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Brief Communication

A review of the role of public health informatics in healthcare



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Abstract

Recognized as information intensive, healthcare requires timely, accurate information from many different sources generated by health information systems (HIS). With the availability of information technology in today's world and its integration in healthcare systems; the term "Public Health Informatics (PHI)" was coined and used. The main focus of PHI is the use of information science and technology for promoting population health rather than of individuals. PHI has a disease prevention rather than treatment focus in order to prevent chain of events or disease spread. Moreover, PHI often operates at the level of government rather than at the private sector. This review article provides an overview of the field of PHI and compares between paper based surveillance system and Public Health Information Networks (PHIN). The current trends and future challenges of applying PHI systems in KSA were also reported.

Keywords: Informatics; Public health; Public health information network; Surveillance systems

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Public health informatics

Introduction and definition

Public health informatics (PHI) is defined as the systematic application of information, computer science and technology in areas of public health, including surveillance, prevention, preparedness, and health promotion. The main applications of PHI are 1. promoting the health of the whole population, which will ultimately promote the health of individuals¹ and 2. preventing diseases and injuries by changing the conditions that increases the risk of the population.² Basically, PHI is using informatics in public health data collection, analysis and actions. Emphasis on disease prevention in the population, realizing its objectives using a large variety of interventions, and work within governmental settings are aspects that make PHI different than other fields of informatics.³ The scope of PHI includes the conceptualization, design, development, deployment, refinement, maintenance, and evaluation of communication, surveillance, and information systems relevant to public health.⁴ PHI could be considered one of the most useful systems in addressing disease surveillance, epidemics, natural disasters and bioterrorism. The use of computerized global surveillance and data collection systems, such as health information exchange (HIE) and health information organization (HIO), could assist in population-level monitoring. This could help to avert the negative impact of a widespread global epidemic.

Surveillance systems

Surveillance in public health is the collection, analysis and interpretation of data that are important for the prevention of injury and diseases. Through available data, possible early detection of outbreaks can be achieved through timely and complete receipt, review, and investigation of disease case reports. An inclusive surveillance effort supports timely

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investigation and identifies data needs for managing public health response to an outbreak or terrorist event.⁵ Worldwide, governments are strengthening their public health disease surveillance systems, taking advantage of modern information technology to build an integrated, effective, and reliable disease reporting system.⁶ A surveillance system, such as syndromic surveillance systems, could collect symptoms and clinical features of an undiagnosed disease or health event in near real time that might indicate the early stages of an outbreak or bioterrorism attack. For instance, local or regional public health departments could alert all the clinicians within an HIO about unique cases of a highly resistant infectious organism or a widespread of communicable diseases. Consequently, HIO can play an important role as part of PHI in providing available patient data in conditions of natural disaster when paper-based records might be destroyed or unavailable.

The latest development of public health informatics, such as geographic information system (GIS), which uses digitized maps from satellites or aerial photography, can be used to provide a large volume of data.⁴ This enables the combination of various information such as geographic location, trends, conditions and spatial patterns. GIS along with the incorporation of mobile technology has proved to be useful in tracking infectious disease, public health disasters and bioterrorism.

Paper-based surveillance

Surveillance systems were mainly in the form of paper reports submitted from hospitals, physicians and clinics to local health departments. In the United States, for example, these institutions forwarded their reports to a state level and eventually to the Centers for Disease Control and Prevention (CDC) through email or fax. The reports would reach their final destination to the World Health Organization (WHO). This system was not quite efficient due to the variation in type of data reported between states. In addition, the dependence on a paper-based system and the delay in the identification of diseases affected the response rate and management of outbreaks.

Paper-based surveillance systems require exhaustive manual data entry and are often considered fragmented because data from different sections of a study are not collected or available. These documents are separately assessed as cases, clusters or trends and therefore are time consuming, limited by incomplete data collection and inadequate analytical capacity. Thus, they are incapable of providing timely information for public health action. Another drawback of paper-based surveillance systems is the vulnerability of the paper records, especially during cases of natural disasters. Further, these systems do not help in the globalization of trends or data.

Modern surveillance systems

Currently, there is a steady transformation into electronic surveillance systems delivering more timely data and information concerning a disease or a situation that can cause an outbreak. This transformation has been facilitated by the modern Public Health Information Network (PHIN),

providing efficient information access and exchange among public health agencies at different levels. PHIN is standardized, allowing for efficient interoperability among different levels of public health entities.^{1,7} To put it in a simpler form, information in PHIN is shared through the network and can be stored and retrieved easily, and it could be tracked back to sources. Data shared through the network can be further analyzed to provide information that helps public health professionals and support their decision. Unlike paper-based surveillance systems, data in PHIN are stored digitally and are not easily destroyed.

Comparison between paper-based and electronic surveillance systems

Generating adequate and meaningful data in a short time could not be achieved with paper-based surveillance systems because of the difficulty in retrieving the data. Furthermore, paper-based systems incur costs in terms of paper, labor, and space for storing. Paper-based data cannot be shared easily with other systems and are more susceptible to privacy and confidentiality breaches. The use of electronic health records further enhances the early detection of cases, clusters, outbreaks and trends of communicable diseases and environmental hazard exposures. These characteristics improve the chances of detection of disease surveillance, epidemics, natural disasters and bioterrorism events. The use of systems, such as real-time outbreak detection systems, allows for the real time, daily detection, analysis and dissemination of outbreak information to the targeted populations and agencies. The use of a geographic information system, such as HealthMap, has further improved the identification, monitoring, alerting and responding to emerging diseases, pandemics, bioterrorism and natural disasters, not only at the national but at the global level.⁸

Real studied examples showed a clear difference between the paper-based surveillance system and PHIN. The examples proved that collecting information for disease surveillance using smartphone devices was faster and cheaper than paper-based surveys, which was considered the traditional way for collecting information about diseases. A surveillance study in Kenya about influenza and respiratory diseases was conducted using paper or smartphones surveys. This study included 2038 questionnaires, of which 1019 were paper based and 1019 were smartphone questionnaires. Researchers in this study found that 3% of smartphone questionnaires were incomplete compared with 5% of the paper-based questionnaires. Additionally, they found that 7 of the paper-based questionnaires were duplicated, while no smartphone questionnaires were duplicated. Furthermore, uploading data from smartphone questionnaires took only 8 h, whereas it took 24 h for paper-based questionnaires. Cost-wise, collecting and processing data from paper-based questionnaires was \$61,830 and \$45,546, respectively, for a smartphone questionnaire.⁹

Applications of PHI

Sources of data include sales records of over-the-counter (OTC) medication, rate of school absence combined with the rate of visits to the school clinic and behavioral factors

associated with the transfer of sexually transmitted diseases. During epidemics and natural disasters public health reports are essential tools to estimate morbidity and mortality. In addition, surveillance data assist in the estimation of the resources and man power needed to handle these disasters. Bioterrorism is another concern where the public is exposed to sudden and uncontrolled circumstances of the biological agents' release. This was observed in the US in the beginning of the 21st century, where letters containing anthrax spores had been mailed to different addresses in the country. This incident resulted in casualties and thousands of people who were at risk of exposure to the anthrax pathogen. It highlighted the weakness of public health surveillance systems at that time and urged authorities for more immediate actions. In addition, it raised several questions of the need to keep dangerous pathogens stored in the US Army Medical Research Institute of Infectious Diseases. Public health infrastructures and surveillance systems became more prepared to detect and to take immediate actions if faced with similar situations. PHI played a role in the collection and analysis of real-time data that were introduced right after the bioterrorism attack.

The data can be either a direct stream or aggregated data over time that are sent periodically through a secured connection to the surveillance systems. Data are then analyzed and converted to information by the usage of statistical algorithms that detect anomalies that could help to identify outbreaks.¹⁰ PHI also played significant roles in responding to worldwide disasters, such as Hurricane Katrina and H1N1 influenza,¹¹ shedding light on the importance and the role of public health in emergency disasters. This is realized by an up-to-date continuity of operations plan (COOP), which has an important role in preparation for disasters.¹² This is achieved by collecting data, detecting a threat and responding to that threat correctly and suitable time.¹³ Hence, the main function of public health is to monitor and detect the population who is at risk and prevent them from facing diseases and outbreaks.

Public health's focus is to study the population; therefore, it is very important to achieve interoperability between different PHI systems and between PHI systems and electronic health records (EHRs). Currently, with the increased adoption of EHRs and their interoperability with PHI, huge and new sources of data will enhance public health surveillance and planning. For this to occur, HIE is also necessary together with well-established data standards (SNOMED, LONIC, HL7 and CHI), different databases, standards-based networks, and strong security and decision support systems.¹⁴

Public health informatics in KSA

Healthcare in the KSA is provided by a wide range of institutions. However, the Ministry of Health (MOH) is the main governmental agency with overall responsibility for health policies and planning. The first attempt to collect information and to address the nation's health issues dates back to 1970. Since then, MOH has come a long way in improving healthcare in the Kingdom. It was in the 1980s when the country witnessed a significant increase in health facilities, both in public and private sectors.¹⁵

Despite the recent technological advancements seen in the country, healthcare professionals in KSA, like most Arab countries, are known for their resistance to change and use of technology in healthcare settings. Although numerous studies highlighted the benefits of introducing an electronic Healthcare Information System (HIS) and PHI, all portrayed the difficulty and challenges of its implementation in the country. Researchers regarded the Saudi Arabian HIS as poor and far less than expected mainly due to its users' limited technological abilities. Systems are adopted but are not fully utilized and understood because physicians are not properly equipped with the necessary IT skills to operate HIS. Bahkali et al. concluded that PHI is not well-developed to deliver efficient healthcare in KSA. Several challenges were identified by the research team including the need for readiness assessment, resistance to change, integration of systems, and confidentiality and privacy of health information.¹⁶ Another study cited the challenges relating to organizational and cultural issues, end user attitudes towards PHI projects, and the lack of specialized human resources to implement HIS.¹⁷ Future recommendations to meet the challenges in KSA focus on forming a new national body for PHI and to monitor its impact on the Saudi healthcare initiatives.

Conclusion

Since its early operation, electronic reporting systems have played an unparalleled role in discovering and containing the spread of diseases in a timely fashion while protecting lives and improving the health of entire populations by reducing the financial and human impact of diseases on the society as a whole. Several applications and initiatives are currently available to meet the growing needs for faster and accurate data collection methods. For example, the Global Outbreak Alert and Response Network of WHO relies on web-based sources for the purpose of daily surveillance. Web applications are being developed regularly to visualize and aggregate news. Mashups can serve as a tool for disease surveillance. Another example is HealthMap that gives a view of the global infectious disease threats and alerts travelers before going to certain countries and regions. Mobile apps and social media networks are widely used by the public and can be used as supporting tools added to the PHIN of disease surveillance.¹⁸ The revolution of information technology and the urge to incorporate it into different aspects of healthcare has become a required task for public health leaders. Patients, healthcare professionals, and public health officials can all help in reshaping public health through the adoption of new information systems, the use of electronic methods for disease surveillance, and the reformation of outmoded processes.

Conflict of interest

The author has no conflict of interest to declare.

Author's contribution

HAA conceived and designed the study, conducted research, provided research materials, and collected and

organized data. The author has critically reviewed and approved the final draft and is responsible for the content and similarity index of the manuscript.

Disclaimers

None.

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