Improving a Regional Outreach Program in a Large Health System Using Geographic Information Systems

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ABSTRACT

As government-insured populations grow, commercially insured populations decrease, and declining insurance reimbursements pressure cost and revenue. Health systems must strive to improve quality while lowering costs. Large medical centers with rural sites must understand their geography and how distances impede access to services, thereby affecting patient health. Without relevant data, which can be provided through the use of geographic information systems (GIS) technology, improvement is often delayed. Gundersen Lutheran Health System, a large multi-specialty system with urban and rural sites in 3 states, is developing an evaluative outreach GIS to facilitate understanding of, and response to, rural health needs. Investing in GIS technology furthers the health system's ability to deliver superior, affordable care.

BACKGROUND

Large regional medical centers must manage multiple geographic information factors to answer operational questions of who, what, where, when, why, and how care should be delivered. In population health terms, these factors include patient locations and densities, clinical service lines, hospitals, clinics, employers, insurance coverage, demographics, medical transportation, and referral patterns. Such overlapping complexity could be better understood by using visual technology.

Gundersen Lutheran Health System is a large multi-specialty integrated health system in western Wisconsin whose focus is on quality and safety, exceptional patient experience, culture that embodies care and ownership, affordable care, and growth. This focus drives the health system toward self-aware critique that stems in part from its 3-state geography,

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hill-and-dale topography, and urban/rural demography. In that regard, the organization recognized the need to provide leaders and analysts with readily available patient data and maps constructed from those data. Recently, the Geographic Information System (GIS) function shifted from paper maps toward dynamic intranet mapping with exportable data tables.

As government-insured populations grow (baby boomers to Medicare recipients), commercial insurance program populations decrease, and declining insurance reimbursements pressure cost and revenue, greater regional awareness must strive to improve quality while lowering costs. Clinical information technologies—electronic health records, data-rich analysis, telemedicine, and GIS—may help the organization succeed. Information technologies augment the value a tertiary medical center can offer to smaller regional hospitals, benefitting rural patients in their own communities via their own physicians and providers. This article describes a GIS system designed to support these missions and its transition from design to production.

METHODS

The health system's service area is comprised of 19 counties in 3 states: western Wisconsin, southeastern Minnesota, and northeastern Iowa. Two decades ago, outreach representatives and regional leaders segmented service areas surrounding local (typically critical access) hospitals into sets of contiguous US Postal Service ZIP codes.

In 2011, a decision was made to develop a prototype into a full GIS project addressing 3 key questions to assist with regional decision-making: (1) What is the viability of a current outreach location? (2) Where does an opportunity exist for new outreach? and (3) Where are there new potential clinic locations or service sites?

To answer these questions, the organization needs to know how well it serves rural patients in proximity to their homes. The performance of a clinical care outreach program is measured in volume of visits, procedures, and charges. (See Figure 1 with visit/trend detail; Figure 2 demonstrates average patient drive times in a rugged area for patients who see particular outreach specialists. Figure 3 displays ZIP code and patient populations.) Any numeric data (cancer severity, for example) from de-identified patient encounters can be mapped in aggregate for a specific area with demographic data, such as average household income, average highest level of education, etc.

The completed GIS will suggest potential outreach locations from state data (by diagnoses set/specialty) in areas that need specialists, ie, finding gaps in services. The issue of new clinic locations or service sites will come from initial recommendations based on patient locations and drive times, and on measured proximity to existing services, and the prospective sites' potential for service and effect on existing clinics.

At Gundersen Lutheran currently, paper maps still provide graphic information to service areas via individual clinical care programs. Data flows through corporate research analysts who conduct tabular and trend analysis of regional activities. Data specialists write programs extracting stored information; analysts add state data and refine results into aggregated tables and graphs. Finally, the cartographer maps some elements for presentations. A lower-cost, faster, automated self-service map and data system holds the promise to improve the planning of services and care for populations who receive care from the system.

The Process

The project uses ArcGIS tools, including ArcMap, ArcGIS Server (ArcSDE), and ArcGIS Business Analyst, by Esri, a leading GIS software vendor,[1] with installations in all levels of government, science, and industry worldwide. These tools are
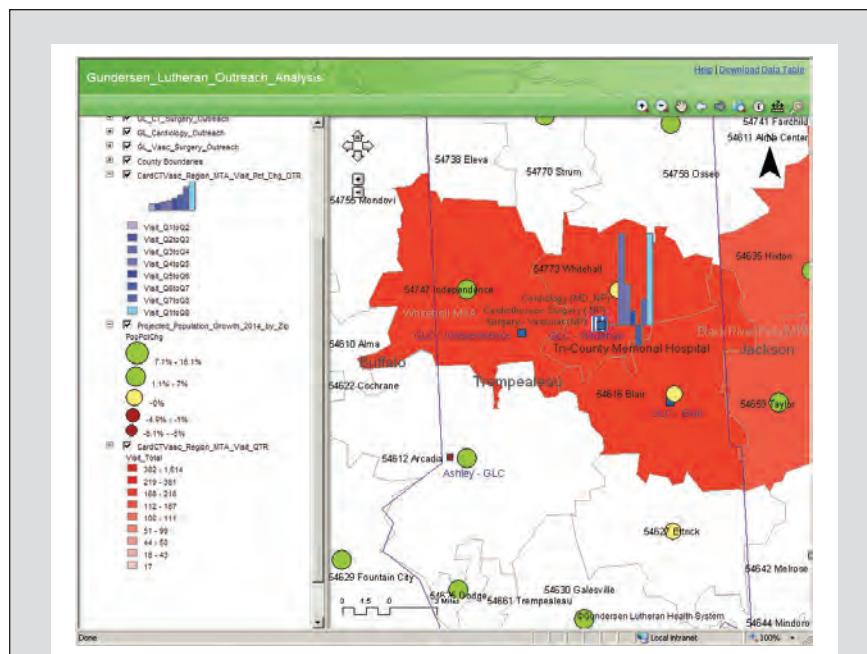

Figure 1. Cardiology/Cardiothoracic Surgery/Vascular Surgery outreach visit activity with quarter-to-quarter percent change, overall period (12-quarter) visit volume, and population growth symbolized in a 2 ZIP code regional hospital service area.
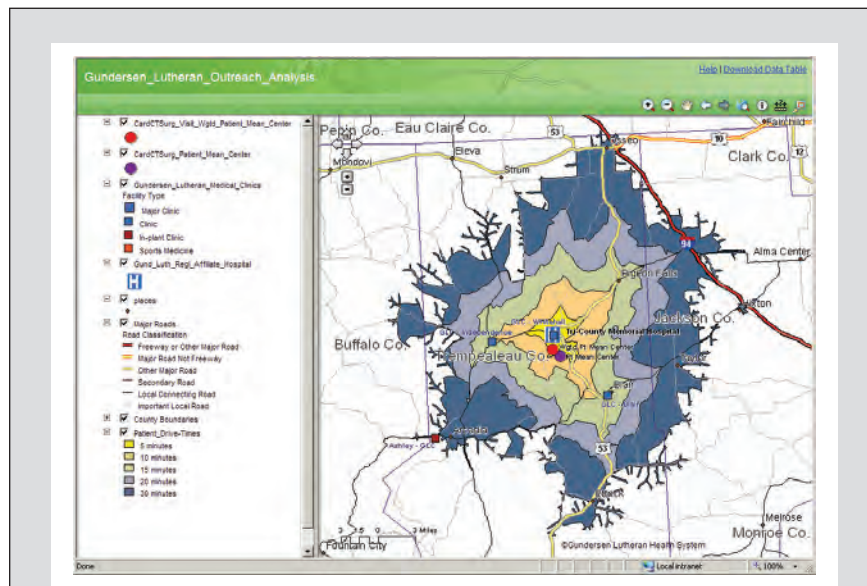

Figure 2. Website representation of Whitehall, Wisconsin, patient average drive-time rings to the Gundersen Lutheran clinic, with Cardiology/Cardiothoracic (CT) Surgery outreach visit count-weighted patient mean residence center, and Cardiology/Cardiothoracic (CT) outreach patient mean residence center, for 149 patients. Note the extended average drive times vs short distances in this topographically steep area.

compatible with open source (non-copyrighted system) databases as well as major commercial databases (eg, Oracle, DB2, SQL Server)[2] and fit well in health care information systems departments. A number of E911 and computer-aided dispatch emergency medical transportation solutions, such as RescueNet
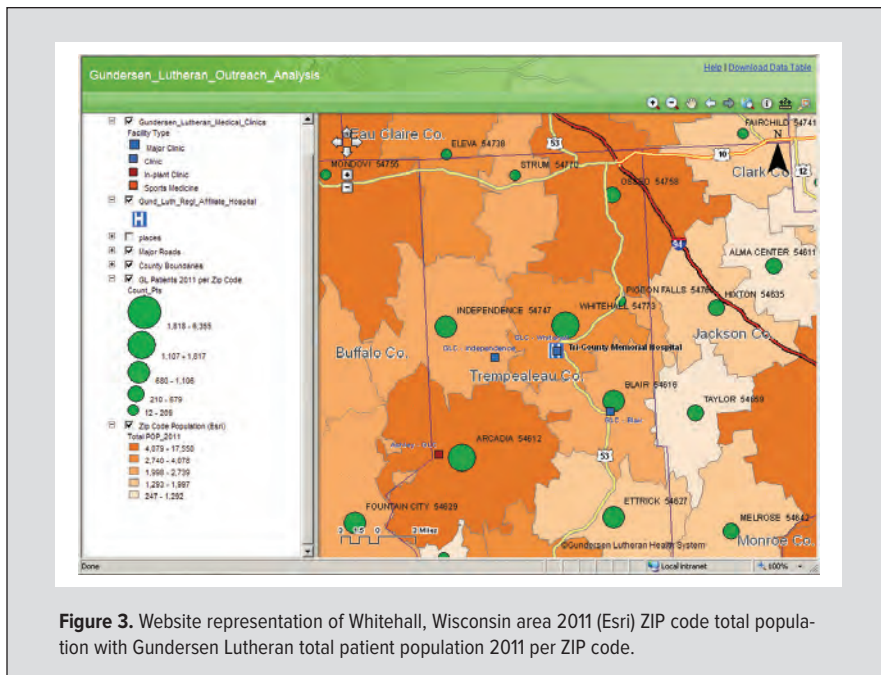
Figure 3. Website representation of Whitehall, Wisconsin area 2011 (Esri) ZIP code total population with Gundersen Lutheran total patient population 2011 per ZIP code.

dures and aggregated total charges, with trended volumes, and trended changes in volume, are applied to the service area. In addition, visits volume per quarter (visits trend), with quarter-to-quarter percent change, are symbolized by small bar graphs (Figure 1).

Employers by type, location, and employee count, with insurance coverage source for large employers, and health maintenance organization coverage areas by county are also important. Any relevant numeric data of interest can be symbolized geographically, gated by importance, availability, cost, and time. Map interface and legend will vary by key question, displaying relevant layers and symbology.

Three primary data sources support the project. First is the system's data warehouse of de-identified patient data narrowed to age, gender, ZIP code, provider, relevant diagnosis group (specialty), visit location, procedure location, and total charges. Second is state data via Wisconsin Hospital Association[4] with Minnesota Hospital Association[5] data-sharing for eastern border and metropolitan counties, and Iowa Hospital Association [6] via Thomson Healthcare.[7] Third, standard map layers via Esri anchor known reference points, features, and boundaries.

Dispatch by Zoll Medical Corporation,[3] are built on the Esri ArcGIS platform.

The description of a GIS, "a relational database with a sense of space," summarizes these software tools' capabilities for organizing, processing, analyzing, and symbolizing spatially related data. Thus, 'geo-' processing operations bind the aggregated de-identified patient data to the specific areas under analysis and make that data available for symbolizing and interpretation in the online map.

The immediate audience for these geographic tools includes research analysts, clinical care program directors, department chairs, marketing leaders and analysts, regional leaders, and system leadership. This team identifies optimal local relationships that support integrated (clinic-hospital) care, efficient resource deployment, affordable costs, and foremost, improve patient health.

State, county, city, and postal code boundaries with demographic data, and transportation and water features underpin the application. Other important data include health system locations—the medical center, outpatient surgical centers, regional hospitals, affiliated nursing homes, and clinics. These data appear as differentiated points defining a clinician's home location. Outreach providers (including telemedicine) will appear at appropriate clinics and appear by specialty and frequency.

Visit volume and trend by outreach location and clinical care program comprise layers in rolling 12-quarter total periods. All de-identified patient visits, either inpatient or outpatient, in a service area (regardless of patient residence), proce-

Use of the GIS System

This application, when complete, will provide decision makers, research analysts, clinical care program leaders, and regional leaders access to data and maps in a self-service mode. Present development primarily supports current outreach viability. De-identified patient encounters as visits, procedures, and charges in a 12-quarter span will flow from the data warehouse, and state data will flow from the hospital associations via the data vendor, into an intranet website whose map interface and legend are determined by the user. Accompanying standard format downloadable data tables will speed statistical and graphical analysis and will directly address expected data skeptics' questions. Choices on how to allocate resources to better serve patients still may involve lively debate but will be better informed by facts.

DISCUSSION

Health systems considering the use of GIS programs to complement existing operational performance research efforts require investment in someone trained in GIS from a geography or

computer science background. In addition to GIS desktop and server software and dedicated server hardware, a successful GIS program requires support from information systems and operational leadership.

Without relevant data, or where there is geographic uncertainty, skepticism and historical anecdotes reign and improvement is often delayed.[8] In essence, GIS visual data enhances the decision process that bears directly on patient care. To do so requires leadership confidence in the quality and value of the information.

As Gundersen Lutheran invests more in geographic information technology, the system should provide insight that simplifies and augments understanding of complex outreach data. One of the system's most notable strengths stands as its ability to deliver superior care to an increasingly Medicare-funded patient base at affordable cost. The GIS clinical information tool will help manage this present day rural health care challenge for patient well-being.

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