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Introduction

Preparation for, early detection of, and timely response to emerging infectious diseases and epidemic outbreaks are a key public health priority and are driving an emerging field of multidisciplinary research, infectious disease informatics. As a critical component of this effort, public health surveillance has been practiced for decades and continues to be an indispensable approach for detecting emerging disease outbreaks and epidemics. Although traditional disease surveillance often relies on time-consuming laboratory diagnosis and the reporting of notifiable diseases is often slow and incomplete, a new breed of public health surveillance systems has the potential to significantly speed up detection of disease outbreaks. These new, computer-based surveillance systems offer valuable and timely information to hospitals as well as to state, local, and federal health officials. They are capable of real-time or near real-time detection of serious illnesses and potential bioterrorism agent exposures, allowing for a rapid public health response. This public health surveillance approach is generally called syndromic surveillance, which is defined as “an ongoing, systematic collection, analysis, and interpretation of ‘syndrome’-specific data for early detection of public health aberrations.”

In recent years, a number of syndromic surveillance approaches have been proposed. According to a recent study conducted by the US Centers for Disease Control and Prevention (CDC), roughly 100 sites throughout the country have implemented and deployed syndromic surveillance systems. These systems, although sharing similar objectives, vary in system architecture, information processing and management techniques, and algorithms for anomaly detection, and have different geographic coverage and disease focuses.

We see a critical need for an in-depth monograph that analyzes and evaluates these existing syndromic surveillance systems and related outbreak modeling and detection work under a unified framework. In particular, the monograph aims to meet the following critical and timely needs.

1. As the body of the syndromic surveillance literature grows rapidly, we see a critical need to provide an integrated and synthesized treatment of the current state of the art, identify challenges and opportunities for future work, and promote fruitful interdisciplinary research. In particular, most existing books on syndromic surveillance (and more generally, biosurveillance) focus primarily on statistical modeling and analytical work. They largely ignore informatics-driven perspectives
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(e.g., information system design, data standards, computational aspects of biosurveillance algorithms, information visualization, and system evaluation). This monograph, with a strong Information Technology orientation, will help fill in this important gap and will provide an accessible review of the field for researchers from a wide range of backgrounds who are working or have an interest in public health surveillance.

2. Because of its practical significance, syndromic surveillance is starting to attract students at all levels from a variety of backgrounds ranging from public health, computer science, information systems, software engineering, public administration and policies, and geographical information systems, among others. These students need an approachable textbook that introduces the key concepts behind syndromic surveillance, the related research framework, the critical research questions and methodologies, systems challenges and the state of the art of syndromic surveillance implementation, and case studies, providing contexts to discuss related technological, analytical, and policy considerations in an integrated manner. The book will present such materials from a multidisciplinary perspective to encourage and promote cross-area training, and to accommodate the variety of the backgrounds of the interested students.

3. The monograph will also provide a much-needed comparative study for public health practitioners and offer concrete insights that could help future syndromic surveillance system development and implementation. Because of the recent rapid developments, it is difficult for public health policy makers, and practitioners from both government agencies and the private sector, to follow up with the body of syndromic surveillance research. This book is intended to serve the purpose of communicating to the policy makers and practitioners recent research findings, related policy and implementation considerations, and case studies containing discussions of concrete application scenarios.

Scope and Organization

The monograph aims to present its chapters in a manner understandable and useful to students, researchers, and professionals. The main coverage of the fifteen chapters is listed below:

- Chapter 1 will discuss the motivation behind syndromic surveillance and offer a high-level overview of the field from research, systems, and implementation perspectives. It will also summarize the major challenges hindering syndromic surveillance system development and adoption.
Chapter 2 will present a conceptual framework used throughout the book to analyze various kinds of syndromic surveillance systems and their components. In addition, a comprehensive summary of all the systems surveyed in our study will be presented in this chapter.

Chapter 3 will be primarily focused on sources of data for syndromic surveillance and related data standards and messaging protocols. It will present how various types of public health-related data have been used for surveillance purposes and how effective they are. It will also survey technical work to facilitate data collection, sharing, and transmission from the point of view of knowledge representation and protocols.

Chapter 4 will present an introductory summary to data analysis and exploration techniques that have been applied to public health syndromic surveillance. The focus will be on various outbreak detection methods, including those monitoring for unusual patterns, indicative of possible outbreaks worth further investigation, in temporal, spatial, and spatial-temporal domains.

Chapter 5 will discuss data visualization and information dissemination issues in the context of syndromic surveillance. Visualization is an important informatics tool to help public health analysts explore and analyze typically voluminous surveillance datasets, preferably in an interactive manner. Information dissemination also plays an important role in syndromic surveillance as mandated and voluntary data sharing and reporting need to take place within and across public health departments and partnering agencies such as homeland security and public safety.

Chapter 6 will focus on system assessment and other policy issues. These issues have been traditionally under-studied or under-appreciated. This chapter will attempt to address such issues through a principled and theory-grounded evaluation and assessment framework based on the Information Systems literature.

Chapters 7–14 will report several real-world case studies, summarizing and comparing eight syndromic surveillance systems, including those that have been adopted by many public health agencies (e.g., RODS and BioSense).

Chapter 15 will conclude the monograph by discussing critical issues and challenges to syndromic surveillance research and system development, and future directions.
Audience

The primary audience for the monograph includes the following:

- Upper-level undergraduates and graduate-level students from a variety of disciplines including but not limited to public health, biostatistics, information systems, computer science, and public administration and policy will benefit from learning the concepts, techniques, and practices of syndromic surveillance.

- Researchers in public health and IT are expected to find this book to be an excellent and comprehensive source of current and comprehensible reviews of the recent advances in the field and benefit from its multidisciplinary angle. It will also help promote community development across disciplines and between academia and practitioners.

- Government public health officials (e.g., epidemiologists at all levels of government) and private-sector practitioners (in both healthcare and IT industries) will be interested in this book as it provides an up-to-date review of current syndromic surveillance research and practice, critical evaluation of current technologies and approaches, and discussion of real-world case studies.
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