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Geographical Effects on Adult Sickle Cell Disease Treatments, Morbidity, and Mortality

Paula Busbee
Walden University

Walden University

College of Health Sciences

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Paula Busbee

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Review Committee
Dr. Carla Riemersma, Committee Chairperson, Public Health Faculty
Dr. Nicoletta Alexander, Committee Member, Public Health Faculty
Dr. Roland Thorpe, University Reviewer, Public Health Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2016

Abstract

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Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

A small percentage of patients with sickle cell disease (SCD) have experienced an increase in life span by 10 years, while others with the same disease continue to die prematurely. The purpose of the study was to evaluate whether or not regional location was a barrier to care for adults with SCD in relation to emergency department visits and health outcomes at 16 and 21 years after the approval of hydroxyurea therapy as treatment. Secondary data were sourced and a retrospective quantitative correlational design was used to examine the effect of hydroxyurea treatment approval on emergency department visits and mortality (dependent variables) with changes in the regions for Northeast, Midwest, South, and West (independent variables). Insurance status, age, gender, and income level (covariables) were employed to describe the population. Chi-Square analysis was used to examine the association of the variables and sample sizes provided by the HCUP datatsets; Nationwide Inpatient Sample (NIS) 2006 (n=67,214), NIS 2011 (n=80,040), Nationwide Emergency Department Sample (NEDS) 2006 (n=164,698), and NEDS 2011 (n=215,296). The results of the analysis revealed a significant association between regional location, emergency department visits, and deaths among SCD patients. The implications for social change include improvements in health and health outcomes regionally, with adult SCD education for health care providers and patients on SCD treatment protocols. Adults with SCD might possibly benefit from this study with improvements in health and health outcomes for all regions once the barrier to care and specific areas are identified.

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Dedication

I dedicate this dissertation to my family. My son Byron and daughter Kristie have given unconditional support throughout this journey. To my mother who departed this life over 20 years ago and left instilled in her children the importance of education.

Acknowledgments

I would like to thank Dr. Carla Riemersma, Dr. Nicoletta Alexander, and Dr. Roland Thorpe Jr. for the advice, recommendations, and support throughout this process. I would like to acknowledge my friends for being there to listen and provide words of encouragement.

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Chapter 1: Topic of the Study

Introduction

Sickle cell disease (SCD) is a genetic blood disorder affecting over 100,000 African Americans in the United States and is one of more than 6,500 rare diseases in the United States recognized by the National Institute of Health (NIH) (Medline Plus: Rare Diseases, 2016). There is mandated newborn testing for SCD in the United States and the number of infants testing positive is over 500 annually (Addis, 2010). The pathophysiology of the disease involves the premature development of red blood cells, resulting in a sickle shape which causes occlusions as it flows through the small blood vessels. The results of the occlusions are known as vaso-occlusive crisis and hemolysis, which lead to severe pain in the joints, back, and anatomical areas of the body with major organs. The major organs that could be affected include the brain (stroke), spleen (splenic infarction), lungs (acute chest syndrome), penis (priapism), kidneys (kidney failure), and gallbladder (cholecystitis) (Addis, 2010). The most severe phenotypes of SCD are Thalassemia β^0 and HbSS; African Americans predominantly have the HbSS phenotype which has been associated with health complications and premature mortality (Serjeant, 2013).

Of the more than 6,500 rare diseases, the Food and Drug Administration (FDA) has approved over 200 preventive drugs for treatment; hydroxyurea was the drug approved by the FDA in 1990 to treat SCD (Developing Products for Rare Diseases, 2016). Improvements in treatment regimens have been credited with increasing the life span by 10 years for males and females; however only a small percentage of patients

have experienced the extended life span. Notably, there has been a 3% decrease in the mortality rate of children, which means that the adult population could increase placing more demands on the healthcare system for accessibility, quality care, and resources (Lanzrros, Carroll, & Haywood, 2013). Therefore, there is a need to evaluate the adult SCD population to identify barriers to care. Overcoming the barriers would be the next step for improving healthcare and outcomes for SCD.

Not only is SCD detrimental to the health and lifestyle of the affected population, but there have been barriers to care identified for adults with sickle cell disease which contributes to the complications (Vallerand & Nowak, 2010). Research has shown that barriers to obtaining care would be insurance status and deficiencies in the number of physicians specializing (hematology) in the field (Bediako & Moffitt, 2011; Treadwell, Barreda, Kaur, & Gildengorin, 2015). The barriers to care when seeking medical care include lack of accessibility and stigmas (drug abuser, drug addict) attached to the disease (Voskaridou et al., 2010).

This research study examined how the health of African American adults living with SCD could be affected according to residential region in the United States. High emergency department services usage, lack of accessibility to care, ineffective pain management and treatments (hydroxyurea use), and mortality rates could be indicators of regional barriers to care (Odesina et al., 2010). The social changes that could occur from the results of this study include the development of effective SCD transition programs, accessible comprehensive sickle cell centers for adults, and improved SCD educational programs.

The transition programs from pediatric to adult care have not provided an environment for adults to receive the quality of care that was standard in the pediatric setting (DeBaum & Telfair, 2012). Additional potential social changes could be improvements in the quality-of-life, health outcomes, and life span with the provision of accessible and quality health care. Chapter 1 is a discussion of how living in different regions of United States could affect the health outcomes of adults with SCD. The literature review reiterated the impact of emergency visits, treatments, and mortality on the lives of patients with SCD.

Background

Emergency room services were used by 90% of adults with SCD for pain management and associated complications from organ damage (Ballas, Gupta, & Adams-Graves, 2012; Brousseau, Owens, Mosso, Panepinto, & Steiner, 2010; Woods et al., 1997). Adults have a higher usage of emergency services than children (Ballas et al., 2012). The reasons for the high usage of emergency services would include lack of accessibility to care, ineffective pain management, and severity of disease (Haywood, Tanabe, Naik, Beach, & Lanzkron, 2013). The lack of accessibility to care and ineffective management of the disease occurred during the transition period from a child with SCD to an adult with SCD (Anderson, Bellot, Senu-Oke, & Ballas, 2014; DeBaum & Telfair, 2012).

Pain is the predominant symptom in sickle cell disease making pain management a priority focus for treatment regimens (Haywood et al. 2013). Three types of pain sensations have been identified in SCD; vaso-occlusive crisis (VOC), hemolysis, and

neuropathic pain (Smith, 2014). Vaso-occlusive crisis and hemolysis cause pain, damage to organs, and could lead to life-threatening complications and death (Booker, Blethyn, Wright, & Greenfield, 2006). Neuropathic pain is experienced in sickle cell disease patients with exposure to extreme temperatures such as hot and cold (Jones et al., 2005). The pain is described as numbness and tingling associated with a pins and needle type sensation (Ballas, 2007). The standard analgesic for severe pain management is opioids (Smith, 2014). Hemolysis and vaso-occlusive crisis should be managed using preventive treatments to improve decreasing the need for high doses of analgesics, major organ damage, and premature mortality (Voskaridou et al., 2010). The preventive treatment used in SCD is hydroxyurea which has been associated with decreased episodes of painful crisis, organ damage, and mortality rates (Colella et al., 2012; Smith et al., 2011). Overall, the use of preventive treatments and effective pain management are needed to improve the health of SCD patients.

The lifespan of sickle cell patients is 43 years for males and 48 years for females (Tanabe et al., 2010). Complications of lung disease from organ damage have been shown to be the cause of death for 65% of adults with SCD (Lanzrros et al., 2013). Researchers have shown in a study from 1979 to 2005 that the median age of death in SCD males was 38 years and females were 42 years which was a decrease in the life span from 42 years for males and 48 years for females noted in 1990 (Lanzrros et al., 2013). According to Voskaridou et al. (2010) the lifespan of SCD patients has increased by 10 years. The differences in research results could imply that the variations in life spans occur with changes in accessibility and treatment regimens in the various regions of the

United States. In this case, regional location in the United States could be a barrier to care.

There was a gap in the literature that did not address the use of treatments and mortality in correlation to different geographic locations in the United States. Regional standards of care, accessibility, and physician performance in treating SCD have not been investigated as a possible barrier to care in SCD. The regional standards of care and physician performance could be examined using indicators which include use of emergency services (accessibility), changes in the number of emergency visits (disease management), and mortality rates in the years after the approval of hydroxyurea. The study was needed to identify significant barriers that could be corrected with appropriate resource allocation and SCD education. The lives of patients with SCD could improve physically and socially from the provision of quality care and improvements in health outcomes.

Problem Statement

There is high usage of emergency department services by adults with SCD which could be from the inability to secure the services of a private physician, inadequate pain management, and lack of a maintenance treatment regimen (Andermariam et al.,2014). The lack of hydroxyurea use among adult SCD patients has created a notable difference in outcomes when compared to the adult patients using hydroxyurea. Sickle cell patients using hydroxyurea as a routine treatment regimen could experience decreased painful episodes, minimal incidents of organ damage, and a longer life span by 10 years (Voskaridou et al., 2010). The problem lies in the need to identify and prevent barriers to

care that could hinder the use of hydroxyurea. According to Yawn et al. (2014), hydroxyurea use should be included as the standard of care for most patients with SCD. Included in the standards of care for SCD routine maintenance are an effective analgesic protocol, hydration, and hydroxyurea (Yawn et al., 2014). Thereby, with the acceptance of hydroxyurea by healthcare providers as a standard of care for SCD, a higher percentage of the population could benefit from the effects.

I designed this study to explore the effects of hydroxyurea approval for SCD treatment by the FDA, mortality rates (mortality), and accessible health care (emergency department utilization) in the four regions of the United States. The effects were examined using numerical data and statistical analysis in a quantitative correlational research design. Emergency visits were considered a predictor of disease management, severity of disease, and accessibility to care. Sickle cell patients require health services urgently due to the unpredictable onset of VOC not responding to the prescribed and recommended daily routine treatments (Tanabe et al., 2010). Studies (Davis, Gergen, & Moore, 1997; Telfair, Hague, Etienne, Tang, & Strasser, 2003) reported there were differences for SCD adults geographically in health service utilization, access to care, and pediatric mortality. McGann and Ware (2011) reported that hydroxyurea compliance was low in SCD patients even though a decrease in organ damage, episodes of painful crisis, and mortality has been associated with hydroxyurea use, which is approved by the FDA for SCD treatment. The physician not prescribing the drug and patient noncompliance with taking the drug were the reasons given for low usage of hydroxyurea (Smith et al., 2011; Ware, 2010). As a result, deficits in accessible resources and quality care

impacting the use of hydroxyurea could occur from a lack of sickle cell education and available physicians to provide care.

Accessibility to health care resources and quality care has been shown to be a deficit for SCD patients that could contribute to a decreased quality-of-life and shortened life span. Sickle cell patients have a high use of emergency services and inpatient hospital services for pain management and treatment for complications from organ damage caused by manifestations of the disease along with increased healthcare costs (Brousseau et al., 2010; Wolfson, Schrager, Khanna, Coates, & Kipke, 2012). High inpatient hospitalization and emergency department visit rates for adults were associated with the use of government sponsored insurances and longer travel distances (Brousseau et al., 2010; Wolfson et al., 2012). Private physicians that provide SCD quality care may not accept government sponsored insurances because of low payment fees, decreasing the availability of specialty care (Jan et al., 2013). Jan et al. (2013) published that for SCD young adults and adolescents the type of hospital and specialty of the provider were significant for improved health outcomes. The literature did not address how living in different geographical regions of the United States could affect resources, treatments, and mortality for sickle cell patients.

Purpose of the Study

A retrospective correlational quantitative design with secondary data was used to describe the relationship between regional geographical location and health outcomes from accessibility and treatments. The data was collected from 46 states and represent the four regions of the United States (Northeast, Midwest, South, and West). The data was

used to explore the effects of regional location (independent variable) on accessibility indicated by use of emergency services (dependent variable), disease management (dependent variable), and mortality rates (dependent variable) 16 and 21 years after hydroxyurea treatment was approved by the FDA. Improvements in treatment regimens could be indicated with decreased emergency service usage, increased use of hydroxyurea, and decreased mortality rates consistently in all regions.

Research Questions and Hypotheses

The information that was provided while responding to the hypotheses and research questions consisted of the effects of regional location on health care accessibility, treatment, and mortality. The number of emergency visits (accessibility), hydroxyurea approval and its effects 16 and 21 years postFDA approval on mortality rates and the number of emergency visits (disease management) were identified for each region. The information was used to answer how geographical location affects accessibility, health outcomes, and mortality of adults with sickle cell disease. The null and alternate hypotheses reflected whether there was a statistical significance for the association between accessibility, treatments, mortality, and geographical location of adults with SCD.

RQ1: Is there a significant association between emergency services use (accessibility) among adults with SCD and regional geographic location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database.

$H_0$1: There is not a significant association between emergency services use (accessibility) and the regional geographical location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database in adults with SCD.

H_a1: There is a significant association between emergency services use (accessibility) and the regional geographical location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database in adults with SCD.

RQ2: Is there an association between the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment?

$H_0$2: There is no significant association in the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment.

H_a2: There is a significant association in the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment.

RQ3: Is there an association between hydroxyurea approval and SCD mortality rates in adults in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later)?

$H_0$3: Hydroxyurea approval does not have a significant association on mortality rates in adults with SCD in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later).

H_a3: Hydroxyurea approval has a significant association on mortality rates in adults with SCD in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later).

Theoretical and Conceptual Framework

The socioecological model was used as the theoretical framework for the study along with data from Healthcare Cost and Utilization Project (HCUP) to determine the effects of internal and external factors that could be associated with sickle cell disease health outcomes; such as, the region where the patient lives, effect of FDA approval of hydroxyurea treatment for SCD, mortality, and geographical location to explain the differences in disease presentations among patients with the same genotype. The differences in outcomes recognized by the socioecological mode could encompass insurance status, income level, and availability of resources representative of local, state, and federal allocations. The history and additional information on the concepts for the socioecological model are discussed in Chapter 2. The concepts from the model were applicable to SCD level of knowledge in patients and physicians for preventive therapies. For example, patients with SCD should avoid extreme weather conditions and temperatures (hot, cold, and windy). With the application of the concepts to SCD barriers to care, the quality of care in SCD could improve with increased knowledge,

along with health care and health outcomes. Even more, the utilization of health services and annual costs for treating SCD would likely decrease.

The conceptual framework for the study was the Donabedian theory of quality care (DTQHC). Donabedian introduced the model in 1966 to evaluate and focus on health outcomes, treatments, and healthcare utilization (Kobayashi, Takemura, and Kanda, 2011). Descriptions were given for the three dimensions of quality health care in the last revision of the model in 1987: health, recipients of care, and providers of care (Kobayashi et al., 2011). It is important to realize that quality care is needed for sickle cell patients to improve their quality of life by decreasing incidents of comorbidities, provision of effective pain management, and decrease rates for premature mortality.

Outcomes for the effects of the regional location (independent variable) were identified and evaluated using the concepts of the model with the examination of emergency visits (accessibility), effect of hydroxyurea treatment for SCD by the FDA on the mortality and emergency visits (disease management) [dependent variables]. Utilization of the model created an environment for identifying and evaluating outcomes and effects of the indicators. The Donabedian model is discussed with more detail in Chapter 2. The research question related to the quality healthcare framework was how does regional location could affect health outcomes, treatment, and mortality in adults with SCD? The documentation and knowledge that increased mortality, poor disease management, and increased emergency services usage could be indicators for the need of resources and education in SCD. Thereby, public officials on the state and federal levels could use the information to allocate resources for the care of SCD patients.

Nature of the Study

A quantitative retrospective correlational method was used to obtain a numerical description of the population in order to describe the association between the variables to include regions, Northeast, Midwest, South, and West (independent variable), and the effect of FDA approval of hydroxyurea treatment on emergency visits and mortality (dependent variables) with statistical analysis. An examination of the variables regionally described whether the independent variable influenced the dependent variables and the correlation of emergency department use (accessibility), mortality rates, and emergency department visits (disease management) 16 and 21 years after hydroxyurea was approved for SCD treatment by the FDA. The datasets were obtained from HCUP; data for HCUP is collected and processed annually and sponsored by AHRQ (Agency for Healthcare Research and Quality, 2012). Two datasets represented in HCUP are the Nationwide Inpatient Sample (NIS) 2006 and 2011 and the Nationwide Emergency Department Sample (NEDS) 2006 and 2011 collected from 46 states representative of the four regions (Northeast, Midwest, South, and West) in the United States. The datasets were available from 2006 to 2013 and include information such as emergency room visits, diagnosis, geographical location, age, disposition, insurance status, and date of death.

Definitions

Acute chest syndrome: A diagnosis used in sickle cell disease when a combination of symptoms exists, such as fever, productive cough, difficulty breathing and decreased oxygen levels; along with a chest x-ray reading of acute infiltrate (Paul, Castro, Aggarwal, & Oneal, 2011).

Analgesic: a drug that relieves pain (Merriam-Webster's Learner's Dictionary, n.d.).

Cholecystitis: inflammation of the gallbladder (Mayo Clinic, 1998-2016).

HbSS: the most severe SCD phenotype which originates from inheriting two copies of the HbS mutation (Centers for Disease Control and Prevention, 2014).

Hydroxyurea: a drug used to treat SCD by preventing the formation of sickle-shaped red blood cells by stimulating the increased production of fetal hemoglobin (McGann & Ware, 2011, p. 2).

Neuropathic: chronic pain caused by damage to nerves (Niscola, Sorrentino, Scaramucci, Fabtitiis, & Cianciulli, 2009, p. 470).

Phenotypes: the genetic and epigenetic properties observed in an organism (Ballas, 2011, p. 512).

Priapism: an involuntary long lasting penile erectile dysfunction (Azik et al., 2012, p. 270).

Splenic infarction: oxygen supply to the spleen is interrupted (Owusu-Ofori & Hirst, 2013, p. 3).

Thalassemia β^0: an inherited lifelong disease that is characteristically similar to SCD with milder symptoms (Serjeant, 2013, p. 2).

Assumptions

Assumptions that were made for this study included:

- Adequate information from the NIS 2006, NIS 2011, NEDS 2006, and NEDS 2011 datasets to complete the study.

- A sufficient sample size to validate the study results.
- Appropriate variances to determine associations and significance of regional location.
- The study findings could be generalizable to adults (21 years and older) with SCD HbSS living in the United States.

Scope and Delimitations

Emergency visits were chosen for this study to indicate that there could be lack of accessibility to care from a private physician or comprehensive sickle cell disease facility. Severity of disease with ineffective pain management was an additional indicator for seeking care in the emergency department. The indicators for the effect of hydroxyurea (treatment) approval by the FDA 16 and 21 years later were the number of emergency visits and the mortality rates. Health care and health outcomes (mortality) were indicators of quality care which would be dependent on physician and patient SCD knowledge, along with effective pain management regimens to decrease episodes of VOC and hemolysis (analgesics and hydroxyurea); thereby decreasing organ damage and life threatening complications, and premature death.

The population identified in this study were male and female adults (21 years and older) living in the United States with SCD HbSS. The International Classification of Diseases, Ninth Revision, Clinical Classification (ICD 9-CM) billing codes that were used for identification were 282.60 (nonspecific SCD), 282.61 (SCD without crisis), and 282.62 (SCD with crisis). The codes were documented within the first five diagnoses fields of the medical record. The age group of the population represented adults that had

transcended from pediatric care to adult care and were confronted with adult barriers to care. Sickle cell disease HbSS has an occurrence of one in 300 to 500 African Americans and the phenotype is predominant in the race; Hispanics have an occurrence of one in 36,000 for HbSS. Other less severe forms of SCD have been identified in people of Mediterranean and Asian descent. Specifically, the barriers to care for adults with SCD HbSS should be examined and provisions made to improve quality of care.

The Health Belief Model (HBM) was not used as a theoretical framework in the study. The focus of the study was the identification of external barriers to care and the effects from lack of resources and knowledge. The concepts of the HBM focus on patient disease knowledge, reasons to control and prevent illness, perceptions of the illness, self-efficacy, considerations for barriers and benefits to care, and self-care management (Glanz, Rimer, & Viswanath, 2008). Statements made pertaining to the results of the study were generalizable to adults (21 years and older) with SCD HbSS living in the United States.

Limitations

The results of the study are limited to the relationship and correlation of the independent variables (regions) and dependent variables (number of emergency visits and mortality rates 16 and 21 years after hydroxyurea approval). Covariates for external validity (gender, insurance status, and income level) for emergency visits and mortality were used to describe the population demographically. Internal validity for accuracy of information on number of emergency visits, mortality rates, and geographical location could affect the results of the study.

Significance

Factors affecting the health outcomes of SCD patients could be identified in this study, such as quality of care, premature death, and accessibility to care. Regional locations that could be lacking in resources and knowledge were identified by increased use of emergency services and mortality rates which could be representative of the lack of accessibility and low rates of hydroxyurea treatment after approval by the FDA. Health outcomes could be improved with the insight provided from the study results; justification would be provided for resource allocation to deficient areas and educational needs of healthcare professionals and patients. Social change could potentially be implicated with the use of SCD standardized treatment protocols to equalize medical treatment of SCD patients, identifying and recommending ways to increase accessibility to care, and to determine healthcare needs for resource allocation.

Sickle cell disease treatment standards were developed by the World Health Organization in 1984 (revised in 2012), and the NIH: National Heart Lung and Blood Institute in 1984 (revised 2002) for the improvement of pain management and health outcomes (Moussavou, Vierin, Eloundou-Orima, Mboussou, & Keita, 2004). Manifestations of SCD impose symptoms and complications on the patients that require frequent inpatient hospital admissions and a high use of emergency services which increases health care expenditures. It was published in studies by (Brousseau et al., 2010; Wolfson et al., 2012) that long travel times to obtain medical care and the use of government issued insurance plans (Medicaid, Medicare) by adults with SCD were associated with increased inpatient hospitalizations and high emergency department

visits. At the same time, increased use of emergency services use could be directly related to the inability of SCD patients to obtain a private physician that will accept the lower fees paid by government issued insurances. The costs of healthcare incurred by adults with SCD were reported by Woods et al., (1997) over a 2 year time frame to be $59 million with government issued insurance plans used by two-thirds of the patients. The estimated costs of SCD health care expenditures for emergency visits and inpatient admits was reported in several studies (Andemariam et al., 2014; Epstein, Yuen, Riggio, Ballas, & Moleski, 2006) as $2.4 billion in 2006 with pain management as the underlying complaint. Adults with SCD have increased medical expenses when compared to children with SCD. A study was published by Kauf, Coates, Huazhi, Mody-Patel, and Hartzema (2009) showing the monthly costs for adult (50 to 64 years) SCD healthcare was $1382 and children (0 to 9 years) was $892. The costs of healthcare for SCD patients are increasing because the patients are living longer. The burden of increasing medical expenses could be decreased with the implementation of effective pain management and treatment regimens which would be reflected in a reduction in inpatient hospital admissions and emergency department visits. For the most part, sickle cell patients could benefit from the use of standardized protocols throughout the United States to improve health outcomes and equalize the use of evidence-based treatments.

Summary

Chapter 1 provided an introduction to the pathophysiology of SCD, complications of the disease, barriers to care, and health outcomes. The problem statement addressed the focus of the study and directed the design of the study and research questions.

Assumptions and limitations were discussed along with the theoretical and conceptual frameworks using the concepts to improve the quality of care and identify the barriers to care. The knowledge gap was identified for regional location to be evaluated as barrier to care and the correlation of emergency visits and how FDA approval of hydroxyurea for SCD treatment could affect emergency visits and mortality rates.

Chapter 2 contains the literature review which is sectioned by the prevailing themes found in the literature; emergency visits, pain management, treatments, complications, and mortality. Barriers to care were identified for many areas including insurance status, location (rural versus urban), lack of accessibility, income level, and stigmas. Geographical regions in the United States had not been evaluated as a barrier to care, which could affect emergency visits, treatment, and mortality rates in the reviewed literature creating a gap in knowledge.

Chapter 2: Literature Review

Introduction

Sickle cell disease HbSS is the most common phenotype among people of African descent and the population group for this research (Public Health of Oregon, 2010). Sickle cell HbSS phenotype is the most serious form causing pain from vaso-occlusive crisis and hemolysis, which in turn would be responsible for damage to major organs, life threatening complications, and mortality (Khoury, Musallam, Mroueh, & Abboud, 2011). People with sickle cell HbSC, Hb $S\beta^0$ and Hb $S\beta^+$ could present with mild to moderate symptoms similar to HbSS (Serjeant, 2013).

Pain management, hydroxyurea, and blood transfusions use in SCD have shown positive effects for decreasing frequency of painful episodes, organ damage, and increased lifespan (Voskaridou et al., 2010). The problem would be the lack of the identification of barriers to care, which could result in decreased SCD comorbidities and increased life span for a greater number of SCD patients. It has been published that physicians are hesitant to prescribe hydroxyurea and have been found not to be up to date on sickle cell disease and treatment regimens (Smith et al., 2011; Ware, 2010). In addition, patients lack education on sickle cell disease, the treatments, and are not compliant with prescribed medications, such as hydroxyurea (Okam, Shaykevich, Ebert, Zaslavsky, and Ayanian, 2014). The literature did not identify how geographical location in the United States affected treatments and mortality of patients with sickle cell disease creating a gap in the exploration of barriers to care.

The purpose of this study was to explore the four regions of the United States for SCD emergency visits, the effect of FDA approval of hydroxyurea for SCD treatment on the number of emergency visits, and mortality for the years 2006 (16 years later) and 2011 (21 years later). The number of emergency visits phenomenally described a need to improve the management of SCD; the need for pain management and complications, provider performance in prescribing hydroxyurea, blood transfusions, and prophylactic blood transfusions. Patient compliance with hydroxyurea could indicate accessibility, and complications could be indicative of disease severity and the need for quality health care.

The literature reviews on SCD focused on research in regards to treatment and mortality variations according to geographical location. Topics reviewed and included in Chapter 2 were resource utilization, standard and evidence based treatments, morbidity, and mortality with emphasis on geographical location to assess treatments and outcomes.

The effect of geographical locations examined in North Carolina and California showed significant factors for high use of emergency services were by adults seeking pain management, further distance to access care, and holders of government issued insurance coverage (Hague & Telfair, 2000; Wolfson et al., 2012). Brousseau et al. (2010) published a retrospective study of eight states representing each region that have 33% of the SCD population in the United States. The study using HCUP data concluded there were high rates of acute care and return visits for the sickle cell population (Brousseau et al., 2010). The research did not discuss the effect of geographical location on treatments, complications, and mortality. Stoles, McKinney, and Silliman (2014) found that statistical significance for increased incidents of VOC, splenic infarction,

ACS, and stroke was not reached for children with HbSS more than patients at sea level locations. The oxygen level and barometric pressure that would be 20% lower than sea level was not significant for increasing complications (Stoles et al., 2014). Limitations for the study were the exclusion of additional climate conditions and adults.

Probst, Moore, Glover, and Samuels (2004) reported disparate conditions for rural locations with a 65% shortage of health care professionals in counties with predominant ethnic minorities. There was an African American majority in 83% of the counties. The effect on healthcare would entail a lack of access and a deficit in quality care. Anderson et al. (2014) argued that deficits in resources for SCD programs has created an environment of poor quality in healthcare and decreased accessibility. Studies were not available showing the regional characteristics in the United States for treating SCD with hydroxyurea as a preventive measure to decrease painful episodes and organ and tissue damage. In addition, regional mortality rates were not reviewed. The context of the geographical location studies was rural and urban locations, insurance status, and accessibility; the treatment standards for SCD by geographical location were not examined.

Literature Search

Walden University library database was used to search for articles by topic in health sciences. CINAHL and MEDLINE simultaneous search for using Boolean/ phrase for sickle cell disease full text. The publication dates entered were 2010 to 2015 for English language and scholarly (peer-reviewed) journals (839 articles). A Google Scholar search was done using key word sickle cell disease treatments adults since 2011 (17,800

results), barriers (8,130 results) and mortality (16,900 results). The majority of the research studies were conducted in the United States and examined genotypes, treatments, morbidity and mortality, emergency visits and implications, and hydroxyurea use. Other areas with studies on SCD included in the review were the United Kingdom, India, and Africa.

Theoretical Foundation

The Donabedian theory of quality health care (DTQHC) is a conceptual model proposed by Donabedian (1966) to promote and evaluate quality health care (Kobayashi et al., 2011) and was used as the framework for this study. The DTQHC model was conducive in concentrating the focus of the topic to healthcare utilization, treatments, and outcomes. The last revision of the model was 1987 and included a description for three dimensions of quality health care; providers of care, recipients of care, and health (Figure 1) (Kobayashi et al., 2011). Sickle cell disease indicators were applied to the dimensions assigned in the DTQHC model. Ensuring the quality of care for patients with SCD could decrease comorbidities, improve the quality-of-life, and increase their lifespan.

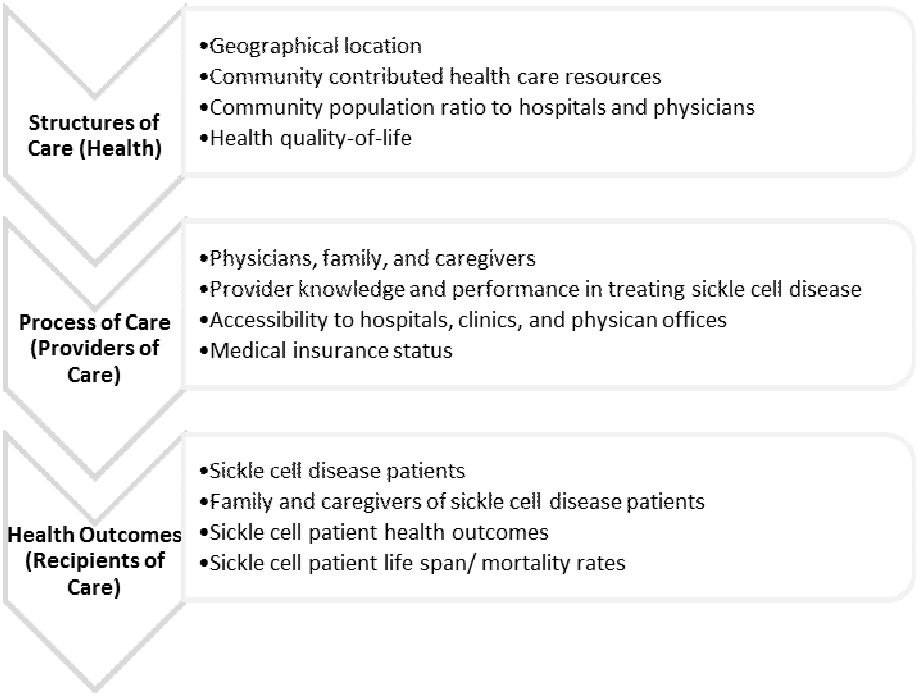

Figure 1. Donabedian theory of quality health care for Sickle Cell Disease

The Donabedian model had not been used to assess and evaluate quality of care and outcomes in sickle cell disease. According to Kobayashi et al. (2011) the model was applied successfully to assess and evaluate patient perceptions for quality care from nursing staff during an inpatient hospital admission. Improvements in the quality of nursing care using the structure, process, and outcomes concepts validated the effectiveness of the Donabedian approach (Kobayashi et al., 2011). Geographical location, knowledge and performance of providers, and accessibility of community resources could affect the health of the population with chronic diseases. Utilization of the model creates an environment for identifying and evaluating outcomes and effects of the categorized indicators. The self-care management theory had been used to assess health outcomes in sickle cell disease and supports intervention to increase resources for

self-care management while improving health care outcomes (Jenerette & Murdaugh, 2008). The Donabedian model could build upon the self-care management theory with the inclusion of the assessment and evaluation of provider performance which could affect resource distribution and self-care management.

Literature Review

The treatments encountered for SCD are symptomatic, preventive, and invasive. Pain management is needed for unpredictable episodes of VOC (symptomatic); hydroxyurea, and blood transfusions are preventive measures for acute and preventive pain management and to decrease organ damage; avoiding overexertion, maintaining hydration, and extreme temperatures are considered preventive; and surgical interventions would be invasive. Major organ damage caused by frequent painful VOC and hemolysis contribute to morbidity and mortality (Platt et al., 1991).

Sickle Cell Disease Manifestations

Sickle cell disease is a genetic inherited blood disorder. Humans have two alleles at each single autosomal locus; one would be inherited from each parent. In SCD, at the sickle cell locus there would be the predominant alleles, the A and the S. the genotype would be any combination of the two alleles (Ballas, S., 2011). Individuals with the AS genotype have sickle cell trait phenotype and the SS genotype have sickle cell disease phenotype (Ballas, S., 2011). Sickle cell disease has been challenging to manage because of the many phenomenal variations. Four genotypes of SCD have been found; HbSS, HbSC, Hb $S\beta^0$ and Hb $S\beta^+$ (Ballas, S., 2011). In addition, there are three types of pain that could be experienced at different levels of severity; vaso-occlusive, hemolytic, and

neuropathic (Niscola et al., 2011). Moreover, each type of pain could be associated with the type and severity of tissue and organ damage.

Pain and pain management are considered the most prominent manifestation of SCD and is the number one reason for treatment of SCD patients in the emergency department (Odesina et al.,2010). Bergman and Diamond (2013) published that painful crisis was the cause of 60% of patient coming to the hospital for treatment and 90% of the painful episodes are treated at home. Painful events described would be unpredictable and severe, causing poor quality of health, excess absences from school and work, and early death (Neville & Panepinto, 2011). Pain frequency and severity were associated with causing major organ damage to the spleen, gallbladder, kidneys, brain, male reproductive organs, and lungs (Platt et al., 1991). Complications of SCD would lead to surgical removal of the organs, hemodialysis, and treatment with chronic blood transfusions. Precursors of painful episodes could include hypoxia, dehydration, overexertion, and exposure to extreme temperatures (Rogovik, Persaud, Friedman, Kirby, & Goldman, 2011; Smith, Coyne, Smith, & Mercier, 2003).

Overall themes that were prevalent in the literature review of SCD included the medical implications of pain management, increased use of emergency services because of ineffective pain management, evidence based preventive treatments with hydroxyurea to decrease frequent episodes of pain that were not prescribed by physicians and used by patients, prophylactic use of blood transfusions to offset life-threatening complications, and mortality. Identified gaps in the literature included geographical location effect on

health care provider practice and performance standards in treating patients with SCD using evidence-based methods for pain management, hydroxyurea, and mortality rates.

Emergency Services

Adult sickle cell patients seek emergency care for painful episodes at higher rates than pediatric and adolescent patients (Tanabe et al., 2010). According to Haywood et al. (2013) emergency visits for SCD related conditions were over 200,000 annually in the United States. Vaso-occlusive crisis is the most frequent complaint given for an emergency department visit; 73% of pediatric patients had episodes of ACS which was associated with tobacco smoke in the home (Bundy, Strouse, Casella, & Miller, 2011). Medical and socioeconomic reasons associated with emergency visits found in the study were asthma, exposure to environmental tobacco smoke, and low income (Bundy et al., 2011; Glassberg, Wang, Cohen, Richardson, & DeBaun, 2012). The reasons identified for increased use of emergency services are availability and the services rendered are accessible for healthcare despite dissatisfaction with the quality of care (Anderson et al., 2014).

Sickle cell patients seeking emergency care were confronted by stigmas of drug addiction, resulting in delayed care which could lead to life threatening complications. Haywood et al. (2013) published that the wait times for SCD patients in emergency departments was 25% longer than the general patient population rated by race, and 50% longer than patients with similar pain complaints from long bone fractures. Epstein et al. (2006) published the health care utilization of 142 sickle cell disease study participants and concluded that there were 54% emergency visits, 24% office visits, and inpatient

utilization was 20%. Tanabe et al. (2010) demonstrated the use of emergency services for adult SCD patients in a prospective, multisite longitudal cohort study; 155 patients with a median age of 32 years totaled 701 emergency visits over a 10-month period. The studies reviewed supported that there were increased use of emergency services by SCD patients for pain management; the phenomenon not investigated were the differences in emergency service usage based on geographic location.

Emergency service utilization would be considered a priority option for sickle cell patients due to the complexities and lack of predictability of the disease. The episodes of painful crisis are sudden and unpredictable. In addition, home pain management regimens may not be sufficient during a severe episode; the average duration for a painful episode is 4 to 6 days (Baker & Hafner, 2012). Insufficient pain management and medical care could lead to increased emergency visits, life-threatening complications, and mortality.

Treatments

The treatments for SCD are based on counteracting the effects of VOC and hemolysis with pain management; opioids, hydroxyurea, and blood transfusions. Opioids are used during a painful crisis to decrease the duration of the episodes and improve quality of life (Baker & Hafner, 2012). Hydroxyurea would be prescribed to increase fetal hemoglobin levels and thereby decrease the frequency of painful episodes (Baker & Hafner, 2012). Blood transfusions are given during an acute episode of acute chest syndrome to dilute the sickling cells with the replacement of normal red blood cells and would be scheduled prophylactically to prevent future incidents (Bowers, Pepple, & Reid, 2011). For the most part, the use of the recommended treatments for pain management

and preventive therapy could lead to improvements in the health outcomes of SCD patients.

Pain Management

The key source for managing SCD effectively is the prevention of frequent painful incidents to decrease tissue and organ damage, and mortality (Bender and Seibell, 2014). Research has shown that increased episodes of vaso-occlusive crisis causes major organ damage, increasing incidents of life threatening conditions and the need for various surgical and medical procedures for sickle cell patients (Booker et al., 2006). A qualitative study, published by Maxwell, Streetly, and Bevan (1999) gave accounts of experiences from sickle cell patients for pain management. The findings suggested that pain management was deficient because of distrust among staff and patients, the application of stigmas of drug addiction and drug seeking, lack of control on medical decisions, and failure of staff to provide psychosocial support (Maxwell et al.,1999).

Health care professionals do not believe that the patient has pain, leading to under treatment. Elander, Marczewska, Amos, Thomas, and Tangayi (2006) and Haywood et al. (2013) published that poor judgment in making pain management decisions was a contributory cause to inadequate treatment of pain. Aborting sickle cell pain early after the onset with hydration, nonsteroidal anti-inflammatory drugs (NSAIDs), narcotics, could lessen tissue and organ damage, and prevent ACS and PHTN (Ballas et al., 2012; Platt et al., 1991). Baker and Hafner (2012) published that alternatives to opioid treatment for pain would be the use of parenteral ketorolac (anti-inflammatory agent). The issues encountered with the use of anti-inflammatory agents are sickle cell pain could be

refractory and the need for opioids after using ketorolac for effective management would be delayed increasing the risks for organ damage and mortality (Baker and Hafner, 2012).

Sickle cell pain was found to be poorly mismanaged with under treatment in a study by (Elander et al., 2011; Niscola et al., 2009). Recommendations have been made for the development of care plans and standardized treatments for SCD pain management to offset mismanagement of SCD pain. Ballas et al. (2012) published that the management of sickle cell painful crisis could decrease inflammation that would normally increase with recurrent episodes, decrease incidents of organ damage and serious complications, such as ACS, PHTN, and decrease incidents of sudden death.

Barriers to treatments using evidence-based pain management protocols have a negative influence on the benefits for prescribing opioids, hydroxyurea, and the use of blood transfusions. Patients with painful sickle cell crisis should be treated aggressively with several methods to counteract symptoms and complications (Odesina et al., 2010). Healthcare providers should not treat SCD symptoms by means of the traditional generic methods; sickle cell treatments should be based on the pathophysiology of the disease process (Mousa et al., 2010). Frequent episodes of VOC were associated with mortality as demonstrated in a cohort study of adults with SCD (Darbari et al., 2013). Odesina et al. (2010) demonstrated that several therapies were needed for effective pain management in SCD. The results of the study were evident after the medical records were reviewed and showed a high use of treatment with one medication, delays in the medical examination, and delayed times for treatment with analgesics (Odesina et al., 2010). A cross-sectional survey published by Thompson and Eriator (2014) reported that 92% of

adults with SCD experienced pain with a duration of more than 6 months and 91% used alternative therapies for pain control. Adults with SCD received low quality healthcare because the use of evidence-based treatments was not provided (Odesina et al., 2010). It was published by Cain, Vang, Simone, Hebbel, and Gupta (2011) using mouse models that sickle cell deep tissue pain and cold sensitivity was increased with age and hypoxia; which could be associated with SCD adults increased use of emergency services for pain management.

Opioids. Patients with SCD require large and frequent dosages of narcotic analgesics. Severe pain in SCD is treated with opioids and decisions for the type of drug and dosage should be individualized (Niscola et al., 2009). According to Delicou and Maragkos (2013) and Mousa et al. (2010) the standard treatment for severe pain in SCD was morphine. Glassberg et al. (2013) published the results of a cross-sectional survey which showed that the majority of emergency physicians self-reported adherence to the pain management standards for SCD; opioids (90%) and repeating the dose in 30 minutes for ineffective management (85%). Physicians with a negative attitude about SCD were less likely to repeat the medication in 30 minutes (20%) (Glassberg et al., 2013).

Barriers to effective opioid use include healthcare provider hesitancy to prescribe dosage amounts needed to manage pain and did not trust that the patient was honest about the level of pain (Elander et al., 2011). Stigmas for drug addict and malingerer have been attached to patients with chronic nonmalignant pain that require opioids for control (Glassberg et al., 2013). According to Vallerand and Nowak (2010) barriers to opioid

therapy exists within the healthcare system and society limiting the ability of the individuals to access and maintenance of adequate pain management.

Hydroxyurea. Research on the use of hydroxyurea has shown that the drug is safe, effective for decreasing painful episodes, and decreases organ damage and premature mortality in SCD (Voskaridou et al., 2010). Yet, a problem exists in not using the drug as a standard treatment for SCD. Preventive treatments used for sickle cell to decrease VOC and prevent complications from organ damage, and early mortality include hydroxyurea and blood transfusions (Voskaridou et al., 2010). The use of hydroxyurea as a treatment for SCD has been explored for greater than 25 years for safety and affect (Ware, 2010). It is the only treatment for SCD approved by the FDA.

Hydroxyurea was first used as a treatment for SCD in 1984; it was found to decrease episodes of VOC and increase Fetal Hemoglobin (HbF) which is decreased in SCD patients and replaced with the mutant gene HbS (McGann & Ware, 2011). In addition, SCD patients are advised to remain well hydrated (drinking fluids) and avoid extreme weather conditions (hot, cold, and windy) (Smith et al., 2003). Hydroxyurea and blood transfusions are considered preventive medical treatments for adults with SCD to improve health and health outcomes. In any case, barriers for using hydroxyurea and blood transfusions could occur from misinformation and lack of knowledge.

Physician and patient hesitancy to comply with the use of hydroxyurea could arise from the controversial use for SCD since the original use of the drug was anti-neoplastic and the long-term safety effect was not known (Ballas et al., 2013). According to Ware (2010), the use of hydroxyurea in young patients with SCD would be considered

safe; however, reports of cancer development in patients taking hydroxyurea for SCD have been reported. The problem with hydroxyurea would be that 59.5% of SCD patients self-reported never using the drug, former use was self-reported by 65.2 %, and current use was 52.9 % (Haywood et al., 2011). The question would be; does geographical location matter for increasing or decreasing the use of hydroxyurea? The reasons for hydroxyurea lack of use were feeling different after taking the medication, advised by the physician, and changes in conditions were not noted (Haywood et al., 2011; Ware, 2010).

Medically and clinically the benefits for taking hydroxyurea for SCD would outweigh the risks; such as reduction of white blood count, lower bilirubin levels, and less hemolysis (Ballas, Singh, Adamas-Graves, & Wordell, 2013; Smith et al., 2011; Ware, 2010). Smith et al. (2011) published that hydroxyurea was significant in decreasing painful episodes, analgesic use, and visits to healthcare facilities. According to McGann and Ware (2011) the benefits and effectiveness of hydroxyurea treatment has been explored for the last 25 years and should be considered a standard treatment for sickle cell disease. Voskaridou et al. (2010) found that the use of hydroxyurea could decrease episodes of VOC and hemolysis which in turn decrease damage to major organs and mortality rates. In addition to ensuring appropriate treatment availability for SCD, dissemination of information, and education for patients and physicians would be beneficial.

Blood transfusions. Blood transfusions are used for acute and chronic prophylactic treatment for the prevention and treatment of ACS, PHTN (Miller & Gladwin, 2012), stroke (Powers, Chan, Hiti, Ramilone, & Johnson, 2005), splenic

infarction (Owusu-Ofori & Hirst, 2013), and priapism ((Azik et al., 2012) and should be considered a standard treatment. The normal red blood cells are used to dilute the concentration of sickled cells to decrease organ damage and mortality (Owusu-Ofori & Hirst, 2013). Research has shown that blood transfusion should be used in the event of severe crisis episodes specifically when there is a previous history of ACS and PH (Miller & Gladwin, 2012).

Most deaths from SCD occur in the hospital during an acute painful crisis; life-saving treatments during these episodes would be blood transfusions (Allareddy et al., 2014). Emergency management for severe SCD painful crisis would use blood transfusions to decrease incidents of premature mortality caused by anemia, vasculopathy, and organ damage (Vichinsky et al., 2011). Patient safety should be considered by health care providers by obtaining a detailed history on SCD patients to avoid blood transfusion complications and to make informed medical decisions for treatment.

Like other treatments, the use of chronic blood transfusions could cause complications, alloimmunization, and iron overload (Cho & Hambleton, 2014). Alloimmunization occurs when the body develops antibodies against the transfused blood, making it difficult to provide a compatible blood match for future transfusions (Cho & Hambleton, 2014). Cho and Hambleton (2014) published that the benefits of regular blood transfusions have been associated with improving outcomes and could have several common side effects.

Transfusion reactions, iron overload, transfusion transmitted infections, and alloimmunization have been associated with regular blood transfusions (Detterich et al., 2013). Sickle cell patients normally have a lower hemoglobin and hematocrit level than the population without SCD and sickle cell trait (Koren, Fink, Admoni, Tennenbaum-Rakover, and Levin, 2009). Koren et al. (2009) published that the management of the hemoglobin and hematocrit levels in SCD patients would involve determining the optimal levels for viscosity and oxygen carrying capacity, instead of attempting to maintain the medical textbook levels; female values equal 12 to 14 (hemoglobin) and 34 to 36 (hematocrit) and 14 to 16 (hemoglobin) and 36 to 40 (hematocrit) for males. Sickle cell patients would have hemoglobin values of (±4 to 6) and hematocrits (±10) points lower. Bowers et al. 2011 found that with the determination of the optimal hematocrit for sickle cell patients, oxygen transport could be maximized, viscosity dependent VOC could be reduced, and transfusion regimens could be appropriately assessed.

Sickle cell disease patients should be involved with treatment regimens and have an awareness of test results, dates of testing, and optimal levels for individual hemoglobin and hematocrit tests to avoid transfusion complications. For this study, blood transfusions in the emergency setting would denote compliance with standard treatment regimens for patients presenting with ACS, PH, splenic infarction, priapism, and stroke. Above all, the literature reiterated the importance of the knowledge necessary to treat sickle cell complications effectively without creating exacerbations.

Morbidity

Symptoms related to morbid conditions increase during painful episodes and presenting complaints to the emergency department could originate from organ and vesicular damage (Glassberg et al., 2012). The common major organ damage in adults from frequent painful episodes would include lung damage (ACS and PHTN), brain infarcts (stroke), and kidney injury (Platt et al., 1994). In this section, a brief description is provided for the morbidities. The symptoms of chest syndrome could include fever, coughing, chest pain, and diagnostically a chest x-ray showing a pulmonary infiltrate (Miller & Gladwin, 2012). Acute chest syndrome in adults with SCD could be manifested from fat embolization in the bone marrow during a painful crisis, which could result in pulmonary emboli causing symptoms of dyspnea and chest pain, with hypoxia (Khoury et al., 2011). Paul, Castro, Aggarwal, and O'Neal (2011) published that acute chest syndrome was considered the most common reason for hospital admission related to symptoms and clinical findings, and death because of misdiagnosis. Pulmonary hypertension has been associated with hemolysis and hemolytic anemia. According to Miller and Gladwin (2012) PHTN occurrence is increased in adults because of chronic anemia, intravascular hemolysis, and increased cardiac output derived from systemic vascular and pulmonary damage.

Wang et al. (2013) published that stroke occurs in 24% of sickle cell patients by the age of 45 years. The high incidence of stroke in adults with SCD and is associated with cerebral perfusion relationship to the degree of anemia (Prohovnik, Hurlet-Jensen, Adams, Devivo, & Pavlakis, 2009). The initiation of blood transfusions as a treatment

regimen could be beneficial in maintaining optimal individual hemoglobin level and stroke prevention (Detterich et al., 2013). Neurological symptoms such as slurred speech, severe headache, and visual disturbances could be reasons for seeking emergency treatment.

Kidney injury in sickle cell disease could result in dialysis dependent kidney failure also known as end-stage renal disease, and death (Audard et al., 2014). Audard et al. (2014) published that ischemic injury to kidneys in sickle cell disease was a common occurrence during VOC. Treatments used to counteract the effects of VOC activity would include monitoring of intravenous hydration to correct electrolyte imbalances (Audard et al., 2014).

Providers of care to sickle SCD patients ought to be aware that medications used to treat painful episodes and blood transfusions could be the primary source of a complication. Health care providers must obtain a detailed history on SCD patients to avoid pain management and blood transfusion complications and to make informed medical decisions for treatment. The literature reviewed did not explore whether morbidity patterns vary based on geographical location and regionally.

Mortality

Mortality rates for adult SCD patients increased during a study conducted from 1979 to 2005; it was published that few children with SCD lived to adulthood and the median age of death was 48 years for females and 42 years for males (Platt et al., 1994). Bender and Seibell (2014) published that a subset of SCD patients would live to ages greater than 55 years, although high rates of morbidity would persist. Contributing to the

increased lifespan would be decreased mortality rates in children by 3% and improved treatments (Bendell & Seibel, 2014). An analysis of the geographic location for treatments and mortality rates could provide information on the subset of SCD that have increased lifespans over 55 years. In addition, increased morbidities have been associated with premature mortality.

Research has shown that deaths in SCD occur within three days of admission to the hospital with a diagnosis of SCD painful crisis (Allareddy et al., 2014). Given that treatment and organ damage complications could be associated with adult SCD mortality. Manifestations of lung damage was the origin of the two most common causes of death in adults with SCD HbSS from frequent VOC and hemolysis, namely acute chest syndrome and pulmonary hypertension (Bender & Seibell, 2014).

Summary

The research for SCD has focused on treatments, the effects of treatments, complications, and mortality. Research was lacking on how barriers to care could affect health outcomes, quality of life, and mortality for adults with SCD. Lack of accessibility to care, stigmas, and lack of knowledge for treatments could contribute to the barriers. In efforts to close the gap and promote effective evidence-based treatments for SCD, the World Health Organization (WHO) developed standards of care to be used as guidelines for SCD pain management (Moussavou et al., 2004). The study followed WHO standards and guidelines for pain management, and pain relief was experienced by 81.6% of the patients (Moussavou, et al., 2004). Additional pain management guidelines and protocols have been published for SCD to ensure quality care (Rees et al., 2003; and Ballas, Carlos,

& Dampier, n.d.). The standards of care could designate priorities in the management of SCD complications and serve as a catalyst in improving the quality of life (Yale, Nagib, & Guthrie, 2000).

According to Bhagat, Baviskar, Mudey, and Goyal (2014) sickle cell patients reported a significantly lower health related quality of life when compared to chronically ill patients of non-communicable diseases. Sickle cell patients have beliefs that the disease could be better managed and accessibility to quality care and appropriate treatments could improve health outcomes and quality of life (Bhagat et al., 2014). Sickle Cell education could improve the prescribing of treatment regimens (physicians), and compliance with treatments (patients). Several studies (Pack-Mabien & Haynes, 2009; Yale et al., 2000) argued that a multidisciplinary approach should be used to manage the care of SCD patients to increase the quality of care and improve health outcomes. The multidisciplinary healthcare team would include a SCD specialist, registered nurse, social worker, patient, and family. Yawn et al. (2014) published strong, moderate, weak, and consensus recommended standards of care for adults with SCD morbidities of VOC, ACS, stroke, renal failure, and PHTN. The strong recommendations are listed below with the consensus recommendations listed for acute renal failure (Yawn et al., 2014).

- VOC: rapid treatment with opioids (intravenous route) for severe pain;
- VOC/ ACS: use of incentive spirometer to prevent ACS during acute VOC;
- ACS/ Stroke: blood transfusions would be used for severe episodes and consultation with a SCD expert;
- ACS: intravenous cephalosporin, oxygen, and oral macrolide antibiotic;

- Stroke: chronic transfusion therapy program;
- Acute Renal Failure (consensus): monitor renal function daily (creatinine levels and fluid intake and output), blood transfusions are not recommended, use hemodialysis when needed for exacerbated conditions; and
- PHTN: obtain a diagnostic echocardiogram.

Despite the efforts to promote quality care, only 59% of SCD have shown improvements in health outcomes and decreased mortality (McGann & Ware, 2011). An analysis on treatments, morbidity, and mortality according to geographical location could reveal additional barriers and deficits in care.

Given the variations in treatment regimens, health, and health outcomes for patients with SCD, the effect of regional contribution was evaluated in this study. The methods that were used to evaluate the association of geographical location with emergency department usage, treatments, and mortality of adults with SCD in the United States are described in Chapter 3.

Chapter 3: Research Method

Introduction

The purpose of the study was to examine the impact of geographical location on the health outcomes of patients with SCD in regards to accessibility to care, treatments, and mortality. Accessibility to care and physician performance for treatment regimens for chronic diseases could vary by geographical location. Several studies (Davis et al., 1997; Smith et al., 2011) have shown barriers affecting the health outcomes of SCD patients include decreased healthcare accessibility and knowledge deficits for the use of hydroxyurea for treatment by providers and patients. Deductively, the literature reviewed reflects that the negative effects of barriers to care in SCD could cause increased comorbidities, decreased quality-of-life, and decreased life span.

Chapter 3 outlines the design of the study. The sections in the chapter discuss the targeted population, research design, sampling and sampling procedures, and methods that were used to analyze the data. The reliability and validity evidence HCUP datasets, which is sponsored by the AHRQ, was provided along with evidence that the data was sufficient to respond to the research questions.

Research Design and Rationale

Dependent Variable(s)

The dependent variables used for this quantitative research design included emergency visits and mortality rates 16 and 21 years after FDA approval of hydroxyurea for SCD treatment. Emergency visits for the purpose of this study indicated accessibility to care, disease management, and severity of disease. Hydroxyurea treatment is the only

drug approved by the FDA to treat SCD; in this study16 and 21 years after the approval, emergency visits and mortality rates were compared regionally and the results were considered an indicator of hydroxyurea use for disease management, severity of disease, and the need for accessible health care. Mortality rates were noted from inpatient hospital admission deaths with ICD-9 CM Codes 282.60 (SCD nonspecific), 282.61 (SCD without crisis), and 282.62 (SCD with crisis) listed in the medical record within the first 5 diagnoses (Diagnosis 1, Diagnosis 2, Diagnosis 3, Diagnosis 4, or Diagnosis 5).

Independent Variable(s)

The four regions in the United States were considered the geographic location and the independent variable. An examination of the Northeast, Midwest, South, and West regions was conducted to analyze significant associations in the medical care and health outcomes of sickle cell patients.

Covariable(s)

Sickle cell HbSS is dominant in subSaharan African descendants, therefore the population in the United States included were African Americans synonymous with the race listed as Black reported in the NIS datasets; NEDS did not include race as a variable. Covariables that could affect the outcome of the dependent variables were insurance status, income level, age, and gender. Age encompassed adults ages 21 years and older. Gender of male and female along with income level, and insurance status were used to provide a demographic description of the population.

Research Design

Correlational research. A retrospective correlational research design was used to examine the relationship of how living in different regions could affect the health and outcomes for adults with SCD. State data reported to NIS 2006 and NIS 2011 that was used in the study include race, gender, age in years, ICD-9-CM Codes 282.60, 282.61, and 282.62 diagnoses (1 through 5), in-hospital deaths, region of hospital, income level, and type of insurance.

Emergency department visits and national estimates were tracked using NEDS. The elements that were reported by the 46 states to the NEDS 2006 and NEDS 2011 database that were used in the study are age in years, gender, ICD-9-CM Codes 282.60, 282.61, and 282.62, region of hospital, type of insurance, income level, and emergency department visits and dispositions (deaths) of patients. Researchers using the database are allowed to study procedures and conditions related to emergency service use. The independent variable (regions) and two dependent variables (ED visits and mortality) were analyzed for correlations with a Confidence Interval of 95% and level of significance of (0.05).

The correlational study design was used to suggest possible associations between the independent and dependent variables. The type of association and the existence of extreme scores were demonstrated using bar charts to present visual representation. There were three dependent variables and one independent variable that was analyzed to determine if a significant relationship existed to contribute knowledge on how the health care system and health outcomes for sickle cell patients could be affected by regional

location. The secondary data provided an overview of SCD patients in the four regions of the United States for the years 2006 and 2011. The sampling method did not allow for the use of the cross-sectional design. Prevalence of chronic diseases is assessed from data collected from a defined period of time using a cross-sectional design to provide information on the entire population in the study. Sampling of the SCD population with a specific phenotype, SCD HbSS, was examined for regional differences; comparisons were not made between the population without SCD and the SCD population. Longitudinal research designs are used to compare the effects of diseases over periods of time. For example, SCD data would be used for the years of 2009, 2010, 2011 2012, and 2013 to compare changes in the health outcomes during the time periods analyzed. The data from two time periods was used for this study which is appropriate for a correlational design.

Represented in the datasets for NIS 2006, NIS 2011, NEDS 2006, and NEDS 2011 was information collected from hospitals in 46 of the HCUP partner states and representative of the Northeast, Midwest, South, and West regions (Agency for Healthcare Research and Quality, 2012). The number of emergency visits was an indicator for accessibility to quality care, appropriate disease management with prescribed medications for home use, and health care quality would be denoted by decreases or increases in mortality rates across the United States among patients with SCD. Emergency visits have been shown to increase among adults with SCD, while there is a low incidence of hydroxyurea use, and the lifespan is short (Andemariam et al., 2014). The correlational research design was used to establish the type of association

between the variables, denote changes in scores, determine whether the relationship is negative or positive, and determine the strength of the relationship.

Healthcare Costs and Utilization Project

The HCUP has a collection of databases with 46 participating states; the two databases that were used for this study are the NIS 2006, NIS 2011, NEDS 2006, and NEDS 2011 which included 46 states that contributed information to both databases for the years 2006 and 2011. The NIS database contains data on inpatient hospital admissions, dispositions, insurance status, and length of stay (NIS 2006 and NIS 2011). The NEDS has emergency department data which includes the reason for visit, diagnoses, and discharge disposition (NEDS 2006 and NEDS 2011). The use of NIS data estimates over 36 million weighted inpatient admissions, treatments, and discharge dispositions annually (Agency for Healthcare Research and Quality, 2013). A representation of special patient populations, a large sample size, uncommon treatments, and rare conditions are found in NIS and NEDS. The data was used to explore the relationship of geographical location to the number of emergency visits by sickle cell patients and mortality rates. The knowledge gained could influence the allocation of resources and dissemination of evidence-based knowledge for SCD which could reduce emergency services usage, improve health outcomes, and reduce health care expenditures.

Methodology

Target Population

The target population included adults (21 years and older), males and females with SCD HbSS identified by ICD-9-CM Codes 282.60, 282.61, and 282.62, with a

hospital registration and discharge as an inpatient or emergency department patient. The targeted population varied by year and by the dataset with NIS representing the frequency of inpatient admits and NEDS representing the frequency of ED visits; NIS 2006 (*N*=67,214), NIS 2011 (*N*=80,040), NEDS 2006 (*N*=164,698) and NEDS 2011 (*N*=215,296). Regionally, frequencies for inpatient admissions and ED visits for the targeted population was NIS 2006; Northeast (*N*=17,657), Midwest (*N*=13,242), South (*N*=30,799) West *(N*=5,517), NIS 2011; Northeast (*N*=13,829), Midwest (*N*=13,663), South (*N*=36,651) West (*N*=6,538), NEDS 2006; Northeast (*N*=25,300), Midwest (*N*=23,190), South (*N*=98,984) West (*N*=17,230), NEDS 2011; Northeast (*N*=43,447), Midwest (*N*=25,602), South (*N*=122,695) West (*N*=13,552). The regions were represented by the states of Alaska, Arkansas, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New York, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, and West Virginia, Wisconsin, and Wyoming. The number of states that contributed data to HCUP NIS and NEDS for the years 2006 and 2011 varied: NEDS 2006 (24), NEDS 2011 (30), NIS 2006 (38) and NIS 2011 (46) (Figure 2, Figure 3, Figure 4, and Figure 5).

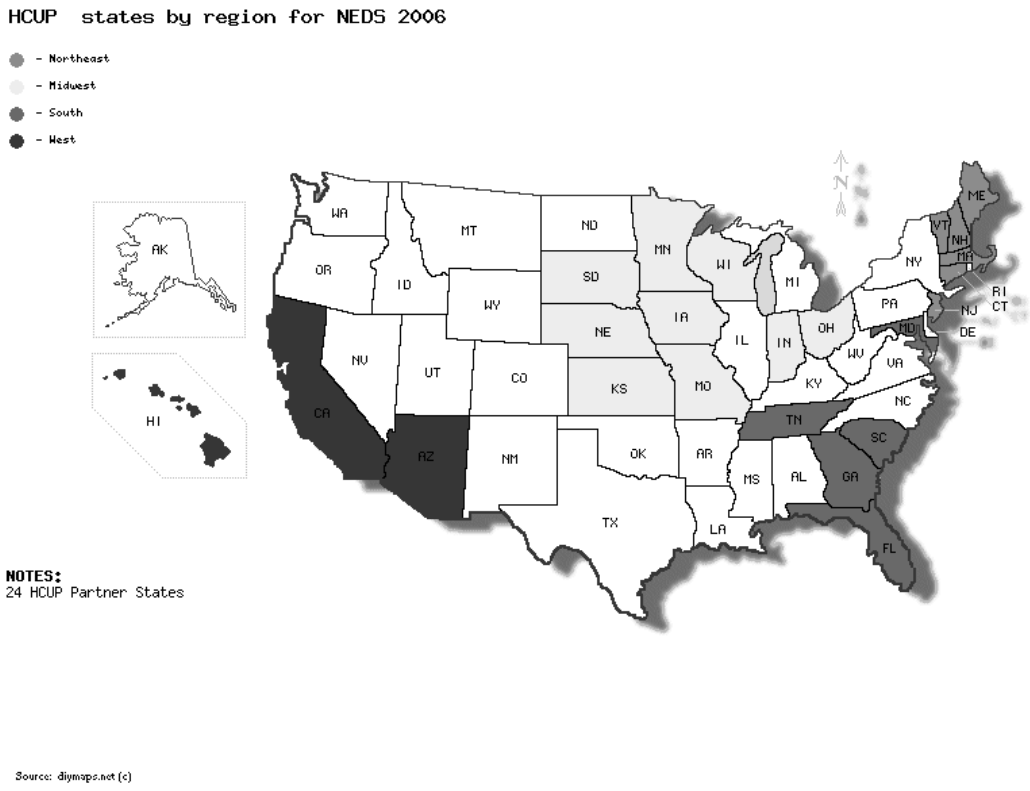

Figure 2. States by region for NEDS 2006

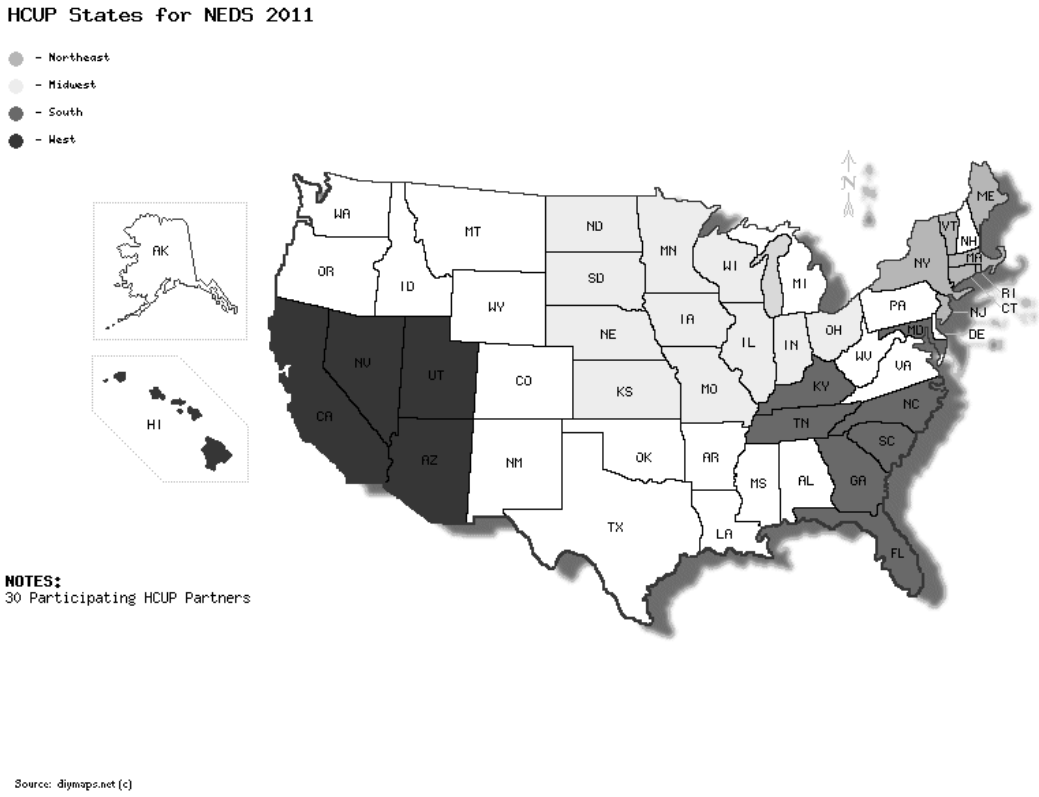

Figure 3. States by region for NEDS 2011

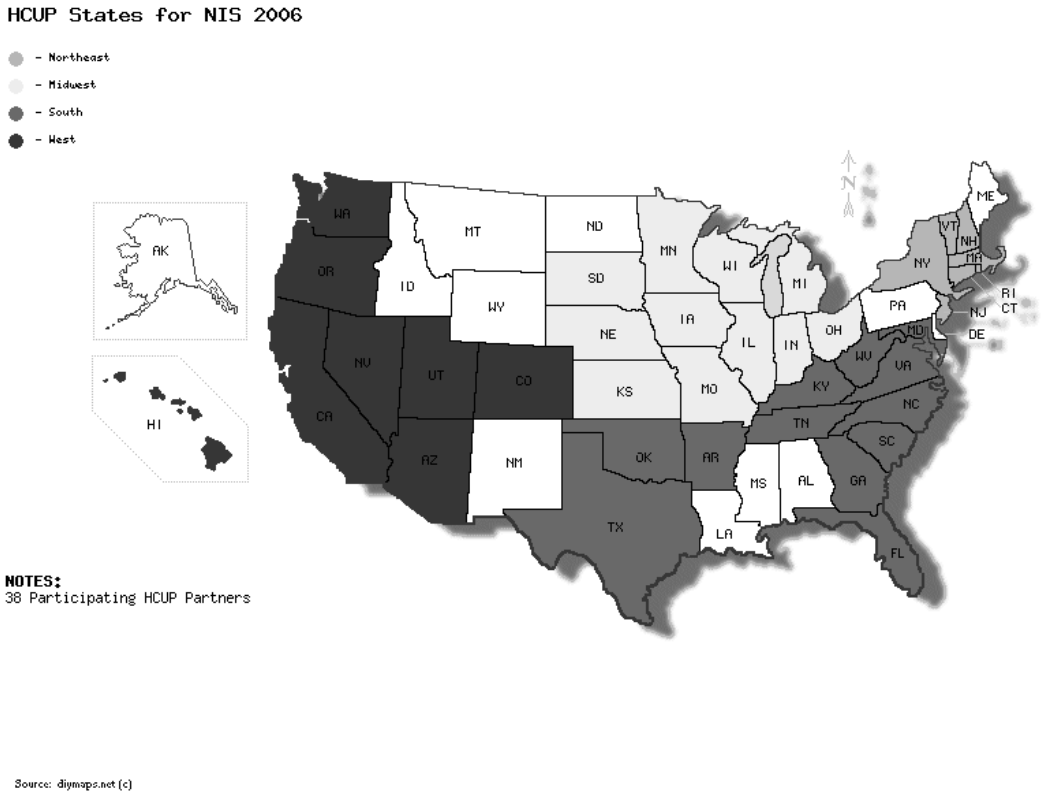

Figure 4. States by region for NIS 2006

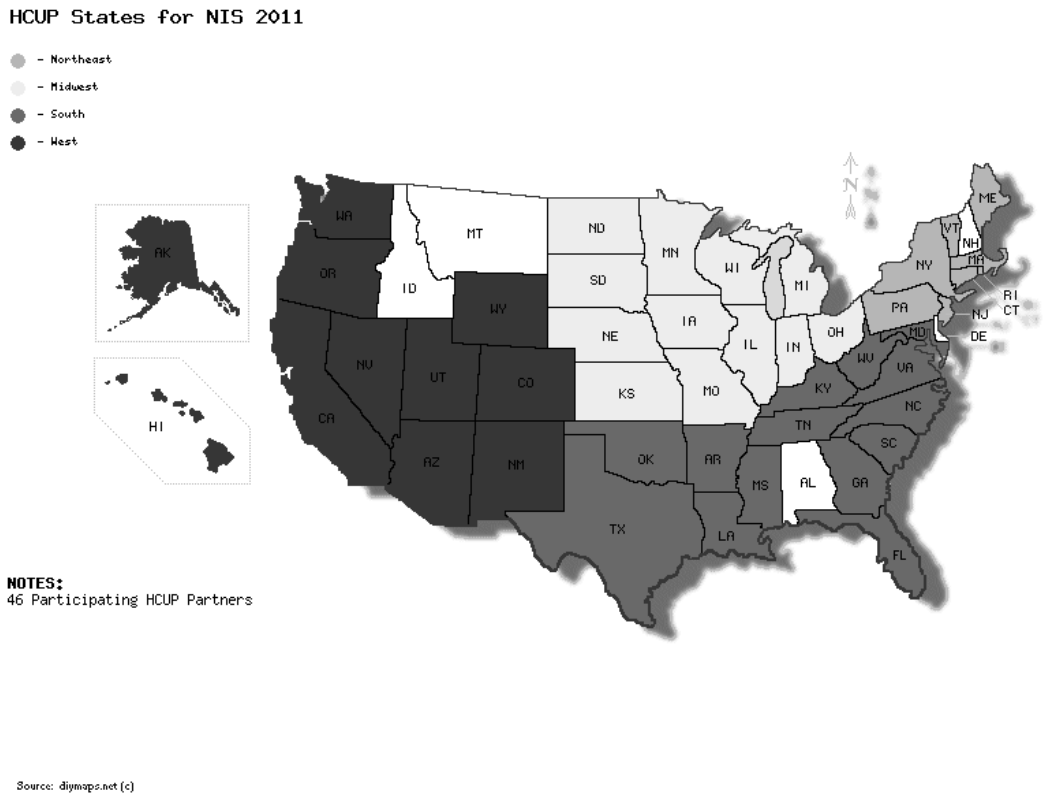

Figure 5. States by region for NIS 2011

Sampling and Sampling Procedures

A 20% sample of all United States community hospitals is approximated in the NIS and NEDS databases. Data for the NIS 2006 files was produced from 1,045 sampled hospitals (Agency for Healthcare Research and Quality, 2012). Included in the sample were hospitals in the Northeast (137), Midwest (299), South (415) and West (194). There were 1,049 hospitals in the stratified sample of NIS 2011 data containing discharge records. National estimates for dispositions would use the NIS 10% subsample core file to weight the data for the years 2006 and 2011 and statistical analysis. The number of sampled hospitals for the NIS 2011 data by region includes the Northeast (129), Midwest (306), South, (417), and West (197). The NEDS 2006 data was comprised of 955

hospital-based emergency departments with over 120 million weighted admits to the ED (Agency for Healthcare Research and Quality, 2012. There were 951 sampled hospital based emergency departments sampled for the NEDS 2011 database and over 131 million weighted ED admits. The NEDS data represents 67% of the United States population (Agency for Healthcare Research and Quality, 2012).

The AHRQ used stratified random sampling, a probability sampling technique, to collect data for HCUP; the samples of sickle cell data are reflective of subgroups that are homogenous, do not overlap, the population is exclusive, and large sample sizes can be accommodated (Frankfort-Nachmias & Nachmias, 2008). The sample was stratified by region (Northeast, Midwest, South, and West), hospital ownership (profit, not-for-profit, public, private, government), location (rural and urban), and hospital type (teaching, nonteaching, trauma center. Simple random sampling was not chosen because of the large sample size. Systematic sampling would not allow the opportunity of equal selection of the population. Cluster sampling requires two stages, a sample would be selected of the area and a sample would be selected for the population and a true representation of the population would not be met (Frankfort-Nachmias & Nachmias, 2008).

Inclusion criteria. The inclusion parameters consisted of adults in the age group of 21 years and over with SCD HbSS from NIS 2006, NIS 2011, NEDS 2006, and NEDS 2011 datasets from the 46 states participating in HCUP for the years 2006 and 2011. First, the ICD-9-CM Codes 282 .60 (nonspecific SCD), 282.61 (SCD with crisis), and 282.62 (SCD HbSS without crisis) were selected; next descriptive statistics followed to designate the frequencies for race (NIS 2006, 2011), age of 21 years and older, income

level, insurance status, ED visits and dispositions (deaths), inpatient admissions and deaths, and regions (Northeast, Midwest, South, and West).

Exclusion criteria. Excluded from the data were patients in age groups less than 21 years, patients that did not have ICD-9 Code 282.60, 282.61, or 282.62 listed in the first five diagnoses in the medical record, and states that did not report data to NIS 2006, NEDS 2006, NIS 2011, and NEDS 2011. After the inclusion criteria were met for the sample, the population was categorized into the corresponding regions (Northeast, Midwest, South, and West).

Power Analysis

Chi-Square was used to analyze the sample because the sample size was large, and the population in the sample had a diagnosis of SCD. For NIS datasets the patients that died while in the hospital were tallied and NEDS datasets were used for frequency of ED visits. The frequency data was used for the analysis. Cramer's V analysis was used to determine the effect size NIS 2006 (.016), NIS 2011(.016), NEDS 2006 (.104), and NEDS 2011 (.010). Effect size was recorded as small in all four datasets which could occur with large sample sizes (Faul et al., 2009).

Procedures for Recruitment, Participation, and Data Collection

The AHRQ invites all hospitals located in the 50 states of the United States to participate in HCUP since 1988, and 46 states signed up as partners to participate in HCUP (Agency for Healthcare Research and Quality, 2012). The number of HCUP partner states that provide annual health care data include inpatient (46), same day surgery and services (34), and emergency services (32) (Agency for Healthcare Research

and Quality, 2012). Reporting of the data is voluntary and annual compliance with reporting to the databases is not consistent for all states. The choice of databases for state reports include the NIS, NEDS, Kids' Inpatient Database (KID), State Inpatient Databases (SID), State Ambulatory Surgery and Services Database (SASD), and State Emergency Department Databases (SEDD) (Agency for Healthcare Research and Quality, 2012).

Forty-six states entered data for NIS 2006, NIS 2011, NEDS 2006, and NEDS 2011(Agency for Healthcare Research and Quality, 2012). The NIS is sampled from the SID and approximates 20% of discharges from community hospitals from the data of more than 7 million hospitals annually (Agency for Healthcare Research and Quality, 2012). National trends for health care utilization, quality, outcomes, and access are analyzed, tracked, and identified by policymakers and researchers using NIS data (Agency for Healthcare Research and Quality, 2012).

In the NIS 2006, NEDS 2006, NIS 2011, and NEDS 2011 data was collected from 46 states that are representative of the four regions of the United States (Northeast, Midwest, South, and West) (Agency for Healthcare Research and Quality, 2012). The number of emergency visits was used as an indicator for accessibility and disease management. Health outcomes were determined by mortality rates. Comparisons were made regionally with the inclusion of mortality rates across the United States among patients with SCD. I used a correlational research design was to establish the association between the variables, denote changes in scores, determine whether the relationship was negative or positive, and determine the strength of the relationship.

Procedure for Gaining Access to Dataset

HCUP data is sponsored by the AHRQ for the purpose of research to assist with public policy, improving health care quality, and as a resource to states and the federal government in making decisions on program development and funding (Agency for Healthcare Research and Quality, 2012). An application requesting the data was filed after completing an online tutorial on data usage and the International Review Board (IRB) approval. The IRB approval number assigned was 01-04-16-0351894. Permission was granted to use the data following the guidelines for confidentiality and protection of identities for individuals and establishments as outlined by the Health Insurance and Affordability Act of 1996 (HIPAA). The application process involved inclusion of the type and purpose of the research, how the data would be used, and the name and reason additional persons would have access to the information. The procedure for accessing the data required the completion of an online tutorial, filing an application and signing the agreement, and payment of fees to purchase the data.

Reputability of the Sources

The NIS datasets for the years 2004 to 2010 were used in a retrospective analysis by Allareddy et al. (2014) to examine acute chest syndrome as a predictor of mortality in adults with SCD. A regression model analysis adjusted the effects of the independent variables which included sex, race, age, type of sickle cell crisis and admission, comorbidities, hospital characteristics, and insurance status. Sickle cell disease HbSS was found to be the phenotype for 84.3% of the admissions (Allareddy et al., 2014). The need for mechanical ventilation and acute chest syndrome predicted higher mortality rates.

Okam et al. (2014) published that following the approval of hydroxyurea for use in SCD by the Food and Drug Administration (FDA) in 1998 there was not a constant decline in hospital admissions using confidence interval of 95%. The study used HCUP datasets for NIS 1998 to 2008 in a retrospective cohort study to test the hypothesis that hospitalizations would decrease with the availability of hydroxyurea.

An examination by Roghmann et al. (2013) on the likelihood of hospitalization contributory factors for priapism diagnoses used the HCUP NEDS data from 2006 to 2009. A prediction of hospital admissions was made based on comorbidities, emergency department volume, insurance status, and hospital location. The results showed SCD patients (*OR* 2.22, $p < 0.001$); significant for hospital admission and seeking emergency treatment for priapism.

Stein, Flum, Cashy, Zhao, and McVary (2013) published study results using HCUP data from NEDS 2006 to 2009 datasets which examined encounters for priapism visits, associated diagnoses by ICD-9-CM codes, hospital characteristics, and hospital charges. The nationwide estimates were calculated with the established weighting of the sample and 21% of the patients had a diagnosis of SCD.

Operationalization of the Variables

The HCUP NIS 2006, NIS 2011, NEDS 2006, and NEDS 2011 datasets were constructed from administrative data reported for billing from participating community hospitals. The information collection process begins with the initial admission to the hospital as an in-patient or emergency department visits and contains ICD-9-CM codes, Current Procedure Terminology (CPT) codes, Clinical Modification (CM) coding for

comorbidities, and disposition. Data collection for NIS 2006 and NIS 2011, NEDS 2006, and NEDS 2011 occurred 16 and 21 years after the approval of hydroxyurea and was used to compare the number of emergency visits and mortality rates.

For this study, a data file was created from NIS 2006 and NIS 2011 datasets for inpatient admission records and deaths of patients with the diagnoses codes 282.60, 282.61, and 282.62 listed within the first five diagnoses, regions, 21 years and older, income level, gender, and insurance status. Data files were created from NEDS 2006 and NEDS 2011 datasets for emergency visits and ED dispositions with data that included diagnoses codes 282.60, 282.61, and 282.62 listed within the first five diagnoses, regions, 21 years and older, income level, gender, and insurance status. Hospital location (region) identifiers were used to designate geographical location and ascertain regional location. There were not any outliers identified in the data. The main predictor variables for the study were regional location (Northeast, Midwest, South, and West); the outcomes included the number of emergency visits and mortality rates for the years 2006 and 2011. Covariates that could affect the outcomes existed with age, gender, insurance status, and income level and were explored using descriptive statistics to assess variations and regional differences (Table 1).

Table 1.

Variables, Operational Definitions, and Conceptualizations

NIS 2006 2011	NEDS 2006 2011	DV	IV	Covariate	Variable Name	Operational Definition	Conceptual definition	Level Of Measurement
X	X			X	AGE	Age listed in numbers; 0 to 124 years (1) 21 years' plus	Age in years	continuous
X	X			X	FEMALE	Gender: (0) male, (1) female	Gender	dichotomous
X			X		RACE	Uniform coding is used for race: (1) white (2) black (3) Hispanic (4) Asian or Pacific Islander (5) Native American (6) Other	Race	categorical
X	X			X	ZIPINC_QRTL	Household income 2006: (1) $1-$35,999 (2) $36,000-$44,999 (3) $45,000-$58,999 (4) $59,000+ Household Income (2011) (1) $1-$38,999 (2) $39,000-$47,999 (3) $48,000-$62,999 (4) $63,000+	Household income by zip code	categorical
X	X			X	PAY1	Information for expected primary payer: (1) Medicare (2) Medicaid (3) Private including HMO (4) Self pay (5) No charge (6) other	Insurance Status	categorical
X	X		X		HOSP_REGION	Region of the hospital: (1) Northeast (2) Midwest (3) South (4) West	Regional location of the hospital	categorical
X	X		X		DX1 DX2 DX3 DX4 DX5	Diagnoses by ICD-9-CM Codes (1) 282.60 (2) 282.61 (3) 282.62	Diagnoses by ICD-9-CM Codes 282.60, 282.61, 282.62	nominal
X		X			DIED	(0) did not die (1) died	Inpatient hospital deaths	categorical
	X	X			ED_EVENT	Emergency Department events (0) ED admission (did not die) (1) Died in ED	Emergency Department visits and deaths	categorical

The number of emergency visits could be an indicator for accessibility to health care, disease management was recognized with emergency visits, and health outcomes were acknowledged with mortality.

Data Analysis Plan

Standard quality control procedures exercised by HCUP for age and date of birth, admission, discharge, and ICD-9-CM codes include confirmation that the data is valid, consistent internally, and when feasible consistent with norms (Agency for Healthcare Research and Quality, 2012). Inconsistent and questionable values are labeled with C or negative 6-filled. The inconsistent values are not changed or fixed; special missing values labels are assigned to preserve the anomalies for the researcher to investigate (Agency for Healthcare Research and Quality, 2012). Edit failures are tabulated and used to assess the quality for each data source. Quality review is conducted by an independent contractor annually to verify all numerical and categorical data elements, frequency distributions, and cross-frequencies (Agency for Healthcare Research and Quality, 2012). Procedures for automated quality control are used to assess the validity of values; numeric data verified as numeric, ranges checked against norms, maximum allowed values checked against data ranges, and diagnostic and procedure codes verified against norms (Agency for Healthcare Research and Quality, 2012). Internal consistency is assessed to capture inconsistencies, such as birthdates that would be inconsistent with the documented age. Edit checks are performed on HCUP data annually since 1998; the edit check numbers are assigned with a description and the action taken (Agency for Healthcare Research and

Quality, 2012). Missing values were eliminated in this study because the variables that were selected from the dataset had less than five percent missing values.

Data Cleaning Procedures

Statistical Program for Social Sciences (SPSS), Stata Data Analysis and Statistical Software for Professionals, and Statistical Analysis Software (SAS) are compatible with HCUP datasets; SPSS was used in this study for statistical analysis. The data was provided on CD-ROMs, downloaded, unzipped, and saved in folders on the (C) drive of the PC. The HCUP datasets were downloaded to SPSS using the SPSS load files that were provided by HCUP.

The data was converted to SPSS, reviewed, and cleaned in stages. First the variables were examined and there were not any errors detected. Next values were added to the variables according to the HCUP values that were assigned in the codebook. Then, frequencies were checked and compared to the summary statistics provided on the H·CUPnet web page to ensure the datasets were downloaded correctly, the statistics were accurate, and to ensure the reliability and validity of the research (Field, 2013). The data was screened for missing data, blank entries, typing errors, coding errors, and misfiled data elements.

The data was cleaned so the same results could be obtained when applied to a similar situation. In addition, valid data would measure the concepts intended. The last step was the selection and coding of the variables that would be used for this study. Variables that were recoded were age by birthdate 0-124 years (21 years plus) and the

first five diagnoses (DX primary, DX1, DX2, DX 3, DX4) were auto recoded using SPSS for ICD-9-CM Codes 282.60, 282.61, and 282.62.

Research Questions and Hypotheses

I used descriptive statistics and frequencies to define the targeted SCD population in the areas of insurance status, income level, age, and gender. Regression was not used for statistical analysis because the assumptions for homoscedasticity were not met and the results would be biased. Chi-Square analysis was used to assess if there was a significant association between the effect of regions on insurance status, age, gender, income level, emergency visits, and mortality (dependent variables) and regions (independent) variable. The research questions that were explored in the present study using HCUP data from NIS 2006, NIS 2011, NEDS 2006, and NEDS 2011 include

RQ1: Is there a significant association between emergency services use (accessibility) among adults with SCD and regional geographic location (Northeast, Midwest, South, and West)?

$H_0$1: There is no significant association between emergency services use (accessibility) and the regional geographical location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database in adults with SCD.

H_a1: There is a significant association between emergency services use (accessibility) and the regional geographical location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database in adults with SCD.

Data Analysis Plan. Chi-Square was the analysis used to explore if there was a significant association of the dependent variables (emergency visits) as an indicator of accessibility to health care as the geographic regions Northeast, Midwest, South, and West (independent variables) change**.**

RQ2: Is there an association between the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment?

$H_0$2: There is no significant association in the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment.

H_a2: There is a significant association in the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment.

Data Analysis Plan. Chi-Square was the analysis used to explore if there was a significant association of the dependent variables (emergency visits) an indicator for disease management as the geographic regions Northeast, Midwest, South, and West (independent variables) change. The significance of the association was shown for the number of emergency visits and mortality rates in accordance to each region and the strength of the relationship.

RQ 3: Is there an association between hydroxyurea approval and SCD mortality rates in adults in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later)?

$H_0$3: Hydroxyurea approval does not have a significant association on mortality rates in adults with SCD in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later)?

H_a3: Hydroxyurea approval has a significant association on mortality rates in adults with SCD in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later)?

Data Analysis Plan. Chi-Square analysis was used to statistically examine if there was a significant association regionally for deaths rates among SCD patients. The regional geographical locations in the Northeast, Midwest, South, and West (independent variable) and the effect on the mortality rates (dependent variable) were compared numerically.

Threats to Validity

Threats to external validity from the use of secondary data would include the accurateness and completeness of the information provided by the participating states. Limitations could be applied by specific states as to how the data could be used and the information in the dataset could be eliminated. Internal validity could be compromised with data input errors and coding. Threats to statistical conclusion validity were avoided by choosing a valid sampling method and meeting the assumptions of the statistical tests used increased the validity of the results. Threats to validity in HCUP datasets were

addressed using edit procedures and were described in the procedures, recruitment, and data collection section. The editing process is annual and conducted prior to release of datasets to counteract the effects of threats to internal and external validity.

Ethical Procedures

An online HCUP data use tutorial and application were filed acknowledging the privacy and confidentiality of using the datasets with existing private records or documents. The agreement to access the HCUP datasets involved compliance with HIPAA guidelines for privacy and confidentiality of the patients and the institutions. The data has HCUP encrypted coding to protect the identity (Agency for Healthcare Research and Quality, 2012). Coding that identifies the institution was eliminated from the dataset. Once the data was received, the targeted population was recoded by diagnosis using the auto recode function in SPSS. Location was identifiable by regional geographic location (Northeast, Midwest, South, and North without the input of zip codes. In addition, the data was stored in a file on a password locked home computer that is used solely by the researcher. According to publications of the Office of Research and Integrity, U.S. Department of Health and Human Services, data storage does not have a time and amount limitation for storage, unless the research is funded and the researcher must allow for the storage requirements of the funding institution. The HCUP billing and discharge data that was used for this study will be destroyed using a software produce such as, Eraser or CyberScrub after five years of maintenance.

According to the guidelines from Walden University (2010A), the Walden University IRB application was filed and approved requesting permission to conduct the research. The information requested on the application included a description of the

- proposed research,
- research stakeholders and partners,
- benefits of the research,
- potential risks and conflict of interest,
- confidentiality and data integrity,
- tools used for data collection, and
- a description of the study participants.

The Potential Risk and Benefits form in the IRB application described opportunities for disclosure that could compromise privacy, confidentiality, and cause unintended effects to others. The goal of the review board was to ensure that Walden University is in compliance with Federal regulations and university ethical standards (Walden University, 2010A).

Summary

Chapter 3 provided a description of the targeted population, datasets, research design, and instrumentation that were used to examine the research questions with reliability and validity. In addition, ethical concerns, confidentiality, and privacy have

been acknowledged. A numerical description of the population was used along with a quantitative retrospective method in a comparative study to describe the association between the variables with statistical analysis. The retrospective correlational design required a review of the literature for the identification of variables that could affect outcomes in SCD, in order to identify outcomes and their relationship to the changes. The goal was to explore whether the independent variable has influenced the dependent variables and the effects of covariates on the outcomes. The approach used to address the research questions involved the use of dependent and independent variables, and covariables to describe the correlation of geographic locations to emergency department visits (accessibility and disease management), and mortality using HCUP data. In Chapter 4 there is a description and significance of the findings from the statistical analysis.

Chapter 4: Results

Introduction

The purpose of this research study stood to compare the effects of geographic locations regionally, emergency department visits, and deaths from SCD using Chi Square. The statistical analyses explored the relationship between the independent variable (regions) and dependent variables (ED visits and mortality). The targeted population was adults age 21 years plus with SCD HbSS in the United States. In previous research barriers to care for SCD patients have been identified in the areas of accessibility, disease management, stigmas, and quality of care (Anderson et al., 2014; Brousseau et al., 2010; Haywood et al., 2013; Smith et al., 2011; Ware, 2010). NIS 2006, NIS 2011, NEDS 2006, and NEDS 2011 HCUP, AHRQ datasets were used to explore regional differences in health care and health outcomes for sickle cell patients at 16 and 21 years after the approval of hydroxyurea for treatment.

Chapter 4 provides a description of the population characteristics by region for the targeted sample. Statistical analyses were used to determine the association of regions, ED visits, and mortality, and answer the research questions. Decisions were made to reject or accept the null hypotheses based on those findings. The research questions and hypotheses that were used to guide the study included:

RQ1: Is there a significant association between emergency services use (accessibility) among adults with SCD and regional geographic location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database.

$H_0$1: There is not a significant association between emergency services use (accessibility) and the regional geographical location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database in adults with SCD.

H_a1: There is a significant association between emergency services use (accessibility) and the regional geographical location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database in adults with SCD.

RQ2: Is there an association between the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment?

$H_0$2: There is no significant association in the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment.

H_a2: There is a significant association in the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment.

RQ3: Is there an association between hydroxyurea approval and SCD mortality rates in adults in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later)?

$H_0$3: Hydroxyurea approval does not have a significant association on mortality rates in adults with SCD in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later).

H_a3: Hydroxyurea approval has a significant association on mortality rates in adults with SCD in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later).

Data Collection

The datasets for the research were obtained from HCUP, AHRQ after Walden IRB approval. Health Care Utilization Project collects administrative data annually from participating partners and the data used for this study was collected from January 1, 2006 to December 31, 2006 and January 1, 2011 to December 31, 2011. The steps for obtaining the datasets and the methods used by HCUP to collect data were discussed in Chapter 3. The dataset for NIS has over 8 million cases and NEDS represents over 27 million cases. The cases from the datasets that met the inclusion criteria for this study were weighted to make national estimates and included NIS 2006 (*N*=67,214), NIS 2011 (*N*=80,040), NEDS 2006 (*N*=164,698), and NEDS 2011(*N*=215,296). The variables were selected from the datasets as demonstrated in Chapter 3, Figure 3.

Discrepancies in Data Collection

During the course of the analysis phases, there were changes made to the research plan that were uncontrollable factors. The following changes were made to the research plan following:

- Race was eliminated in the NEDS files by HCUP because of nonreports of race by the states that followed regulatory mandates; race was reported in the NIS files and used in the study to describe the population. NIS 2011 showed that 93.9% of patients diagnosed with SCD HbSS were African American (Table 5).
- Black was used to describe the race for people of subSaharan African descent in the HCUP data files, for this study African American has been used instead of black.
- In order to encompass the majority of sickle cell HbSS cases, the diagnosis codes used in the study were expanded to include 282.60 (nonspecific sickle cell anemia) which is used when the genotype is not known, 282.61 sickle cell anemia HbSS without crisis, and 282.62 (sickle cell anemia HbSS with crisis);
- The number of medical record recorded diagnoses was expanded from using only the primary and secondary diagnoses (diagnoses 1and 2), to include diagnoses 1 through 5. This change was made to capture the diagnosis of SCD from the billing invoices when other medical and surgical conditions received billing priority, such as pneumonia or a cholecystectomy.

Descriptive and Demographic Characteristics

The population sizes for the research were presented in four datasets, NEDS 2006, NEDS 2011, NIS 2006 and NIS 2011 files, containing the subgroup of sickle cell patients selected for this research. Included was the age group of 21 plus years with diagnoses 1 through 5 with the ICD-9-CM Code of 282.60 (nonspecific sickle cell anemia), 282.61 (HbSS sickle cell anemia without crisis), and (282.62 HbSS sickle cell anemia with

crisis). Statistical analyses were performed on the SCD subgroup to describe the population. The descriptive and demographic characteristics are shown in Table 2, Table 3, Table 4, and Table 5. The NEDS datasets were used to measure ED visits and NIS datasets were used to measure inpatient hospital admissions. All data were weighted for analyses with the application of discharge weights provided in the datasets to predict national estimates.

The weighted sample size generated from HCUP data files allowed for generalizability of the observed ED visits nationally. The inclusive population weighted sample size for NEDS 2006 *N*=164,698 (Table 2), and NEDS 2011 *N*=215,296 (Table 3). The largest SCD sample population was represented in the NEDS 2011 dataset. The sample was comprised of 42% males and 58% females with 47% from the low income quartile. Medicare and Medicaid were identified as the primary insurance for 35% and 42%, respectively. Regionally, 45% of the population lived in the South (Table 3). The HCUP datasets represent 67% of the sampled sickle cell population in the United States.

Table 2

NEDS 2006 Sample Descriptive Demographic Characteristics (weighted)

Variable	*n*=Frequency	Valid Percent	Mean	Standard Deviation
Gender		100.0	.56	.497
Male	73,201	44.4		
Female	91,497	55.6		
Race (not reported)				
Median Household Income		100.0	1.81	.976
$1-$35,999	81,381	48.0		
$36,000-$44,999	42,172	21.0		
$45,000-$58,999	24,545	19.8		
$59,000+	13,403	11.2		
Hospital Region		100.0	2.66	.861
Northeast	25,300	15.4		
Midwest	23,190	14.1		
South	98,984	60.1		
West	17,230	10.5		
Expected Primary Payer		99.8	2.11	1.043
Medicare	49,218	29.9		
Medicaid	72,195	43.8		
Private	25,413	15.4		
Self-pay	13,886	8.4		
No charge	1,046	.6		
Other	2,557	1.6		
Disposition from Emergency Department		100.0	.56	.497
Did not die	157,375	99.8		
Died in ED	49	.0		
NEDS 2006 Total *N*= 164,698				

Table 3

NEDS 2011 Sample Descriptive Demographic Characteristics (weighted)

Variable	*n*= Frequency	Valid Percent	Mean	Standard Deviation
Gender		100.0	.001	.497
Male	33,492	41.8		
Female	46,549	58.2		
Race (not reported)				
Median Household Income		100.0	1.81	.976
$1-$38,999	99,917	46.4		
$39,000-$47,999	52,266	24.3		
$48,000-$62,999	38,651	18.0		
$63,000+	18,907	8.8		
Hospital Region		100.0	3.00	.912
Northeast	43,447	20.2		
Midwest	35,602	16.5		
South	122,695	57.0		
West	13,552	6.3		
Expected Primary Payer		99.8	1.98	1.017
Medicare	70,262	35.2		
Medicaid	91,877	42.1		
Private	30,884	16.0		
Self-pay	17,574	4.2		
No charge	763	.3		
Other	3,427	2.0		
Disposition from Emergency Department		100.0	.56	.497
Did not die	215,254	99.8		
Died in ED	41	.0		
NEDS 2011 TOTAL *N*= 215,296				

The weighted sample size generated from the HCUP data files allows for generalizability of the observations nationally. The inclusive population weighted sample size for NIS 2006 was (*N*=67,214) [Table 4] and NIS 2011 (*N*=80,040) [Table 5] for inpatient hospital admissions, representing 67% of the sickle cell anemia HbSS population nationally. The largest sample size was the NIS 2011 data comprised of 42% males and 58% females, with 48% from the low income quartile. Medicare and Medicaid

were identified as the primary insurance for 35% and 42% of the population. Regionally, 46% of the population lived in the South (Table 5).

Table 4

NIS 2006 Sample (weighted) descriptive demographic characteristics

Variable	*n*=Frequency	Valid Percent	Mean	Standard Deviation
Gender		100.0	.58	.493
Male	28,166	41.9		
Female	38,987	58.1		
Race		100.0		
White	806	1.6		
Black	46,205	68.7		
Hispanic	1,835	2.7		
Asian or Pacific Islander	48	.1		
Native American	41	.1		
Other	675	1.0		
Median Household Income		100.0	1.87	1.018
$1-$35,999	32,208	49.3		
$36,000-$44,999	15,882	24.3		
$45,000-$58,999	10,810	16.5		
$59,000+	6,469	9.9		
Hospital Region		100.0		
Northeast	17,657	26.3		
Midwest	13,242	19.7		
South	30,799	45.8		
West	5,517	8.2		
Expected Primary Payer			2.07	1.081
Medicare	21,614	32.2		
Medicaid	28,659	42.6		
Private	11,584	17.2		
Self-pay	2,964	4.4		
No charge	536	.8		
Other	1,805	2.7		
Disposition from Hospital		100.0	.01	.078
Did not die	66,777	99.4		
Died	416	.6		
NIS 2006 Total *N*= 67,214				

Table 5

NIS 2011 Sample (weighted) Descriptive Demographic Characteristics

Variable	*n* = Frequency	Valid Percent	Mean	Standard Deviation
Gender		100.0	.58	.493
Male	33,492	41.8		
Female	46549	58.2		
Race		100.0	2.11	.630
White	936	1.3		
Black	70,511	93.9		
Hispanic	1,773	2.4		
Asian or Pacific Islander	192	.3		
Native American	27	.0		
Other	1,682	2.2		
Median Household Income		97.7	1.94	1.059
$1-$38,999	37,560	48.0		
$39,000-$47,999	16,453	21.0		
$48,000-$62,999	15,517	19.8		
$63,000+	8,753	11.2		
Hospital Region		100.0	2.213	1.175
Northeast	13,829	26.3		
Midwest	13,663	19.7		
South	36,651	45.8		
West	6,538	8.2		
Expected Primary Payer		99.8	1.98	1.017
Medicare	28,185	35.2		
Medicaid	33,698	42.1		
Private	12,849	16.0		
Self-pay	3,396	4.2		
No charge	214	.3		
Other	1,637	2.0		
Disposition from Hospital		100.0	.00	.065
Did not die	79,683	99.6		
Died	336	.4		
NIS 2011 *N* = 80,040				

The variables hospital disposition (dependent) and hospital region (independent) did not meet the assumptions for the proposed regression analysis for normality and homoscedasticity. Homoscedasticity was evaluated with the Levene's test ($p < .001$). The variances were not equal across the sample. The sample met the assumptions for Chi-

Square analysis. The dependent and independent variable were categorical and were measured at a nominal level. The dependent and independent variables consisted of two or more categories.

Results

Chi-Square analysis was used to determine the relationship between hospital region (independent) and ED visits and mortality (dependent) variables. The assumptions that were met included the variables were categorical and consisted of two or more categorical independent groups. The predetermined confidence interval was 95% and *p* value was <0.05 for the statistical analysis. The NEDS 2006 and NEDS 2011 datasets were analyzed to respond to research questions number 1and 2. The NIS 2006 and NIS 2011 datasets were analyzed to answer research question number 3.

Research Question 1

RQ1: Is there a significant association between emergency services use (accessibility) among adults with SCD and regional geographic location (Northeast, Midwest, South, and West)?

$H_0$1: There is no significant association between emergency services use (Accessibility) and the regional geographical location (Northeast, Midwest, South, and West) represented by 46 states in the United States from the HCUP database in adults with SCD.

H_a1: There is a significant association between emergency services use(accessibility) and the regional geographical location (Northeast, Midwest, South, and

West) represented by 46 states in the United States from the HCUP database in adults with SCD.

The NEDS 2006 with a sample size of *N*=164,704 was significant for an association between regions and emergency services use Pearson chi-square x (21) = 5331.293, *p* =. 000 (Table 6, Figure 6). The strength of the association was weak; Phi (.180), *p* = .000 and Cramer's (.104), *p* = .000 (Table 7). The NEDS 2011 with a sample size of *N*= 215,132 was significant for an association between regions and emergency services use Pearson chi-square x (3) 44.502, *p* =. 000 (Table 6, Figure 6). The strength of the association was weak; Phi (.014), *p* = .000 and Cramer's (.010), *p* = .000 (Table 7).

Research Question 2

RQ2: Is there an association between the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment?

$H_0$2: There is no significant association in the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment.

H_a2: There is a significant association in the number of emergency department visits (disease management) for adults with SCD in the four regions (Northeast, Midwest, South, and West) 16 and 21 years after FDA approval of hydroxyurea for SCD treatment.

The NEDS 2006 data was significant for an association between regions and emergency services use Pearson chi-square x (21), = 5331.293, *p* = .000 (Table 6, Figure

6). The strength of the association was weak; Phi (.180), p = .000 and Cramer's (.104), p = .000 (Table 7). The NEDS 2011 data was significant for an association between regions and emergency services use Pearson chi-square x (3) 44.502, p = .000 (Table 6, Figure 6). The strength of the association was weak; Phi (.014), p = .000 and Cramer's (.010), p = .000 (Table 7).

Table 6

NEDS 2006, NEDS 2011 Chi-Square Tests

NEDS 2006	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5331.392	21	.000
Likelihood Ratio	6876.872	21	.000
Linear-by-Linear Association	903.557	1	.000
N of Valid Cases	164,704		
NEDS 2011	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	44.502	3	.001
Likelihood Ratio	41.671	3	.001
N of Valid Cases	215,132		

Table 7

NEDS 2006 and NEDS 2011 Chi-Square Symmetric Measures (weighted)

NEDS 2006		Value	Approximate Significance
Nominal by Nominal	Phi	.180	.000
	Cramer's V	.104	.000
N of Valid Cases		164,704	
NEDS 2011		Value	Approximate Significance
Nominal by Nominal	Phi	.014	.000
	Cramer's V	.010	.000
N of Valid Cases		215,132	

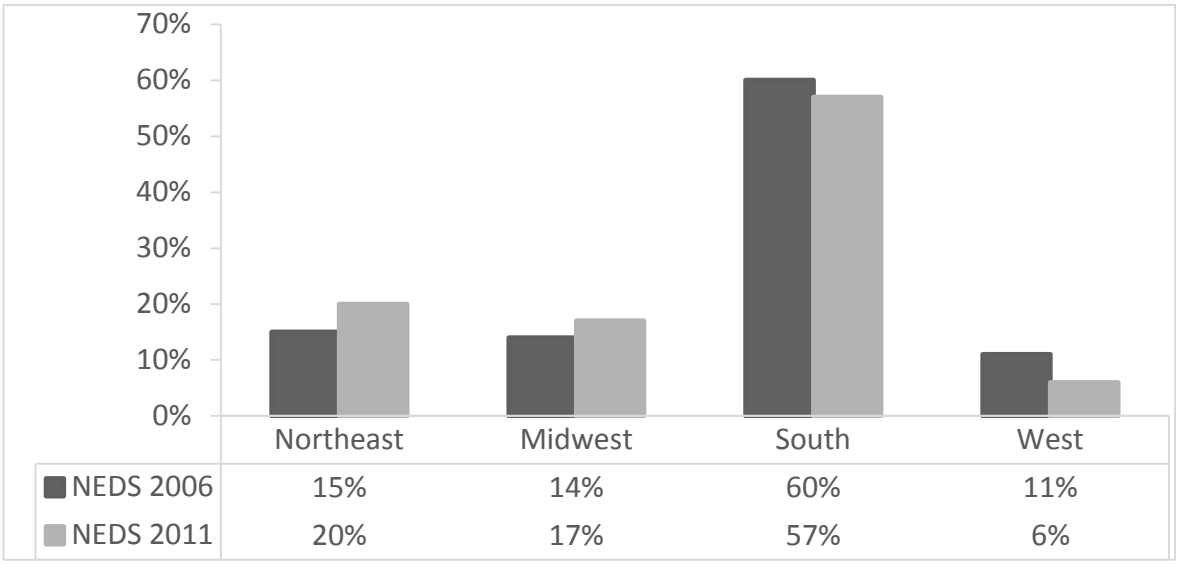

Figure 6. NEDS 2006 and NEDS 2011 Chi-Square significant association for emergency visits by region

Research Question 3

RQ 3: Is there an association between hydroxyurea approval and SCD mortality rates in adults in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later)?

$H_0$3: Hydroxyurea approval does not have a significant association on mortality rates in adults with SCD in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later)?

H_a3: Hydroxyurea approval has a significant association on mortality rates in adults with SCD in relation to geographic location (Northeast, Midwest, South, and West) in 2006 (16 years later) and 2011 (21 years later)?

There was significant association between mortality and geographic location for patients with SCD for NIS 2006 data. Pearson chi-square x (3), N= 17.866, p = .000 (Table 8, Figure 7). The strength of the association was weak; Phi and Cramer's V N= 67,193 (.016), p = .000 (Table 9). The association between mortality and hospital regions was significant in the data from NIS 2011 with Pearson chi-square x (4), N= 20.663, p = .000 (Table 8, Figure 7). The strength of the association was weak; Phi and Cramer's V N= 80,019 (.016), p = .000 (Table 9).

Table 8

NIS 2006, NIS 2011 Chi-Square Tests (weighted)

NIS 2006			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	17.866	3	.000
Likelihood Ratio	17.889	3	.000
Linear-by-Linear Association	5.643	1	.018
N of Valid Cases	67,193		
NIS 2011	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.663	4	.000
Likelihood Ratio	19.892	4	.001
Linear-by-Linear Association	7.242	1	.007
N of Valid Cases	80,019		

Table 9

NIS 2006 and NIS 2011 Chi-Square Symmetric Measures (weighted)

NIS 2006		Value	Approximate Significance
Nominal by Nominal	Phi	.016	.000
	Cramer's V	.016	.000
N of Valid Cases		67,193	
NIS 2011		Value	Approximate Significance
Nominal by Nominal	Phi	.016	.000
	Cramer's V	.016	.000
N of Valid Cases		80,019	

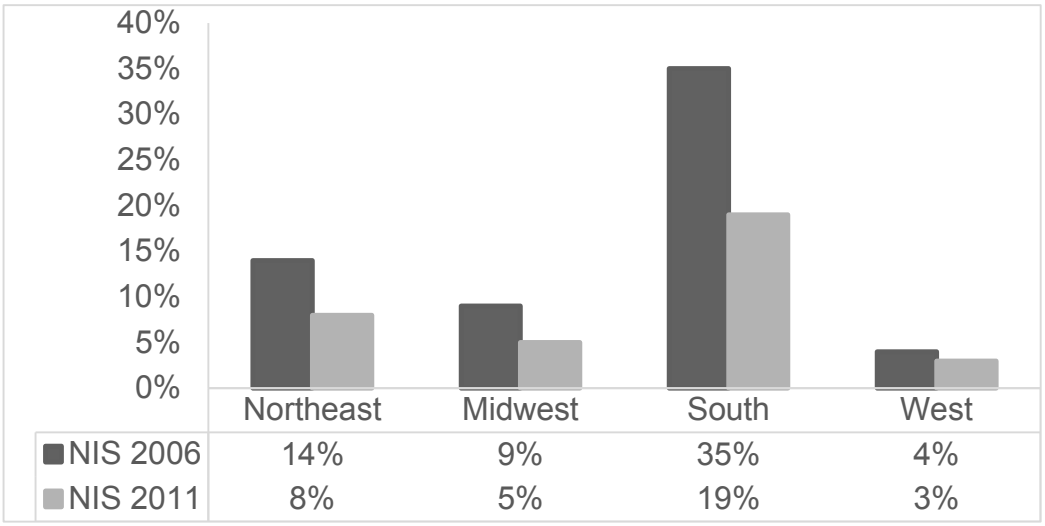

Figure 7. NIS 2006 and NIS 2011 Chi-Square significant association for inpatient dispositions by region, died in hospital

Summary

I designed the study to explore the effects of geographical regions on the health of sickle cell anemia patients 16 and 21 years after the approval of hydroxyurea by the FDA for treatment. Inpatient deaths and ED visits were used as indicators to document changes in health and health outcomes. The NEDS 2006, NEDS 2011, NIS 2006, and NIS 2011 datasets were tested separately with Chi-Square. The results revealed a significant association between ED visits (dependent variable), deaths (dependent variable), and regions (independent variable). The associations were weak according to Phi and Cramer results. ED visits increased in the Northeast (*N*=43,447), Midwest (*N*=35,603), and South (*N*=122,695), when compared to 2006 when ED visits in the Northeast were (*N*=25,300), Midwest (*N*=23,190), and South (*N*=98,984) [Table 10]. The West showed a decrease in ED visits shows a summary of inpatient deaths and emergency department visits by region results for are in 2011 (*N*=13,552) and 2006 showed an increase (*N*=17,230)

[Table 10]. The Northeast, Midwest, South, and West had more deaths in 2006 than 2011.

Table 10

NIS 2006, NIS 2011, NED 2006, and NEDS 2011 Summary of inpatient deaths and emergency department visits by region

		Northeast	Midwest	South	West
NEDS 2006	ED Visits	25,300	23,190	98,984	17,230
NEDS 2011	ED Visits	43,447	35,602	122,695	13,552
NIS 2006	Inpatient Deaths	93	62	233	28
NIS 2011	Inpatient Deaths	62	37	152	24

The results for the research questions are

- **RQ1**: There was a significant association between ED visits (accessibility) and geographic regions in the United States.
- **RQ2**: There was a significant association between ED visits (disease management) and geographic regions in the United States.
- **RQ3**: There were decreased mortality rates in the four regions of the United States (Northeast, Midwest, South, and West) 13 years after the FDA approved Hydroxyurea for treatment.

Relative to the findings revealed in Chapter 4, Chapter 5 includes a discussion of the future research, relevance of the findings, limitations of the study, and the social change that could occur to improve the health and health outcomes of patients with sickle cell anemia, 21 years and older.

Chapter 5: Discussion

Introduction

This study was used to document the effects of geographical locations on the health and health outcomes of SCD patients, 21 years and older, 16 and 21 years after FDA approval of hydroxyurea for the treatment of the disease. The findings of the study are important because hydroxyurea is the only drug approved by the FDA as a preventive measure to counteract the effects of SCD. Hydroxyurea increases and improves the ability of the body to produce fetal hemoglobin which is decreased or nonexistent for sickle cell patients (McGann & Ware, 2011). The increased production of fetal hemoglobin decreases the sickling of the red blood cells, thereby decreasing painful episodes, organ damage, and increases the life span (McGann & Ware, 2011). Medically, it is recommended that hydroxyurea should be a standard of care for patients with SCD by WHO and the NHLBI (Moussavou et al., 2004).

Emergency visits and inpatient hospital deaths were measured regionally with HCUP datasets; NEDS 2006 and NEDS 2011 were used to document accessibility and disease management (emergency visits) regionally and NIS 2006 and NIS 2011 were used for health outcomes (deaths) regionally. The results for the years were compared to document regional changes that could indicate accessibility and disease management. The findings using Chi-Square analysis showed that the relationship between regions, emergency department visits, and deaths was significant. Phi and Cramer's revealed that the strength of the relationships was weak.

The association between ED visits (accessibility and disease management) and regions was discovered in RQ1 and RQ2 in this study and was significant based on Chi-Square results. RQ3 disclosed a significant association between deaths and regions using Chi-Square.

Interpretation of Findings

Increased frequency of emergency visits found in this study were consistent with previous studies by (Brousseau et al., 2010; Wolfson et al., 2012) showing patients with SCD with high rates of emergency department visits (accessibility to care and disease management). Regionally emergency department visits increased from 2006 to 2011 with the NEDS datasets, except the West showed a decrease (Table 11).

Table 11

ED Visits 2006 and 2011

	ED Visits 2006	ED Visits 2011
Northeast	25,300	43,447
Midwest	23,190	35,602
South	98,984	122,695
West	17,230	13,552

The availability and accessibility of care were the reasons identified that sickle cell patients seek care in emergency departments (Bundy et al., 2011; Glassberg et al., 2012; Haywood et al., 2013). Pain management was found to be the primary reason sickle cell patients sought care in the emergency department (Tanabe et al., 2010). The alternate hypotheses for this study were supported for Research Questions 1 and 2; there is a significant association between emergency visits (accessibility and disease management) and regional location (Northeast, Midwest, South, and West) in the United States.

Mortality rates for sickle cell patients showed regional decreases in this study from 2006 to 2011(Table 12).

Table 12

NIS Recorded Deaths

	Deaths 2006	Deaths 2011
Northeast	93	62
Midwest	62	37
South	233	152
West	28	24

According to a publication by Bender and Seibell (2014), ages 55 years and older would be the life expectation for a subset SCD patients and high rates of morbidity would persist. Platt et al. (1994) reported that the median age of death was 42 years (males) and 48 years (females). The number of sickle cell deaths by region, which was not found in previous research, was explored in this study; age at the time of death was not examined. The alternate hypothesis was supported in the findings; there was a significant association with SCD mortality rates and the four regions in the United States 16 and 21 years after the approval of hydroxyurea.

Limitations of the Study

The study population for generalization was limited to adults 21 years and older with SCD (nonspecific 282.60), HbSS (without crisis 282.61), and HbSS (with crisis 282.62) by ICD-9-CM Codes. The analysis was performed 16 and 21 years after the approval of hydroxyurea in 1990 by the FDA, however, the consumption of hydroxyurea was not measured. The results of the study provide an overall view of the adult sickle cell population in terms of emergency visits (accessibility and disease management) and

mortality (health outcomes) by region for the years 2006 and 2011. Limitations would be the information reported and restrictions on data use that was applied by specific states; the information could have been eliminated in the dataset, such as race, and the number of incidents per region could not be reported if the frequency was 10 or less. Internal validity could be compromised with data input errors and coding.

Recommendations

Sickle cell patients 21 years and older with HbSS, the most severe genotype that is predominate among people of subSaharan African descent living in the United States that used emergency services in 2011 were:

- Low income (46.4%) (Table 3).
- Insured by Medicaid (42.1%) (Table 3).
- Lived in the Southern region of the United States (57%) (Table 3).

There were differences in the emergency visits and deaths among the regions, the South had the highest rates in emergency visits; South (122,695), Northeast (43,447), Midwest (35,602), and West (13,552). Future research could focus on the Southern region of the United States to explore disease management and accessibility to care. Increased emergency visits could be reduced with the implementation of standardized treatment regimens for SCD patients, thereby reducing the costs for frequent emergency visits for treatments (Andemariam et al., 2014; Epstein et al., 2006; Hague & Telfair, 2000; Kauf et al., 2009; Wolfson et al., 2012).

Comparatively, the mortality rates in 2011 were higher in the South (152) than the Northeast (62), Midwest (37), and West (24). Mortality may possibly be investigated

further to explore the age groups, treatment regimens, and whether there was an increase or decrease in morbidities for adults with SCD. Additional future research could document the age of death for males and females with SCD HbSS phenotype, and note if there is an increase in life span for 43 years (males) and 48 years (females), with the inclusion of the role of hydroxyurea in the sample population.

Implications

An indicator for accessibility, disease management, and severity of disease is the frequency of sickle cell patients seeking care in emergency departments Bergman & Diamond, 2013; Haywood et al., 2013). The effect on accessibility and disease management could be initiated by a lack of continuity of care from private physicians. Accessibility to care is affected by insurance coverage; the majority of patients have government funded insurance (Medicaid) which is not widely accepted by private physicians because of the low payment fees (Brousseau et al, 2010; Jan et al., 2013; Wolfson et al., 2012). Providers of healthcare could be educated on the Sickle Cell Treatment Act of 2003-2004 which provides for matched funding on treatment costs of Medicaid covered SCD patients (108th Congress 1st Session, 2004). Education on a chronic disease self-management care model could benefit SCD improvements in disease management and health outcomes regionally (Jenerette & Murdaugh, 2008). The socioecological model was the framework used to integrate the effects of internal and external factors on the health and health outcomes of sickle cell patients. Factors that would require consideration for education and treatments would be income level, insurance status, and the incorporation of the region where the patients reside.

The concepts of the Donabedian model for quality in healthcare used with the guidelines of a chronic disease self-care management model could be effective in improving health outcomes and quality of care for sickle cell patients. Providers of care would communicate with patients in regards to laboratory tests values and discuss treatment regimen decisions collaboratively. A chronic disease self-care management model specific for SCD would include patient awareness of norms for individual hemoglobin and hematocrit levels, date of last blood transfusion, routine medications, surgical and medical history, and effective pain management regimen. The elements of SCD self-care management can contribute to the concepts of providers of care and health outcomes in the Donabedian model for quality health care. Educating providers and patients would be beneficial in introducing a chronic disease self-care management model and contribute to the effectiveness of the process.

Improvements in education and increased SCD awareness would be the initial steps needed for social change to occur and benefit advances in disease management, health care, and health outcomes. Social change implications could involve the creation of a group of SCD patients with better quality health and quality of life. The changes would increase the probability of progress academically and in the workforce.

Future research might include a discussion on qualitative and mixed methods to explore the use of hydroxyurea by the adult population and the development of education for health care professionals and sickle cell patients. The results of this study could lead to improving education in collaboration with a SCD chronic disease self-care management model for health care providers, patients, families, and medical

organizations. Demographically the majority of the sickle cell population congregated in the South with a majority in low income quartiles, and high rates of government issued insurance. The Southern region had increased deaths and ED visits that exceeded the other regions and could be the alpha site to target an educational program. The National Sickle Cell Disease Act of 1972 provides funding to disseminate educational materials for provider and patient education, and grants for research on controlling and treating the disease (American Society of Hematology, 2008).

Conclusion

Since SCD was discovered over 100 years ago, treatment regimens have been geared toward symptoms caused by the condition; opioids for pain management, blood transfusions for severe sickling and painful crisis, surgical interventions to remove damaged organs, and hemodialysis to replenish renal function for damaged kidneys. Since 1990, hydroxyurea is the only drug approved by the FDA for preventive treatment, yet research has shown that it is not widely prescribed by physicians or used by patients. Increased frequency of emergency department visits demonstrated in this study indicate a need for improvements in disease management. There were decreased frequencies in death rates in the results that should be investigated further concerning comorbidities and treatment regimens.

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