Chapter 15

CHALLENGES AND FUTURE DIRECTIONS

We conclude this monograph by discussing key challenges facing syndromic surveillance research and summarizing future directions.

1. CHALLENGES FOR SYNDROMIC SURVEILLANCE RESEARCH

Although syndromic surveillance has gained wide acceptance as a response to disease outbreaks and bioterrorism attacks, many research challenges remain.

First, there are circumstances in which syndromic surveillance may not be effective or necessary. The potential benefit of syndromic surveillance as to the timeliness of detection could not be realized if there were hundreds or thousands of people infected simultaneously. In extreme cases, modern biological weapons could easily lead to mass infection via airborne or waterborne agents. In another scenario, syndromic surveillance could be rendered ineffective if the cases involved only a few people (e.g., the anthrax outbreak in 2001) and thus would not trigger any alarms and could go undetected (2005b). In this situation, one single positive diagnosis of a spore of anthrax could be sufficient to confirm the event.

Second, disease data tend to be noisy and incomplete. Although reporting of most notifiable diseases through the chain of public health agencies is required by law, the hospitals, laboratories, and clinicians participate largely on a voluntary basis. Patients making ER visits may not be representative of the population in the neighboring community; the participating hospitals and laboratories are not necessarily good random samples from which reliable statistical inference can be successfully made. This reinforces the need for careful evaluation of data sources and collection procedures.

Third, many public health practitioners are unfamiliar with advanced surveillance analytics. Model selection, interpretation, and fine-tuning all require proper training. One approach that can potentially reduce the learning curve is to provide a carefully-engineered interactive visualization environment for the user to experiment with analysis methods, explore the analysis results, and validate hypotheses in an intuitive and visually informative environment.

Fourth, many false alarms are being generated by syndromic surveillance systems daily or weekly, as it is difficult to distinguish natural data variations from real outbreaks. Human reviews and follow-up investigations are necessary for signaled outbreaks, which are costly in time and labor. A typical investigation requires a group of epidemiologists, public health officials, healthcare providers, and their support staff to go through a multistep procedure for alert review and event evaluation.

Fifth, there is a critical need to develop computational and mathematical methods to facilitate response planning and related policy- and decision-making. Such methods should rely on an understanding of specific disease spreading patterns. They can be used to evaluate alternative policies and interventions and provide guidelines for scenario development, risk assessment, and trend prediction (Roberts, 2002).

2.   SUMMARY AND FUTURE DIRECTIONS

- Existing systems differ significantly in scope and purpose (e.g., geo-graphical cover-age, types of data and diseases monitored). For instance, a majority of systems surveyed focus on biodefense and detecting bio-terrorism attacks; while other systems target at outbreak detection for specific diseases such as influenza (Hyman and LaForce, 2004).

- The absence of standard vocabularies and messaging protocols leads to interoperability problems among syndromic surveillance systems and underlying data sources. HL7 standards and XML-based messaging protocols represent a potential solution for addressing these problems.

- Each syndromic surveillance system implements a set of outbreak detection algorithms. There is an urgent need for a better understanding of the strengths and limitations of various detection techniques and their applicability. Also, implemented algorithms could be potentially reused across systems as sharable resources.

- System evaluation and comparison are confounded by a number of practical issues. Systematic, field-based, objective comparative studies among systems are critically needed.

With regard to promising future research directions in syndromic surveillance, we see a number of opportunities for informatics studies on a wide range of topics. We list some of the potentially fruitful areas of studies below. (a) Data visualization techniques, especially interactive visual data exploration techniques, need to be further developed to meet the specific analysis needs of syndromic surveillance. (b) Outbreak detection algorithms need to be improved in terms of sensitivity, specificity, and timeliness. In particular, how to deal with incomplete data records, how to perform privacy-conscious data mining, and how to leverage multiple data streams are all interesting research questions. Furthermore, thorough evaluation of outbreak detection algorithms using synthetic or real data is critically needed. (c) System interoperability research and event management models are worth studying. (d) In the context of bioterrorism preparation, research on predicting and responding to bio-attacks is critically needed. Work reported in (Harmon, 2003) points to an interesting direction in this area of study: by examining the preceding events based on historical data of terrorism attacks, the culminating event can be predicted to occur within a certain time window. (e) This survey is focused on human diseases. Agricultural bio-attacks and certain animal diseases (e.g., mad cow, foot-and-mouth, and avian flu) are gaining increasing attention in biosurveillance practice. For example, the US Department of Agriculture and the US Geological Survey (USGS), through its National Wildlife Health Center and other partners, administer and manage databases for wildlife diseases (e.g., http://www.usda.gov/). How to detect and respond to agricultural bioattacks and disease events poses interesting technical challenges (e.g., the importance of environmental data such as air, water, or weather). Developing cross-species syndromic surveillance approaches and cross-fertilizing methods from human and animal syndromic surveillance research hold interesting potentials.

In closing, we briefly discuss the expanding scope of syndromic surveillance systems. Although syndromic surveillance systems have been developed and deployed in many state public health departments, there is a critical need to create a cross-jurisdictional data sharing infrastructure to maximize the potential benefit and practical impact of syndromic surveillance. In a broader context, public health surveillance should be a truly global effort for pandemic diseases such as SARS. There is a need to address issues concerning global data sharing (including multilingual information processing) and development of models that work internationally. International politics, global commerce interests, and cultural and regional considerations are some of the issues that need to be considered in global syndromic surveillance.