

A MODEL FOR ASSESSMENT OF POTENTIAL GEOGRAPHICAL ACCESSIBILITY: A CASE FOR GIS

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ABSTRACT

Health is geographically differentiated thereby creating an inextricable link between “place” and “health”. Differences in access to healthcare services and resulting adverse health outcomes when there is inadequate healthcare are major public health priorities. While the literature is replete with research about disparities in healthcare access and health outcomes, a greater understanding of geographical enabling factors and predisposing characteristics is needed. The purpose of this concept article is to present a discussion of development of a theoretical framework for study of potential geographical access to healthcare from a perspective of Andersen’s Behavioral Model of Health Services Use (Andersen, 1995). An adaptation of Andersen’s model, *The Model for the Assessment of Potential Geographical Accessibility*, is presented as a conceptual framework to aide in future studies of potential geographical accessibility. The application of geographical information systems (GIS) technology and methodology as an analytical tool will also be presented.

INTRODUCTION

Differences in access to healthcare services and the resulting adverse health outcomes are major public health priorities. The Institute of Medicine (IOM, 2002) and the Department of Health and Human Services (USDHHS, 2000), identified the need for strategies to improve access to healthcare services and to support improvement of health outcomes (AHRQ, 2002; IOM, 2002). Furthermore, Healthy People 2010 designates two central goals for the nation’s health: (a) to increase quality and years of healthy life, and (b) to eliminate health disparities (USDHHS, 2000). Many studies have been conducted to identify the characteristics of disparities in healthcare access and health outcomes. Findings of these studies indicate that while most Americans have high quality healthcare available, gaps or disparities in healthcare access and health outcomes continue to exist. These disparities are associated with age, education, race and ethnicity, gender, income and socioeconomic status (SES), and place of residence and location of healthcare services.

Healthcare policy changes over the past decade have drastically decreased access to healthcare services. The rural health environment has been impacted by these changes in many ways (Bushy, 2000; Folland, et al., 2001). Significant decreases in healthcare services to an already vulnerable, at-risk rural population have compounded existing problems of resource disparities. Loss of community health services, healthcare professional shortages, rapidly rising cost, hospital closures, homecare cut backs, and tighter government payment schedules are just a few of the changes that have led to greater resource disparities for rural populations (USDHHS, 2000; Eberhardt, et al., 2001). Because of structural, financial and sociocultural barriers in rural populations, they have fewer healthcare resources than urban populations. These rural resource disparities often lead to complex adverse health outcomes and rural health status disparities (Fryer, et al., 1999; Lovett, Haynes, Sunnenberg, & Gale, 2002; Lin, Allen, & Penning, 2002).

While the amount of research about disparities in healthcare access and health outcomes is overwhelming, there is a paucity of literature that provides a greater understanding of geographical enabling factors and predisposing characteristics. More information about the relationship between and the effect of social and geographical factors that enable people to obtain healthcare is needed. Specifically, are healthcare services located in a manner that allows equal access? Research linking specific types of mortality of specific regions of the country to access to specific types of healthcare services could provide information to assist in the reduction of the excess mortality found in at-risk populations.

Andersen's Behavioral Model of Health Services Use has often been used as a framework for the assessment of healthcare access, outcomes, and quality. Within this framework is embedded the premise that the lack of timely access to healthcare services may potentially cause adverse health outcome as evidenced by higher mortality rates.

FRAMEWORK FOR THE STUDY OF ACCESS

R.M. Andersen began to examine the concepts of "access" in 1968. His seminal work explored "systems" and "behavior" of medical care and identified and defined concepts of "access" (Andersen, 1970). Andersen, along with L. A. Aday, further examined concepts of access in a comprehensive literature review (Aday & Andersen, 1974). This work both conceptualized and operationalized "access" to medical care and provided an integrated theoretical framework for use in the study of access to medical care. In these works, the authors showed how empirical indicators could be derived from the concepts of access. Later Andersen updated this framework of access to a behavioral model of health services use (Figure 1) (Andersen, 1995). Today, concepts of Andersen's model remain relevant and are used as a framework for assessment of healthcare access, outcomes, and quality (Love, et al., 1995; Fryer, et al., 1999; Phillips, et al., 2000; Henton, et al., 2002; Leong-Wu & Fernandez, 2006; Lo & Fulda, 2008).

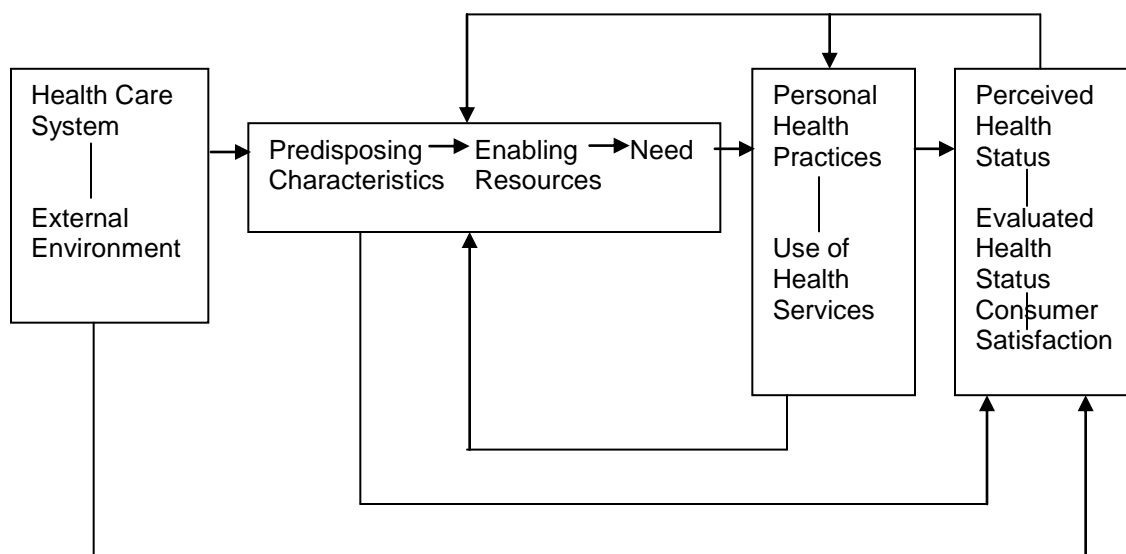


Figure 1. An Emerging Model – Phase 4

Note. From Revisiting the behavioral model and access to medical care: Does it matter? By R. M. Andersen, 1995, *Journal of Health and Social Behavior*, 36, (March) 1–10. Reprinted with permission.

The concepts identified by Andersen within a framework for study of access are defined (Andersen, 1995). In Table 1 these concept definitions provide a clear basis for understanding the application of the model.

Table 1
Concepts within a framework for the study of access

| Concept | Definition |
|--|--|
| Health Policy | Andersen (1995) suggests that it is the evaluation of the effect of health policy that health planners and policy makers are most concerned about. |
| Characteristics of the Healthcare Delivery System | Specifically, “delivery system” - “those arrangements for the potential rendering of care to consumers” (Andersen, 1995). |
| a. Resources | a. Resources – the labor and capital devoted to healthcare. These resources include health personnel, physical structures, equipment, and materials for the provision of healthcare and are assessed by both volume and distribution of services. |
| i. Organization | i. Organization – “what the system does with its resources. It refers to the manner in which medical personnel and facilities are coordinated and controlled in the process of providing medical services” (Andersen, 1995) |
| ii. Entry | ii. Entry – process of gaining entrance into the healthcare system and can be measured in terms of travel time, waiting time, etc. Another term for entry is “access”. |
| iii. structure | iii. Structure – includes whom the patient sees and how he is treated as measures of what happen to the patient after entering the system. |
| Characteristics of the Population at Risk | Individual’s determinants of health service use. |
| a. Predisposing component | a. Predisposing component – variables that exist before the onset of the illness that describe the individual propensity to use services. Measures of this component include age, sex, race, religion, and values about health and illness. |
| b. Enabling component | b. Enabling component – means or resources individual have available for the use of services. Individual or family resources include income and insurance coverage, while attributes of the community of residence include rural-urban character and region. |
| c. Need component | c. Need component – level of illness that brings about health service use. May be perceived by the individual or evaluated by delivery system. |
| Utilization of healthcare services | External validation of the effect of the characteristics of the population at risk and of the delivery system on entry (or non-entry) into the system. Andersen (1995) state that health policy makers are concerned with both those who do and do not get into the healthcare system. |
| a. Type | a. Type – kind of services received (hospital, physician, pharmacy, etc.) |
| b. Site | b. Site – place where the service is received. |
| c. Purpose | c. Purpose – whether care is preventive in nature, illness-related, or custodial. These reason or purposes for care have different patterns of care seeking in the concept of access. The purpose of health services is important to the understanding of the specific healthcare demands of those who seek healthcare services. |
| d. Time interval | d. Time interval – is measured in terms of contacts, volume, or continuity measures. |

Andersen's original Behavioral Model of Health Services Use was initially developed in the late 1960's to help understand the use of health services; to define and measure equitable access to healthcare; and to assist in health policy development to promote equal access to healthcare (Andersen, 1995). In the revised "Behavioral Model of Health Services Use" Andersen posits that health service use is a function of people's predisposition to use services, factors that enable or impede use, and their need for care (Andersen, 1995). These factors make individual contributions in prediction of healthcare use.

Predisposing characteristics include demographic factors, social structure factors, and health beliefs. Biological imperatives such as age and sex would be included in demographic factors that might explain the need for healthcare. Measures of social structure are education, occupation, ethnicity, as well as social networks, social interactions, and culture. It is Andersen's position that while health beliefs add to the model's ability to explain health services use in general, measures of enabling resources and need explain more of the variation.

In assessment and measurement of "enabling resources" Andersen further challenges researchers to go beyond obvious measures of "regular source of care", "physician populations" and "hospital bed counts". Andersen believes that for healthcare service utilization to happen, it is imperative that both "personal enabling resources" and "community resources" be socially and geographically available. The kinds and types of health services available where people live as well as their organizational structure and process are important factors.

Both community and personal enabling resources must be present for use to take place. First, health personnel and facilities must be available where people live and work. Then, people must have the means and know-how to get to those services and make use of them. Income, health insurance, a regular source of care, and travel and waiting times are some measures that can be important here (Andersen, 1995).

One of the strongest determinants of this model of health service use is the "need" factor. Andersen presents "need" as perceived health status, evaluated health status, or consumer satisfaction. He sees perceived health status as a social phenomenon that is explained by social structure and health beliefs. Evaluated health status is a biological imperative represented by "professional judgment" about health status (i.e. functional status, mortality, and morbidity, etc.). These biological and social components are dynamic and interrelated and vary with changes in medicine and medical care that is driven by technology, policy, and geography. Evaluated need (such as mortality) is most related to "kind and amount of medical care provided" (Andersen, 1995).

A more specific model for assessment of access can help with understanding the health status of specific populations in relationship to the provision of specific health services. Evaluation of specific small-area "need" and the relationship to that area's predisposing factors and enabling resources can change health outcomes. Assessment of mortality rates and the relationship to location or distance to health services can improve mortality rates. A Model for Assessment of Potential Geographical Accessibility (See Figure 2) is presented for the study of diseases by specific geographical areas. This model was originally adapted from Andersen's "Behavioral Model of Health Services Use" to guide a study of access to cardiac intervention services in Alabama and Mississippi (Author, 2007). The model provides a framework that can be replicated or modified based on specific healthcare systems, predisposing characteristics, enabling resources, need, or health status variables to guide studies of access and health outcomes.

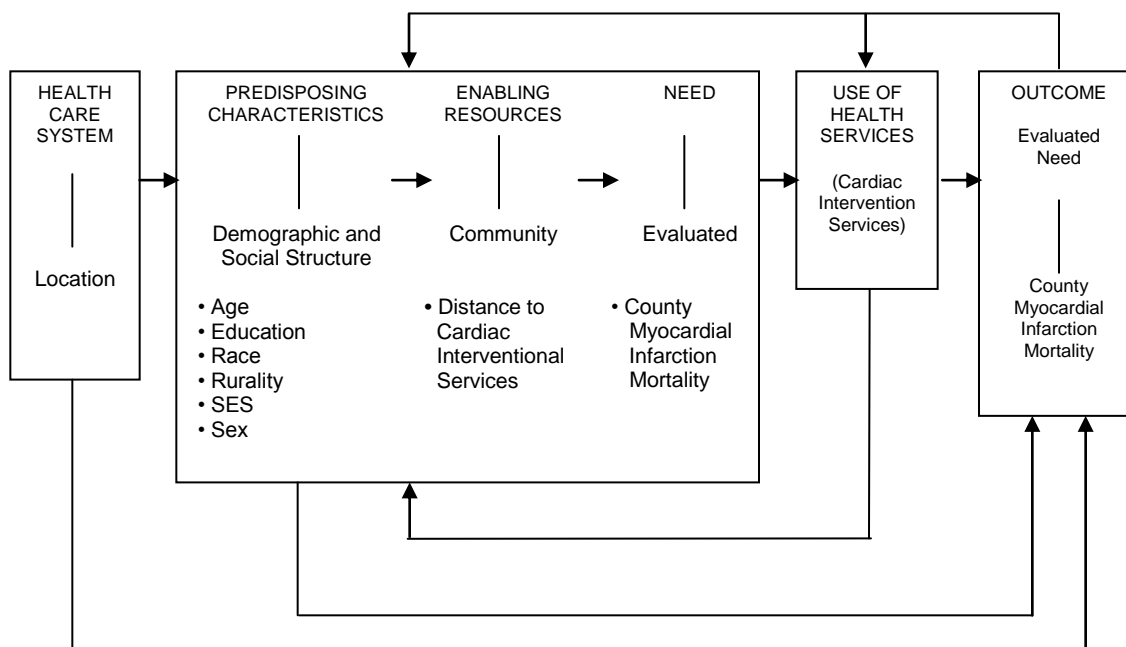


Figure 2. Model for assessment of potential geographical accessibility
Adapted with permission R. M. Andersen (See Appendix D)

HEALTHCARE ACCESS

Access as defined by Andersen is the “ability to use health services when and where they are needed” (Andersen, 1995). Cromely & McLafferty further describe access as the “power to command health service resources” (2002). Potential access or the population’s potential for access is more simply defined as the “presence of enabling resources” (Andersen, 1995). The lack of enabling resources can lead to decreased access to healthcare services. Barriers of access such as race, age, education, income, sex, culture, ethnicity, sexual orientation, lack of insurance, and geographical location can affect the use of healthcare services (Cromley & McLafferty, 2002; AHRQ, 2002).

The concept of access is multidimensional. Dimensions of access include availability, accessibility, accommodation, affordability, and acceptability. Aday and Andersen further divide accessibility into socio-organizational and geographical aspects (1974). The geographical dimension of access includes empirical measures such as distance, travel time, transportation, and the associated cost. Measures of access often focus on geographical location of service “provision” and the relationship to the population in “need”. Both “time” and “space” create constraints to access (Cromley & McLafferty, 2002). Therefore, the location of healthcare services and the associated distance and travel time are important health policy issues.

Over thirty years ago Julian Tudor Hart described the imbalance between “need” and “provision” of healthcare services in Great Britain (Hart, 1971). Hart’s seminal research described class gradients in mortality and morbidity in Britain and proposed that a more “just” distribution of healthcare resources would subsequently equalize the social and geographical differences in health outcomes such as mortality. The “inverse care law” proposed by Hart stated that “the availability of good medical care tends to vary inversely with the need for it in the

population served” and that this law “operates more completely where medical care is exposed to market forces, and less so where such exposure is reduced” (USDHHS, 2000). The inverse relationship between “need” for healthcare and “provision” of healthcare continues to exist despite advances in healthcare. Current literatures suggest that this phenomenon is evident in healthcare in both developed and undeveloped countries.

Need is most often assessed using population characteristics and risk factors such as population distribution, age, sex, income, etc. But need is more than a function of population distribution and other population characteristics. Need is better defined by burden of disease indicators such as morbidity and mortality data. Mortality data have been widely used as an indicator or surrogate for health status or healthcare needs evaluation (Gatrell, 2002). Where high rates of mortality exist, there is a high burden of disease. Mortality data can indicate the geographical areas where resources are most needed. Research relating mortality data to the geographical location of healthcare services by specific diseases and procedures can help healthcare planners and policy makers achieve equitable distribution of resources. Geographical resource distribution studies are needed to describe and analyze inequity in the spatial distribution of healthcare resources and the relationship to burden of disease.

ACCESS AND HEALTH OUTCOMES

Health status is an outcome of multiple determinants. Individual biology and behaviors, physical and social environments, policies and interventions, and access to quality healthcare are predisposing factors that can contribute to the health of people and communities (USDHHS, 2000; Eberhardt, et al., 2001; Ricketts, 1999). These predisposing factors for health status are often interdependent and interrelated creating a complex web of causation for health outcomes (Bushy, 2000; Friedman, 1994).

There are many structural, financial, and socio-cultural barriers to access to quality healthcare. These barriers are an integral part of the complex web of causation of many disease processes because they affect health-seeking behaviors, health service utilization, and ultimately may lead to adverse health outcomes (Bushy, 2000; Friedman, 1994).

According to Andersen (1995), health outcomes are measured and defined by health status, satisfaction, and quality of life. Dunkin states that outcomes are “complementary in measuring access, especially for complex chronic health problems” and “can provide insight about barriers that may impede access to services” (Dunkin, 2000).

Over the years many studies have documented differences in health outcomes as well as challenges that groups experience in accessing quality healthcare (Blustein & Weitzman, 1995; Black, et al., 1995; Weitzman, et al., 1997; Bullen, et al., 1996; Goodman, et al., 1997). Differences in health outcomes and health status are referred to as “healthcare disparities”. When there are differences or variations in health outcomes among populations, inequality in healthcare access is a valid assumption (AHRQ, 2002). Inequalities also exist when all patients do not have access to care that meets the standards for “best practice”. These inequalities create underserved, at-risk populations and have been identified by Congress as priority populations. These groups include women, children, the elderly, minority groups, low-income groups, residents of rural areas, and individuals with special healthcare needs varying across regional and geographical areas of the country. Priority populations are the targets of many health initiatives directed toward identifying strategies to improve access and health outcomes (AHRQ, 2002; USDHHS, 2000). One such strategy could be the use of GIS for assessment of healthcare access and health outcomes.

A CASE FOR GIS

Geographic Information Systems (GIS) are a growing technology and methodology. GIS are computer-based information systems that combine mapping capabilities with data referenced by spatial or geographic coordinates. They can capture, organize, store, manipulate and analyze spatial data. GIS can link and join geographical features on a map with attribute data as well as query databases to produce patterns of health outcomes (Gatrell, 2002). They can produce maps beneficial for medical geography.

GIS are important tools for showing inequalities in health between regions. Because where healthcare is located matters, GIS analysis of health data and healthcare service locations is valuable for describing and understanding relationships between healthcare access and health outcomes. Mapping of health data can establish patterns of health disparities.

GIS can integrate statistical and geographic data and allow for the visualization of spatial relationships. GIS is efficient for analyzing health data, revealing trends and determining relationships that might be missed in a strictly tabular format. Mapping and visualization of health disparities and their relationship to the geographical location of healthcare services can allow for better resource allocations to disparate and underserved populations (Scott, et al., 1998; Blake & Bentov, 2001; Luther, Studnicki, Kromery, & Lomando-Frakes, 2003; Love & Lindquist, 1995; Lovett, et al., 2002; Gatrell, et al., 2002; Leong-Wu & Fernandez, 2006).

The World Health Organization (WHO, 2003) identifies the value of public health mapping and GIS. According to the 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.

The literature is replete with reports of regional, locational, and small-area analysis of health disparities (Bullen, et al., 1996; Andrews & Phillips, 2002; Bamford, et al., 1999; Haynes, et al., 1999). GIS is effective in the management and analysis of health data at these levels. Analysis at the census tract or county level is important in the identification of patterns of healthcare outcomes and the association or linkage to political processes and policy makers (Cromley & McLafferty, 2002; Gatrell, 2002; Elliot, et al., 2000; Meade & Earickson, 2000).

SUMMARY

The United States Department of Health and Human Services identifies in its national health initiative the priority that all people, including the most vulnerable, should have health that allows them to have a productive life by the year 2010 (USDHHS, 2000). Healthcare access is becoming increasingly complex as a growing and diverse population and rapid healthcare reform continue to modify the provision of healthcare services. Improving healthcare access, reducing geographical variability in health outcomes, and eliminating disparities are major social and political issues.

Many disparities exist within the current United States healthcare system. These inequalities have been shown to restrict healthcare access and lead to regional health outcome disparities. Decreasing access contributes to patterns of excessively high disease incidences, morbidity, and mortality.

Because the match between “need” and “provision” is an important determinant of equitable access more studies are needed to describe specific geographical patterns of health. The literature supports the use of small-area analysis for the study of access. Andersen’s Behavioral Model of Health Service Use provides one approach to the assessment of access to healthcare services. Application of the adapted Model for the Assessment of Potential Geographical Accessibility (See Figure 2) provides an opportunity to evaluate the specific relationship between location and “provision” of healthcare and mortality rates or “need”. It can provide a guide for future studies of healthcare access. The model can be modified by using other healthcare services, predisposing characteristics, enabling resources, healthcare need, or by other health outcomes or health status variables.

Further research is also needed in the use of GIS to both visually identify and empirically measure spatial relationships of geographical, environmental, and social influences of disease. More research of predisposing characteristics and enabling factors for other specific populations is needed.

GIS is becoming instrumental in the synthesis of information to foster awareness of specific health concerns, facilitate development of intervention strategies, and enhance utilization of resources. GIS technology can be of great value in health planning, the development of health policies and the allocation of healthcare resources.

Regional disparities in mortality rates observed can provide valuable starting points for the analysis of healthcare service accessibility. With further analysis, those responsible for the development of healthcare policy can modify healthcare services and define quality healthcare sensitivity and responses to these issues of decreased access and excess mortality. Social justice requires the reversal of healthcare inequalities by better distribution of resources. Healthcare policy must not neglect the vulnerable populations created by geographical inequality.

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