sensing participants, the most attractive prospect of having such a component is the short-term forecasts in infection and at-risk patterns that can be generated by the simulations.

B. Civic Engagement

This component provides the cutting-edge addition to existing PE efforts. The key idea here is to activate the general public to contribute to surveillance efforts in the event of disease outbreaks. In this instance, citizens can report breeding sites, mosquito bites and Dengue symptoms using their smartphones in image (Figure 3), text (Figure 4) or video formats. These inputs are automatically reflected in the hotspot maps and can be accessed by health authorities for responding to citizen concerns as well as for initiating preventive actions in specific communities. The process is facilitated rapidly because of two reasons: a) mobile phone-based inputs from citizens are geo-tagged; and b) the MoBuzz system captures geo-spatial coordinates, time and date, and phone number of the contributor.

C. Dynamic Health Communication & Alerts

The repository of outbreak information based on weather and citizen data is used to disseminate health messages to both, individuals and communities. At the individual level, citizens receive tailored messages based on their input to the system. For instance, a citizen reporting malarial symptoms to MoBuzz will instantly receive a complete information guide on Dengue symptoms, and cues to various preventive actions. At the community level, the system will automatically send health education messages to communities/zones (Figure 5) that are highlighted on the maps as possible hotspots. Public health surveillance efforts are thus used to generate and deliver health communication messages. At a fundamental level, the system acts as a catalyst between the citizen and the public health system where the contributions of each stand to benefit the other. Overall, the intention is to use MoBuzz for efficient and effective risk prevention and outbreak management. In addition to communication modules, the system is capable of sending alerts to citizens living in areas identified as potential hotspots.

D. Scenario

Let’s use the schematic (Figure 6) to explain a possible scenario for the use of MoBuzz. (From left), the meteorological department feeds weather data to the system that is used to generate hotspot maps. Concurrently, a vigilante citizen, John reports a possible breeding site by sending a picture to MoBuzz. In response, the system sends him preventive messages that he can send to his family/friends that can further disseminate to other actors in their social network (possibly vulnerable public).
The messages contain information about the MoBuzz website/mobile app. This activates the vulnerable actors to register on the MoBuzz website (or download the app), allowing them to receive future alerts automatically. The information continues to go viral as the vulnerable individuals continue to send it to other members in their respective social networks. These individuals follow a similar protocol for registration and can potentially request MoBuzz for specific "kinds" of information based on their issues of concern. In the meantime, the dynamic maps displayed on the website and available on the mobile app can be used by community organizations such as NGOs and civic agencies to strategize preventive efforts. The innovation in MoBuzz lies in integrating the disparate fields of epidemiology, civic engagement and health communication using social media.

E. Content Validation

One of the major challenges of a technology-driven participatory health system enterprise is validating the quality of informational inputs from citizens. Our validation process is consistent in keeping with the core idea of using participatory media and crowd sourcing technologies. In that, we use people (individuals and health systems personnel) as validation experts. For instance, MoBuzz receives a breeding site alert from Zone X. The system will send a validation request to all its registered users and health personnel in the same zone. These individuals can visit the site and use mobile-based reporting to revert to MoBuzz on the authenticity of this input. Health personnel living in the same area can do the same.

F. Challenges and Future Directions

One of the key questions we encountered in the process of conceptual ideation and prototype design was: how do we get people to participate? In response, we propose an incentive-based system that offers, let’s say, 5-minutes of free talk time for inputs and an equal number for validation. Such incentive will involve a partnership with multiple stakeholders including telecom companies, civic agencies and health authorities. We recognize that offering an easy-to-use, simple and attractive interface design will add to the adoption and usability MoBuzz and its various affordances. Moving forward, we plan to test the three main components among various audience groups using experimental techniques and assess their responses to the system in terms of media, messaging, design and interface. From an applied standpoint, we propose that our system can be replicated to address gaps in the prevention and management of a number of infectious disease outbreaks such as SARS and H1N1. Conceptually, our idea broadens the current understanding of participatory epidemiology and highlights future opportunities for epidemiologists and health communication experts to integrate their expertise than work in tandem.

REFERENCES


