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Guest Editorial

Public health informatics

> "*Imagine a public health system where all reportable disease and laboratory information is available within 24 hours of collection, analysis of the data for anomalies is ongoing and automatic, and alerts are distributed in an automated fashion to relevant members of both the public health and clinical community. Furthermore, a steady stream of electronic information from a wide variety of sources regarding the health status of every community would be collected, analyzed, and disseminated continuously*."

This was a futuristic scenario in Spring 2001 just months before the September 11th attacks. It was this vision that prompted the convening of the American Medical Informatics Association's Spring 2001 Congress that brought together the informatics and public health communities to develop a national agenda for the growth and development of public health informatics [1]. More than 500 participants attended the meeting held in Atlanta, Georgia, May 15–17, 2001.

Six years have passed since that meeting and the September 11th attacks. During that time, anthrax events, emerging infectious diseases and unforeseen natural disasters such as Katrina, Rita and the Asian tsunami have occurred. Each one has uncovered serious weaknesses in our public health infrastructure. Each event has also reinforced the increasingly urgent need to better utilize methods from the discipline of public health informatics to strengthen the public health infrastructure we all depend on to aid in the detection and response to bioterrorism and other public health emergencies.

A great deal has changed in public health over the past 6 years. Obesity is now the fastest-growing cause of death and disease in our nation—second only to smoking in its lethal impact. The number of deaths associated with excess weight has increased over 30 percent, now claiming more than 400,000 American lives each year. Obesity also has serious non-lethal health consequences. For example, children now suffer much more frequently from type 2 diabetes, high blood pressure, and poor overall health.

Health literacy, a major public health issue, prevents millions of Americans from successfully managing their health. As health information has become more accessible to millions of Americans via the Internet, it has become increasingly apparent that the 90 million Americans who cannot adequately understand basic health information are being left behind. Low health literacy results in patients' inadequate engagement in, and benefit from, health care advances and is linked with such adverse outcomes as poorer self-management of chronic diseases, less healthy behaviors, higher rates of hospitalizations, and overall poorer health.

While informatics alone will not solve all the challenges of public health, "the need for informatics development has been recognized within all public health disciplines" [2]. Public health informatics is defined as the systematic application of information and computer science and technology to public health practice, research, and learning [3,4]. A major focus of public health informatics has been on syndromic surveillance and outbreak detection—not surprising given that expansion of public health informatics as a field coincided with the September 11th attacks and the terrorist acts that followed. Prior to September 11th, 2001, PubMed lists only six articles containing the search words "public health informatics." This same PubMed search expands to include over 600 additional articles since that date. The unprecedented allocation of resources to automate surveillance systems has also spurred research to address this particular public health topic. It may be surprising to some of our readers that the post-September 11th investment in public health is the single largest since the Second World War. The categorical nature of the funding has mandated that these resources be used exclusively for bioterrorism and preparedness.

As a result, recent papers published in mainstream informatics journals reflect surveillance and outbreak detection as the core of public health informatics. The paper in this issue by Buckeridge [5] reviews 35 such studies that have evaluated outbreak detection through automated syndromic surveillance. In general, the results suggest that syndromic surveillance systems are capable of detecting some types of disease outbreaks rapidly

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and with high sensitivity, although there are inconsistencies in the specific determinants of both detection and outbreak. Buckeridge concludes by calling for additional evaluations to further address deficiencies in the evidence and to identify the potential influence of other factors on outbreak detection. Although evidence for syndromic surveillance systems remains inconclusive, such systems are thought to serve critically important public health objectives, including early detection of important events and situational awareness during and after events. The book review by Khan [6] included in this issue reviews *The Handbook of Biosurveillance* [7], one of the first single reference books to cover biosurveillance in detail. From a public health informatics perspective, numerous challenging research questions remain, despite assertions by a growing number of critics who consider such effort a squandered investment. As the utility of syndromic surveillance systems is being evaluated, the informatics methods developed to build these systems are also enabling surveillance capabilities for other public health purposes.

Excellent examples of what some refer to as "dual use" systems for surveillance are included in this special issue. Sims et al. [8] studied methadone-related harm by adopting an informatics approach to surveillance to examine concurrent trends in methadone-related morbidity and mortality and methadone prescription rates. The authors demonstrate the utility of concurrently analyzing multiple public health data sources for evidence of morbidity and mortality due to adverse events. This approach is of particular relevance as surveillance of health care safety and quality increasingly becomes the domain of public health agencies. Odero and colleagues [9] describe an electronic injury surveillance system that provides data for improving patient care and monitoring injury incidence and distribution patterns. The authors created digital maps of injury spatial distribution using geographic information system (GIS) software and correlated injury type and location with patients' clinical data. A computer-based medical record system, complemented by GIS technology and an injury-specific component, presents a valuable tool for injury surveillance, epidemiology, prevention and control for communities served by a specific health facility.

The dual use of automated surveillance systems appears to be strengthening the liaison between clinical care providers and public health. The increased attention to more rapid and timely epidemiological investigation of new types of data is invigorating the practice of public health at the local level by providing new "vital signs" of community health relevant to both health care and public health. This interaction has extended appreciation for the role of local public health and has facilitated communication between clinical medicine and public health. Improved data sharing and communications should support both early outbreak detection and the other purposes of public health surveillance.

1. A broader perspective

While investment in bioterrorism and automated surveillance systems has stimulated new informatics methods and public health services, the focus of this investment can also be viewed as a limiting strategy for the growth of public health informatics as an application area of biomedical informatics. There are several other grand challenges that public health must undertake, many of which have potential informatics solutions. To build a public health informatics strategy for the future, informaticians must develop broader perspectives on what constitutes public health, and by extension what constitutes public health informatics.

2. Strengthen prevention in the public health/clinical continuum

Viewing the relationship between public health and clinical medicine as a continuum, we see that taking a public health perspective does not mean adopting an either/or dichotomy between public health and clinical care, or abandoning acute care for sick individuals in favor of preventive care for populations [10]. One way to understand a public health perspective is by examining the notion of disease risk in populations. Public health recognizes that disease risk consists of a continuum across populations rather than a simple dichotomy between high-risk and low-risk individuals. There is simply no clear division between being at-risk or not-at-risk of disease with regard to factors such as cholesterol levels, blood pressure, diet and physical activity, exposure to toxic substances, stress, and a wide range of other social and environmental influences [10]. The majority of people fall in the middle of the risk distribution, and usually only a small percentage fall at the extremes of high- or low-risk. Exposing a large number of people to a small risk can yield a larger absolute number of cases of a condition than exposing a small number of people to a large risk. This reality argues for the development of strategies that focus on the modification of risk for the entire population rather than only for specific high-risk individuals. Intervening medically, for example, focusing only on individuals at high-risk, may have limited impact on population outcomes because the greater proportion of those with moderate risk levels may ultimately translate into more chronic disease or other poor outcomes.

Clinical preventive services are defined as "medical procedures, tests or counseling that health professionals deliver in a clinical setting to prevent disease and promote health, as opposed to interventions that respond to patient symptoms or complaints" [11]. Public health too, has the mandate to prevent disease and promote health. Such clinical preventive services delivered to individuals, if provided with high quality and consistency across populations, yield population-level benefits. When clinical services intervene with moderate risk individuals as opposed to only the

individuals at the highest risk, they share with public health the responsibility to keep populations healthy and free from disease.

Informatics methods and systems will be integral to improving the quality and consistency of clinical preventive services. Systems will evolve from two main starting points: disease registries whose roots are to track populations with a given disease and the care they receive, and electronic health records. In this issue, Kukafka and colleagues [12] discuss modifications of the more clinically focused electronic health record needed to support the lifestyle counseling recommendations in many clinical preventive guidelines. Electronic heath records typically have structured data elements, which enable sorting and reporting about populations and provide the data upon which to develop decision support. According to Kukafka et al., an extension of these data elements will be necessary to support the decision logic and tailored recommendations from the public health perspective that are based on the interconnectedness and influences of the biological, behavioral, physical and socio-environmental domains. For example, direct patient input might be useful in collecting the behavioral and socio-environmental information that is not typically collected at a visit with a clinician, but may assist in tailoring interventions from a public health perspective. Patients could contribute information about personal stress levels or home and family environment, or they could complete depression screening or other instruments.

3. Building healthier communities

Many factors in the community setting affect the overall health of individuals. A community can be a town, city or other type of geographic entity where people share common institutions and often a local government. In turn, each of these communities contains many interdependent smaller networks of schools, faith-based organizations, and social groups. There is a host of leverage points at which communities can help influence laws, social norms, and the environment to promote attitudes, behaviors and actions to support public health goals. The traditional public health approach is to build community coalitions, and there is a long history and strong empirical research grounded in participatory action that gives direction for building healthier communities. Public health informatics can introduce new applications towards this end. Web 2.0 technologies, such as collaborative and social networking software, may be prime tools for achieving this goal and should be explored further.

4. Advancing knowledge management in the public health informational environment

There are several areas where public health informatics can contribute to the challenge of public health knowledge management. For example, informatics methods can be used to support the information needs of public health professionals. The paper in this issue by Revere et al. [13] reports the results of a literature review focused on the information needs of public health professionals. This review was undertaken to order to develop system requirements to inform the design and development of a system to support the collection, management, and retrieval of public health documents, data, learning objects and tools. Another paper in this issue by Merrill et al. [14] emphasizes the importance of public health information management at the organizational level. According to the authors, the structure of public health agencies presents considerable challenges to effective information flow. The management of the collection, analysis, use and communication of health-related information is considered the most important public health service. The authors apply organizational network analysis in a pilot study to assess the technique's ability to inform decision making for pubic health managers by affording insight into the organizational process. The study results demonstrate that the method has potential utility for public health information management. In another organizational application of informatics, Timpka et al. [15] describe how actor network theory can be used to identify the organizational interventions necessary for the development of a unified information infrastructure for inter-organizational mental health services. Such organizational interventions must be considered and applied when developing such complex public health information systems.

The paper in this issue by Lavrac and colleagues [16] uses data mining and decision support methods, including novel visualization methods, to improve knowledge management in support of health care across an entire community. The main achievement of their study was the creation of a model of the availability and accessibility of health services to a population in a given area. Using the model, it was possible to identify the regions that differ from the average and to consequently explain the causes for such situations, providing many benefits for health care planning and management processes.

The public at large is another group where a major impact can be achieved when informatics methods are applied to improve their information environment. Areas include health behavior change, self-care, and chronic disease and injury prevention and control. Tailored communication is an example of an approach that already has been applied to the essential public health service of consumer education and empowerment. Public health communication has typically been limited to mass media (brochures, billboards, radio, television, etc.) that reaches many people with a low per-person cost, but offers little or no proven efficacy [17]. Informatics methods that include the tailoring of health recommendations and programs have been shown to have the reach and low per-person cost of mass media, while achieving the higher efficacy of personalized treatments found in more intensive approaches [10,18–20].

5. Conclusions

The papers included in this special issue represent a snapshot of public health informatics methods as applied to surveillance and outcome detection, knowledge management and public health information needs, data mining and visualization for health planning, and redesigning clinical electronic health records for public health purposes. The field has burgeoned over the past 6 years, and although resources and thus emphasis has been tied to the post-September 11th call for national security, new applications have advanced the practice of public health. This special issue provides some examples of emerging application areas for public health informatics that take into account critical public health challenges.

We believe that a narrowly focused view of public health, and by extension public health informatics, exposes the field to potentially negative outcomes. Public health practice is an inherently diverse discipline. This is reflected in the structure of our country's accredited schools of public health, which provide core areas of study including health services administration, biostatistics, epidemiology, behavior sciences/health education, and environmental health sciences. To select as a mainstay only one aspect of public health practice—surveillance—excludes most professionally trained public health practitioners and thus fails to integrate informatics methods and solutions into the field of public health at large. Second, a narrow focus runs the risk of fragmenting the field of public health informatics. The well-known informatics solution is to add additional modifiers to the term 'informatics'. For example, *population health informatics* is a recent umbrella term subsuming applications of technologies that have a population focus and the potential to improve public health. *Behavioral informatics* has been used to incorporate the study of the use of technologies by patients and health care providers as well as the design, implementation, and evaluation of behavior change interventions delivered through advanced technologies. The emerging area of *consumer health informatics* considers the use of electronic information and communication to improve medical outcomes and the health care decision-making process. However, all of these types of informatics serve ends that have traditionally been part of public health, and we suggest that they should similarly be considered portions of the broad discipline of public health informatics.

Whether public health informatics will leverage the post-September 11th resources and limelight to address the broader scope of public health challenges is unclear. What is clear, however, is the need to develop more evidence that supports informatics solutions in all areas of public health. We hope that this issue will stimulate further thinking about new informatics solutions and approaches to be taken towards this goal.

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