KFL&A PublicHealth

Spatial-temporal Cluster Detection Approaches in the Syndromic Surveillance System

Technical Report

Jie Tian[1], DongMei Chen[1], and Don McGuinness[2]

[1]Department of Geography, Queen's University, Kingston, ON
[2] Queen's University Emergency Syndromic Surveillance Team, KFL&A Public Health Unit, Kingston, ON

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1. INTRODUCTION

Traditional disease surveillance has relied on individual health-care providers. They compulsorily notify the appropriate public health authorities if any suspicious outbreak is recognized. However, complaints of close syndromes may have shown certain spatial pattern at the community level well before patient-level data raise an alarm (Lewis et al., 2002). The modern surveillance system stems from this fact and is built on an administrative community level. The current syndromic surveillance system for the health unit of Kingston-Frontenac-Lennox and Addington (KFL&A) is based on emergency department admissions. In particular, case data is received electronically from six hospital emergency departments located in KFL&A. By focusing on symptoms rather than confirmed diagnoses, the syndromic surveillance aims to detect possible disease outbreaks promptly. The surveillance system stores all the historical case data and supports temporal queries. Alerts are sent by the system when a notable increase in patients presenting for care with similar symptoms is detected. However, despite these functions, a modern syndromic surveillance is further expected to facilitate public health authorities detect and response to unusual outbreaks of disease rapidly. The outbreaks may result from bioterrorism attacks, outbreaks of infectious disease or other public health emergencies. Early detection of such outbreaks could allow appropriate public health intervention and minimize negative impact.

Disease outbreaks are likely presented as clusters of complaints in space, in time or in both. The statistics of disease clustering have been studied for many decades (Anselin, 1995; Kulldorff, 1999; Marshal, 1991; Ord and Getis, 1995). They are generally intended to tackle two issues: 1) whether there is an overall tendency for clustering to occur; 2) if yes, where clusters specifically occur. A number of approaches have therefore been developed in the literature for either testing clustering degree (e.g. global Moran's I and global Getis-Ord Gi*) or detecting specific clusters (e.g. local Moran's I, local Getis-Ord Gi*, and scan statistical approaches). Furthermore, clustering is understood as a concept related to scale of measurement (Marshal, 1991). Clustering of complaints may be analyzed at different spatial and/or temporal scales, depending on analytical purposes. As for a surveillance, its cluster detection should more focus on local clusters occurring during short periods.

This study intends to explore the potential for incorporating a function of detecting and locating disease outbreak in the KFL&A surveillance system. The major approaches for detecting spatial, temporal, and spatio-temporal clusters are briefly reviewed and compared in section 2. The related GIS data and the exemplary case data extracted from the surveillance database are described in section 3. To demonstrate the functionality of spatial-temporal detection, a group of retrospective analyses was performed in section 4. Furthermore, a set of case data is simulated to imitate different scenarios of static disease outbreaks in terms of size and location. The sensitivity of the approaches to different outbreak cluster sizes and locations is examined in section 5. In addition, the importance of complete postal information is illustrated by comparing the detection results from the simulated case data with six-digit postal codes and its aggregated version with five-digit postal codes. In section 6, data of three consecutive days with disease spreading is simulated for dynamic cluster detection.