Using Geographic Information Systems to Define Healthcare Access in an Urban Community Health Center Network

Andrew Bazemore, MD
Robert Phillips, MD MSPH
Thomas Miyoshi MSW

Abstract:

The use of geographic information systems(GIS) to better understand access to primary health care has been demonstrated successfully, including the pilot application of GIS in a Community Health Center(CHC) setting. However, these early applications have not been tested within the complex population dynamics of a major urban setting. Developing a tool capable of evaluating current CHC services and guiding future resource allocation is of particular interest given Bush Administration plans to double the capacity of CHC's nationally over a five year period. Building on one author's(Phillips) early work, our ongoing project demonstrates the application of GIS to the assessment of clinical service areas, the identification of underserviced populations, and to strategic planning and resource allocation within a network of urban CHC's.

Community health centers receive federal grant funding under Section 330 of the Public Health Service Act and, as such, have a legislative mandate to serve underserved areas or populations. These medical underserved areas or populations(MUA or MUP) are geographically defined by federal and state planners. [1]. It therefore might be expected that some geographic measure of access would be used to measure CHC utilization by these targeted populations. However, neither governmental planners nor the renewal process for CHC grants require geographic outcomes measurement, and little work has been done towards their ascertainment.

Early applications of geographic information systems(GIS) to understand access to primary health care have been described by several authors, including an excellent summary in previous ESRI conference proceedings[234]. The integration of GIS into primary care research has been slowly gaining ground in recent years as technology has improved and become more accessible to health care researchers. In relation to the study of CHC's, Phillips et al describe the merging of CHC administrative clinic data with existing population data using GIS to visually depict access to care by underserved populations of Boone County, Missouri[5].

Since the publication of these early efforts in the analytic mapping of public clinics for the underserved, called 'Safety Net' clinics, the current presidential administration has outlined a plan to expand safety net coverage. The Health Centers Presidential Initiative outlined by President Bush and the Department of Health and Human Services calls for a doubling of CHC capacity nationwide over a five year period (2002-2006)[6]. However, these plans lack adequate evaluative tools at the individual CHC or community level. Recent efforts to take make use of analytic mapping in the expansion process –as through

strategic utilization of the Primary Care Service Areas(PCSA) designations created by Goodman et al – offer potential value to state and federal planners[78]. However, with single PCSA's often containing over 250,000 individuals and population segments of wide sociodemographic diversity, these maps are too big to allow for strategic planning at any but a macroscopic level.

Data permitting smaller area analytic mapping exists, as all CHC's are mandatorily required to report standard data on every patient seen. This data, entered into the Uniform Data Set(UDS), includes addresses, complete sociodemographic information, all diagnoses recorded for each visit, payment method, and standardized percent of poverty for each patient. Using GIS to combine the data from the UDS with population data(e.g. 2000 census data) would provide a flexible tool at the CHC level to evaluate existing services, identify populations in need of services, or prioritize service expansion.

Our primary project objective was to determine whether such a flexible tool could be created for CHC leaders in an urban setting. We extended the methods piloted in Boone County, Missouri to a major urban center and its largest CHC network. The study was conducted in collaboration with Baltimore Medical Systems, Inc(BMSI), which at study onset was operating four CHC's in Baltimore, Maryland. After approval of the study protocol by the Institutional Review Board of Georgetown University School of Medicine and the approval of a data use licensing agreement to protect patient confidentiality, we began the first phase of analytic mapping. It was agreed that initial maps would be generated to define health service areas and market penetration rates for BMSI and to identify potential priority populations for expansion of CHC services. Afterwards, CHC leaders were to gather to appraise initial map results and guide further phases of mapping.

Uniform data set(UDS) information on each patient visit from one of four CHC's between July 1st, 2000 and June 30th, 2001 were geocoded by household address. The unit of analysis was set at the patient, rather than patient visit, level, and a 99.2% geocoding accuracy was achieved. To identify areas of under service and graphically represent each clinic's service community, clinic and system-wide service areas and penetration rates were mapped, using matched population data. Using a modified Griffith's commitment index, service area was defined as the census block groups containing 60% of center users. Penetration rate was defined by census block group as clinic users per total block group population.

Service area maps and a system-wide aggregate service area map revealed access and utilization patterns for each clinic. Maps of the designated MUA for a clinic were also generated, allowing CHC leaders to recognize differences between assigned and actual service area. User penetration maps varied widely by clinic, but they helped to identify one clinic with higher than expected concentrations of clinic patients relative to census block group populations. Upon review by clinic leaders, the maps were thought to reveal that neighboring block groups might be primed for the addition of new clinical resources or marketing of services.

CHC leaders found analytic mapping to be extremely helpful, and identified a number of potential applications of the project. These included strategic planning of future marketing efforts and expansion, grant-seeking, disease surveillance and cluster identification, and community health promotion and outreach. Qualitative analysis by a range of CHC clinicians and leaders of a variety of maps, including point maps, service area maps, and penetrance maps, was critical to the appropriate interpretation of all maps produced.

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CHC leaders were able not only to comprehend the maps presented, but also to immediately generate a number of new questions for analysis. The impact of the analytic mapping effort on CHC decision-making was also seen quickly. For example, BMSI leaders cancelled a plan to move one clinic 17 blocks northeast after reviewing maps for that clinic. These service area maps and point maps were created to reveal information about a sociodemographic group deemed 'vulnerable' by clinic leaders for that clinic. The maps, when correlated with the knowledge of community infrastructure possessed by these leaders, revealed that a large cluster of these vulnerable patients would have their clinic access severely limited by what had seemed – in Euclidean distance- to be a very short move. Sample verbatims from the meeting reveal other examples of how CHC leaders saw how knowledge gained from maps could translate into immediate gains for their clinics, and also how they gained new insight into their patients' care-seeking behaviors(Table 1).

Phase One of our mapping project is now complete, and our meetings with BMSI leaders have generated a wealth of further mapping ideas that will benefit their CHC network. Future goals of the project include the expansion of our collaboration to include all other CHC's and safety net clinics in urban Baltimore. This would allow for a more comprehensive picture of primary care access by underserved populations in a major metropolitan area. Such a map could complement and potentially validate PCSA mapping efforts, and could serve as a model for use by state and federal planners. Eventually, a web-based GIS interface using software such as ArcIMS would be ideally suited to permit CHC planners to analytically map their own clinic data.

Author Information:

Dr. Andrew Bazemore is an Assistant Professor of Family Medicine at the University of Cincinnati(UC) and a health services researcher at the Institute for Health Policy and Health Services Research at UC.
andrew.bazemore@uc.edu

Dr. Robert Phillips is the Assistant Director of The Robert Graham Center: Policy Studies in Family Practice and Primary Care(part of the American Academy of Family Physicians) and Assistant Professor in the Department of Family Medicine at Georgetown University.
bphillips@aafp.org

Thomas Miyoshi is a Senior Instructor in the Department of Family Medicine at the University of Colorado.
thomas.miyoshi@uchsc.edu

TABLE 1: Verbatims from the initial meeting with CHC leaders[9]:
Chief Operations Officer: "I'm just excited… We're doing this expansion grant for Belair Road and there [are] two key questions in the grant being asked 'Why do guys think you need to expand?' 'Tell us who is not being served in your MUA that you need to expand[for]' Now I've got these maps. I can now say 'Look at all of these people in my clinic area that are not being served' and we need to expand…Now I have to get some outreach persons [to explain this]"
Director of Pediatric Services, BMSI: "And yet a population seems to be going out of its way to avoid one center and go to another… despite Belair Road being right at its back door. Could it be that a bus route goes directly to the other clinic, and we need to be incorporating maps of bus lines into our expansion strategy?"

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