Student Focuses on eHealth Innovations in Public Health to Win Competition

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Congratulations to Theresa M. Lee who wrote the winning essay for the 2013 COACH: Canada’s Health Informatics Association Student Innovation Competition. A Masters of Health Informatics student at the University of Toronto, Theresa examines the rich potential of consumer-centric e-Health technologies. (See About the Competition below.) Theresa will present her essay at the e-Health 2013 Conference in Ottawa May 28.

Public Health

Public health is the “science and art promoting health, preventing disease, prolonging life and improving quality of life through the organized efforts of society.” The information needs of the public health workforce have become all the more urgent with the increasing frequency of emergence of new infectious diseases such as severe acute respiratory syndrome (SARS) and Asian bird flu, as well as the increasing concern about acts of bioterrorism, such as the spread of anthrax spores via the US Postal Service in 2001.

Emerging Infectious Diseases

Socio-economic, environmental and ecological trends in today’s globalized world have been met with increases in emerging and re-emerging infectious diseases. The fast pace of population growth, loss of biodiversity, international travel, economic trade, and the movement of people, livestock, and commercial goods have accelerated the movement of pathogens. Potential for local outbreaks and global pandemics from emerging and re-emerging infectious diseases threatens our health and well-being.

The epidemic of SARS in 2003, re-emergence of avian influenza A in 2005, and the sudden emergence of H1N1 in 2009, all highlight the importance of shared global responsibility for surveillance and disease control. In particular, SARS has brought awareness of the world’s collective economic vulnerability to epidemic shocks, the key role of public health, and the shortcomings in epidemic surveillance and preparedness.

Conventional Public Health Surveillance

Traditional public health disease surveillance is ill equipped for timely detection of emerging threats. Outbreaks typically have been recognized based on accumulated case reports of reportable diseases by clinicians and laboratory staff, who alert public health officials about clusters of diseases after tests are ordered and specimens have been obtained, transported, processed, and resulted. After manually retrieving disease case reports, statistical tools are used for pattern recognition warranting public health investigation. This procedure has been proven to be time-consuming and costly, hindering public health’s mandate to prevent illness and injury when outbreaks fail to be recognized in a timely manner.

Public Health Informatics

Public health informatics (HI) is “the systematic application of information, computer science and technology to public health practice, research, and learning.” Strategic decisions for improving population health cannot be made without information, which is routinely created, obtained, analysed, synthesized, and transferred in everyday practice of public health. Information management systems are needed for the increasing volume and complexity of knowledge and information in health systems.

As such, public HI strategies are increasingly used to obtain a complete picture of a population’s health and risk status, and to support effective public health data flow and decision making in both urban and remote locations. The field of public HI serves various facets of public health including emergency response, environmental health, nursing, and administration, and most notably benefitted public health surveillance.

Public HI offers an opportunity to improve links between healthcare providers and
public health departments, making surveillance more effective and timely.\textsuperscript{13} Integrated electronic health records and clinical information systems could be continuously monitored for changes in the incidence or characteristics of identifiable illnesses or even specific clusters of findings. Such analysis is computationally intensive due to the large number of possible sign and symptom patterns, but is made possible with electronic data.

**Syndromic Surveillance**

Syndromic surveillance focuses on the early symptom period before clinical or laboratory confirmation of a particular disease and uses both clinical and alternative data sources.\textsuperscript{14} The capacity of a surveillance system to rapidly identify anomalous patterns of illness and injury is important\textsuperscript{15} to serve as an early warning system for impending public health emergencies, documenting the impacts of interventions, tracking progress towards specified goals, and monitoring and clarifying the epidemiology of health problems to advise public health policy and strategies.\textsuperscript{16}

In addition, public HI has introduced Public eHealth, the development of innovative ways to use inexpensive and powerful computers, online databases, the capacity for universal connection of people and computers, and multimedia communications to support the mission of disease prevention and health promotion.\textsuperscript{10}

**Public eHealth**

**Infodemiology**

Search query data from engines such as Google and Yahoo can be harnessed as a form of collective intelligence where patterns of population-level searching mirror and predict disease outbreaks even earlier than traditional methods like sentinel physician reports.\textsuperscript{17,18} Eysenbach\textsuperscript{18} originally demonstrated the potential value and cost-effectiveness of such a strategy for surveillance of influenza in Canada, and coined the term infodemiology for “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.”\textsuperscript{19}

Social software has moved the Web from a “read-only” to “read-write-and-participate” environment,\textsuperscript{20} and Web 2.0 applications and social software technologies encourage group interaction in a space where individuals can participate, socialize, and set social norms. The rapid and accelerating growth of the Internet has improved the usefulness and sensitivity of these systems, which can improve the timeliness of outbreak reporting.\textsuperscript{20,21}

During the 2009 H1N1 influenza pandemic, non-traditional surveillance sources such as Internet news sources provided new public health data.\textsuperscript{22} Software programs called “web-crawlers” that search Internet sites for specific terms, then use these search terms to generate reports or maps of disease activity, can provide important information on disease.\textsuperscript{4,21} Non-traditional sources of information retrieved from such programs have been recognized in the 2005 revision of the International Health Regulations as important sources of epidemic intelligence.\textsuperscript{21}

Collectively, these sources can overcome certain limitations of traditional surveillance systems, including reporting delays, inconsistent population coverage, and a poor sensitivity to detect emerging diseases.\textsuperscript{23} These sources are used in surveillance systems such as the Global Public Health Intelligence Network (GPHIN) and HealthMap. Such systems are now in use by national and transnational public health organizations such as the World Health Organization (WHO), Centers for Disease Control and Prevention, the European Centre for Disease Prevention and Control, and the Public Health Agency of Canada.\textsuperscript{4}

**Global Public Health Intelligence Network (GPHIN)**

Canada was at the frontier in introducing Web-based surveillance technologies to the world.\textsuperscript{17} In 1997, Health Canada created the Global Public Health Intelligence Network (GPHIN).\textsuperscript{24} This software application retrieves articles that provide relevant information pertaining to the possibility of a public health emergency. The value of this network was demonstrated when the system identified the outbreak of SARS in Guangdong Province, China, as early as November 2002, more than two months before the WHO publicly published details on cases of the new respiratory illness.\textsuperscript{17}

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The network obtains information from news feed aggregators based on established search queries every 15 minutes. Although automation is a key component, GPHIN also employs trained analysts who provide essential linguistic, interpretive and analytical expertise.\textsuperscript{24} This data is disseminated to various public health agencies, including the WHO.\textsuperscript{17}

HealthMap is an open access online infectious disease outbreak monitoring system used by public health authorities, travellers, physicians, and patients, to gain a real-time understanding of global outbreak activity.\textsuperscript{25} It uses automated querying, filtering, integration, and visualization of Web-based reports on infectious diseases. The system integrates outbreak-related data from more than 30,000 electronic sources, including the Google News aggregator, news media, expert-curated ProMED-mail, and other validated electronic public health reporting sources.\textsuperscript{26,27} HealthMap uses text-processing algorithms to classify the diseases and locations associated with each report.\textsuperscript{28} In conjunction with geographic information systems (GIS), HealthMap allows the summarization of vast amounts of tabular data into compelling visual maps (figure 1) that can provide insight and engage the attention of policy makers and the public at large.\textsuperscript{17,29} Applications like HealthMap can improve our understanding of the ecology and causes of complex health issues, and guide the design and evaluation of population-based programs and strategies.
Advantages

There are numerous advantages to Internet- and event-based surveillance systems such as GPHIN, HealthMap, BioCaster, and ProMED that rely on non-traditional reports of disease. These programs fuel online resources that deliver real-time intelligence on emerging infectious diseases to diverse audiences, from public health officials to international travelers on user-friendly, open-access websites. The systems can provide information outside traditional communication channels, which can hold crucial details for outbreak detection, and it uses information that is available freely, without requiring manual reporting on the part of governments or local public health officials. Systems are relatively inexpensive to operate and can be automated. In addition, they can be disseminated in near real-time, allowing the public to have greater access to health surveillance information. As such, disease outbreaks can be detected earlier than with traditional reporting mechanisms.

Considerations

To fully realize the potential of public health and Public eHealth innovations, there are four factors to be taken into consideration.

Standards and Interoperability

To take advantage of these opportunities to link data not available traditionally in public health, development and use of standards should be improved to facilitate data exchange. Development and use of standards will require substantial time, resources, effort, and commitment. These depend on partnerships between regional health authorities, national agencies engaging in public health surveillance, and non-governmental actors across the globe. Surveillance systems are often set up without full consideration of the information system and surveillance architecture in which they need to operate. This can result in a mismatch of recommendations for surveillance approach, data definitions and formats, laboratory methods, and software. The establishment of detailed informatics standards for surveillance at the global level would provide countries with the opportunity to adapt those standards to each country’s epidemiology, disease control, and health priorities. Although there are numerous ways in which ICT can improve public health practice, there are challenges to developing coherent, integrated public health information systems across regions as well as developing integration between public health and clinical care. A major difficulty in meeting these needs is the great breadth of the public health discipline, which makes it difficult to identify the multitude of specific public health information needs. For example, there will be differences between infectious diseases and chronic diseases, in the investigative methods and epidemiological response.

Terminology and Quality of Data

New surveillance strategies in Public eHealth bring with them challenges with text mining, natural language processing, machine translation, ontologies and reasoning. Information can be unstructured and difficult to interpret and often requires advanced computational techniques to effectively implement. There is concern with the lexicon that practitioners use, including definitions and conceptual frameworks that are understood by those in public health relevant fields. Also important to consider are accurate interpretations of multilingual text and the detection of aberrations, for example, in contexts of vaccination campaigns or use of terminology in the media, such as the use of ‘fever’ for ‘Bieber Fever’ or ‘Obama Fever.’ Considering the issue of lexicon in surveillance, the true reliability, sensitivity and specificity of new surveillance methods remains unclear and require further investigation. The percentage of outbreaks that can be identified by these strategies needs to be identified. The specificity must also be verified to take into account the workload for verifying the rate of high false-positives.

Proprietary vs. Open-source Software

Open-source development is underpinned by the public health philosophy of shared ownership of knowledge for good of the wider community, not dissimilar to the ethos of public health itself. Coordinated efforts in advancing open-source software is crucial for using ICT to support population health. The real value of open approaches and dynamically evolving products is that they allow availability in low-resource settings, where a lack of access to sophisticated ICT limits use of public health data, creating a need to always look to other organizations for direction. In addition, purchase or use of certain equipment can complicate or contribute to fragmenting the surveillance and health protection in a region.

Privacy

There are privacy concerns for strategies that have the potential to identify individual Internet activity. It is important to address pervasive concerns about the impact of information technology on confidentiality and privacy. Standards must extend to ethical concerns, data sharing, privacy and confidentiality, and human subjects protection.

Conclusion

The need for innovative information systems for public health is growing because of challenges related to antibiotic resistance, emerging infectious 3 and chemical and biological terrorism. Practitioners, researchers and the public alike will need reliable, timely data with which to make information-based decisions, improve communication and tools to analyze data and present new knowledge. With consideration for standards, interoperability, integration, privacy and other ethical issues, innovations in Public eHealth can support effective detection and management of health problems. It can provide tools to collect, share, and analyze health information as diseases and outbreaks move across geographic regions, creating a foundation for decision making and planning by providing cost-effective, timely, and useful evidence.

References

11. Reidpath, D. D. & Allyote, P. Opening up public health: a strategy of information and communication technology


