

Challenges of Electronic Medical Surveillance Systems

Jaques Reifman, Gary Gilbert, Mary Parker, David Lam

Telemedicine and Advanced Technology Research Center

U.S. Army Medical Research and Materiel Command

Fort Detrick, Maryland 21702

USA

E-mail: reifman@tatrc.org / gilbert@tatrc.org / parker@tatrc.org / lam@tatrc.org

ABSTRACT

In this paper, we discuss the technical challenges of electronic medical syndromic surveillance systems intended to provide early warning of bioterrorist attacks and naturally occurring epidemics. The discussion includes challenges associated with both civilian and military environments. In particular, we address the challenges in: (1) establishing an automated data collection infrastructure, (2) achieving timely access to quality data from disparate sources, (3) developing sensitive and specific outbreak detection algorithms, and (4) developing comprehensive and realistic simulation models for detection-algorithm development and validation. In addition, we identify unique attributes of military and North Atlantic Treaty Organization settings that may affect the development, deployment, and usage of medical surveillance systems. We conclude that considerable work and research are needed to overcome these challenges, that the information provided by these systems may lack the necessary specificity for follow-on mitigating actions, and that their cost-effectiveness and practical relevance, vis-à-vis the traditional reliance on health care providers to identify outbreaks, is still to be demonstrated.

1.0 INTRODUCTION

The 2001 anthrax attacks in the U.S. and the international outbreak of Severe Acute Respiratory Syndrome (SARS) heightened the importance of information technologies that could provide early warning of bioterrorist attacks and naturally occurring epidemics. Electronic medical surveillance systems, whose genesis precedes these recent events and which are oftentimes referred to as syndromic surveillance systems, are being widely investigated as a potential dual-use early indicator of abnormal events. These systems are not intended for disease diagnosis or longitudinal health monitoring, but rather to detect impending epidemic outbreaks and identify infected individuals early in the course of their disease through disparate data sources before a confirmed diagnosis is made. Generally, these syndromic systems target the detection of abnormal patterns in non-specific data, such as school and work absenteeism, over-the-counter pharmacy sales, nurse triage calls, and data logs of clinical symptoms and signs (in the form of acute respiratory infection or gastrointestinal illness) from encounters with primary care physicians. More recently, there has been an interest in broadening the scope of such systems to improve their timeliness by integrating public health information with risk indication and vulnerability information.

A multitude of electronic medical syndromic surveillance systems are being investigated for both military and civilian settings [1,2]. The various services and agencies of the U.S. Department of Defense (DoD) are sponsoring the development of different systems for both deployed and garrison-based forces, and many other

government agencies as well as just about every state and local government in the U.S. is investigating their own approach. While there is clearly no lack of interest and resources being targeted to the development of syndromic surveillance systems, before their potential benefits can be fully exploited—not to mention the questionable practical usefulness of these systems’ outputs—a number of key technical challenges need to be addressed and overcome.

In this paper, we identify and discuss numerous technical challenges for developing and deploying medical surveillance systems in both military and civilian settings. In particular, we address the challenges in: (1) establishing an automated data collection infrastructure, (2) achieving timely access to quality data from disparate sources, (3) developing sensitive and specific outbreak detection algorithms, and (4) developing comprehensive and realistic simulation models to generate development and validation data for the detection algorithms. Moreover, we discuss the unique attributes of military and North Atlantic Treaty Organization (NATO) settings that may affect the development, deployment, and usage of these systems.

2.0 DATA ACQUISITION INFRASTRUCTURE

One of the major challenges in implementing any type of automated medical syndromic surveillance system is establishing and maintaining the information processing infrastructure to collect, store, transmit, and share data for analysis. This is especially true in a mixed military/civilian environment and in locations where military forces have been forward deployed. Military and civilian agencies use disparate information systems and data communications networks to record, store, transmit, and consolidate data relevant to epidemic surveillance. Military and civilian medical information systems are often incompatible in hardware, software, data architecture, and/or data transmission protocols. There are even significant incompatibilities among government agencies and within the same agency, the individual military services, organizations, and functional activities. Some of the most useful data are not even collected digitally or are so sensitive (e.g., intelligence data) that merging them with less sensitive private data (e.g., nurse triage, doctor visits, pharmaceutical sales, school/work absenteeism) is difficult, if not impossible.

Within the DoD Health System, a 20-year effort has been underway to create a comprehensive “cradle to grave” global health information system that captures, stores, processes, and facilitates analysis of the medical records of military members, retirees, and their families. The effort is culminating in the implementation and population of a world-wide DoD clinical data repository that takes inputs from disparate DoD medical and non-medical information systems to consolidate various types of data from outpatient and hospitalization records from military and military contracted medical facilities, including clinical symptoms and signs, chief complaints, test and laboratory orders, and pharmacy data. Only recently, through initial implementation of its Theater Medical Information Program (TMIP), has the DoD effort encompassed the forward deployed military forces in war zones like Bosnia, Kosovo, Afghanistan and Iraq. Along the way, this effort has encountered significant bandwidth and information processing and infrastructure roadblocks. Fortunately, some major innovative solutions in military information processing strategy are nearing implementation. Figure 1 provides an overall illustration of the various sources and types of data that need to be integrated.

