2022

Age and Pain Predicting Hospital Length of Stay Among Individuals With Sickle Cell Disease

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Walden University
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Abstract

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Doctor of Philosophy
Health Services

Walden University
August 2022

Abstract

Most patients with sickle cell disease (SCD), especially those from low socioeconomic status, experience financial constraints in meeting their hospital bills resulting from prolonged hospital stays. The research was guided by Andersen's (1995) behavioral model of health services (BMHS) as the theoretical framework. The purpose of this retrospective quantitative correlational study was to evaluate whether and the extent to which age and pain crisis affect the length of hospital stay among patients with SCD in the United States. Secondary data were collected from the Healthcare Cost and Utilization Project (HCUP). A chi-square test was used to test the relationship between variables using data from a randomly selected sample size (100,000 cases) from the HCUP data sets. Chi Square statistics from the same sample were used to determine the relationship between age and length of stay of patients with SCD. The results indicated a significant relationship between age and pain crisis and length of hospitalization among SCD patients; older patients with pain crises had lengthier hospital stays. Results may be used to educate individuals about sickle cell self-care management to reduce the financial burdens on patients with SCD and their families.

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Dedication

I dedicate this dissertation to my family. My mother, Robin, and sister, Josephine, have given unconditional support throughout this journey. To my brother who departed this life over 8 years ago, from sickle cell disease, and left instilled in me the importance of access to health care services and education to acquire the knowledge to make a difference.

Acknowledgments

I would like to thank Dr. Cynthia Newell, Dr. Kristin Wiginton, and Dr. Suzanne Richins for the advice, recommendations, and support throughout this process. I would like to acknowledge my friends and colleagues for being there for support, listening, and providing words of advice and encouragement.

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Chapter 1: Introduction to the Study

Sickle cell anemia disease (SCD) is an illness that impacts the blood and often results in various care needs among the patients (CDC, 2017). For effective management of the recurring and impulsive crises of pain, organ dysfunctions, pulmonary problems, as well as several other infections, people living with SCD require effective preventive care and treatment and, in some cases, referrals (Geethakumari et al., 2021; Puri et al., 2016). A significant number of patients with SCD experience random episodes of acute pain that necessitate health care visits (Evensen et al., 2016). Hospitalization is associated with increased expenditure, which could cause a heavy financial burden to the patients and their families (Bou‐Maroun et al., 2018; Yeruva et al., 2016). Understanding aspects associated with the length of hospitalization could help policymakers and health care administrators alleviate the potential challenges of SCD patients and its extensive impact on the families.

One of the primary reasons individuals with SCD are hospitalized is pain crisis, also known as vaso-occlusive pain episodes (VOE; Treadwell et al., 2014). Without appropriate and rapid care in treating VOE, patients could end up being hospitalized for prolonged periods (Panepinto et al., 2005). Provision of proper care is negatively affected by challenges such as systems-based staffing limitations in which there are fewer nurses than patients, lack of primary care physicians who specialize in treating the disease, and constraints of facilities such as the absence of enough emergency department (ED) rooms to use for attending to SCD patients (Treadwell et al., 2014). Other barriers associated with access to care at the ED include misunderstandings and biases among health care providers concerning sickle cell pain and sufficient medication dosing (Treadwell et al., 2014). Provider biases frequently result in inadequate treatment of the pain, which may cause pseudo addiction in addition to a series of increased inpatient and ED utilization (Treadwell et al., 2014). Negative experiences with the delivery of care received by patients with SCD have led families and patients to delay seeking care regardless of the VOE pain resulting from increased risk of adverse outcomes (Treadwell et al., 2014). Recent research has indicated that patients have conveyed frustration regarding inadequate access to and attention from health care services after reporting their pain due to insufficient administration of analgesics and the alleged preoccupation of health care staff (Treadwell et al., 2014).

According to a survey conducted by Jenerette and Brewer (2010), adult patients suffering from SCD have reported a lack of access to primary care and inadequate treatment of pain in the ED, resulting in an increased hospital stay. This study addresses whether and to what extent the age and pain diagnosis among patients with SCD affect their length of hospitalization. Results of this study may have social change implications regarding the well-being of individuals living with SCD. Stating and understanding the challenges faced by SCD patients may inform manifestation of support interventions that health care leaders and policymakers need to implement. Understanding how pain and age relate to length of hospitalization could inform policymaking. This chapter introduces the research topic by describing the research problem, purpose of the study, research questions and hypotheses, theoretical framework, nature of the study, operational definitions, assumptions, scope, delimitation, limitations, and significance of the study.

Background

Sickle cell anemia is a genetic condition that affects nearly 100,000 people in the United States (Ribeil et al., 2017). About 1 out of every 500 African Americans have SCD (Ribeil et al., 2017). SCD is a multisystemic condition with several complications such as stroke, recurrent pain, pulmonary complications, anemia, and joint pain (Ribeil et al., 2017). The social environments of patients with SCD are associated with pain experiences resulting from the disease's complications such as gallstones, avascular necrosis of joints, and leg ulcers. Most of these patients come from low socioeconomic settings, which adds to the difficulties in accessing health care because most rely on government health services as their insurance provider (Ribeil et al., 2017). Lack of quality education is high among people with SCD. For instance, youths with SCD have high absence rates in the learning or work environment (Ribeil et al., 2017). The absenteeism is due to uncontrolled and unpredicted pain episodes. People with SCD should undergo regular treatments that include monthly blood transfusions and periodic screening (Ribeil et al., 2017). These treatments help reduce some of the complications that SCD patients face in their day-to-day lives (Jenerette & Brewer, 2010).

Care needs can be classified as health care needs or social care needs (McGilton et al., 2018; Poitras et al., 2020). Health care needs comprise the needs that require care, treatment, disease prevention, illness, injury, or disability. Social care needs refer to assisting the patient in executing daily living activities and maintaining independence (McGilton et al., 2018). Among individuals living with SCD, the pain, stiffness, and resulting emotional impact of the condition may result in health care and social care needs (Lee et al., 2019; Ojelabi et al., 2017). Pain attacks could also interfere with life, work, and the ability to carry out daily activities (Treadwell et al., 2014). Pain and stiffness result in reliance on others for care (Keller et al., 2014; Treadwell et al., 2014).

Pain crisis is regarded as one of the leading causes of hospitalization among individuals with SCD (Abd Elmoneim et al., 2019; Hawasawi et al., 1998). Based on a retrospective study involving 739 children with SCD, Abd Elmoneim et al. (2019) noted that pain crisis was the cause of admission in 49% of the cases. Hawasawi et al. (1998) noted that 77.3% of the hospitalizations were due to pain crises. Hawasawi et al. based their conclusions on data from patients between the ages of 6 months and 12 years. In addition to being the cause of hospitalization, pain crisis is also associated with the length of hospital stay (Ellison & Bauchner, 2007; Panepinto et al., 2005). Based on the analysis of 2,500 hospitals in the Healthcare Cost and Utilization Project's (HCUP) kids' inpatient database. Panepinto et al. (2005) noted that pain crisis led to a variation in hospitalization duration among different age groups. Panepinto et al. also reported that the average length of stay was 4.4 days.

Although researchers have assessed the health care needs among people living with SCD, there has been limited focus on the influence of the patient's age (Bemrich-Stolz et al., 2015). A better understanding of how hospitalization, care needs, and challenges vary with age could facilitate improved management of people living with SCD during childhood and adulthood (Bemrich-Stolz et al., 2015). A retrospective correlation approach was utilized to examine the correlation of age and diagnosis of pain crisis with length of hospitalization of patients with SCD in the U.S. The research was guided by Andersen’s (1995) behavioral model of health services (BMHS) as the theoretical framework.

Problem Statement

Researcher has not examined whether and to what extent a relationship existed between age, diagnosis of pain crisis, and length of hospitalization of patients with SCD in the United States. The length of hospital stay among patients with SCD is of great importance in the era of cost-conscious care. With increased chronicity and care involved in managing the condition associated with SCD, such as pain crisis, the economic burden increases (Bou□Maroun et al., 2018; Yeruva et al., 2016).

Focusing on pain crisis as a potential determinant of the length of stay were informed by the evidence suggesting that those with pain crisis tend to have more extended stays (see Ellison & Bauchner, 2007; Panepinto et al., 2005). However, most of the existing literature on the association between pain crisis and the length of hospital stay was based on the children’s population. Studies on children with SCD indicated that older children with pain crisis experience a significant increase in the length of hospital stay compared to the younger children (Ellison & Bauchner, 2007). However, the question addressed in the current study was whether individuals with SCD of different age groups, adults included experience alterations in the length of hospital stay based on the presence of pain crisis.

Focusing on individuals living with SCD of different age groups were essential because the landmark advances in pediatric sickle cell care have yet to be experienced by adults, which could impact the challenges experienced by young and older people (see

Kayle et al., 2018). Therefore, research on the relationship between age, diagnosis of pain crisis, and length of hospitalization of patients with SCD in the United States was vital in addressing the existing knowledge gap and developing more effective prevention strategies. The population of interest in this study was people living with SCD whose data were captured in the HCUP data in 2019. The unit of analysis for this study was patients with SCD in the United States.

Purpose of the Study

The purpose of this quantitative correlational study was to determine whether and to what extent age and pain crisis correlates with the length of hospitalization among people living with SCD in the United States. The HCUP's National Inpatient Sample (NIS), Nationwide Readmission Database (NRD), and Nationwide Emergency Department Sample (NED) are annual surveys developed and distributed by the Agency for Healthcare Research and Quality (AHRQ; Boudreaux et al., 2019).

Variables in the current study included age, diagnosis of pain crisis, and length of hospitalization. The predictor variables were age and pain diagnosis, and the criterion variable was hospital stay. Diagnosis of pain crisis and the length of hospitalization were dichotomous categorical variables measured on a nominal scale. Age was a continuous variable.

Research Questions and Hypotheses

I employed a quantitative correlational design. The study focused on patients with SCD from United States. The study involved three research questions to examine the extent to which age and diagnosis of pain crisis correlate with the length of hospital stay among people living with SCD in the United States by using binary logistic regression (see Patel, 2021).

Research Question 1 assessed the direction and strength of the correlation between age and the length of hospital stay. Age was the predictor variable and was measured on a continuous scale, while length of hospital stay was the criterion variable and was measured on the nominal scale. Length of hospital stay was expressed as either prolonged or shortened as guided by the average length of hospitalization documented in the literature. Bou-Maroun et al. (2018) reported a median length of hospitalization stay of 3 days of the NIS, while Panepinto et al. (2005) reported an average length of stay was 4.4 days. According to the Agency for Healthcare Research and Quality (AHRQ), the national average for a hospital stay is 4.5 days (Schlauch et al., 2020).

Research Question 2 focused on determining the strength of the association between the study's predictor variables (age and pain diagnosis). Age was measured on a continuous scale, while pain diagnosis was measured on a nominal scale and expressed as either with or without a pain crisis. The age and pain diagnosis data were obtained from 2019 NRD and NIS.

Research Question 3 addressed the gap in the literature relating to how age and pain diagnosis may predict the length of hospital stay. In this question, age and pain diagnosis were the predictor variables, and length of hospital stay was the criterion variable. The findings of this research question were expected to indicate whether and to what extent age and pain predict the likelihood of prolonged hospital stay among people living with SCD in the United States.

The research questions (RQs) that guided the study were as follows:

RQ1: To what extent does an association exist between age and hospital stay among individuals living with SCD in the United States?

H_o1: There is no significant association between hospital stay and age among individuals with SCD in the United States.

H_a1: There is a significant association between hospital stay and age among individuals with SCD in the United States.

RQ2: To what extent does an association exist between age and diagnosis of pain crisis among individuals living with SCD in the United States?

H_o2: There is no significant association between pain diagnosis and age among individuals with SCD in the United States.

H_a2: There is a significant association between pain diagnosis and age among individuals with SCD in the United States.

RQ3: To what extent do age and pain diagnosis predict the length of hospital stay among individuals with SCD in the United States?

H_o3: Age and pain diagnosis do not predict the length of hospital stay among individuals with SCD in the United States.

H_a3: Age and pain diagnosis predict the length of hospital stay among individuals with SCD in the United States.

Conceptual Framework

The conceptual framework for the study was Andersen’s BMHS, which provides an essential framework in assessing the challenges faced by individuals with SCD

(Cronin et al., 2018). According to the BMHS, patients' demographic factors such as age and the need for care such as pain crisis are essential predisposing factors that influence the utilization of health care services (Andersen & Newman, 1973). The BMHS provided the framework upon which the influence of age and pain crisis diagnosis was assessed as a potential determinant of the length of hospitalization. The BMHS also provided the basis for examining whether the length of hospitalization may vary based on prevailing conditions and level of illness (pain crisis) among the patients (see Andersen & Newman, 1973).

The results of the effects of the length of stay (dependent variable) were determined and estimated by using the concepts of the model in which the HCUP datasets (NIS and NEDS) expressed the length of hospital stay as a continuous variable. The duration of hospitalization was expressed as either prolonged or not prolonged based on the average length of hospitalization documented in the existing literature. The model also involves two independent variables (age and pain crisis). Age was evaluated on a continuous scale, while pain diagnosis was evaluated on a nominal scale and expressed as either with pain crisis or without pain crisis. In the HCUP data sets, the pain diagnosis variable includes the ICD-10-CM Diagnosis Code D57 and D5700 (Fingar et al. (2019). The use of Andersen's BMHS established a condition for identifying and evaluating the results and the effects of the various indicators.

Nature of the Study

A correlational design was used to assess the association between the study variables. The quantitative approach enabled assessment of the collected data using statistical techniques that allowed the testing of hypotheses associated with the research questions. Unlike qualitative methods, the quantitative methods facilitated testing of the study's hypotheses while limiting biases associated with researcher subjectivity, which are common in qualitative approaches (see Cadena-Iñiguez et al., 2017). The fact that qualitative approaches rely on respondents' experiences and feelings subject the approaches to increased recall bias that limit the applicability and validity of the study (Gerring, 2017). Unlike qualitative research designs, the quantitative method allows the researcher to use statistical techniques that enable the generalization of findings (Cadena-Iñiguez et al., 2017). The results of the current quantitative study could be used to explain the relationship between age, pain diagnosis, and length of hospital stay among individuals living with SCD in the United States.

The adopted quantitative design was the retrospective correlational design. The correlational design was the best approach to address associations between the study variables. This design does not require manipulating the data as is the case in experimental studies (Thompson & Panacek, 2007). The correlational design is appropriate for retrospective studies that rely on existing data records, such as the current study in which data were obtained from the HCUP data set. The retrospective correlational design enabled completion of the study within the institution's timelines and work with limited financial resources by facilitating the use of existing data.

Definitions

Andersen behavioral model of health services (BMHS): The BMHS explains health care utilization based on three determinants: predisposing, enabling, and the need for care (Andersen & Newman, 1973). For example, patients' demographic factors such as age and the need for care in pain crisis are predisposing factors that influence the utilization of health care services (see Andersen & Newman, 1973).

Pain crisis: A common painful complication of SCD in adolescents and adults (Treadwell et al., 2014).

Sickle cell disease (SCD): SCD attacks hemoglobin, which results in pain and organ dysfunction in the human body. There is no cure, but medications that prolong life and make the patients comfortable are available (Bender, 2017).

Assumptions

Assumptions are defined as aspects of the study that researchers believe to be true (Theofanidis & Fountouki, 2018). The primary assumption in the current study was that the HCUP data were representative of the target population. This assumption was appropriate because the survey was based on a stratified sampling approach to collect data from all HCUP-participating hospitals (see Boudreaux et al., 2019). The survey also covered more than 97% of the U.S. population, including 48 states plus the District of Columbia (Boudreaux et al., 2019). The other assumption was that the HCUP data contained adequate information on the length of hospitalization, pain diagnosis, and the age of the individuals living with SCD.

Scope and Delimitations

Delimitations are the aspects of the study that are controllable by the researcher and indicate the scope of the research (Miles, 2019). One of the delimitations in the current study was the lack of the assessment of the influence of other demographic variables such as gender, race, and socioeconomic status. Other demographic variables were excluded to avoid introducing further complexity to the study. This study focused only on one demographic variable (age). The other delimitations of the study included the lack of assessment of the predicting effects of other variables on length of hospital stay, including access to care and patients’ views. The study focused on the length of hospital stay and pain diagnosis as provided in HCUP data (see Fingar et al., 2019).

Limitations

Limitations are the aspects of the research that are not within the researcher’s control and could impact the research (Theofanidis & Fountouki, 2018). One of the limitations associated with the current study was the restriction of the analysis to the existing HCUP data. The lack of availability of the existing recorded data limited my access to obtain additional data that could have been used to develop further insights into the research question. The use of HCUP data introduced the challenge of relevance because it restricted the study to 3-year-old data, posing doubts regarding the relevance to the existing situation. Despite the highlighted limitations, the use of 2019 HCUP data offered the advantage of reduced time constraints and cost limitations (see Boudreaux et al., 2019; Fisher & Chaffee, 2018). The use of quantitative design also posed limitations because it restricted me from obtaining primary data and in-depth interviews of the lived experiences of people with SCD. To address the highlighted limitations, I triangulated the findings using evidence from secondary sources (see Hammerton & Munafò, 2021). There may have been a small risk of cross-listed patients, however, randomly selecting the 100,000 patients from the much larger pool limited this potential problem.

Significance

Researcher has not addressed the challenges faced by people with SCD in acquiring health care. This study addressed length of stay, pain crisis, and age of people living with SCD in the United States. Health care officials may use the results to implement solutions such as supporting the transition period from adolescent to adulthood for people living with SCD. Despite the increased research on the topic, the influence of age on hospital stay was not well understood. This study may promote awareness of the steps and interventions required to help people living with SCD curb the challenge of inaccessibility to hospital or health care services and the possible association with financial constraints. Based on the findings, this study may be used to develop appropriate quality care among people living with SCD. Out-patient care facilities, public health programs, and other facilities providing care services to people with SCD may use the information learned in this study to create policies and procedures that meet the health care requirements of this population.

Summary

SCD is a chronic blood condition that causes considerable pain and leads to organ dysfunction and pulmonary problems, among other complications that cause prolonged hospitalization (Centers for Disease Control and Prevention, 2017). This chapter provided background information on the SCD condition, statement of the problem, and purpose of the study. Chapter 2 provides the literature review. The main topics explored in this chapter include SCD, pain crisis, length of hospital stays, and the influence of the patient’s age.

Chapter 2: Literature Review

The current research addressed the problem associated with the limited knowledge regarding the relationship between age, diagnosis of pain crisis, and length of hospitalization of patients with SCD in the United States. The length of hospital stay among patients with SCD is of great importance in the era of cost-conscious care. With increased chronicity and care involved in managing the condition associated with SCD, such as pain crisis, the economic burden increases (Bou□Maroun et al., 2018; Yeruva et al., 2016). The aim of Chapter 2 was to identify and analyze previous research to provide a foundation of knowledge on the aspects associated with length of hospitalization among people living with SCD in the United States. The main topics explored in this chapter include an overview of SCD, pain crisis, length of hospital stay, and the influence of the patient's age. The chapter begins with the description of the research strategy and how Andersen's BMHS was used to understand the utilization of the health care services by people living with SCD in the United States.

Literature Search Strategy

I retrieved the articles from Walden's online library and medical databases such as MEDLINE, Cochrane, EMBASE, PubMed, PsycINFO, CINAHL, and PsycARTICLES. I used phrases and keywords such as *hospitalization*, *hospital stay*, *length of hospitalization*, *sickle cell disease*, *pain crisis*, *vaso-occlusive pain episodes*, and *age*. The initial search captured 85 papers and articles. After analysis, 61 papers and articles were included in this study. Different factors, including the scope of the study, time of publication, and the relevance of the literature in the study, helped in the analysis.

Of the 61, only 29 of the papers and articles focused on the hospital stay among individuals living with SCD and the influence of aspects such as pain crisis and age.

Theoretical Foundation

Andersen developed the theory in the 1960s; however, a series of phases occurred until the 1990s (Andersen & Newman, 1995). The BMHS explains health care utilization based on three determinants: predisposing, enabling, and the need for care. The first determinant, predisposing, focuses on the characteristics of the individual before the onset of the illness (Andersen & Newman, 1973). Based on this determinant, BMHS proposes that the likelihood of medical service utilization varies across different patients based on social and demographic factors such as age (Andersen & Newman, 1973; Bazargan et al., 2019). The enabling component explains that conditions may enhance or inhibit the use of medical services by the patients (Aday & Andersen, 1974). The third determinant, the need for care, highlights the importance of the perceived level of illness in utilizing health care services (Andersen & Newman, 1973). Based on the need for care determinants, BMHS proposes that patients or their families elect to use health care services such as hospitalization based on the perceived level of illness (Andersen & Newman, 1973).

The enabling component is used to explain the conditions that may enhance or inhibit the use of medical services by the patients (Aday & Andersen, 1974). Some of the enabling components include demographic factors such as age (Aday & Andersen, 1974). According to BMHS, the organizational factors, which refer to the factors that determine the ability of an individual to have a regular source of care, serve as enabling factors. The framework identifies the enabling organizational factors that include time taken to travel to the health care facility, means of transportation, and waiting for the time for health care (Babitsch et al., 2012). The BMHS does not limit the enabling factors to only health-care-related factors but also includes the relative price of goods and services, affluence structures, and distribution of health care personnel (Babitsch et al., 2012). The availability of educational programs, the quality of health care management, and the existing health care policies also constitute the contextual enabling factors (Aday & Andersen, 1974; Andersen, 1995).

Based on the BMHS, the third determinant, the need for care, can be described based on the individual and contextual levels (Babitsch et al., 2012). At the individual level, an important consideration is given to the perceived need for health care services and the evaluated needs (Aday & Andersen, 1974). The BMHS highlights the importance of the perceived level of illness in utilizing health care services (Andersen & Newman, 1973). The examples of perceived needs include the patients’ views and experiences regarding their health and the symptoms associated with illness (Andersen et al., 2007). The evaluated needs include professional reports based on the assessment and objective diagnosis and determination of the need for medical care. The contextual level needs include the environmental need characteristics that incorporate occupational considerations. The contextual level needs also involve the population health indices such as mortality and morbidity (Babitsch et al., 2012). Based on the need for care determinants, BMHS proposes that patients or their families elect to use health care services such as hospitalization based on the perceived level of illness (Andersen & Newman, 1973).

Researchers have used the BMHS in assessing the influence of predisposing, enabling, and need for care on the utilization of health care services (Babitsch et al., 2012; Bock et al., 2018). Roberts et al. (2018) examined the existing evidence guided by BMHS to determine factors associated with health service utilization. Roberts et al. identified demographic factors as critical predisposing factors. Bock et al. (2018) reported that the psychological factors that include self-efficacy determine the hospitalization rate. Hankins and Shah (2020) also used the BMHS to assess factors that determine adherence with health among patients with SCD.

Andersen's BMHS provides an essential framework in assessing the challenges individuals face with SCD (Cronin et al., 2018). According to the BMHS, patients' demographic factors such as age and the need for care such as pain crisis are essential predisposing factors that influence the utilization of health care services (Andersen & Newman, 1973). The BMHS, therefore, provided the framework upon which the influence of age and pain crisis diagnosis was assessed as a potential determinant of the length of hospitalization. The BMHS also provided the basis for assuming that the length of hospitalization may vary based on prevailing conditions and level of illness (pain crisis) among the patients (see Andersen & Newman, 1973).

Literature Review

The aspects associated with hospitalization among individuals living with SCD are diverse. The following literature review provides insight into the documented influence of pain crisis and age. The review focuses on length of stay. The first theme is SCD and its prevalence. The second theme is pain crisis, and the third and fourth themes are length of hospital stay and the influence of age.

Overview of SCD

SCD refers to a collection of inherited blood disorders characterized by the alteration in the shape of erythrocytes from the standard biconcave shape to a crescent shape (Piel et al., 2017; Ware et al. 2017). SCD occurs due to the inheritance of abnormal beta-globin alleles carrying the sickle mutation on the HBB gene (Novelli & Gladwin, 2016; Piel et al., 2017; Ware et al., 2017). SCD can exist in homozygous or heterozygous states (Novelli & Gladwin, 2016; Piel et al., 2017; Ware et al., 2017). The heterozygous conditions include (a) hemoglobin C with HbS, (b) HbS with β-thalassemia, and (c) HbS with other beta-globin variants such as HbSD or HbSOArab (Ware et al. 2017). The form of SCD that results in a high frequency of hospitalization and increased risk of lifelong illness is homozygous HbSS, which is characterized by pathological sickle hemoglobin (Novelli & Gladwin, 2016; Piel et al., 2017; Ware et al., 2017). SCD is different from the sickle cell trait, which is characterized by the inheritance of hemoglobin A and hemoglobin S (Novelli & Gladwin, 2016; Ware et al., 2017). However, sickle cell traits could also result in adverse outcomes (Novelli & Gladwin, 2016; Ware et al., 2017).

SCD occurs due to red blood cells having a distorted shape. Normally erythrocytes undergo alteration in morphology that is reversible based on the presence of oxygen (Novelli & Gladwin, 2016). However, among homozygous HbSS individuals, the erythrocytes assume elongated rigid shapes resulting in the blocked blood flow in specific areas and subsequently leading to abnormal endothelial interaction (Piel et al., 2017; Ware et al. 2017). In the early stages of the development of SCD, the erythrocytes can regain the normal shape from the sickle shape (Novelli & Gladwin, 2016). However, the erythrocytes are rigid due to several cycles of sickling and unsickling (Ware et al., 2017).

The irreversibly sickled erythrocytes contribute to vascular damage and other complications such as vaso-occlusion, infection, anemia, and infarction (Novelli & Gladwin, 2016; Piel et al., 2017; Ware et al. 2017). The vaso-occlusion of sickled erythrocytes with cellular and plasma factors increases the risk of acute and chronic complications due to inflammation (Piel et al., 2017; Ware et al., 2017). The critical characteristic of SCD is acute pain (Ware et al., 2017). Patients with SCD experience acute pain, which results from the lack of adequate supply of oxygen and infarction-reperfusion injury (Fingar et al., 2019). Individuals with SCD experience pain in various areas of their bodies, including the chest, back, and extremities (Novelli & Gladwin, 2016; Piel et al., 2017; Ware et al., 2017).

SCD is among the most common recessively inherited disorders (Piel et al., 2017). SCD affects more than 5 million individuals worldwide (Badawy et al., 2018). Piel et al. (2017) projected that by 2050 the number of children born with SCD would increase to 400,000 per year. The prevalence of SCD is high in sub-Saharan Africa and the Mediterranean basin, where the sickle cell trait offers protection against malaria (Fingar et al., 2019; Piel et al., 2017). In the United States, almost 100,000 people live with SCD (Fingar et al., 2019). However, Jang et al. (2021) noted that despite the United States having a low prevalence of SCD, the condition is associated with high health care utilization. Brousseau et al. (2010) noted that in 2004, the United States incurred $500 million from the hospitalization of individuals with SCD resulting from the painful crisis.

Pain Crisis Among SCD Patients

Pain affects most people with SCD (Jang et al., 2021; Novelli & Gladwin, 2016; Uwaezuoke et al., 2018). Patients with SCD can suffer from various crises (Jang et al., 2021; Novelli & Gladwin, 2016). According to Uwaezuoke et al. (2018), a painful crisis is responsible for significant morbidity among individuals with SCD. Individuals who experience painful crises also suffer from fever, which suggests that the pain could result from infection (Uwaezuoke et al., 2018). Most patients with SCD experience painful crises arising from ischemic pain (Jang et al., 2021; Novelli & Gladwin, 2016). Chronic pain is associated with higher levels of mast-cell activation markers, while acute pain is linked to elevated plasma levels of endothelin-1 and PGE2 (Uwaezuoke et al., 2018).

Painful crises among SCD patients occur in four phases (Jang et al., 2021; Novelli & Gladwin, 2016). The first phase is characterized by low intensity aching pain, which could last for about 3 days (Jang et al., 2021). In the first phase, the patients may experience numbness and pain. Phase 2 is characterized by a rapid increase in aching, which occurs due to local tissue infarcts caused by vaso-occlusion (Jang et al., 2021). The third phase is due to postinfarct inflammatory processes and is marked by constant severe pain associated with fever (Jang et al., 2021). The third phase lasts for a maximum of 5 days. The painful crisis subsides in the fourth phase and lasts for 1 to 2 days (Uwaezuoke et al., 2018). The different phases of painful crises could influence the length of hospital stay (Jang et al., 2021). According to Jang et al. (2021), the painful crisis does not always follow the straightforward path described but is a fluid process that can prolong the hospital length of stay.

One such crisis is acute chest syndrome, which results in hospitalization due to vaso-occlusive crises (Jang et al., 2021; Novelli & Gladwin, 2016). Acute chest syndrome is associated with reduced long-term survival and high chances of contracting chronic lung disease (Jang et al., 2021). Evidence suggested that patients with acute chest syndrome are likely to experience prolonged hospitalization (Novelli & Gladwin, 2016). Vichinsky et al. (2000) carried out a 30-center study that involved the analysis of 671 episodes of acute chest syndrome in 538 patients with SCD. The researchers noted that the mean length of hospitalization among individuals with SCD who presented with acute chest syndrome was 10.5 days.

People with SCD often experience a life disrupted by random pain crises and feel powerless when it comes to influencing the quality of care they receive (Jenerette & Brewer, 2010). For these reasons, 80% of adults with SCD avoid seeking assistance from primary care physicians and self-manage their pain (Jenerette & Brewer, 2010). Yusuf et al. (2010) revealed that people with SCD have one thing in common for seeking medical assistance: pain symptoms. Panepinto et al. (2012) also noted that patients with SCD experience a high degree of pain. Jenerette et al. (2014) noted that most adults with SCD do not access care unless the pain intensifies, which results in hospitalization following emergency care admission. Cronin et al. (2018) also reported that individuals with SCD are more likely to experience uncontrolled pain leading to an increased likelihood of hospitalization. In a study that involved SCD patients admitted in hospitals in Ghana, Narh et al. (2021) reported that those diagnosed with a pain crisis were more likely to be hospitalized than those without a pain crisis. Although Narh et al. suggested that the length of hospital stay is prolonged among patients with SCD diagnosed with episodes of pain crisis, the study was based in Ghana, and it is not clear whether the same trends exist among American patients.

Shah et al. (2019) observed that pain crisis is associated with high acute health care utilization and is the main reason for inpatient admission. Shah et al. based their conclusions on a retrospective quantitative study that involved the analysis of data of 8,521 patients extracted from Medicaid Analytic. The patients had a median age of 30 years. According to Shah et al., most of the episodes of pain crisis (70.3%) were uncomplicated episodes and were associated with infectious diseases, fever, and pulmonary disorders. Shah et al. noted that 85.0% of the hospitalizations related to SCD complications were due to vaso-occlusive crisis.

Length of Hospital Stay and the Influence of Age

It is essential to consider the length of hospital stay because it influences the financial burden individuals face with SCD (Cronin et al., 2018; Fingar et al., 2019; Narh et al., 2021). Fingar et al. (2019) argued that the cost of hospital stays among patients with SCD and related conditions in the United States totaled $811.4 million in 2016. Fingar et al. noted that the cost was associated with an average length of stay of 5 days. Fingar et al. reported that individuals between 18 and 34 years of age incurred the most costs ($435.3 million) with SCD.

Huo et al. (2018) observed that sickle cell disease is associated with enormous healthcare resource utilization. The researchers noted that the patients living with sickle cell disease experience life lung diseases that need routine comprehensive care. Based on the assessment of data collected from 11821 individuals living with sickle cell disease aged between 0 to 96 years, Huo et al. (2018) noted that the average length of stay was four days. Huo et al. (2018) argued that the enormous economic burden of sickle cell disease could be reduced by addressing the length of stay, which often results in increased patient out-of-pocket expenses.

Determining the factors that influence the length of stay among patients with sickle cell disease is essential in making critical decisions regarding early screening and support for the patient (Narh et al., 2021). Fingar et al. (2019) analyzed the data on sickle cell disease using the Healthcare Cost and Utilization Project (HCUP) National (Nationwide) Inpatient Sample to determine the characteristic of inpatient stays. Fingar et al. (2019) noted that among the 134,000 hospitalized cases of sickle cell disease patients, pain crisis diagnosis is represented by 71.3%.

Various research suggest that age could influence the hospitalization of patients with sickle cell disease (Cronin et al., 2019; Fingar et al. 2019; Narh et al., 2021; Mucalo et al., 2021). Cronin et al. (2019), based on a cross-sectional cohort study carried out across six centers across the U.S. between October 2014 and March 2016, noted a high hospitalization rate among the older patient. Similar observations were reported by Mucalo et al. (2021) in a study that involved assessing data from the SECURE-SCD Registry on patients with SCD and COVID-19 illnesses. Mucalo et al. (2021) noted that among 364 individuals aged 18 years and less, 146 of them were hospitalized, while among 386 individuals aged above 18 years, 231 were hospitalized. However, Leschke et al. (2012) suggested that the hospitalization among the young and old individuals living with sickle cell disease do not vary. Leschke et al. (2012) based their observation on a retrospective cohort study that involved the analysis of data obtained from Wisconsin Medicaid claims data for hospitalized children and adults with sickle cell disease from 2003 to 2007. Leschke et al. (2012) noted that among 186 patients aged 19 years and those aged 20 years and above (n = 222), the hospitalization rate was 17%.

Fingar et al. (2019) noted that 50 % of the hospitalized cases of sickle cell disease patients (n = 134,000) were patients aged between 18 and 34 years. Fingar et al. (2019) observed that the number of stays for patients aged between 18 and 34 increased by 40.6 percent between 2000 and 2014. Fingar et al. (2019) further reported a gradual increase in the number of SCD-related stays among adults aged >64 years. Fingar et al. (2019) noted that among individuals with sickle cell disease aged above 45 years, hospital stay between 2000 and 2014 accounted for up to 14% of all sickle cell disease-related hospital stays. The researchers also reported that for individuals aged between 45 to 64 years, the number of hospital stays increased by 98.8 % between 2000 and 2014. According to Fingar et al. (2019), the length of hospital stay among individuals with sickle cell disease varies based on the age of the patients. Based on the analysis of HCUP NIS data from 2000 to 2016, (Fingar et al. 2019) observe that among individuals with sickle cell disease aged below 18 years with a principal diagnosis of sickle cell disease, the length of hospitalization could be one day or shorter. Among older individuals, the mean length of hospital stays is five days but could be longer.

In a recent study carried out by Narh et al. (2021), the length of stay among patients admitted for sickle cell disease was suggested to vary with age. The researchers analyzed 22680 sickle cell disease hospitalization patient records collected from a nationwide sample in Ghana between 2012 and 2017. Narh et al. (2021) focused on determining the variation in the length of stay with time and the potential influence of social demographic factors. The researchers observed that the median length of stay was three days with an interquartile range of 2 to 4 days. Narh et al. (2021) observed from Ghanian samples that the median age of hospitalization was 16 years with an interquartile range of eight to 24. The researchers noted that with an increase in the age of the patients, the length of stay reduces. Narh et al. (2021) made this observation based on comparing patients with sickle cell disease aged zero to four years to the patients aged between 10 to 14 years and those aged between 25 to 29 years. Narh et al. (2021) did not assess whether such trends continue among older individuals aged above 30 years.

Summary and Conclusions

This literature review provided a detailed description of Andersen's Behavioral Model of Health Services and its appropriateness as a framework for understanding the research topic. The theoretical framework provides the basis for understanding the potential association between the patients' demographic factors such as age, the need for care such as pain crisis, and the utilization of healthcare services (length of hospital stay). The literature review provides an understanding of the potential financial burden associated with prolonged length of hospital stay. Reviewed evidence suggests that a pain crisis could influence the length of hospital stay. The patient's age is also highlighted as one of the potential determinants of length of hospital stay among people with SCD. However, no evidence discusses the influence of both age and pain crises. It should also be noted that the studies that have discussed age or pain crisis are not based on the updated data such as HCUP NIS 2019 (Fingar et al. (2019). Chapter 3 provides a detailed description of the methodology used to assess if and to what extent a relationship exists between the age, pain diagnosis, and length of hospitalization among people living with SCD in the U.S.

Chapter 3: Research Method

Whether and to what extent a relationship existed between age, diagnosis of pain crisis, and length of hospitalization of patients with SCD in the United States was not known. The length of hospital stay among patients with SCD is of great importance in the era of cost-conscious care. With increased chronicity and care involved in managing the condition associated with SCD, such as pain crisis, the economic burden increases (Bou□ Maroun et al., 2018; Yeruva et al., 2016). This chapter includes a description of the methodology. The research design and rationale are discussed, followed by a detailed description of the methodology focusing on the population and selection of the sample; the research materials and instrumentation; and the procedures for data collection, management, and analysis. The section also addresses the threats to validity.

Research Design and Rationale

Description of the Variables

The length of hospital stay was the dependent variable. The HCUP data sets (NIS and NEDS) expressed the length of hospital stay as a continuous variable. However, this variable was operationalized and measured on a nominal scale in the current study. The length of hospital stay was expressed as either prolonged or not prolonged based on the average length of hospitalization documented in the existing literature. Because the AHRQ identified the national average length of hospital stay to be 4.5 days (Schlauch et al., 2020), hospital stays longer than 4.5 days were considered prolonged.

There were two independent variables (age and pain diagnosis). Age was measured on a continuous scale, while pain diagnosis was measured on a nominal scale and expressed as either with pain crisis or without pain crisis. In the HCUP data sets, the pain diagnosis variable includes the ICD-10-CM Diagnosis Code D57 and D5700 (Fingar et al., 2019).

Design

A retrospective correlational design was used to address the study's research questions. The focus of the study was to determine the association between the study's dependent and independent variables. The selection of the correlational design was based on the best approach in addressing associations between the study variables (see Seeram, 2019). Using the correlational design, I employed statistical techniques such as correlational tests and binary logistic regression to address the research questions (Calvello, 2020; Patel, 2021).

The research design did not require manipulating the data as is the case in experimental studies (see Seeram, 2019). The correlational design is appropriate for retrospective studies that rely on the existing data records, such as the current study in which data were obtained from the HCUP data set. The HCUP 2019 data set consists of the NIS, NRD, and NED, which are annual surveys developed and distributed by the AHRQ (Boudreaux et al., 2019). By facilitating the use of existing data, the retrospective correlation design enabled me to complete the study within the timelines imposed by the institution and work with limited financial resources.

Health Care Costs and Utilization Project

People with SCD whose data were gathered in the HCUP database in 2019 were the target demographic for this study. People with SCD in the United States served as the study’s unit of analysis. Inpatient stays are included in HCUP, the nation’s most comprehensive repository of hospital care statistics (Fingar et al., 2019). I analyzed the length of hospitalization among patients living with SCD in the United States. Researchers use NIS data to uncover and analyze health care utilization patterns (AHRQ, 2016).

The NEDS gathers information on inpatient and outpatient patients with SCD. The NEDS enables clinicians to examine ED use patterns and make meaningful decisions regarding the critical treatment option. The length of hospital stay data were acquired from the 2019 NRD and NIS. The age and length of stay in the hospital were acquired from the 2019 NRD and NIS. The age and pain diagnostic data came from the 2019 NRD and NIS.

The data were analyzed to determine whether and to what extent there is a link between age, pain diagnosis, and length of hospitalization among people with SCD in the United States. The results could influence resource allocation and transmission of evidence-based knowledge for SCD, thereby lowering emergency room visits, improving health outcomes, and lowering health care costs. Health care experts could use the information to investigate different options for assisting people with SCD as they transition from adolescence to adulthood. The study may draw professional and public attention to the actions and interventions that may be taken to help patients with SCD deal with the problem of prolonged hospital stays and the potential financial burden that comes with it.

Methodology

Target Population

The study's target population included individuals of all age groups who were diagnosed with SCD HbSS identified by ICD-10-CM Codes D571 (SCD without crisis) and D5700 (Hb-SS disease with crisis, unspecified). The study included the inpatient records with data on the length of hospital stay. The 2019 NIS, NEDS, and NRD data were considered. The 2019 NIS data set has about 7 million hospital inpatient records. Weighted, it estimates more than 35 million hospitalizations nationally, covering 98% of the U.S. population. Unweighted, the 2019 NEDS data set contains over 30 million ED visits, and weighted estimates include roughly 145 million ED visits. The 2019 NEDS includes data from 40 states and the District of Columbia, approximating a 20% stratified sample of U.S. hospital owned EDs. The unweighted NRD data set contains approximately 18 million weighted discharges; it estimates roughly 35 million discharges (Boudreaux et al., 2019; Fang & Owens, 2021).

Sampling and Sampling Procedures

I obtained samples from the HCUP data set compiled by the AHRQ (AHRQ, 2016). The AHRQ (2016) used stratified random sampling to select the included participants and data records. The approach adopted by the AHRQ was probabilistic, which indicated that the inclusion of the participants was based on random selection, which allowed me to make solid statistical inferences about the study population (see Nguyen et al., 2021). The adopted stratified random sampling involved stratification by region, hospital ownership, location (rural and urban), and hospital type. The stratified sampling was also associated with enhanced samples’ diversity and improved variance similarity. Stratification, however, posed challenges in evaluating the data (see Nguyen et al., 2021).

Inclusion Criteria

I included individuals of all age groups and gender diagnosed with SCD HbSS from NIS 2019, NEDS 2019, and NRD 2019 from all participating states. I selected data sets with ICD-10-CM Codes D571 (SCD without crisis) and D5700 (Hb-SS disease with crisis, unspecified). Only those participants with a specified length of hospitalization were included.

Exclusion Criteria

I excluded patients without ICD-10-CM Codes D571 or D5700. I also excluded patients who were not diagnosed with SCD and those who were treated at an ED but were not hospitalized.

Power Analysis and Sample Size Calculation

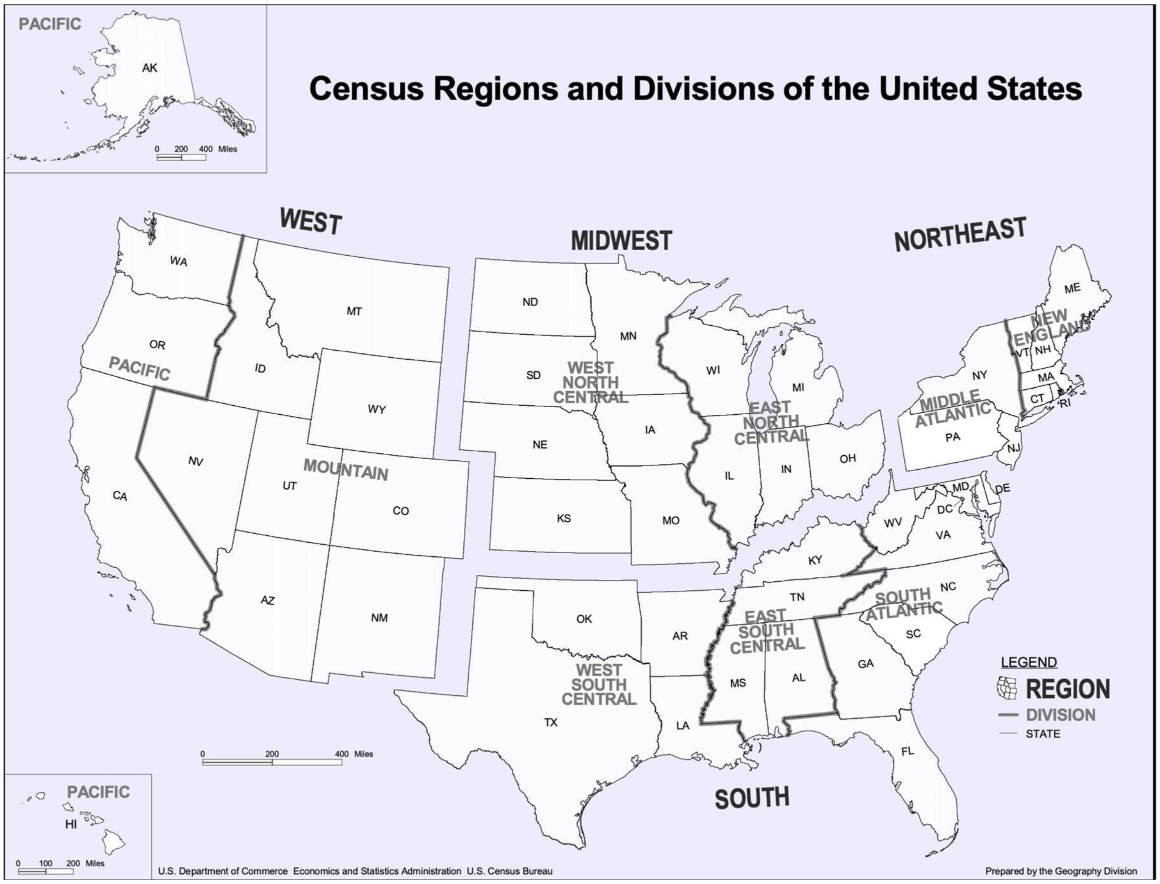
I carried out sample size calculation using an a priori approach; this approach provided the allowed amount of determination of the sample size to reach a desired level of power. According to Fritz and MacKinnon (2007), a power of 0.80 and above ensures attaining statistical significance and limited risk of Type II errors. I chose a statistical power of 0.95. The sample size calculation was carried out using a G*Power 3.1.9.2 calculator (see Faul et al., 2009). Based on the examination of the research question, the appropriate statistical approach that was used to assess the research question was binary logistic regression. The sample size calculation for binary logistic regression in this study revealed a minimum of 104 to achieve a power of 0.95 (see Faul et al., 2009).

Procedures for Recruitment, Participation, and Data Collection

I collected the data from existing HCUP data compiled by the AHRQ, in which participants were selected across all states of the United States (Boudreaux et al., 2019; Fang & Owens, 2021). HCUP databases were derived from administrative data. The AHRQ obtained the hospital inpatient records from 48 states and the District of Columbia. From 2012, HCUP's hospital inpatient data has included a sample of discharges from all hospitals participating in HCUP. The inpatient data approximates a 20% stratified sample of all discharges from U.S. community hospitals (HealthyPeople.gov, 2020). The procedure for the recruitment of the inpatients included the random sampling of the hospitals from the sampling frame. Within each sampled hospital, all procedures of discharging patients with SCD were included to assist me in analyzing the length of stay. The sampling was carried out in each hospital stratum that included the four U.S. census regions (see Figure 1) of Northeast, Midwest, West, and South; hospital location defined as urban or rural area hospitals; teaching status defined as teaching and nonteaching hospitals; ownership defined as public, private not-for-profit, or private investor-owned; and hospital size defined as small, medium, or large hospitals. Reporting of the data was voluntary. The patient's identity was protected by eliminating identifying details such as names and contact addresses.

Figure 1

Illustration of the Nationwide Reach of HCUP



Note. Source: https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

Procedure for Gaining Access

I accessed the HCUP data by obtaining paid permission from the AHRQ (2016) to download and extract the required data for the study. Such permissions included paid permission from the AHRQ to download and extract the required data. Institutional review board (IRB# 12-13-19-0500645) approval was obtained following the submission of the detailed steps I would take to ensure adherence to the confidentiality and protection of identities of individuals as stipulated in the Health Insurance and Affordability Act of 1996. Obtaining permission to access and download the data from HCUP involved filing an application and signing an agreement that required ethical use of the data for the purposes stated in the application. I then made the payment of fees to purchase the data. A password was provided that allowed a restricted number of downloads.

Reputability of the Sources

Researchers have used the HCUP data, demonstrating their usefulness in addressing aspects related to SCD. According to Allareddy et al. (2014), the HCUP provides a reasonable sampling frame, and Allareddy et al. noted that SCD HbSS accounts for 84.3% of the admissions. The HCUP data also represent the national population because a random sampling approach is used to collect data across 98% of the U.S. population (Boudreaux et al., 2019).

Fingar et al. (2019) published evidence suggesting the use of HCUP NIS offers insights into the association between age and hospital stays among individuals with SCD. Fingar et al. observed that patients aged 18–34 years had prolonged hospital stays. Okam et al. (2014) noted that using HCUP data provides the basis for determining the variation in the length of hospital stay among individuals with SCD. Okam et al. (2014) based their analysis on the data extracted from the NIS data from 1998 to 2008. Okam et al. (2014) also noted that among adults aged 45–64 years, the length of hospital stay was high compared to children and the overall length of stay.

Dupervil et al. (2016) provided evidence linking the diagnosis of pain crisis with hospitalization. Dupervil et al. based their analysis on the data extracted from NEDS for the years 2006 through 2010. Allareddy et al. (2014) published results using HCUP NIS that indicated that length of hospital stay could be associated with pain diagnosis. Allareddy et al. (2014) based their study on adults with SCD who experienced acute chest syndrome. Allareddy et al. (2014) obtained their data from the NIS 2004-2010 dataset.

Operationalization of the Variables

The 2019 HCUP datasets (NIS, NEDS, and NRD) were developed from the administrative data collected from the participating HCUP partners. NIS is based on the data collection efforts of data organizations in the participating states in partnership with the AHRQ. From the identified data set, I obtained the data of patients with ICD-10-CM Codes D571 (SCD without crisis) and D5700 (Hb-SS disease with crisis, unspecified) of different ages. Table 1 provides a detailed description of each variable and how it was measured.

Table 1

Variables, Operational Definitions, and Conceptualizations

Variable name	Type of variable	Operational definition	Conceptual definition	Level of measurement	Source data
Age	IV	Age of the patients provided in numbers	Age in years	Continuous	NIS 2019 and NEDS 2019
Length of hospital stay	DV	Number of days the patient spent in the hospital	Prolonged stay of (more than 4.5 days) Not prolonged length of stay (4.5 days and below)	Nominal	NIS 2019 and NRD 2019
Pain crisis	DV	Pain diagnosis of the patient at the ED before hospitalization	With crisis Without crisis	Nominal	NIS 2019

Data Analysis Plan

In this study, data were analyzed using SPSS ver. 23. After downloading and unzipping the data using WinZip26, the researcher converted the data file from a. *ACS* file to a. *SAV* file to facilitate reading using SPSS. The conversion was facilitated by the SPSS load files obtained from the HCUP database.

Data Cleaning

The data were then cleaned through the identification of errors. No errors were found. The next step in the data cleaning process was to filter the data to retain only the data required to answer the research question. The approach was made to ease the handling of the data. The data were then filtered based on the ICD-10-CM Codes D571 (Sickle-cell disease without crisis) and D5700 (Hb-SS disease with crisis, unspecified). The next step involved the recording of the data. The length of hospital stays of 4.5 days and below were coded as “Not prolonged length of stay” and assigned a numeric code of 1. The length of stays of more than 4.5 days was coded as “prolonged length of stay” and assigned a numeric code of 1. The next step was to compile the data to determine missing data and remove them. Cross tabulations were carried out to check missing values. No missing values were recorded.

Research Questions and Hypotheses

The assessment of the DVs and IV was carried out using descriptive statistics. Means and standard deviations were used to describe the age. Minimum and maximum values were used to determine the range, which described the data spread. Frequencies and percentages were used to describe the length of stay and diagnosis of pain crisis. In this study, the following research questions were assessed.

RQ1: To what extent does an association exist between age and hospital stay among individuals living with SCD in the US?

H_o1: There is no significant association between hospital stay and age among individuals with SCD in the US.

H_a1: There is a significant association between hospital stay and age among individuals with SCD in the US.

The analysis approach was used because the data met the following assumptions: (1) age is a continuous variable, and hospital stay is a dichotomous variable; (2) based on the assessment of produced boxplot, there were no significant outliers for age for each group of the hospital stay. (3) Levene's test of equality of variances showed equality of variance with $p \geq .05$, and (4) the data showed normal distribution based on the assessment of the Shapiro-Wilk test of normality.

RQ2: To what extent does an association exist between age and pain diagnosis among individuals living with SCD in the US?

H_o2: There is no significant association between pain diagnosis and age among individuals with SCD in the US.

H_a2: There is a significant association between pain diagnosis and age among individuals with SCD in the US.

The assessment was also carried out using point-biserial correlation. The data met the assumptions for this test. Age was considered the continuous independent variable, and hospital stays the dependent variable.

RQ3: To what extent does age and pain crisis diagnosis predict the length of hospital stay among individuals with SCD in the US?

H_o3: Age and pain diagnosis do not predict the length of hospital stay among individuals with SCD in the US.

H_a3: Age and pain diagnosis predict the length of hospital stay among individuals with SCD in the US.

The analysis was carried out using binary logistic regression. The use of the statistical technique was based on the dependent variable (length of hospital stay) and was dichotomous. One of the IVs was measured continuously and the other on a nominal scale. The data also showed the independence of observations where each participant was counted once. There were also linear relationships between continuous DV and the logit transformation of the IV. No significant outliers exist were reported.

Threats to Validity

Since this study used existing data, there are concerns regarding the accurateness and completeness of the information provided by the HCUP partners. Such discrepancies in the recording of the data reduce the external validity and affect the generalizability of the findings (Ferguson, 2004). During the process of filtering and coding the data, errors could occur that might affect the study's internal validity. The researcher limited the errors during the filter by adopting an automated approach using the "select data" command in SPSS. The coding was also automated using SPSS.

Ethical Procedures

The researcher complied with the HIPAA guidelines for the privacy and confidentiality of the patients and the institutions (Murray et al., 2011). The HCUP data used in this study were coded to protect the identity of the participants and the institutions that partnered with AHQR. The researcher further coded the data using SPSS, increasing the protection of the participants. The researcher ensured that the data were used for the intended purpose only and no other unauthorized third parties accessed it. The researcher securely stored the data on a password-protected computer that could be accessed by the researcher alone. To further enhance the data security, the researcher committed to destroying the data five years after the completion. The researcher obtained and strictly followed IRB regulations. No data were collected before the IRB approval, and after receiving approval, no alterations were made to the research approach without obtaining a go-ahead from the IRB.

Summary

Chapter 3 contained an in-depth discussion of the research methodology. The chapter indicates that quantitative retrospective correlational design best addresses the research questions and hypotheses. The unit of analysis was as the patients with SCD in the US. The use of binary logistic regression facilitated the assessment of how age and pain diagnosis may or may not predict the likelihood of prolonged length of hospital stay. The detailed outcome of the analysis mentioned in Chapter 3 is presented and described in Chapter 4. Chapter 4 is the results and findings.

Chapter 4: Results

The purpose of the study was to determine whether and to what extent there was any association between age, pain crisis, and length of stay in hospital among patients with SCD in the United States. The first research question addressed the correlation between age and length of stay in hospital. The second research question was designed to assess the correlation between age and pain diagnosis in patients. The final research question was designed to determine whether age and pain diagnosis predict the length of stay in the hospital among patients with SCD.

Data Collection

Data were collected from the HCUP website, and the data had over 1 million cases. Therefore, a random sample of 100,000 cases was selected for data analysis, as shown in Table 2. Data was collected for 2019 from NIS, NEDS, and NRD data sets on the HCUP website (see Fingar et al., 2019). A subset of the large data file was created with 100,000 samples to test the research hypotheses. A sample size of 100,000 was considerable and was representative of the population because it contained patients from all U.S. states.

Table 2

Descriptive Table on Age and Region of Data Set

Variable Name	Variable specifications	Sample
Age	Less than 54.6 years	65000
	More than 54.6 years	35000
Region of dataset	NIS	35000
	NEDS	30000
	NRD	35000

The two dichotomous nominal variables in the study were length of stay in the hospital, which was calculated as < 4.5 days = 1 and > 4.5 days = 2, and pain crisis, which was coded as 0 = “without pain” and 1 = “with pain. A chi-square test was performed, and the results showed that there was a significant association between pain crisis and length of stay in hospital among patients with sickle cell disease ($\chi 2$ (1) = 2476, *p* < .001). Approximately 37% of the patients with pain diagnosis had prolonged stay in the hospital (*n* = 23,221) compared to only 22% of those without any pain diagnosis having a prolonged stay in the hospital (*n* = 8,128), as shown in Table 3 and Figure 2.

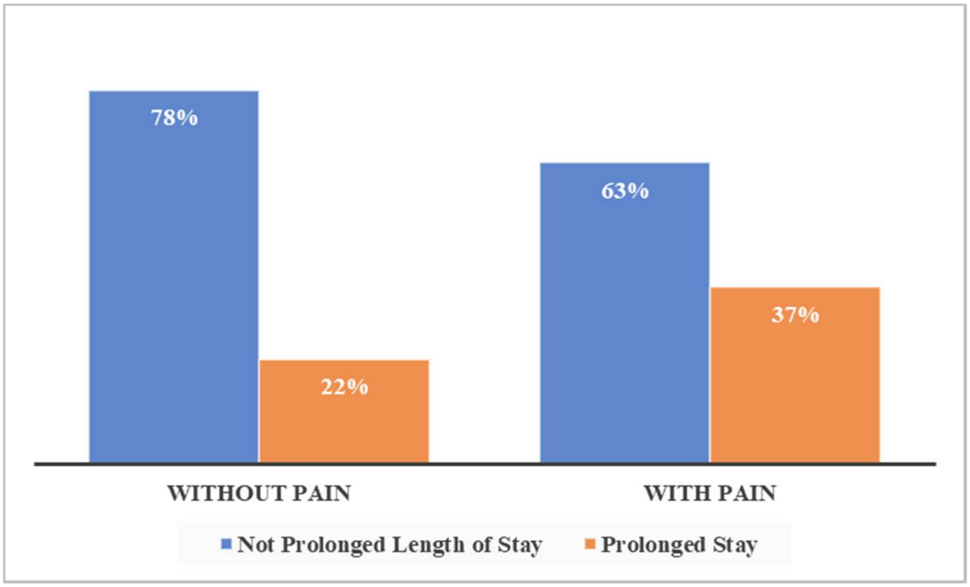
Table 3

Chi-Square Test Between Length of Stay and Pain Diagnosis

Length of stay	Without pain *f*	Without pain %	With pain *f*	With pain %	$\chi 2$ (1)	*p* value
Not prolonged	29,054	78%	39,597	63%	2476	<.001
Prolonged	8,128	22%	23,221	37%		
Total	37,182	100%	62,818	100%		

Figure 2

Distribution of Patients With and Without Pain Diagnosis and Length of Stay



The mean age of patients with SCD in a sample of 100,000 patients was 54.6 years (*SD* = 24.19). The average length of stay in the hospital was 4.48 days (*SD* = 57.27; see Table 4).

Table 4

Descriptive Statistics

Variable	Mean	Median	*SD*
Age	54.66	60	24.19
Length of stay	4.48	3	57.27

The frequency distribution indicated that approximately 63% of the patients in the sample were diagnosed with pain (*n* = 62,818). Approximately 69% did not have a prolonged stay in the hospital (*n* = 68,651; see Table 5).

Table 5

Frequency Distribution

Variable	*f*	%
Pain		
Without pain	37,182	37.18%
With pain	62,818	62.82%
Length of stay		
Not prolonged	68,651	68.65%
Prolonged	31,349	31.35%

Results

Research Question 1

The first hypothesis stated that there is a significant association between hospital stay and age among individuals with SCD in the United States. Age was a continuous variable, and length of hospital stay was a dichotomous categorical variable. A point-biserial correlation was calculated, and the results indicated that there was a significant, positive, but weak correlation between length of stay and age of patients, r (99998) = .193, $p < .001$ (see Table 6). The results showed that older patients with SCD were more likely to stay longer in the hospital than younger patients with SCD (see Figure 3). Therefore, the first hypothesis was accepted.

Table 6

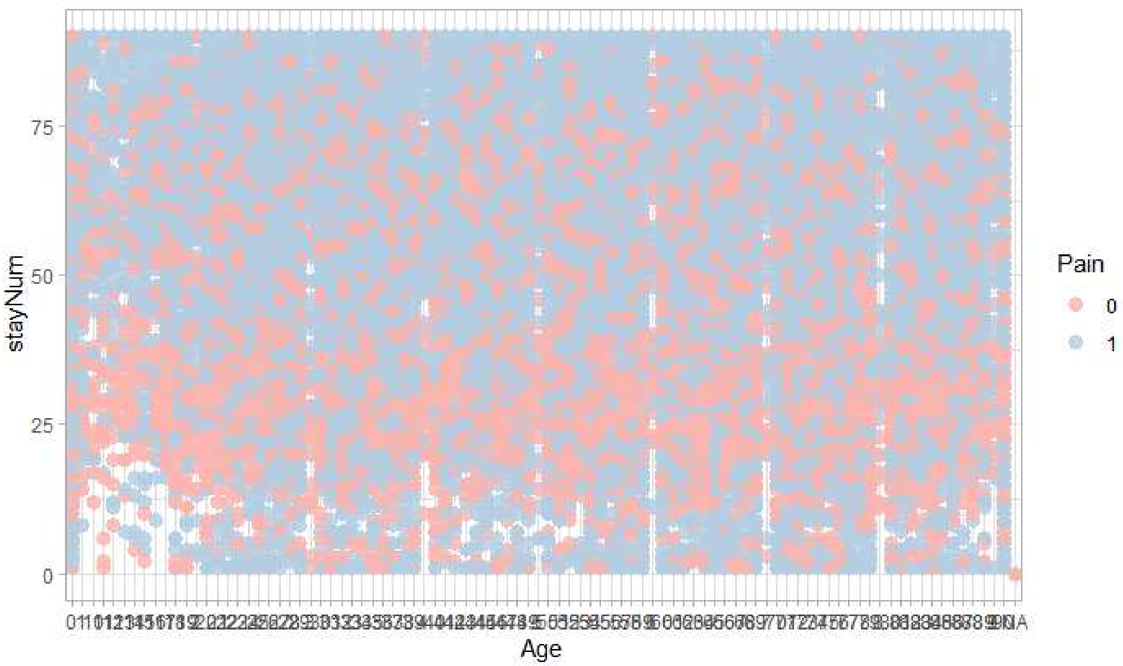
Correlation of Age With Length of Stay and Pain

Biserial correlation	Length of stay	Pain
Age	.193*	.340*

Note. * $p < .001$.

Figure 3

Scatter Plot of Correlation Between Age (Continuous) and Length of Stay (Continuous) With Color Coding Based on Pain Diagnosis

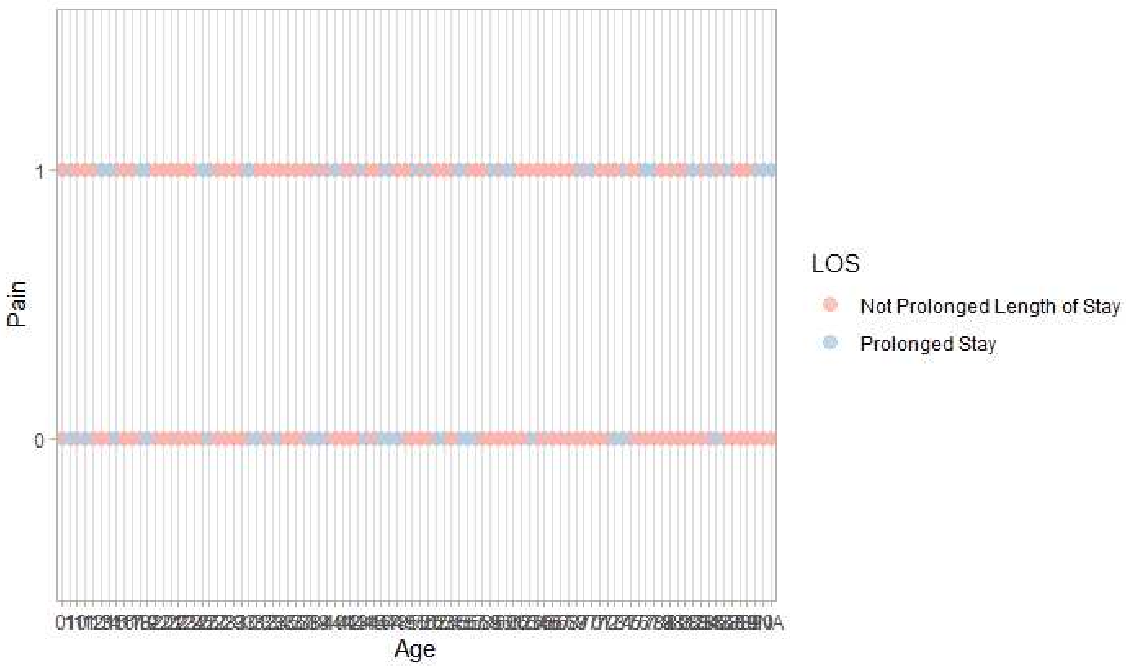


Research Question 2

The second hypothesis stated that there is a significant association between pain diagnosis and age among individuals with SCD in the United States. A point-biserial correlation analysis was conducted because age was a continuous variable and pain diagnosis was a dichotomous nominal variable. The results of point-biserial correlation indicated that there was a significant, positive, and moderate correlation between age and pain diagnosis, r (9998) = .340, p < .001. Results showed that older patients with SCD were more likely to have been diagnosed with pain compared to younger patients (see Figure 4). An increase in age was associated with the likelihood of pain diagnosis. Therefore, the second alternative hypothesis was also accepted.

Figure 4

Scatterplot for Correlation Between Age and Pain Diagnosis With Color Coding Based on Length of Stay



Research Question 3

The third and final hypothesis stated that age and pain diagnosis predict the length of hospital stay among individuals with SCD in the United States. Length of hospital stay was the dependent variable and was dichotomous. Age was the first independent variable and was measured on a continuous scale. The second independent variable was pain diagnosis, which was a dichotomous nominal variable.

Logistic regression results indicated that the regression model could explain approximately 4% of the variation in the length of stay in the hospital of patients with SCD based on their age and pain diagnosis (McFadden's R^2 = .040). The results showed that age had a significant impact on length of stay in the hospital, *B* = .016, *SE* = .000, *OR* = 1.016, *p* < .001. Older patients were 1.02 times more likely than younger patients with SCD to stay longer in the hospital. Every yearly increase in age there is a 1.6% increase risk of a longer length of stay. Pain diagnosis also had a significant impact on length of stay in the hospital, *B* = .505, *SE* = .016, *OR* = 1.657, *p* < .001 (see Table 7). SCD patients with pain diagnosis were 1.66 times more likely than patients with no pain diagnosis to stay longer in hospital (see Figure 5). Therefore, the third hypothesis was also accepted.

Table 7

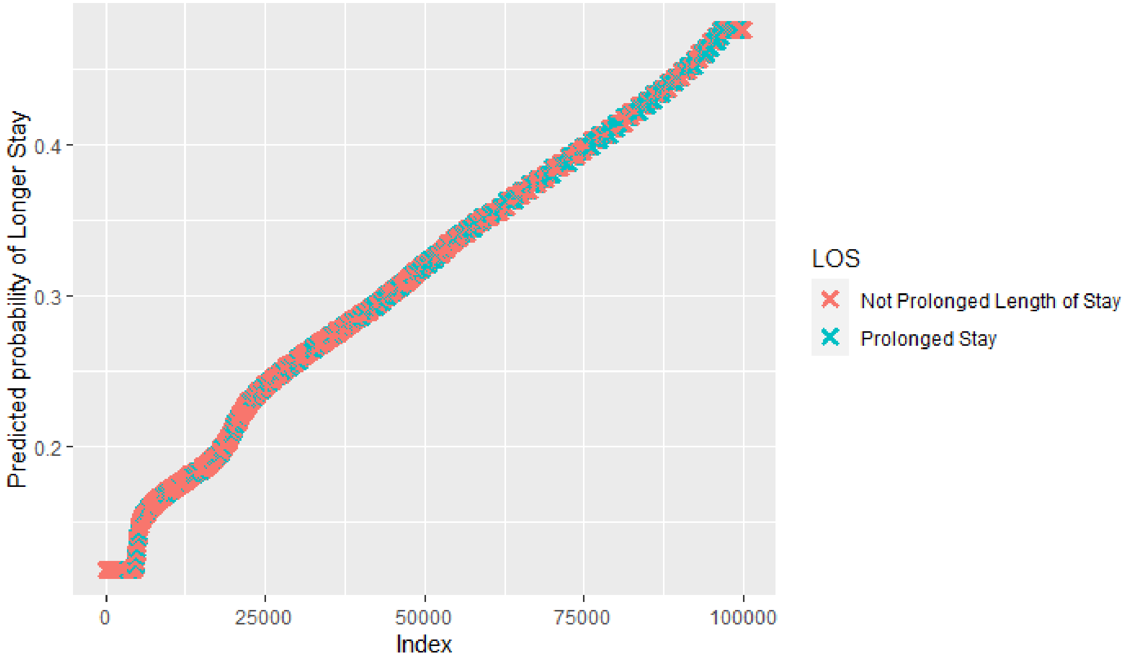
Logistic Regression Model Summary

Coefficient	*B*	*SE*	*z value*	*Odds ratio*	*p value*
Intercept	-2.004	0.021	-97.070		<.001
Age	0.016	0.000	47.610	1.016	<.001
Pain	0.505	0.016	31.940	1.657	<.001
McFadden's R^2	0.040				<.001

Note. Dependent variable = length of stay.

Figure 5

Logistic Regression Plot Predicting Length of Stay Based on Age and Pain Diagnosis



Overall, the results showed a significant and positive association of the age of patients with SCD with their pain diagnosis and length of stay in the hospital. Older patients were more likely to stay for a longer duration in the hospital and were also more likely to be diagnosed with pain. Also, pain diagnosis and age of patients were significant predictors of the length of stay of SCD patients in the hospital. Older patients had a higher odds ratio to stay longer in the hospital. Similarly, patients with pain diagnoses were also more likely to have a prolonged stay in the hospital.

Summary

The study was conducted to understand the relationship between the age of patients with SCD, their pain diagnosis, and the length of their stay in the hospital in the

United States. HCUP data sets (NIS, NEDS, and NRD) for 2019 contained massive data of over a million cases with SCD (see Fingar et al. 2019). For this research, a representative random sample of 100,000 cases was selected, and the results showed a significant association between age, pain diagnosis, and length of stay in the hospital. The chi-square test indicated a significant association between these two factors. However, the Phi coefficient indicated that the effect size was small (Phi coefficient ϕ = .157). Out of the sample of 100,000 patients, 34.35% of patients had prolonged stays at the hospital (n = 31,349). Out of these patients having a prolonged stay at the hospital, approximately 74% were diagnosed with pain (n = 23,221).

The results indicated a significant association between hospital stay and age among individuals with SCD in the United States. Results also indicated a significant association between pain diagnosis and age among individuals with SCD in the United States. Finally, results showed that age and pain diagnosis predicted the length of hospital stay among individuals with SCD in the United States. Overall, the results suggested that older patients with pain diagnoses were more likely to stay longer in the hospital due to SCD in the United States. The outcomes of the quantitative study could be used to explain the association between age, pain diagnosis, and length of hospital stay among individuals living with SCD in the United States.

Chapter 5 includes a discussion of the results with recommendations for future research on this topic and the limitations of the study.

Chapter 5: Discussion, Conclusions, and Recommendations

Three issues have arisen from the analysis of the population sample, instrumentation, management, and analysis of the data set using the point-biserial correlation. Prioritizing the point-biserial correlation has supported the purpose of the study, which was to predict hospitalization among individuals living with SCD using the predetermined variables. The information and data evident in the findings could add information to the strategies and methods of predicting the severity of patients with SCD. This research has important information that could be used by the U.S. Department of Health and Human Services. The predictability of patients with SCD was addressed through examining the correlation between age and the length of stay in the hospital. The findings indicated a significant connection between age and pain of patients in predicting the likelihood of hospitalization.

Dichotomous nominal variables and the chi-square test were instrumental in identifying the relationship between pain diagnosis and hospitalization length. The chi-square test used with 37,182 people as a sample population for people without pain and 62,818 for those with pain. The test's purpose was to test the correlation between length of stay in hospitals and pain diagnosis. The results indicated that 78% of the population sample of those without pain, which was 29,054, did not have a prolonged stay in the hospital. However, 22% of those without pain, which was 8,128, had a prolonged stay.

On the other hand, 63% of the patients with pain, which was 39,597, did not have a prolonged stay in the hospital, while 37% of those with pain, which was 23,221, had a prolonged stay. This indicated that the chi-square test was instrumental in identifying the significant relationship between pain diagnosis and length of hospital stay. The test results indicated that patients with SCD who suffer from pain stay longer in the hospital than those who do not experience pain. Therefore, results suggest that pain determines hospital admission regarding SCD. In other words, when a patient with SCD suffers from pain, it indicates increased likelihood of hospital admission.

Interpretation of the Findings

The mean age of the population sample was 54.66 years, and the median age was 60 years. The dispersion of the age of the population sample was 24.19, while the average number of days that the patients stayed in the hospital was 4.48 with a standard deviation of 57.27, which indicated the number of days stayed by the patients in the hospital was spread out and not close to each other.

The findings of the study were consistent with the results of the prior research conducted from the work of different scholars. According to the reviewed evidence, a pain crisis could influence the length of hospital stay (Fingar et al. (2019). Patients who have acute chest chronic syndrome are likely to experience prolonged hospitalization. Literature also indicated that age influences the hospitalization of patients with sickle cell disease (Cronin et al., 2019). A longer stay in the hospital results in an increased financial burden among the victims. However, there was no evidence to indicate the relationship between the pain crisis and age. The findings of the study show that there is a significant association between hospital and age among individuals with SCD. Despite the major findings made in the study, this study did not compare the length of stay for pain associated with SCD and other pain-related diagnoses. However, no evidence discusses the influence of both age and pain crises on the length of hospital stay. These sources have explained either the relationship between age and length of hospital stay or pain crisis and length of hospital stay without using the updated data such as HCUP NEDS, NRD, and NIS 2019. This gap showed the need for research in the current study. The research in this area could help identify the relationship between age, pain crisis, and length of hospital stay among patients with SCD.

RQ1: Correlation Between Age and Length of Hospital Stay

A scatter plot was instrumental in calculating the point-biserial correlation relationship between age and length of hospitalization. A scatter plot is significant in calculating the interrelationship and the strength of data sets. Patients who suffer from pain were represented by gray dots, while red dots represented those without pain (see Figure 3). The scatter plot showed a positive relationship between the length of stay and the patients' age in both patients who experienced pain and those who did not experience pain. This indicated that as the patients grew older despite having pain, their stay in the hospital increased. However, when I measured the strength of the data set using the scatter plot, there was evidence of a weak relationship between the length of stay and the age of the patients. The scatter plot indicated a strong relationship between the patients with pain and their stay in the hospital. In addition, the scatter plot indicated that patients experiencing pain had a more extended stay in hospital despite their age.

RQ2: Correlation Between Age and Pain Diagnosis in Patients

The scatter plot was also used to calculate the strength of the correlational relationship between age and pain. Age was considered a continuous variable among patients, while pain was a dichotomous nominal variable. The first point-biserial correlation was conducted, and the results showed that there was a positive correlation between age and pain diagnosis. In this regard, the scatter plot indicated that as the age of the patients increased, so did the chances of pain diagnosis occur (see Panepinto et al., 2005). This means that as the patient got older, their chances of being diagnosed with pain increased. The scatter plot presents the strength of correlational relationships in the form of strong, moderate, or weak. Therefore, the scatter plot presented a moderate relationship between age and pain by having points cluster in different points but in a linear line (see Figure 4). However, the scatter plot indicated that there was a strong relationship between age and prolonged length of stay and not prolonged stay. Therefore, this representation indicated a correlational relationship between age, pain diagnosis, and length of stay in hospitals.

RQ3: Length of Stay in Hospital Can Be Predicted by Age and Pain Diagnosis

The logistic regression plot was the choice of data analysis and was instrumental in indicating the predictability of length of hospital stay could be determined by age and pain diagnosis. In the scatter plot presentation, the length of stay in the hospital was dichotomous and was the dependent variable. Age was measured on a continuous scale as the initial independent variable. Pain was the second independent variable. The scatter plot showed a robust correlational relationship that predicted the length of hospital stay by age and pain diagnosis. The logistic regression is a model of statistical analysis that predicts the outcome of data sets based on the observational data (Calvello, 2020). Therefore, the regression model predicts the variable data by assessing the correlational relationship between one or more independent variables (Calvello, 2020). In the current study, the logistic regression model summary indicated a significant standard of evidence in the population sample that indicated a correlation between age and pain and the predictability of staying longer in hospitals. Based on the age of the patients, the regression model showed a weaker relationship in predicting the length of staying in the hospital (see Ellison & Bauchner, 2007; Panepinto et al., 2005). Older patients with SCD were 1.02 times more likely to stay longer in the hospital. However, the regression model summary indicated that pain diagnosis had significant effects on the length of hospital stay. The regression model indicated that SCD patients with pain diagnosis were 1.66 times more likely to stay longer in hospitals compared to patients not diagnosed with pain.

The logistic regression plot indicated that as patients grew older, their chances of getting diagnosed with pain increased. Results suggest that as SCD patients grow older, they are more likely to stay longer in hospitals. Younger SCD patients did not have a significant indication of pain, so their likelihood of staying longer in hospitals was decreased. Patients diagnosed with pain despite their age had an increased likelihood of staying longer, but older patients with pain diagnoses stayed longer in hospitals compared to younger patients with pain diagnoses. This analysis is significant to providing hospitalization predictability of SCD patients based on their age and pain diagnosis.

Limitations of the Study

The generalization of the sample population was limited to data sets with ICD-10-CM Codes D571 and D5700. The research was limited to the prior approach and did not produce verifiable evidence. The results presented the general view of patients with SCD from 2019 in terms of pain and age. The limitations of the study were states that were included in the study. These states may have omitted some of the significant determinants of the study, such as the prevalence rate of SCD by state and prevalence by race. The data set may also have been exposed to penetration or attacks internally through coding and malware installation by employees.

Recommendations

Calculating the severity of SCD is significant to understand the length of stay in hospitalization. Calculation of the correlational relationship between severity and age was significant in this study. Sickle cell severity is a crucial determinant of hospitalization predictability of SCD: A sickle cell patient could be young but have a high severity rate, causing him to spend more time in hospital. Nonetheless, an older adult with a low severity rate would spend less time hospitalized. Future research could include the prevalence rate of the disease in every state. Additionally, conducting an inclusive empirical analysis would be significant to obtaining verifiable evidence. A Pearson's correlation coefficient would demonstrate the correlation between two variables.

Implications

There is a relationship between the accessibility of health management and the amount of time spent by patients in hospitals. Incorporation of accessible health services into the health systems would enhance the service levels for individuals, families, and society at large. The prolonged stay of patients in hospitals may be reduced by providing social health amenities that would facilitate regular checkups. Health insurance accessibility would also be necessary at the family level because it would reduce the financial burden of SCD management. The Sickle Cell Disease Treatment Act of 2003–2004 could be taught at the societal level to educate family members and other members of the society in managing the disease. Additionally, sensitizing caregivers as well as SCD patients regarding the self-care management process may be instrumental in ensuring that their treatment is effective. The BMHS concepts used to measure quality in health care using the required guidelines could be impactful to improve the patient's quality of life and health effects. SCD self-care management would also be imperative to reducing the length of patients' stay in hospitals (Bemrich-Stolz et al., 2015). The development a self-care management model that entails medical information such as the medication prescription, blood transfusion information as well as levels of hemoglobin for a patient can be crucial for care of SCD patients. Future research concerning the same should prioritize the use of the mixed methods approach to determine the impact of self-care treatment on pain of sickle cell patients. This study did not compare the length of stay for pain associated with SCD and other pain-related diagnoses. A recommendation for future research is to evaluate for significant differences in length of stay between patients with SCD pain diagnoses and patients with other pain diagnoses.

Conclusion

Pain and age have been found to affect the hospital length of stay of patients with SCD. Pain has been the leading cause of hospitalization among SCD patients. However, as the age of SCD patients increases, so does their probability of being diagnosed with pain. This affects the social and economic situation of the family. The hospitalization rate among SCD patients increases as they grow older. Findings from the current study may be used to increase accessibility to health management services and education about SCD self-care management, which is imperative in the case of helping patients with and without pain, whether old or young, to decrease the length of their stay in hospitals. Findings may also benefit patients with SCD economically in savings on their hospital expenditure by shortening the length of hospital stays. Decreased fatalities could result from forms of treatment, which warrants further research in the area. Patients' prolonged hospital stay may be reduced by adding closer social health facilities that would enable regular checkups.

References

Abd Elmoneim, A. A., Al Hawsawi, Z. M., Mahmoud, B. Z., Bukhari, A. A., Almulla, A. A., Sonbol, A. M., & Makhdoum, A. M. (2019). Causes of hospitalization in sickle cell disease children in the western region of Saudi Arabia. A single-center study. *Saudi Medical Journal*, *40*(4), 401. https://doi.org/10.15537/smj.2019.4.24049

Aday, L. A., & Andersen, R. (1974). A framework for the study of access to medical care. *Health Services Research*, *9*(3), 208–220. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1071804/

Agency for Healthcare Research and Quality. (2016). *Introduction to the HCUP Nationwide Inpatient Sample (NIS)*. https://hcup-us.ahrq.gov/db/nation/nis/NIS_Introduction_2016.jsp

Allareddy, V., Roy, A., Lee, M. K., Nalliah, R. P., Rampa, S., Allareddy, V., & Rotta, A. T. (2014). Outcomes of acute chest syndrome in adult patients with sickle cell disease: predictors of mortality. *PLoS One*, *9*(4). https://doi.org/10.1371/journal.pone.0094387

Andersen, R. M. (1995). Revisiting the behavioral model and access to medical care: Does it matter? *Journal of Health and Social Behavior*, 1–10. https://doi.org/10.2307/2137284

Andersen, R., & Newman, J. F. (1973). Societal and individual determinants of medical care utilization in the United States. *The Milbank Memorial Fund Quarterly. Health and Society*, 95–124. https://doi.org/10.2307/3349613

Babitsch, B., Gohl, D., & Von Lengerke, T. (2012). Re-revisiting Andersen's behavioral model of health services use: A systematic review of studies from 1998–2011. *GMS Psycho-Social-Medicine*, *9*, 1–25. https://doi.org/10.3205/psm000089

Badawy, S. M., Barrera, L., Cai, S., & Thompson, A. A. (2018). Association between participants' characteristics, patient-reported outcomes, and clinical outcomes in youth with sickle cell disease. *BioMed Research International.* https://doi.org/10.1155/2018/8296139

Bazargan, M., Smith, J. L., Cobb, S., Barkley, L., Wisseh, C., Ngala, E., & Assari, S. (2019). Emergency department utilization among underserved African American older adults in South Los Angeles. *International Journal of Environmental Research and Public Health*, *16*(7), 1175. https://doi.org/10.3390/ijerph16071175

Bemrich-Stolz, C. J., Halanych, J. H., Howard, T. H., Hilliard, L. M., & Lebensburger, J. D. (2015). Exploring adult care experiences and barriers to transition in adult patients with sickle cell disease. *International Journal of Hematology & Therapy*, *1*(1). https://doi.org/10.15436/2381-1404.15.003

Bender, M.A. (2017). *Sickle cell disease.* https://www.ncbi.nlm.nih.gov/sites/books/NBK1377/

Bock, J. O., Hajek, A., & König, H. H. (2018). The longitudinal association between psychological factors and health care use. *Health Services Research*, *53*(2), 1065–1091. https://doi.org/10.1111/1475-6773.12679

Boudreaux, M., Gangopadhyaya, A., Long, S. K., & Karaca, Z. (2019). Using data from the healthcare cost and utilization project for state health policy research. *Medical*

Care, *57*(11), 855–860. https://doi.org/10.1097/MLR.0000000000001196

Bou□Maroun, L. M., Meta, F., Hanba, C. J., Campbell, A. D., & Yanik, G. A. (2018). An analysis of inpatient pediatric sickle cell disease: Incidence, costs, and outcomes. *Pediatric Blood & Cancer*, *65*(1), Article e26758. https://doi.org/10.1002/pbc.26758

Brousseau, D. C., Owens, P. L., Mosso, A. L., Panepinto, J. A., & Steiner, C. A. (2010). Acute care utilization and rehospitalizations for sickle cell disease. *JAMA*, *303*(13), 1288–1294. https://doi.org/10.1001/jama.2010.378

Buchanan, I. D., Woodward, M., & Reed, G. W. (2005). Opioid selection during sickle cell pain crisis and its impact on the development of acute chest syndrome. *Pediatric blood & cancer*, *45*(5), 716-724. https://doi.org/10.1002/pbc.20403

Cadena-Iñiguez, P., Rendón-Medel, R., Aguilar-Ávila, J., Salinas-Cruz, E., Cruz-Morales, F. D. R. D. L., & Sangerman-Jarquín, D. M. (2017). Quantitative methods, qualitative methods, or combination of research: An approach in the social sciences. *Revista Mexicana de Ciencias Agrícolas*, *8*(7), 1603–1617. https://doi.org/10.29312/remexca.v8i7.515

Calvello, M. (2020). *Correlation vs. regression made easy: Which to use + why*. https://www.g2.com/articles/correlation-vs-regression#what-is-regression

Center for Disease Control and Prevention. (2017). *Sickle cell disease (SCD)*. https://www.cdc.gov/ncbddd/sicklecell/index.html

Cronin, R. M., Hankins, J. S., Byrd, J., Pernell, B. M., Kassim, A., Adams-Graves, P., &

Treadwell, M. (2018). Modifying the health belief model factors associated with missed clinic appointments among individuals with sickle cell disease. *Hematology*, *23*(9), 683–691. https://doi.org/10.1080/10245332.2018.1457200

DeShazo, J. P., & Hoffman, M. A. (2015). A comparison of a multistate inpatient EHR database to the HCUP nationwide inpatient sample. *BMC Health Services Research*, *15*(1), 1–8. https://doi.org/10.1186/s12913-015-1025-7

Dupervil, B., Grosse, S., Burnett, A., & Parker, C. (2016). Emergency department visits and inpatient admissions associated with priapism among males with sickle cell disease in the United States, 2006–2010. *PloS One*, *11*(4), Article e0153257. https://doi.org/10.1371/journal.pone.0162056

Ellison, A. M., & Bauchner, H. (2007). Socioeconomic status and length of hospital stay in children with vaso-occlusive sickle cell disease crises. *Journal of the National Medical Association*, *99*(3), 192–196.

Evensen, C. T., Treadwell, M. J., Keller, S., Levine, R., Hassell, K. L., Werner, E. M., & Smith, W. R. (2016). Quality of care in sickle cell disease: Cross-sectional study and development of a measure for adults reporting on ambulatory and emergency department care. *Medicine*, *95*(35), 1–7. https://doi.org/10.1097/MD.0000000000004528

Fang, Z., & Owens, P. L. (2021). *Changes in hospitalizations and in-hospital deaths for adults aged 65 years and older in the initial period of the COVID-19 pandemic (April–September 2020), 13 states*. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs [Internet].

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior research methods*, *41*(4), 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Ferguson, L. (2004). External validity, generalizability, and knowledge utilization. *Journal of Nursing Scholarship*, *36*(1), 16–22. https://doi.org/10.1111/j.1547-5069.2004.04006.x

Fingar, K. R., Owens, P. L., Reid, L. D., Mistry, K. B., & Barrett, M. L. (2019). *Characteristics of inpatient hospital stay involving sickle cell disease, 2000–2016: Statistical brief# 251*. Healthcare Cost and Utilization Project (HCUP) Statistical Briefs [Internet]

Fisher, G. G., & Chaffee, D. S. (2018). Research using archival data. *Advanced Research Methods for Applied Psychology* (pp. 76-84). https://doi.org/10.4324/9781315517971-9

Fritz, M. S., & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological science*, *18*(3), 233–239. https://doi.org/10.1111/j.1467-9280.2007.01882.x

Geethakumari, K., Kusuma, Y. S., & Babu, B. V. (2021). Beyond the screening: The need for health systems intervention for prevention and management of sickle cell disease among tribal population of India. *The International Journal of Health Planning and Management*, *36*(2), 236–243. https://doi.org/10.1002/hpm.3081

Gerring, J. (2017). Qualitative methods. *Annual Review of Political Science*, *20*, 15-36. https://doi.org/10.1146/annurev-polisci-092415-024158

Hammerton, G., & Munafò, M. R. (2021). Causal inference with observational data: the need for triangulation of evidence. *Psychological Medicine*, *51*(4), 563–578. https://doi.org/10.1017/s0033291720005127

Hankins, J. S., & Shah, N. (2020). Tackling adherence in sickle cell disease with mHealth. *The Lancet Hematology*, *7*(10), e713–e714. https://doi.org/10.1016/s2352-3026(20)30299-4

Hawasawi, Z. M., Nabi, G., Al Magamci, M. S. F., & Awad, K. S. (1998). Sickle cell disease in childhood in Madina. *Annals of Saudi Medicine*, *18*(4), 293–295. https://doi.org/10.5144/0256-4947.1998.293

HealthyPeople.gov. (2020). Healthcare cost and utilization project-Nationwide inpatient sample. https://www.healthypeople.gov/2020/data-source/healthcare-cost-and-utilization-project-nationwide-inpatient-sample

Huo, J., Xiao, H., Garg, M., Shah, C., Wilkie, D. J., & Mainous Iii, A. (2018). The economic burden of sickle cell disease in the United States. *Value in Health*, *21*, S108. https://doi.org/10.1016/j.jval.2018.07.826

Jang, T., Poplawska, M., Cimpeanu, E., Mo, G., Dutta, D., & Lim, S. H. (2021). Vaso-occlusive crisis in sickle cell disease: a vicious cycle of secondary events. *Journal of Translational Medicine*, *19*(1), 1–11. https://doi.org/10.1186/s12967-021-03074-z

Jenerette, C. M., & Brewer, C. (2010). Health-related stigma in individuals living with sickle cell disease. *Journal of the National Medical Association*, *102*(11), 1050. https://doi.org/10.1016/s0027-9684(15)30732-x

Kayle, M., Shah, N., Tanabe, P., Sloane, R., Maslow, G., Pan, W., Holl, J.L., & Docherty, S. (2018). Trajectories of sickle cell disease severity during transition to adult care. *American Society of Hematology, 132*(1), 318. https://doi.org/10.1182/blood-2018-99-112158

Keller, S. D., Yang, M., Treadwell, M. J., Werner, E. M., & Hassell, K. L. (2014). Patient reports of health outcome for adults living with sickle cell disease: development and testing of the ASQC-Me item banks. *Health and Quality of Life Outcomes*, *12*(1), 1–11. https://doi.org/10.1186/s12955-014-0125-0

Lee, L., Smith-Whitley, K., Banks, S., & Puckrein, G. (2019). Reducing health care disparities in sickle cell disease: A review. *Public Health Reports*, *134*(6), 599–607. https://doi.org/10.1177/0033354919881438

McGilton, K. S., Vellani, S., Yeung, L., Chishtie, J., Commisso, E., Ploeg, J., & Puts, M. (2018). Identifying and understanding the health and social care needs of older adults with multiple chronic conditions and their caregivers: A scoping review. *BMC Geriatrics*, *18*(1), 1–33. https://doi.org/10.1186/s12877-018-0925-x

Miles, D.A. (2019). Research methods and strategies: Let's stop the madness Part 2: Understanding the difference between limitations vs. delimitations. https://www.researchgate.net/publication/334279571_ARTICLE_Research_Methods_and_Strategies_Let's_Stop_the_Madness_Part_2_Understanding_the_Difference_Between_Limitations_vs_Delimitations

Murray, T. L., Calhoun, M., & Philipsen, N. C. (2011). Privacy, confidentiality, HIPAA, and HITECH: implications for the health care practitioner. *The Journal for Nurse*

Practitioners, *7*(9), 747–752. https://doi.org/10.1016/j.nurpra.2011.07.005

Narh, C. T., Der, J., Ofosu, A., Blettner, M., & Wollschlaeger, D. (2021). Time trends, sociodemographic and health factors associated with discharge and length of stay of hospitalized patients with sickle cell disease in Ghana: A retrospective analysis of national routine health database. *BMJ Open*, *11*(10), Article e048407. https://doi.org/10.1136/bmjopen-2020-048407

Nguyen, T. D., Shih, M. H., Srivastava, D., Tirthapura, S., & Xu, B. (2021). Stratified random sampling from streaming and stored data. *Distributed and Parallel Databases*, *39*(3), 665–710. https://doi.org/10.1007/s10619-020-07315-w

Novelli, E. M., & Gladwin, M. T. (2016). Crises in sickle cell disease. *Chest*, *149*(4), 1082–1093. https://doi.org/10.1016/j.chest.2015.12.016

Ojelabi, A. O., Graham, Y., & Ling, J. (2017). Health-related quality of life predictors in children and adolescents with sickle cell disease: A systematic review. *International Journal of Tropical Disease & Health*, 1–14. https://doi.org/10.9734/ijtdh/2017/31954

Okam, M. M., Shaykevich, S., Ebert, B. L., Zaslavsky, A. M., & Ayanian, J. Z. (2014). National trends in hospitalizations for sickle cell disease in the United States following the FDA approval of hydroxyurea, 1998 to 2008. *Medical care*, *52*(7), 612. https://doi.org/10.1097/mlr.0000000000000143

Panepinto, J. A., Owens, P. L., Mosso, A. L., Steiner, C. A., & Brousseau, D. C. (2012). The concentration of hospital care for acute sickle cell disease□related visits. *Pediatric Blood & Cancer*, *59*(4), 685–689. https://doi.org/10.1002/pbc.24028

Panepinto, J. A., Brousseau, D. C., Hillery, C. A. & Scott, J. P., (2005). Variation in hospitalizations and hospital length of stay in children with vaso□occlusive crises in sickle cell disease. *Pediatric Blood & Cancer*, *44*(2), 182–186. https://doi.org/10.1002/pbc.20180

Patel, K. (2021). What is binary logistic regression and how is it used in analysis? https://www.dataversity.net/what-is-binary-logistic-regression-and-how-is-it-used-in-analysis/

Piel, F. B., Steinberg, M. H., & Rees, D. C. (2017). Sickle cell disease. *New England Journal of Medicine*, *376*(16), 1561–1573. https://doi.org/10.1056/nejmra1510865

Poitras, M. E., Hudon, C., Godbout, I., Bujold, M., Pluye, P., Vaillancourt, V. T., Débarges, B., Poirier, A., Prévost, K., Spence, C., & Légaré, F. (2020). Decisional needs assessment of patients with complex care needs in primary care. *Journal of Evaluation in Clinical Practice*, *26*(2), 489–502. https://doi.org/10.1111/jep.13325

Powars, D. R., Chan, L. S., Hiti, A., Ramicone, E., & Johnson, C. (2005). Outcome of sickle cell anemia: a 4-decade observational study of 1056 patients. *Medicine*, *84*(6), 363-376. https://doi.org/10.1097/01.md.0000189089.45003.52

Puri, S. A., Haywood, C., Beach, M. C., Lanzkron, S., Guidera, M., Valenzuela-Araujo, D., Rothman, R. E., & Dugas, A. F. (2016). Improving emergency providers' attitudes toward sickle cell patients in pain. *Journal of Pain and Symptom Management*, *51*(3), 628–632. https://doi.org/10.1016/j.jpainsymman.2015.11.004

Ribeil, J. A., Hacein-Bey-Abina, S., Payen, E., Magnani, A., Semeraro, M., Magrin, E., & Bartolucci, P. (2017). Gene therapy in a patient with sickle cell disease. *New England Journal of Medicine*, *376*(9), 848–855. https://doi.org/10.1056/nejmoa1609677

Roberts, T., Esponda, G. M., Krupchanka, D., Shidhaye, R., Patel, V., & Rathod, S. (2018). Factors associated with health service utilization for common mental disorders: A systematic review. *BMC Psychiatry*, *18*(1), 1–19. https://doi.org/10.1186/s12888-018-1837-1

Schlauch, M., Rogers, P., Pyne, R., Tomchik, C., Ellis, C., & Gartrell, K. (2020). Implementation of lean daily management: A vascular access team quality improvement project to enhance nurses' workflow and patient outcomes. *Journal of the Association for Vascular Access*, *25*(3), 18–27. https://doi.org/10.2309/java-d-20-00011

Seeram, E. (2019). An overview of correlational research. *Radiologic Technology*, *91*(2), 176–179. http://www.radiologictechnology.org/content/91/2/176.extract

Shah, N., Bhor, M., Xie, L., Paulose, J., & Yuce, H. (2019). Sickle cell disease complications: Prevalence and resource utilization. *PLoS One*, *14*(7), Article e0214355. https://doi.org/10.1371/journal.pone.0214355

Theofanidis, D., & Fountouki, A. (2018). Limitations and delimitations in the research process. *Perioperative Nursing*, *7*(3), 155–163. https://doi.org/10.5281/zenodo.2552022

Thompson, C. B., & Panacek, E. A. (2007). Research study designs: Non-experimental.

Air Medical Journal, *26*(1), 18–22. https://doi.org/10.1016/j.amj.2006.10.003

Tisdale, J. F., Thein, S. L., & Eaton, W. A. (2020). Treating sickle cell anemia. *Science, 367*(6483), 1198–1199. https://doi.org/10.1126/science.aba3827

Treadwell, M. J., Barreda, F., Kaur, K., & Gildengorin, G. (2015). Emotional distress, barriers to care, and health-related quality of life in sickle cell disease. *Journal of Clinical Outcomes Management*, *22*(1), 10–20. https://www.mdedge.com/jcomjournal/article/146719/hematology/emotional-distress-barriers-care-and-health-related-quality

Treadwell, M. J., Bell, M., Leibovich, S. A., Barreda, F., Marsh, A., Gildengorin, G., & Morris, C. R. (2014). A quality improvement initiative to improve emergency department care for pediatric patients with sickle cell disease. *Journal of Clinical Outcomes Management*, *21*(2), 62–70. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4580258/

Uwaezuoke, S. N., Ayuk, A. C., Ndu, I. K., Eneh, C. I., Mbanefo, N. R., & Ezenwosu, O. U. (2018). Vaso-occlusive crisis in sickle cell disease: current paradigm on pain management. *Journal of Pain Research*, *11*(2018), 3141–3150. https://doi.org/10.2147/jpr.s185582

Vichinsky, E. P., Neumayr, L. D., Earles, A. N., Williams, R., Lennette, E. T., Dean, D., Nickerson, B., Orringer, E., McKie, V., Bellevue, R., Daeschner, C., Abboud, M., Moncino, M., Ballas, S., Ware, R., & Manci, E. A. (2000). Causes and outcomes of the acute chest syndrome in sickle cell disease. *New England Journal of Medicine*, *342*(25), 1855–1865. https://doi.org/10.1056/nejm200006223422502

Ware, R. E., de Montalembert, M., Tshilolo, L., & Abboud, M. R. (2017). Sickle cell disease. *The Lancet*, *390*(10091), 311–323. https://doi.org/10.1016/s0140-6736(17)30193-9

Yeruva, S. L., Paul, Y., Oneal, P., & Nouraie, M. (2016). Renal failure in sickle cell disease: Prevalence, predictors of disease, mortality, and effect on length of hospital stay. *Hemoglobin*, *40*(5), 295–299. https://doi.org/10.1080/03630269.2016.1224766

Yusuf, H. R., Atrash, H. K., Grosse, S. D., Parker, C. S., & Grant, A. M. (2010) Emergency department visits made by patients with sickle cell disease: A descriptive study. *National Library of Medicine*, *38*(4), 1999–2007. https://doi.org/10.1016/j.amepre.2010.01.001