# Chapter 71
# GIS Application of Healthcare Data for Advancing Epidemiological Studies

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## ABSTRACT

*Healthcare practices increasingly rely on advanced technologies to improve analysis capabilities for decision making. In particular, spatial epidemiological approach to healthcare studies provides significant insight in evaluating health intervention and decisions through Geographic Information Systems (GIS) applications. This chapter illustrates a space-time cluster analysis using Kulldorff's Scan Statistics (1999), local indicators of spatial autocorrelation, and local G-statistics involving routine clinical service data as part of a limited data set collected by a Northeast Ohio healthcare organization over a period 1994 – 2006. The objective is to find excess space and space-time variations of lung cancer and to identify potential monitoring and healthcare management capabilities. The results were compared with earlier research (Tyczynski & Berkel, 2005); similarities were noted in patient demographics for the targeted study area. The findings also provide evidence that diagnosis data collected as a result of rendered health services can be used in detecting potential disease patterns and/or utilization patterns, with the overall objective of improving health outcomes.*

## INTRODUCTION

The increasing demand for health data analysis in spatial and temporal scale has made emerging technologies such as Geographic Information Systems (GIS) an essential tool for healthcare information systems. In healthcare settings application of such new technology are proving useful in the analysis of health data and planning of healthcare services (Pfeiffer, Robinson, Stevenson, Stevens, Rogers, & Clements, 2008). The ability of GIS to manage and retrieve georeference data has demonstrated its value in the integration of complex epidemio-

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logical models through visualization of spatial and temporal relationships. This has been recognized by the World Health Organization (WHO):

*Geographical information systems (GIS) provide ideal platforms for the convergence of disease-specific information and their analyses in relation to population settlements, surrounding social and health services and the natural environment. They are highly suitable for analyzing epidemiological data, revealing trends and interrelationships that would be difficult to discover in tabular format. Moreover GIS allows policy makers to easily visualize problems in relation to existing health and social services and the natural environment and so more effectively target resources. (World Health Organization, 2008)*

Geographical analysis is not only important for the identification of patterns of healthcare outcomes it also offers insight into understanding the association or linkage to political processes and policy makers (Cromley, 2002; Gatrell, 2002). Health data from managed health care organizations offers the opportunity to analyze unusual geographical patterns of disease. Routine, aggregated healthcare data stored in health systems can be utilized to identify disease clusters or utilization patterns. Recently methods have been sought to further improve identification within case and disease management programs.

The real world clinical service data stored in healthcare information systems provides opportunity to analyze spatio-temporal patterns at finer granularity. The investigation of space and space-time epidemiological patterns often gives rise to the explanation of factors that might create an adverse health condition. This study uses routine, aggregated service data to find excess space and time variations in rendered services where the primary diagnosis was lung cancer. From the health care management point of view, if clusters are detected and explanatory factors linked, this understanding allows for better patient care, i.e. serving a particular population with targeted specialists, and preventing spread of disease amongst populations. This research aims to study different clustering methods of the spatial and spatio-temporal patterns of lung cancer particularly for routine clinical service data collected by a Northeast Ohio healthcare organization over a period from 1994 – 2006.

## GIS

Geographic information systems (GIS) integrate computer applications and data for capturing, storing, querying, analyzing, viewing and modeling geographic and spatial information for improved decision making. GIS are distinguished from other information systems, based on their ability to utilize geographic data (ESRI, 2010; Chang, 2006). GIS originated in the 1960s and 1970s, and were introduced to mainstream use during the 1990s with the addition of a graphical user interface, reduced software and hardware costs, and available data. GIS have been used in a wide spectrum of applications including: natural resources planning, hazard management, crime mapping, transportation, navigation, farming, environmental monitoring, and epidemiology, among others (Chang, 2006; Li, 2008).

The application architecture below displays common components within a healthcare information system for epidemiological studies: a web server, GIS, and database. The web component includes data entry, exchange, and transfer, along with a centralized user interface for healthcare information. The web server also permits viewing of displayed data either on-premise or remotely, enabling greater accessibility of information by the end-user. The GIS maintains geographic and spatial information, and also incorporates statistical and data analysis tools, such as a path analysis, data querying, map data exploration, frequency distribution, regression, chi-square analysis, and multivariate analysis to analyze healthcare data

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