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Racial Disparities of Post Stroke Physical Therapy in South Carolina

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in South Carolina

by
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Chairman, Advisory Committee

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Dedication

This manuscript is dedicated to my incredibly supportive mother and wonderful wife. This work would never have been possible without your love and patience. I hope that this work and all that is to come in the future makes you both proud.

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Abstract

AARON E. EMBRY. Racial disparities of post stroke physical therapy in South Carolina. Under the direction of Dr. Kit Simpson Dr. PH

Background and Purpose: Stroke is a devastating event that drastically changes the lives of many people worldwide. Stroke statistics vary across the United States with the highest rates in the southeast. Physical therapy is often required to return to normal function. Appropriateness for physical therapy is based on individual impairments, thus access to and amount of physical therapy should not differ between races.

Methods: Using a South Carolina UB-92 data subset for 2002, univariate analysis is performed against physical therapy and race for ischemic stroke victims. Logistic regression is used to test for differences in access to physical therapy. Multiple linear regression is then used to assess differences between racial groups in the amount of physical therapy received. Goodness of fit is tested and results are interpreted and presented.

Results: After controlling for all covariates, race is not associated with access to physical therapy care. Variables associated with access to physical therapy are insurance, intensive care unit, length of stay, age, and Charlson score. Hosmer and Lemeshow test is significant ($p<0.01$) with 75% concordance. Multiple linear regression results indicate that blacks receive \$60 ($p<0.01$) less physical therapy than whites. Significant variables include length of stay, age, gender, and hospital size. The adjusted R-square is 0.35. When individuals that did not survive are removed from the analysis the results remain similar with an R-square of 0.45. Although there is no significant difference in access to physical thearpy, the whites receive more physical therapy than blacks. The under-utilization of physical therapy for African American patients may be

substantial given their high stroke burden and the resulting greater rehabilitation need for this group. Further studies are indicated to examine physical therapy treatment rates in surrounding states for stroke and other common cardiovascular conditions.

Introduction

Sudden interruption of blood supply to the brain by a blood clot or a broken blood vessel, otherwise known as a stroke or cerebrovascular accident (CVA) can lead to dramatic changes in the lifestyle of individuals and their families. A severe stroke can create a long hospital stay or result in immediate death. In the United States someone suffers a stroke every 40 seconds and every 3-4 minutes a stroke results in death.[1] Each year approximately 600,000 Americans experience a new stroke or 158 per 100,000 each year.[1] Among persons 45 to 64 years old, 8-12% of ischemic strokes (caused by blood clots) and 37-38% of hemorrhagic strokes (caused by bleeding) result in death within 30 days.[2] Stroke is the third leading cause of death among blacks when considered separately from other cardiovascular diseases behind diseases of the heart and cancer[1,3]. South Carolina is one of a group of states in the southeast that make up the 'stroke belt', due to higher prevalence, incidence, and mortality rates of cerebrovascular accidents.[1] Overall prevalence of stroke in blacks is 4.0% as compared to whites at 2.3%.[1] Blacks continue to have increased incidence and mortality relative to whites each year[1,4,5,6] with particular differences in younger cohorts.[4,7] Differentiation between recurrent and initial stroke with an average risk of initial stroke in blacks is almost twice that of their white counterparts.[8] Blacks have higher age and sex adjusted rates of disability resulting from ischemic stroke,[9] greater initial severity,[10] and greater residual physical deficits.[11,12] The etiology of stroke has been well studied and causal relationships have been established between stroke and elevated blood pressure[13]. Post stroke rehabilitation is an important

intervention to minimize disability from stroke, and early physical therapy (PT) is a very important part of stroke rehabilitation. PT aims to re-train the physical function lost or altered following a cerebrovascular accident. Retraining optimal motor function and sensory integrity for activity at the highest level possible and meaningful integration into society is paramount for patient success and future quality of life. Roughly 80% of stroke patients who receive PT are expected to need between 10-60 visits during a single continuous episode of care.[14] The optimization of post-stroke quality of life is important across all races and genders. If an already disproportionately disadvantaged group does not receive the care required for good functional outcomes, the current gap in health care inequalities could easily widen.[15] It has been shown that the amount and type of rehabilitation following a stroke are important in optimizing functional outcome.[16,17,18] Few studies have analyzed racial disparities of rehabilitation utilization following a stroke[19] and none have recently studied any state in the 'stroke belt', specifically South Carolina. We do not know if there are disparities of inpatient rehabilitation utilization following a stroke. Thus, we will identify post stroke African-Americans and Caucasians admitted to hospitals in South Carolina using the South Carolina hospital discharge dataset for all hospitalizations with a primary diagnosis of cerebrovascular accident (CVA) or stroke. First, we aim to determine if differences exist in the access to physical therapy services. Then, we will examine whether African-American stroke patients receive less inpatient physical therapy following stroke than their Caucasian counterparts.

Review of Literature

Historical Overview

Stroke or cerebrovascular accident has been described as a major health problem,[20] a catastrophic event affecting all aspects of an individual's life,[21] and a devastating disease that can cause death or serious disability.[22] Internationally, stroke consumes an estimated 2-4% of health-care costs, with industrialized countries like the United States accounting for more than 4% of direct health-care costs.[23] With such strong language it is no surprise that stroke is the third leading cause of death in the United States,[1,3] also representing a major cause of long term disability.[24] Xie et al reported in a study of 2.5% of the adult stroke survivors in the United States, survivors were generally older, less likely to be Hispanic, and more likely to live in the Midwest, and were disproportionately black[25]. The survivors also had a higher prevalence of co-morbid conditions such as hypertension, diabetes, coronary artery disease, heart disease, as well as noncardiovascular conditions.[25] Using four separate quality of life forms, Xie et al aimed to quantify the national impact of stroke on health related quality of life (HRQoL) in the noninstitutionalized population in the United States by analyzing the Medical Expenditure Panel Survey (MEPS). A secondary aim used the same MEPS dataset to assess the impact of stroke on disparities in HRQoL among demographic subgroups and previous disparities have been published. Quality of life was measured using the SF-12 (physical and mental health components), EQ-5D, and EQ VAS.[25] However, this study defined of a stroke survivor to include those individuals that have ever been diagnosed with a having had a stroke or a transient ischemic attack. High numbers of transient ischemic attacks may significantly alter the results since the recovery and functional deficits are not as severe thus biasing the HRQoL measures

toward the null hypothesis. After controlling for significant confounders, Xie et al reported that stroke significantly affects the quality of life of the survivors and future public health interventions should focus on developing culturally appropriate interventions for non-white populations.[25] The authors also stated that there are racial differences in the access and utilization of health care services following a stroke, with whites with greater access and enrolled more frequently than their non-white counterparts. The significance of stroke on the individual patient level is therefore apparent and every effort should be employed to reduce the amount of residual physical deficit following a stroke.

There is also a greater proportion of mortality among blacks with a national age adjusted death rate 35% higher for blacks than their white counterparts.[26] Among blacks stroke is the third leading cause of death for women and sixth for men[27] with an obvious world wide racial importance.[28] Blacks are at an increased risk compared with whites for death from both hemorrhagic and ischemic stroke.[29] Of the two stroke types it is accepted that hemorrhagic strokes occur more often and are more deadly. Acute medical management is vastly different between the two,[23] with different mechanisms to achieving neuro-cerebrovascular stabilization.

Contemporary Related Studies

In a 2005 review article of ethnic disparities in stroke, Stansbury and colleagues published a list of the current literature involving stroke and racial/ethic differences on common outcome measures.[4] Nearly every measure including incidence, mortality, acute care, delays to onset of care, tPA administration, length of stay, procedures, and rehabilitation all showed at least minimal differences among whites and their non-white counterparts. Most pertinent to this study is the current published literature on ethnic variations in rehabilitation. There is no clear

evidence indicating that ethnic designation was the greatest single predictor of PT nor that a greater proportion of black patients receive rehabilitation than whites.[4,7,19,30,37] The most poignant research states that there are greater residual disabilities for black stroke patients upon follow up.[4] Black patients also seem to have a delay in the initiation of rehabilitation with an overall trajectory of recovery later and less complete than their white counterparts.[4] The authors concluded with commentary on the importance for local data and its difference from any national study. Although national patterns are important and define the need for attending to stroke disparities, they may not prove to be reliable guides for local public health efforts or clinical praxis.[4] This is especially important to us as there are no current published studies on rehabilitation disparities in the stroke belt of the United States. "Large and persisting ethinic disparities in stroke mortality and the burden of disease are a priority issue for both public health and medical care."

Bhandari et al published a study in 2005 titled Racial disparities in outcomes of inpatient stroke rehabilitation.[30] The authors hypothesized that nonwhite patients would have less favorable outcomes than their white counterparts as they evaluated the association between race and outcomes of inpatient stroke rehabilitation. In a retrospective cohort study of post-stroke patients in a 42 bed community based inpatient rehabilitation facility between the years 2001 and 2005, 1591 patients met the initial inclusion criteria. Dependent variables included functional improvement at discharge from the rehabilitation facility, discharge disposition, and functional improvement at 3 months after discharge. The primary predictor was race, categorized as White, Black, Asian America, Hispanic, and other. The study collected a series of variables categorized into demographic, rehabilitative, and clinical. Multivariable linear regression model was used to

determine the effect of race on functional improvement at discharge and multivariable logistic regression model to determine the effect of race on discharge disposition. Using an admissible total of 1002 patients, the sample consisted of 42% white, 42% black, 10% Asian American, 3% Hispanic, and 3% other. Medicaid or dual coverage including Medicaid and Medicare was more likely to be the primary insurance in the non-white groups as compared to the whites. Blacks and Hispanics had a first stroke at a younger age than whites, or have suffered a previous stroke upon study initiation. There were no significant differences in the type of stroke, length of stay, interval between stroke onset and admission to stroke rehabilitation, or the intensity of total rehabilitation therapies provided at the rehabilitation facility. Black race was associated with significantly lower FIM score improvement at discharge, and home discharge with lower functional abilities when compared to whites. At three month follow-up blacks remained with lower FIM scores when compared to whites. The authors concluded that black stroke patients did not show as much functional gain from inpatient rehabilitation as whites, yet were more likely to be discharge to home which may be resultant from providers filtering options to black patients based on assumptions or expectations of patient preferences. Blacks were also found to experience less functional improvement from inpatient rehabilitation between admission and discharge than whites. In a 2006 study published in the American Journal of Physical Medicine and Rehabilitation, Gregory aimed to determine two things among stroke patients admitted to acute care hospitals in Maryland.[19] The first was the determination of factors associated with discharge to inpatient rehabilitation facilities, and second if racial disparities exist in discharge to inpatient rehabilitation facilities. This study utilized a statewide database that included all acute care hospitalizations to nonfederal hospitals in the state of Maryland from the calendar year

2000. This may limit the sample size as there may be a difference from individuals admitted to federal hospitals in Maryland. In a cross sectional retrospective study design, variables were collected and compared across black and white patients who comprised 98% of the total admissions. Variables collected included age, gender, marital status, geographic environment of residence, type of insurance, length of stay, and discharge disposition from the acute care hospital for strokes. Insurance type was limited to Medicare and other which is good for study power but may not provide enough information about the variability of patients within the other category. For example, patients with Medicare may present differently than Private Pay. One of the strengths of this study is the inclusion of stroke type. Hemorrhagic strokes are more severe with greater residual deficits than ischemic type strokes.[2] The utilization of the Charlson Comorbidity Index provides a good measure of individual severity which is a clinically important variable for functional outcome and receipt of rehabilitation services. The main outcome measure is discharge disposition from the acute care hospital, requiring a multiple logistic regression for the completion of the aims. An appropriate analytic plan is well outlined and followed in the results and tables presentations. The authors did not mention any a-priori power calculations nor sample size calculations. A total of 13,167 people were admitted for stroke and where thus included in the initial study design. Of those, only 12,208 survived to be discharged to destination and were included in the final analysis. However, the authors decided to include those individuals that died during the acute hospitalization for the univariate analysis. The authors found that people included in this study population blacks were more likely to be younger, female, unmarried, live in an urban setting, and have had a hemorrhagic stroke. Blacks also had a longer length of stay, even though levels of comorbid diseases were similar per the

calculated Charlson Comorbidity Indices. Blacks were more likely than whites to be discharged to inpatient rehabilitation facility or nursing home, and less likely to be discharged home or rehabilitation in a skilled nursing facility. Stratifying by urban or rural living status, negated these differences proving that where the patient lives may be a strong indicator for inpatient rehabilitation facility admission. The authors noted an overall increase admission in the rural setting as compared to the urban. Racial differences were not noted in the urban setting as they were in the rural environment. The final logistic regression model yielded that after controlling for other covariates, there was not a statistically significant association between black patients and discharge to inpatient rehabilitation facility. The factors that were associated were, living in an urban area, Medicare insurance, and length of stay. Interactions found significant were black patients living in an urban setting, and black patients who suffered a hemorrhagic stroke were more likely to be discharged to inpatient rehabilitation facility. These findings lead the authors to believe that the location of the patients provide the greatest barrier or access to rehabilitation facilities, not race. Most of the post stroke rehabilitation facilities are located in the urban environment so rural patients access to this care will be already limited. Insurance type is important because although more white patients had Medicare, prior approval was needed for non-Medicare insurance, which may also hinder access to proper rehabilitation. Increased length of stay was associated with admission to inpatient rehabilitation, which could be a factor of more time for insurance approval prior to discharge. The authors did not have any direct measures of stroke severity, but the surrogate measures used are commonly used and sufficient.[31, 32] Including better socioeconomic markers such as education level and income, as well as better markers of individual functional ability are suggestions for future research that can not be gained

from any large statewide database. The authors emphasize the importance of such a study in North and/or South Carolina as these states are considered the buckle of the stroke belt where minority populations have a greater burden of stroke morbidity and severity.[33]

A 2008 study published in Stroke by Ottenbacher and colleagues aimed to examine post stroke outcomes across different racial and ethnic groups.[37] They hypothesized that discharge setting will vary across racial and ethnic groups with non-Hispanic whites discharged home more frequently. This study used the Uniform Data System for Medical Rehabilitation (USDMR) which is the largest non-governmental national registry of standardized information on rehabilitation inpatients in the United States. This dataset includes all demographic and hospital charges as well as measures of function. Using a large sample of records from 828 hospitals in all 50 states records were collected and analyzed for study inclusion. Patients under 30 years old, with abnormally long length of stay, not meeting usual hospital admission categories were excluded, which reduced the total number of included subjects to 161,692 or 91% of the original sample. This study did not eliminate racial/ethnic categories, but they did collapse Asians, American Indians, Hawaiians and Pacific Islanders, and Alaskan Natives into one group. This does not allow for proper analysis of ethnicity between the members of the collapsed group. There could also be some protective cultural influences from these groups that may improve clinical outcomes. The statistical methodology included one way ANOVA with post hoc Chi-Square followed by hierarchical multivariable linear regression to estimate the effects of race/ethnicity on selected outcome measures. Logistic regression was then used to examine the effects of race/ethnicity on discharge setting. Non-Hispanic whites were more likely to be older, married, and less likely to be on Medicaid insurance, and have had a hemorrhagic stroke. Time

to inpatient rehabilitation from stroke was the shortest in the non-Hispanic whites who remained statistically significant after controlling for age and type of stroke. Length of stay was consistent across all racial/ethnic groups, and FIM ratings were found to be similar between the non-Hispanic whites and blacks at admission and discharge. In the oldest quartile of all subjects, the difference in FIM discharge scores between the non-Hispanic whites and blacks was higher than the lowest quartile. In both groups, non-Hispanic whites rated higher in the adjusted model. The unadjusted and adjusted analysis revealed that non-Hispanic whites were discharged home less frequently than blacks, Hispanics, and other minority groups. The authors ultimately concluded that there is a presence of disparities in post stroke outcomes for persons from minority populations.

Manuscript

Racial disparities of post stroke physical therapy in South Carolina

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Disclosures: None of the authors have any relevant disclosures.

Abstract

Background and Purpose: Stroke is a devastating event that drastically changes the lives of many people worldwide. Stroke statistics vary across the United States with the highest rates in the southeast. Physical therapy is often required to return to normal function. Appropriateness for physical therapy is based on individual impairments, thus access to and amount of physical therapy should not differ between races.

Methods: Using a South Carolina UB-92 dataset subset for 2002, univariate analysis is performed against physical therapy and race for ischemic stroke victims. Logistic regression is used to test for differences in access to physical therapy. Multiple linear regression is then used to assess differences between racial groups in the amount of physical therapy received. Goodness of fit is tested and results are interpreted and presented.

Results: After controlling for all covariates, race is not associated with access to physical therapy care. Variables associated with access to physical therapy are insurance, intensive care unit, length of stay, age, and Charlson score. Hosmer and Lemeshow test is significant ($p<0.01$) with 75% concordance. Multiple linear regression results state that blacks receive \$60 ($p<0.01$) less physical therapy than whites. Significant variables include length of stay, age, gender, and hospital size. The adjusted R-square is 0.35. When individuals that did not survive are removed from the analysis the results remain similar, with an R-square of 0.45. Although there is no significant difference in access to physical therapy, the whites receive more physical therapy than blacks. The true under-utilization may be even greater given the increased stroke burden on African Americans that should result in greater rehabilitation for this group. Future

studies are indicated for physical therapy treatment in surrounding states for stroke and other common cardiovascular conditions.

Key Words

Disparities, Physical Therapy, Stroke, South Carolina

Selected Abbreviations and Acronyms

CVA = Cerebrovascular Accident

ICU = Intensive Care Unit

PT = Physical Therapy

IRQ = Interquartile Range (25%-75%)

HMO = Health Maintenance Organization

UB92 = Uniform Budget reporting form 92

IRB = Internal Review Board

Introduction

Sudden interruption of blood supply to the brain by a blood clot or a broken blood vessel, otherwise known as a stroke or cerebrovascular accident (CVA) can lead to dramatic changes in the lifestyle of individuals and their families. A severe stroke can create a long hospital stay or result in immediate death. In the United States someone suffers a stroke every 40 seconds and every 3-4 minutes stroke results in death.[1] Each year approximately 600,000 Americans experience a new stroke or 158 per 100,000 each year.[1] Among persons 45 to 64 years old, 8-12% of ischemic strokes (caused by blood clots) and 37-38% of hemorrhagic strokes (caused by bleeding) result in death within 30 days.[2] Stroke is the third leading cause of death among blacks when considered separately from other cardiovascular diseases behind diseases of the heart and cancer[1,3]. South Carolina is one of a group of states in the southeast that make up the 'stroke belt', due to higher prevalence, incidence, and mortality rates of cerebrovascular accidents.[1] Overall prevalence of stroke in blacks is 4.0% as compared to whites at 2.3%.[1] Blacks continue to have increased incidence and mortality relative to whites each year[1,4,5,6] with particular differences in younger cohorts.[4,7] Differentiation between recurrent and initial stroke with an average risk of initial stroke in blacks almost twice that of their white counterparts.[8] Blacks have higher age and sex adjusted rates of disability in ischemic stroke,[9] greater initial severity,[10] and greater residual physical deficits.[11,12] The etiology of stroke has been well studied and causal relationships have been established between stroke and elevated blood pressure[13]. Post stroke rehabilitation is an important intervention to minimize disability from stroke, and early physical therapy (PT) is a very

important part of stroke rehabilitration. PT aims to re-train the physical function lost or altered following a cerebrovascular accident. Retraining optimal motor function and sensory integrity for activity at the highest level possible and meaningful integration into society is paramount for patient success and future quality of life. Roughly 80% of stroke patients who receive PT are expected to need between 10-60 visits during a single continuous episode of care.[14] The optimization of post-stroke quality of life is important across all races and genders. If an already disproportionately disadvantaged group does not receive the care required for good functional outcomes, the current gap in health care inequalities could easily widen.[15] It has been shown that the amount and type of rehabilitation following a stroke are important in optimizing functional outcome.[16,17,18] Few studies have analyzed racial disparities of rehabilitation utilization following a stroke[19] and none have recently studied any state in the 'stroke belt', specifically South Carolina. Thus we identified post stroke African-Americans and Caucasians admitted to hospitals in South Carolina using the South Carolina hospital discharge dataset for all hospitalizations with a primary diagnosis of ischemic cerebrovascular accident (CVA) or stroke. First, we aimed to determine if differences exist in the access to physical therapy services. Then we examined whether African-American stroke patients receive less inpatient physical therapy following stroke than their Caucasian counterparts.

Materials and Methods

The South Carolina electronic hospital discharge data set based on the 1992 Uniform Budget reporting form (UB92) was used for the analysis. The database was a compilation of information from patients hospitalized and discharged in 2002. Patient records were transcribed into the proper format and submitted to the Office of Research and Statistics in South Carolina.

Only one record per discharged patient including elderly and newborns was submitted per admission. Reporting and submission guidelines were clearly outlined in the document accompanying the database. This project was approved as a non-human research study by the Medical University of South Carolina's (MUSC) Institutional Review Board (IRB). All patient identifiers and hospital information were omitted and subjects described in the database were not contacted. This statewide database contained individuals with a primary diagnosis of stroke who were both admitted and discharged in 2002. The database was analyzed utilizing SAS 9.1 (Carey NC) with the assistance of faculty from the MUSC Department of Biostatistics.

Study population

This was a secondary data analysis of the South Carolina UB-92 dataset subset for patients with a primary diagnosis of ischemic stroke. This data contained information on patients admitted to any South Carolina hospital in the year 2002 with the primary diagnosis of ischemic stroke as identified by the International Classification of Diseases (ICD-9) codes 433-434 and 437. A total of 5041 observations all with at least one day of admitted stay were initially entered into the study. Patients of races other than Black or Non-Hispanic Whites were eliminated in order to obtain a clear dichotomous race exposure variable. All individuals resided in counties of South Carolina, North Carolina, or Georgia but were admitted only to South Carolina hospitals. The initial dataset contained approximately 140 variables available for analysis of which we selected the most clinically relevant and previously published for inclusion in this study.

Outcomes

Our main outcome measure was physical therapy, a continuous charge reported in United States Dollars (USD) ranging from $0 - $13,000. For the first stage of the analysis this variable

was dichotomized into two groups: did not receive therapy (PT charge = $0: n=1174) and did receive therapy (PT charge >$0: n=3817). The second stage of the analysis maintained the continuous nature of the physical therapy charge variable for the multiple linear regression model.

Variables

The independent variable of interest used in this analysis is patient race defined as either Caucasian/white or African-American/black. For our purposes Caucasian and white were considered synonymous as well as African-American and black. Once the data was manipulated to delete the observations that did not fall into either of these two racial categories the number of available observations decreased to 4991 with the same number of variables. Covariates were chosen based on previously published literature[7,12,19] as well as available variables with statistically significant associations with the outcome at p=0.05. Potential covariates included gender, type of health insurance, number of days in the intensive care unit (ICU), age, length of stay, size of hospital, and Charlson score. Gender was a dichotomous variable reported as either male or female. Type of health insurance was included as the primary payer source. This variable had nine levels (self pay, Medicare, Medicaid, commercial insurance, worker's compensation, indigent/charitable organization, other government, health maintenance organization, or not stated). These levels were collapsed into four categories: self pay, Medicare, private pay, and other government. Those with the value of not stated were subsequently deleted from the analysis. Intensive care unit days (ICU) was a continuous variable in the analysis. This variable was calculated as a summative measure of the adult and pediatric ICU days to ensure that all age groups were considered with the variable. Any observations with ICU stays in both

the pediatric and adult categories were questioned for data collection accuracy. The ICU variable was transformed into a dichotomous variable: either did or did not have any days in the ICU. Age was presented in the original dataset as a categorical variable with 20 levels. For the purposes of this analysis, we collapsed these levels into three age groups: Under 40, 40-65, and over 65 years old. Length of stay was measured as a continuous variable with each unit increase representing one full day. Hospital characteristics needed to be included and the number of beds served as an indicator for the size of the hospital. This variable was a three level categorical variable with levels indicating small (<100), medium (101-299), and large (300+). Charlson score was a summative, continuous indicator describing the severity of the individual, calculated using primary and multiple secondary diagnoses along with primary and secondary procedure codes. The Charlson score was a compilation of diagnostic and procedure codes of common disease processes including but not limited to: rheumatoid arthritis, cardiovascular, renal and hepatic diseases, AIDS, malignancies, and diabetes. Each individual was then assigned a summative total score representing their Charlson Score. A predictive propensity score was included to stratify according to the probability of each individual to receive physical therapy treatment. This scale was a five level equidistant predictive probability used to control for selection bias coded 0-4. Potential interactions were not included in this analysis.

Statistical Analysis

Univariate analysis was performed using Chi-Square and Student's independent two sample t-test or their non-parametric equivalent for categorical and continuous data respectively. A five level propensity score was calculated and included for stratification. All subjects were stratified based on their probability of getting physical therapy treatment. The five stratified

levels were equidistant and calculated from the probability of receiving physical therapy. Variables selected a priori were fit to a multiple logistic regression model to determine differences in access to physical therapy care. This step was repeated with only the variables that were statistically significant p=0.05 for the final logistic model. The same set of variables was fit to a linear regression model to investigate the differences in the amounts of physical therapy received between the two groups with and without the statistically significant variables (p=0.05). Finally, the logistic and linear regression model assumptions were checked along with an appropriate goodness of fit for both models. The analysis was then run without the individuals that have a discharge coding of expired (or died) and re-examined for statistical significance.

Results

A total of 5041 patients were admitted to South Carolina hospitals during the calendar year 2002 with a primary diagnosis of stroke. From this original data set 50 observations represented either Asian, American Indian, Hispanic, or other, and were eliminated from analysis. Of those 4991, black subjects numbered 1628 (33%) while the number of whites was 3363 (67%). Data were collected and assigned to one of three categories: personal, health care, and hospital. Characteristics of the study population with corresponding statistical significance are presented in Table 1. When compared to their white counterparts, blacks were more likely to be 40-65 years old, have primary insurance other than Medicare, and longer length of stay. Gender was approximately equally distributed across the two races. Initially it appeared that there was a difference in the access to physical therapy, with blacks being the greater proportion of recipients of services (p=0.01). Statistically significant racial differences were not found for

gender. The Charlson score ranged from 1-11 for all observations. The number of days in the ICU ranged from 0-32 for whites and 0-48 for blacks but both were heavily right skewed.

Table 1: Characteristics of the Study Population

Variables	White Frequency (%) n = 3363 (67%)	Black Frequency (%) n = 1628 (33%)	p-value
Personal Characteristics			
Physical Therapy Received †			0.01
No	826 (25)	348 (21)	
Yes	2537 (75)	1280 (79)	
Age Group †			<0.01
Under 40	59 (2)	39 (2)	
40-65	793 (24)	700 (43)	
65 and above	2511 (75)	889 (55)	
Gender †			0.83
Male	1515 (45)	728 (45)	
Female	1848 (55)	900 (55)	
Healthcare Characteristics			
Primary Insurance †			<0.01
Self Pay	85 (3)	113 (7)	
Medicare	2631(79)	1039 (64)	
Private	515 (15)	265 (16)	
Other Government	120 (4)	203 (13)	
Length of Stay median,(IQR) ‡	5 (3,8)	5 (4,10)	<0.01
Number of Days in ICU median,(IQR) ‡	0 (0,0)	0 (0,0)	0.01
Charlson Score median,(IQR) ‡	2 (1,3)	2 (1,3)	<0.01
Hospital Characteristics			
Number of Beds †			<0.01
Under 100	336 (10)	145 (9)	
101-299	1723 (51)	755 (46)	
300 and above	1299 (39)	728 (45)	

† Chi-Square or Mantel-Haenszel Chi-Square
‡ Wilcoxon Rank-Sum

More information is provided in table 2 analyzing the differences in those that did or did not receive physical therapy. Gender was not statistically different between those that did and

did not receive PT. A difference was noted between those that did and did not receive physical therapy in terms of race, age group, insurance status, length of stay, Charlson Score, and number of beds. Those that did receive physical therapy were more likely to be black, over age 65, have Medicare as their primary insurance, and be treated in a larger hospital.

Table 2: Access to Physical Therapy Services post Stroke			
Variables	Did NOT Receive PT Frequency (%)	Did receive PT Frequency (%)	p-value
	n = 1174	n = 3817	
Personal Characteristics			
Race †			0.01
White	826 (70)	2537(66)	
Black	348 (30)	1280 (34)	
Age Group †			<0.01
Under 40	37 (3)	61 (2)	
40-65	409 (35)	1084 (28)	
65 and above	728 (62)	2672 (70)	
Gender †			0.72
Male	533 (45)	1710 (45)	
Female	641 (55)	2107 (55)	
Healthcare Characteristics			
Primary Insurance †			<0.01
Self Pay	44 (4)	154 (4)	
Medicare	785 (67)	2885 (76)	
Private	267 (23)	513 (13)	
Other Government	73 (6)	250 (7)	
Length of Stay median,(IQR) ‡	3.0 (2,5)	6 (4,10)	<0.01
Days in ICU median,(IQR) ‡	0 (0,0)	0 (0,0)	0.72
Charlson Score median,(IQR) ‡	2 (1,2)	2 (1,3)	<0.01
Hospital Characteristics			
Number of Beds †			0.04
Under 100	122 (10)	359 (9)	
101-299	612 (52)	1866 (49)	
300 and above	440 (37)	1587 (41)	
† Chi-Square ‡ Wilcoxon Rank-Sum			

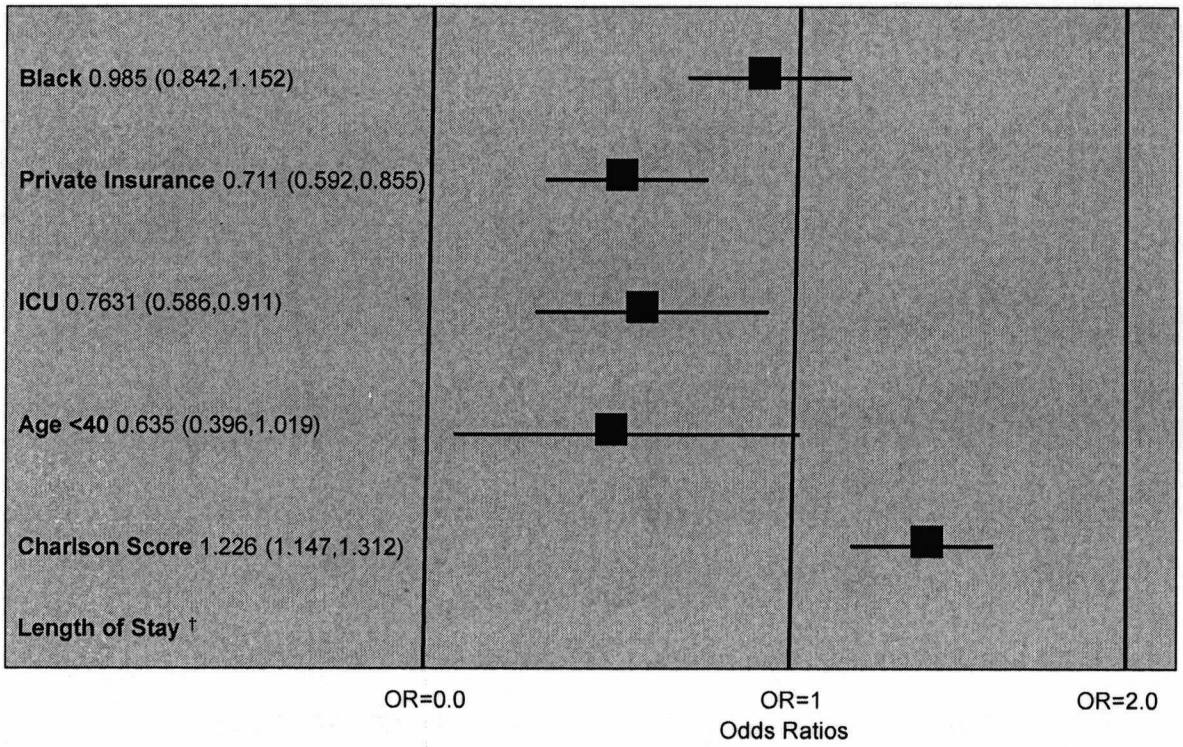
Among those that did receive physical therapy, table 3 outlines the charges received for each characteristic. Among those that received physical therapy, other government insurance, increased length of stay, number of days in the ICU, Charlson Score, the number of beds and age group, were associated with increased physical therapy charges. Individuals under age 40 were more likely to incur higher physical therapy charges. An association between race and increased PT charges was not detected.

Table 3: Statistics of Physical Therapy Recipients		
Variable	Physical Therapy Charge median (IQR) n = 3817	p-value
Personal Characteristics		
Race †		0.06
White	400 (200,700)	
Black	400 (200,700)	
Age Group ‡		0.04
Under 40	500 (200,900)	
40-65	400 (200,700)	
65 and above	400 (200,700)	
Gender †		0.93
Male	400 (200,700)	
Female	400 (200,700)	
Healthcare Characteristics		
Primary Insurance ‡		<0.01
Self Pay	400 (200,800)	
Medicare	400 (200,700)	
Private	400 (200,700)	
Other Government	500 (300,1000)	
Length of Stay *	0.612	<0.01
Number of Days in ICU *	0.122	<0.01
Charlson Score *	0.084	<0.01
Hospital Characteristics		
Number of Beds ‡		<0.01
Under 100	500 (300,900)	
101-299	400 (200,700)	
300 and above	500 (300,800)	
† Wilcoxon Rank-Sum ‡ Kruskal-Wallis * Spearman Correlation Coefficient		

Of the 4991 original observations, 4966 were used in the adjusted analysis and 25 were deleted for missing values. Of the 25 missing values, 20 (80%) were deleted because of missing primary payer values, and 5 (20%) from the number of beds variable. The adjusted analysis odds ratios for the first aim are presented in Figure 1. After controlling for other covariates, there was not a statistically significant association detected between race and receipt of physical therapy ($p = 0.85$). Factors associated with access to physical therapy services included private insurance ($p<0.01$), length of stay in the ICU ($p <0.01$), age less than 40 ($p=0.05$), length of stay ($p<0.01$), and Charlson Score ($p<0.01$). From these results we see that race was not significantly associated with the access to physical therapy services. With an odds ratio of 0.985 and 95% confidence intervals from 0.842-1.152 we concluded that race was not the primary predictor of access to acute physical therapy care following a stroke. Hosmer and Lemeshow goodness of fit test resulted in a p-value < 0.01 indicating that this model is a good representation of the data analyzed. This logistic regression model also resulted in a substantial 76% concordance.

Figure 1: Access to Physical Therapy

Statistically significant variables only



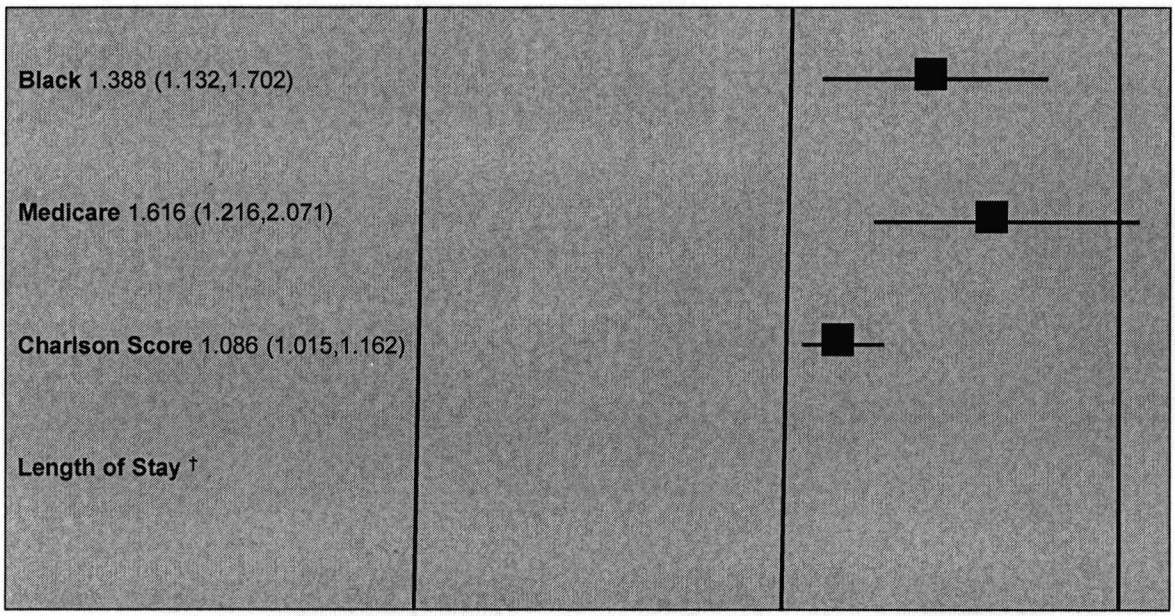
† Length of stay is statistically associated with access to physical therapy p<0.01

Hosmer and Lemeshow test: Chi-Sq=32.07 p<0.01

We took an extra step to look into any potential racial disparities with regards to discharge from inpatient hospital to rehabilitation facilities. Table 2 demonstrates that there is a 38% increase in the probability of discharge to a rehabilitation facility for black post stroke patients ($p<0.01$). Charlson Score and Medicare insurance were associated with a 62% ($p=0.02$) and 9% ($p<0.01$) increase in probability of discharge to rehabilitation center respectively. This model had a 59% concordance and a Hosmer and Lemeshow goodness of fit test result ($p=0.07$).

Figure 2: Discharge to Rehabilitation Center

Statistically significant variables only



† Length of stay is statistically associated with access to physical therapy p<0.01

Hosmer and Lemeshow: Chi-Sq=14.49 p=0.07

Of those that received physical therapy, 3817 remained eligible for final linear analysis. The amount of physical therapy services received, measured in United States Dollars (USD) charges, were determined to be not significant (p=0.144) in the unadjusted model. Multiple adjusted models were run. The first contained all variables of interest and the final model has all non-significant (p>0.05) variables removed presented in table 4. Black race was associated with $61 less charged physical therapy services per hospital admission when compared to whites. When compared to middle age patients 40-65, individuals under 40 receive an average of $230 (p<0.01) more physical therapy, and those over 65 receive $93 less (p<0.01). Females receive

$41 less physical therapy than males (p=0.04). Hospital size is also significant with small hospitals providing $342 more physical therapy care to post stroke. This linear regression model has an adjusted R-square of 35%.

Table 4: Amount of Physical Therapy Received		
Variable	Parameter Estimate	p-value
Black	-60.68	<0.01
Length of Stay	1377.98	<0.01
Under 40	230.09	<0.01
Over 65	-92.64	<0.01
Female	-40.69	0.04
Small Hospital	341.62	<0.01
Large Hospital	49.42	0.02

When those that 'expired' (died), 'expired in medical facility', and 'expired at an unknown place' are removed from the dataset, the results are similar. Table 5 shows the final linear regression with the remaining variables that were statistically significant for survivors. Black subjects receive $65 (p<0.01) less physical therapy than whites, and females receive $40 less than males (p<0.01). As compared to middle age, individuals under 40 years old receive $207 more PT (p<0.01) and those over 65 receive $100 less physical therapy (p<0.01). Consistent with the previous model the smaller hospitals give $340 (p<0.01) more physical therapy than medium sized hospitals and $53 more in large hospitals (p=0.01). The R-square is 36%.

Table 5: Amount of Physical Therapy Received (Among those individuals that survived)		
Variable	Parameter Estimate	p-value
Black	-65.8	<0.01
Length of Stay (Log)	1447.42	<0.01
Under 40	207.16	<0.01
Over 65	-100.18	<0.01
Female	-40.29	<0.01
Small Hospital	340.03	<0.01
Large Hospital	53.06	0.01

Table 6 presents the final results for this study. When controlling for the average of all available characteristics, we find that white men receive a greater amount of physical therapy than any other gender/race group per hospitalization. Black women receive significantly less physical therapy than white men on the average of $100 less per hospitalization.

Table 6: Mean Physical Therapy Charge per Hospitalization			
		Gender	
		Male	Female
Race	White	$663	$623
	Black	$563	$562

Discussion

Increased mortality and incidence rates for multiple cardiovascular-pulmonary diseases have earned the southeast the distinction of being the stroke belt of the United States. South

Carolina is the center of the stroke belt and arguably one of the most devastating examples of personal health care responsibility gone wrong. There is not a large amount of literature aimed at the consequences of the cerebrovascular accident within the stroke belt. This absence of quality research prompted this research inquiry. Similar to the commonly understood reality of the black stroke patient, in our study population blacks were more likely to be in the younger age group categories than whites,[4,7] while whites were more likely to have Medicare.[20]

In this study we aimed to determine if there is a difference in physical therapy service utilization following a stroke, which is a common necessity to return to normal daily function. Potential interactions are not included in this analysis because there is no published evidence supporting their use in this type of analysis that is compatible with available data. Previous studies did include the interactions such as race and stroke type, which we are unable to assess at this time. Initial unadjusted analysis found that race is significantly associated with access to physical therapy. Access to physical therapy is defined as either receiving or not receiving physical therapy rehabilitation. If physical therapy was consulted, and an evaluation is performed, a charge would appear for physical therapy services. Thus we conclude two things. First, consumer/patient access to physical therapy is equal between whites and blacks following an ischemic stroke in South Carolina. Second, physician/provider referrals to physical therapy services do not differ between whites and blacks. A previous study by Kuhlemeier and Steins found no racial differences in the referral rates to rehabilitation among stroke patients.[21] The most significant predictors of access to physical therapy are Charlson Score and length of stay, two clinically obvious factors. Anyone in the hospital long enough will most likely result in a weakened state requiring rehabilitation. Black patients have a longer length of stay under the

unadjusted analysis and this may have increased their likelihood of access to physical therapy services. A high number of comorbidities will also increase the potential need for physical therapy services to improve functional abilities prior to discharge. Initially Charlson score was applied to general medical records to predict mortality rates,[22] but the Charlson score has been successfully altered for individuals with stroke. In coding the Charlson score it is important to note that there are no zero values as stroke is one of the co-morbidities included in the scoring analysis. Unexpectedly we found that an increase in the number of days spent in the intensive care unit is associated with decreased odds of receiving physical therapy. Perhaps the individuals in the ICU are determined to be sicker and thus do not receive extensive physical therapy prior to discharge from the acute care setting of the hospital. Clinically those individuals that are in the ICU longer may suffer greater residual deficits requiring more physical therapy, or may be too involved and thus not appropriate for normal physical therapy intervention. Perhaps the discharge destination of these patients represents a larger proportion into skilled nursing facilities rather than discharge home. We did find that blacks, patients with Medicare, and an increased length of stay were more likely to be discharged to a rehabilitation center. This is likely to alter the results if a follow up study is performed to include all facets of post stroke rehabilitation.

In answering the second aim of this research, we found $61 lower physical therapy charges for the black cohort versus their white counterparts. The reasons for this are not currently known but it has been previously suggested that there may be potential racial bias among health care workers. Our final results demonstrate differences in amount of physical therapy received with an apparent interaction between race and gender. The order of receipt of

physical therapy by charges recorded is: white men, white women, black men, and finally black women. It is apparent that whites receive greater amounts physical therapy, with the clear disparity of white men and black women. If randomization is not possible or ethical the utilization of a propensity score reduces the potential for bias.[22] Calculation of a propensity score is similar to performing a post-hoc stratification with adjustments for the effects of all potential confounders. Rosenbaum and Rubin showed that the inclusion of five strata suffice to eliminate greater than 90% of bias.[23] The use of a propensity score is important in this research attempt as its inclusion in the regression models accounts for the probability of getting physical therapy. This calculated propensity score is a stratification tool and is used as a prediction and not an actual value. The included propensity score used has 5 levels that are equidistant in regards to calculated risk of receiving PT following a stroke. This also allows the regression analysis to compare across the five levels of propensity score. Ruben published a paper stating that when used appropriately, propensity controls for 90% of variation, similar to that of randomization techniques.[23] This is an epidemiological approach to removing selection bias from retrospective data analysis.

With an R-square value of 35%, this model accounts for more than one third of the total variation seen in the data. The inclusion of more variables may provide a better explanation of racial difference seen in physical therapy utilization following a stroke that we were not able to obtain from this retrospective database. Previous studies have used variables such as stroke type,[19,24] residential status,[19] geographic location of the hospital[7], medical conditions associated with the stroke such as levels of current and prior physical function[7], and if possible differences in acute hospital management.[4]

This study does not aim to investigate differences among ethnic groups which may prove more significant than race. However race as the independent variable, most notably black/white, is a common practice in similar retrospective studies.[19, 25]

This research is important because macrolevel data may not apply to local specificities or problems that impact minority populations.[4] National-level data are rarely sufficient to help determine the problems and differences exist in smaller geographic areas.[26] This is the first study of its kind analyzing racial disparities in physical therapy care of any state in the stroke belt. This study could lead to increased care of a disproportionately disadvantaged racial group, leading to better functional outcomes and less care giver burden, and narrowing the gap in the care of cardiovascular disparities in the southeast United States. Our results demonstrate that there is no difference in access to physical therapy services based on race, but the amount of service provided does differ between black and white patients. Our study highlights two meaningful questions that are important to addressing health care disparities to one of the most significant health conditions affecting the United States today.

Study Strengths and Limitations

To date this is the first study of its kind, analyzing a key state in the United States stroke belt for differences in physical therapy intervention post stroke. The database utilized included all hospital admissions with the primary diagnosis of cerebrovascular accident in the year 2002. Adequate sample size with few observations removed from final analysis provides good information. Although South Carolina does not have racial proportions directly resembling the United States, the proportions are similar enough to draw some meaningful conclusions. However, the racial distribution of this study is very similar to the entire southeast.

As our data set only contains ischemic stroke diagnosis codes, this study can not take into account the potential differences observed between hemorrhagic and ischemic stroke subtypes. Hemorrhagic strokes typically are associated with increased severity and increased need for PT. It is well published that there are differences in mortality rates, as well as residual deficits[19] depending upon type and region but we were unable to control for this potential confounder. This study also uses hospital charges as a surrogate for amount of physical therapy care received. Although hospital charges are standardized under the Joint Commission of Hospital and Organizations (JCHAO), minor variation and potential billing errors may affect the data. We have to assume that charges received for each individual are correct and complete. If there are errors in billing data it is not unreasonable to believe that this would be due to chance and thus evenly distributed across racial groups. The relative amount of therapy may not be a good surrogate for functional outcomes. A healthy pre-stroke individual may respond differently to injury than an unhealthy counterpart and thus require less physical therapy intervention for the achievement of functional goals. It is clear that functional outcomes are achieved with thorough and extensive physical therapy intervention, but national health care cuts may be leaving our patients, especially the black cohort with disproportionate and often dangerous long term physical dysfunction. We also did not include interaction terms a-priori as there are no previously published significant pairings that are available in our dataset. Even in posteriori analysis of a select group of interaction terms did not yield any meaningful or statistically significant results.

Conclusion

Utilizing a state wide hospital dataset from 2002, we found that the access to physical therapy following an ischemic stroke does not differ between whites and blacks in South Carolina. However, with equal opportunity for care, whites did receive a greater amount of physical therapy services than their black counterparts as measured in hospital charges. This research suggests potential racial disparities in the utilization of physical therapy services and warrants further investigation in similar states of the stroke belt to confirm our results, and initiate programs to eliminate this difference.

Acknowledgements

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Summary and Limitations

Discussion

Increased mortality and incidence rates for multiple cardiovascular-pulmonary diseases have earned the southeast the distinction of being the stroke belt of the United States. South Carolina is the center of the stroke belt and arguably one of the most devastating examples of personal health care responsibility gone wrong. There is not a large amount of literature aimed at the consequences of the cerebrovascular accident within the stroke belt. Similar to commonly understood reality of the black stroke patient, in our study population blacks were more likely to be in the younger age group categories than whites,[4,7] while whites were more likely to have Medicare. [30]

In this study we aimed to determine if there is a difference in physical therapy service utilization following a stroke, which is a common necessity to return to normal daily function. Potential interactions are not included in this analysis because there is no published evidence supporting their use in this type of analysis that is compatible with data available in this dataset. Previous studies did include the interactions such as race x stroke type, which we are unable to assess at this time. Initial unadjusted analysis found that race is significantly associated with access to physical therapy. We have defined access to physical therapy, as either receiving or not receiving physical therapy rehabilitation. If physical therapy was consulted, and an evaluation is performed, a charge would appear for physical therapy services. From this we can conclude two things. First, consumer/patient access to physical therapy is equal between whites and blacks following an ischemic stroke in South Carolina. Second, physician/provider referrals

to physical therapy services do not differ between whites and blacks. A previous study by Kuhlemeier and Steins found no racial differences in the referral rates to rehabilitation among stroke patients.[34] The most significant predictors of access to physical therapy are Charlson Score and length of stay, two clinically obvious factors. Anyone in the hospital long enough will most likely result in a weakened state requiring rehabilitation. Black patients have a longer length of stay under the unadjusted analysis and this may have increased their likelihood of access to physical therapy services. A high number of comorbidities will also increase the potential need of an individual for physical therapy services to improve functional abilities prior to discharge. Initially Charlson score was applied to general medical records to predict mortality rates,[35] but the Charlson score has been successfully altered for individuals with stroke. In coding the Charleson score it is important to note that there are no zero values as stroke is one of the co-morbidities included in the scoring analysis. An increase in the number of days spent in the intensive care unit is associated with decreased odds of receiving physical therapy. Perhaps the individuals in the ICU are determined to be sicker and thus do not receive extensive physical therapy prior to discharge from the acute care setting of the hospital. Clinically those individuals that are in the ICU longer may suffer greater residual deficits requiring more physical therapy, or may be too involved and thus not appropriate for normal physical therapy intervention. Perhaps the discharge destination of these patients represents a larger proportion into skilled nursing facilities rather than discharge home. We did find that blacks, patients with Medicare, and an increased length of stay were more likely to be discharged to a rehabilitation center. This is likely to alter the results if a follow up study is performed to include all facets of post stroke rehabilitation.

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With an R-square value of 35%, this model accounts for over one third of the total variation seen in the data. The inclusion of more variables may provide a better explanation of racial difference seen in physical therapy utilization following a stroke that we were not able to obtain from this retrospective database. Previous studies have used variables such as stroke type,[19,20] residential status,[19] geographic location of the hospital[7], medical conditions associated with the stroke such as levels of current and prior physical function[7], and if possible differences in acute hospital management.[4]

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This research is important because macrolevel data may not apply to local specificities or problems that impact minority populations.[4] Often national-level data are rarely sufficient to help determine the problems and differences relevant to smaller geographic areas.[38] This is the first study of its kind analyzing any state racial disparities in physical therapy care in the stroke belt. This study could lead to increased care of a disproportionately disadvantaged racial group, leading to better functional outcomes and less care giver burden, and narrowing the gap in the are of cardiovascular disparities in the southeast United States.

Our results demonstrate that there is no difference in access to physical therapy services based on race, but the amount of service provided does statistically differ between black and white patients. Our study highlights two meaningful questions that are important to addressing health care disparities to one of the most significant health conditions affecting the United States today.

Study Strengths and Limitations

To date this is the first study of its kind, analyzing a key state in the United States stroke belt for differences in physical therapy intervention post stroke. The database utilized included all hospital admissions with the primary diagnosis of cerebrovascular accident in the year 2002. Adequate sample size with few observations removed from final analysis provides good information. South Carolina does show racial proportions similar to that of the United States, and relates more closely with the southeast in terms of total demographic make-up.

As our data set only contains ischemic stroke diagnosis codes, this study can not take into account the potential differences observed between hemorrhagic and ischemic stroke subtypes. It is well published that there are differences in mortality rates, as well as residual deficits[19] depending upon type and region but we were unable to control for this potential confounder. This study also uses hospital charges as a surrogate for amount of physical therapy care received. Although hospital charges are standardized under the Joint Commission of Hospital and Organizations (JCHAO), minor variation and potential billing errors may affect the data. We have to assume that charges received for each individual are correct and complete. If there are errors in billing data it is not unreasonable to believe that this would be due to chance and thus evenly distributed across racial groups. The relative amount of therapy may not be a good surrogate for functional outcomes. A healthy pre stroke individual may respond differently to injury than their unhealthy counterpart and thus require less physical therapy intervention for the achievement of functional goals. It is clear that functional outcomes are achieved with thorough and extensive physical therapy intervention, but national health care cuts may be leaving our

patients, especially the black cohort with disproportionate and often dangerous long term physical dysfunction. We also did not include interaction terms a-priori as there are no previously published significant pairings that are available in our dataset. Even in posteriori analysis of a select group of interaction terms did not yield any meaningful or statistically significant results.

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not yield any meaningful or statistically significant results. The statistics utilized in this analysis are beneficial, but a more complicated program including macro may be beneficial for the most accurate results due to the non-normal nature of the data. This study followed the statistical analysis used in similar publications[19, 37], which may be sufficient for publication but could be improved upon in future publication attempts.

Conclusion

Utilizing a state wide hospital dataset from 2002, we found that the access to physical therapy following an ischemic stroke does not differ between whites and blacks in South Carolina. However, with equal opportunity to care, whites did receive a greater amount of physical therapy services than their black counterparts as measured in hospital charges. Patients that are African-American, have Medicare insurance, with an increased length of stay, and a higher Charlson score all demonstrate an increased possibility to be discharged from acute care to a rehabilitation facility. White males receive more than $100 in physical therapy care over black females following an ischemic stroke in South Carolina hospitals. This research suggests potential racial disparities in the utilization of physical therapy services and warrants further investigation in similar states of the stroke belt to confirm our results, and initiate programs to eliminate this difference.

Future directions

Large long term studies need to be performed including functional status markers such as Functional Independence Measures (FIM) scores, to determine if the amount of physical therapy difference between races affects ultimate rehabilitation success. Including hemorrhagic stroke subtypes and interaction terms in future studies, along with all facets of rehabilitation following a stroke will provide greater information. Further exploration is needed in the stroke belt for potential racial differences in physical therapy care as well as any area of rehabilitation including occupational therapy and speech language pathology. The lack of research in physical therapy literature describing potential or actual disparities should also be explored and addressed both locally and nationally.

Personal Future Directions

In the future I plan to continue my clinical research in the area of neuromusculoskeletal physical therapy. Current ideas include the concept of overtraining ie running/jumping on return to functional ambulation post stroke, the utilization of passive and active assistive robotics for pre gait training post stroke, and a collaborative study involving stem cell implementation following stroke or spinal cord injury and differences functional outcomes achieved.

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