RISK, FUNCTIONAL OUTCOMES, AND THE UTILIZATION OF REHABILITATION SERVICES AMONG SURVIVORS OF CEREBROVASCULAR ACCIDENT: A POOLED, CROSS-SECTIONAL POPULATION-BASED STUDY

by

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LIST OF ABBREVIATIONS

AHA: American Heart Association

ASA: American Stroke Association

BMI: Body Mass Index

CMS: Centers for Medicare and Medicaid Services

CPT: Current Procedural Terminology

CVA: Cerebrovascular Accident

HCPCS: Healthcare Common Procedure Coding System

HRS: Health and Retirement Study

ICD-9: International Classification of Diseases, Volume 9

ICF: International Classification of Functioning, Disability, and Health

OT: Occupational Therapy (Therapist)

PT: Physical Therapy (Therapist)

SLP: Speech-Language Pathology (Pathologist)

SES: Socioeconomic Status

tPA: Tissue Plasminogen Activator

WHO: World Health Organization

Risk, Functional Outcomes, and the Utilization of Rehabilitation Services among Survivors of Cerebrovascular Accident: A Pooled, Cross-Sectional Population-Based Study

Abstract

by

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Many studies conducted on risk factors for cerebrovascular accident (CVA) rely on homogeneous populations from small geographic areas and lack information about relevant personal and clinical features. Very few studies have looked at long-term functional ability following CVA. CVA clinical guidelines for recommend on-going use of rehabilitation by CVA survivors, but little is known about the extent to which this occurs. The Health and Retirement Study, a nationally, representative sample from the US, and linked Medicare claims data were used to study incidence and effects of first CVA, functional ability of CVA survivors, and the utilization of rehabilitation by survivors. The data were pooled cross-sectionally and Generalized Estimating Equations were utilized as the primary analysis method. Results confirm previous findings that age, gender, and smoking status increase CVA risk. The study also found that: 1) Individuals who were disabled had increased risk for CVA. 2) Age, education, and overweight BMI had a significant effect on the odds of dying in those sustaining a CVA. 3) Of those who survived CVA more than 2 years, age and type of CVA were predictive of worse functional ability. 4) Age, race, co-morbidity, current use of rehabilitation, and depressive symptoms were all associated with worse post-CVA functional ability. 5) Employment status and physical activity behaviors at baseline, better cognition, social support, and mild initial severity of CVA were all predictive of better post-CVA functional ability. 6) Age, type of CVA, and recurrent CVA were the primary predictors of rehabilitation use. 7) Those who were employed at baseline used less rehabilitation services overall. Study findings suggest that 1) the role of employment and BMI in CVA risk and severity should be further studied; 2).attention by healthcare providers to post-CVA depression, cognition, and social support might improve CVA survivors' functional ability; and 3) health system factors, such as medical provider knowledge and attitudes about rehabilitation services, may need to be studied to understand variation in CVA clinical guideline implementation. Overall, this study demonstrates the value of using large databases to study utilization of rehabilitation services.

CHAPTER 1: INTRODUCTION TO THE STUDY

Problem Statement

Each year, approximately 795,000 people in the United States sustain a cerebrovascular accident (CVA). CVAs, along with other cerebrovascular diseases, are estimated to be the leading cause of death from non-communicable disease worldwide (Go et al, 2013; World Health Organization [WHO], 2013). Case mortality rate from CVA is approximately 22.9% within 1 month of onset. (Feigin et al, 2003) Many individuals who survive a CVA develop some level of disability. When utilizing disability-adjusted life years (DALYs), it ranks as the 6th leading cause of disability worldwide. (WHO, 2013) Medical advances, including improved preventative and acute care efforts, have led to declining mortality rates from CVA; however, as the number of those who survive increases, so does the number of people faced with disability. (Schwamm, et al, 2010; Desrosiers, et al, 2002) Not only is the disability that CVA imposes a problem for individuals, but direct and indirect care has serious financial consequences. It is estimated that, on average, 0.27% of a nation's gross domestic product is spent on CVA and that CVA accounts for approximately 3% of total health care expenditures. (Demaershchalk, Hwang, & Leung, 2010; Evers, et al, 2004)

Many experts study predictors of CVA risk along with interventions that will improve survival and minimize sequelae for those who sustain a CVA. As an example, a recent review from the American Heart Association (AHA) and American Stroke Associations (ASA) that focused on the acute management and prevention of CVA created improved care pathways for the prevention and early management of CVA (Schwamm, et al, 2010). This type of research aids in understanding incidence of CVA and the multitude of factors that influence CVA risk. However, there is no clear evidence on how baseline factors, medical conditions, and social-environmental factors, when taken together, influence the risk of CVA since many people who possess a number of these risk factors never sustain a CVA. Previous work has not provided an accurate picture of all these risk factors.

In addition, how survivors of CVA regain functional ability is poorly understood. The immediate, acute phase of recovery from CVA has been studied; however, the discussion has focused on survival and mortality, not the daily functional abilities of survivors. Research has not focused on functional ability patterns and what factors influence functional abilities following CVA. It is important to understand the functional abilities of survivors of CVA, since any disability experienced has medical, functional, and social consequences. Decreased functional abilities also necessitate increased assistance from family, friends, and community agencies.

Occupational therapy (OT), physical therapy (PT), and speech language pathology (SLP) are rehabilitation professions whose primary focus is to restore function in individuals who have disability and dysfunction in motor and/or cognitive domains. Rehabilitation services are frequently prescribed for individuals following a CVA. International guidelines for CVA support the use of rehabilitation services by both short-term and long-term survivors of CVA, however it appears that the guidelines are not well adopted. Clinical guidelines in the US advocate multidisciplinary involvement to improve the functional recovery of individuals following CVA and support practice to prevent functional decline. (National Stroke Foundation [NSF], 2010) However, studies suggest that individuals do not routinely follow the guidelines, with as little as 30% of survivors being seen by rehabilitation professionals in a given year.

This study aimed to answer the following questions: 1) How do incidence and severity of CVA in older adults differ by demographic characteristics, co-morbidity, and personal lifestyle factors, 2) What factors contribute to level of disability among survivors of CVA over time, and 3) What factors are associated with participation and level of utilization of rehabilitation among long-term survivors of CVA. By answering these questions, it was hoped that factors that influence both incident and severity of CVA would be better understood. In addition, by understanding the functional ability of CVA survivors over time, it would support interventions for both individuals and families who are affected by CVA. Finally, rehabilitation services that are recommended by international guidelines for CVA care might be viewed as a viable way to prevent functional decline or to improve functional ability among survivors of CVA.

Questions, Aims, and Hypotheses

Question 1 (Table 1). How do incidence and severity of CVA in older adults differ by demographic characteristics, co-morbidity, and personal lifestyle factors?

Aim 1. Describe CVA incidence by a.) demographic characteristics, b.) co-morbidity, and c.) baseline personal lifestyle factors.

Aim 2. Describe CVA severity by a.) demographic characteristics, b.) co-morbidity, and c.) baseline personal lifestyle factors

Table 1

Hypotheses - Question 1: Aims 1 and 2

	Outcome Measures	
	Incidence of CVA (yes/no)	Severity of CVA (death and index of severity)
Health Condition: Disease disorder, injury, or trauma		
Number of co-morbidities	Incidence increases with multiple morbidity	Severity increases with multiple morbidity
Personal Factors: Demographic Characteristics		
Age	Incidence increases as age increases	Severity increases as age increases
Gender	Incidence rate increases in men <85 and women >85	Severity increases in women
Race	Incidence rates increase in black individuals	Severity increases in black individuals
Ethnicity	Incidence rates increase in those who identify as Hispanic or Latino	Severity increased in those who identify as Hispanic or Latino
SES	Incidence rates increase in lower SES categories	Severity increases in lower SES categories
Personal Factors: Baseline Personal Lifestyle Factors		
Presence of physician visit in previous 12 months	Incidence of CVA increases in those who indicate physician visit in previous 12 months	Severity increases in those who report visit with a regular physician in the previous 12 months
Smoking behaviors	Incidence increases with presence of smoking	Severity increases in the presence of smoking
Drinking behaviors	Incidence increases in heavy drinkers	Severity of CVA increases in heavy drinkers
Physical activity behaviors	Incidence decreases in the presence of physical activity	Severity of CVA decreases in the presence of vigorous physical activity
Work status	Incidence of CVA increases in those individuals who are not working	Work status will have no effect on severity
Body mass index	Incidence increases in obese individuals	Severity increases in obese individuals

Question 2 (Table 2). What factors contribute to level of disability among survivors of CVA over time?

Aim 3. Examine how health condition (co-morbidity, CVA type and severity, and presence of new incident CVA), demographic characteristics, baseline personal lifestyle factors, cognition, depression, social support, and participation in rehabilitation influence disability from CVA and how it changes over time.

Table 2

Hypotheses - Question 2: Aim 3

	Outcome Measure
	Functional ability (participation in life tasks)
Health Condition: Disease disorder, injury, or trauma	
Number of co-morbidities	As the number of co-morbidities increase, functional ability will decrease
Initial CVA severity	The greater the severity of the CVA, functional ability will be worse
Type of CVA	Individuals who survive a CVA that is ischemic will have higher levels of disability than those with hemorrhagic CVA;
Time elapsed since CVA	There will be an interaction effect with time; in the acute stage, disability will be increased; in the long term (>12 months) functional ability will improve; in the very long-term (>5 years) functional ability will decrease again.
Presence of new CVA	Presence of new, incident CVA will predict worse functional ability
Cognitive deficits	Cognitive deficits following a CVA will predict worse functional ability
Presence of depressive symptoms	In the presence of depressive symptoms, functional ability will decrease
Personal Factors: Demographic Characteristics	
Age	Functional ability will decrease as age increases in first onset CVA
Gender	Women will have worse functional ability following CVA
Race/Ethnicity	Black and Hispanic groups will have worse functional ability after CVA
SES	Lower SES will predict less functional ability
Personal Factors: Baseline Lifestyle Factors	
Presence of physician visit in previous 12 mos.	Functional ability will increase in the presence of a physician visit over the previous 12 months
Smoking behaviors	Functional will decrease in the presence of smoking
Drinking behaviors	Heavy drinkers will have decreased functional ability after CVA
Physical activity behaviors	Those with increased physical activity at baseline will present with increased functional ability over time
Body mass index	Normal BMI will predict the best functional ability
Work	Those who were working prior to the CVA, will have improved functional ability following the CVA

Table 2 (cont'd)	
Hypotheses - Question 2: Aim 3	
	Outcome Measure
	Functional ability (participation in life tasks)
Environmental Factors	
Social support	In the presence of increased social support, functional ability will increase
Participation	
Presence of rehabilitation	The presence of rehabilitation will predict a more moderate level of functional ability. Those with high levels of functional ability and those with very low levels of low levels of functional ability will be less likely to participate in rehabilitation in the long-term.

Question 3 (Table 3). What factors are associated with participation and level of utilization of rehabilitation among long-term survivors of CVA?

Aim 4. Examine how demographic characteristics, personal lifestyle factors, level of disability, social support, cognition, depression, insurance status, CVA recurrence, and time elapsed since CVA influence participation in rehabilitation.

Aim 5. Describe levels of utilization of rehabilitation services among survivors of CVA by demographic characteristics, personal lifestyle factors, level of disability, social support, cognition, depression, insurance status, presence of new stroke, and time elapsed since stroke.

Table 3		
Hypotheses - Question 3: Aims 4 and 5		
	Outcome Measure	
	Participation in rehabilitation (Yes/No)	Utilization of rehabilitation (Intensity)
Health Condition: Disease disorder, injury, or trauma		
Number of co-morbidities	As the number of co-morbidities increases, so does the likelihood for participation in rehabilitation	As the number of co-morbidities increases, so does the intensity of rehabilitation services.
Initial stroke severity	As severity of stroke increases, participation in rehab will be more likely.	Those with moderate level stroke severity will receive the most intense rehab.

Table 3 (cont'd)		
Hypotheses - Question 3: Aims 4 and 5		
	Outcome Measure	
	Participation in rehabilitation (Yes/No)	Utilization of rehabilitation (Intensity)
Type of stroke	People with ischemic stroke will be more likely to participate in rehabilitation.	In-patient stroke intensity will be higher in those with hemorrhagic stroke. Those with ischemic stroke will receive more intense therapy in the long-term.
Time elapsed since stroke	In the short term, participation in rehab will be increased; as time progresses, participation will be decreased.	In the short term, there will be more intensity in rehab services; as time progresses, utilization will taper.
Presence of new stroke	Presence of new stroke will predict participation in rehab.	Presence of new stroke will predict greater utilization of rehab,
Cognitive deficits	Presence of cognitive deficits will predict less participation in rehabilitation.	Presence of cognitive deficits will predict less intensity of rehabilitation.
Presence of depressive symptoms	Presence of depressive symptoms will predict decreased participation in rehab.	Presence of depressive symptoms will predict less intense rehab utilization.
Personal Factors: Demographic Characteristics		
Age	Participation will decrease as age increases.	Intensity will decrease as age increases.
Gender	There will be no difference between gender and participation.	There will be no difference between gender and utilization.
Race/Ethnicity	There will be no difference between race/ethnicity and participation.	There will be no difference between race/ethnicity and utilization.
SES	Lower SES will lead to less participation.	Lower SES will lead to less intense utilization of rehab.
Insurance status	Those with any type of health insurance will be more likely to participate.	Intensity of rehab will depend upon insurance status.
Personal Factors: Baseline Lifestyle Factors		
Presence of physician visit in previous 12 months	Those with a reported physician visit within the previous 12 months will be more likely to participate in rehab.	Those with a reported physician visit within the previous 12 months will predict greater intensity of rehab
Smoking behaviors	Those who smoke will be less likely to participate in rehab.	Those who smoke will receive less intense rehab.
Drinking behaviors	Those who drink heavily will be less likely to participate in rehab.	As the amount of drinking increases, intensity of rehab will decrease.
Physical activity behaviors	Those who are most physically active at baseline will be more likely to participate in rehab.	Those with low levels of physical activity at baseline will receive the most intense rehab.
Body mass index	There will be no difference in BMI and participation in rehab.	There will be no difference in BMI and intensity of rehab.
Work	Those who are working at baseline will be more likely to participate in rehab.	Those who are working at baseline will have an increase in utilization of rehab.
Environmental Factors		
Social support	Those with a strong social support network will be most likely to participate in rehab.	Those with a strong social support network will receive the most intensive rehab.

Organization of the Study

Chapter 1 has presented a statement of the problem and research questions with aims and hypotheses. Chapter 2 contains a review of related literature separated by aim to help the reader understand the research related to the problems being investigated: what factors influence CVA risk and severity, how functional abilities change over time following CVA, who utilizes rehabilitation services, and how rehabilitation services are utilized by survivors of CVA. The methodology and information about the databases utilized in the study and analyses are presented in chapter 3. In chapter 4, the results are included for each of the five study aims. Finally, chapter 5 is a summary of the study and findings, conclusions from the findings, discussion, conclusion, and recommendations for further study.

CHAPTER 2: LITERATURE REVIEW

Overview

Many experts study predictors of CVA risk along with interventions that will improve survival and minimize sequelae for those who sustain a CVA. As an example, a recent review from the American Heart Association (AHA) and American Stroke Associations (ASA) that focused on the acute management and prevention of CVA created improved care pathways for the prevention and early management of CVA (Schwamm, et al, 2010). This type of research aids in understanding incidence of CVA and the multitude of factors that influence CVA risk. However, there is no clear evidence on how baseline factors, medical conditions, and social-environmental factors, when taken together, influence the risk of CVA since many people who possess a number of these risk factors never sustain a CVA. Previous work has not provided an accurate picture of all these risk factors.

The Framingham Study Risk Profile, a tool that is utilized to assess risk of CVA is based on CVA risk factors discovered in the Framingham Study. (Wolf, D'Agostino, Belanger, & Kannel, 1991) According to the risk profile, non-modifiable risk factors for CVA include: age, gender, and race, while modifiable risk factors include: hypertension, smoking, diabetes, hyperlipidemia, hormone replacement therapy, atrial fibrillation, and carotid stenosis (Wolfe, D'Agostino, Belanger, & Kannel, 1991). Since the risk profile was developed, emerging research suggests additional factors might have a role in CVA risk. Personal lifestyle factors, including participation in regular, physical activity, moderate drinking, and regular visits with a physician, have emerged as protective mechanisms against CVA. It has been accepted that these additional personal lifestyle factors may explain variations in the rate of CVA (Myint et al, 2012).

Aims 1 & 2: Factors Influencing CVA Incidence and Effects

The primary aims of question one were to determine if a combination of baseline personal lifestyle factors along with other traditional risk factors would help identify individuals who are at risk for CVA and if these same factors influenced the effects from CVA.

Presence of co-morbidities. Co-morbidities are recognized to impact the risk of several chronic conditions, including CVA. The presence of only one or no co-morbidity predicts adequate functional status in individuals with a chronic, disabling condition. As the number of co-morbidities increase, functional outcomes are less favorable (Fischer et al, 2006; Fultz, et al, 2003; Goldstein et al, 2004; Verbrugge, et al, 1994).

Demographic characteristics. Studies have explained the influence demographics might have on incidence and severity of CVA. However, it remains difficult to make conclusions about which demographic characteristics influence CVA incidence and severity the most.

*Age***.** Along with other chronic health conditions, age is correlated with increased incidence and prevalence of CVA (Fang, Shaw, & George, 2012). Older persons demonstrate an increased risk for incident of CVA and severity also increases as people age (Rojas et al, 2007). There may be an interaction effect with age and various co-morbidities, whereby as age increases, co-morbidity becomes less of a factor in CVA risk and severity (Rojas et al, 2007).

Gender. To date, most studies of the relation between gender and CVA have been contradictory. Women tend to be older at onset of CVA and also have more serious effects from CVA upon initial presentation. The risk of CVA is lower in males at younger ages, however after the age of 85, the risk of CVA is higher in females (Appelros, Stegmayr, & Terént, 2009; Caso et al, 2010; Sealy-Jefferson et al, 2012). Also, women who sustain a CVA are more likely to have hypertension and atrial fibrillation upon stroke onset (Giralt et al, 2012). During emergency management, women are less likely to receive tissue plasminogen activator (tPA), which may impact the severity of the resulting CVA. In addition, there is evidence that women do not receive the same intensity of diagnostic and other therapeutic treatments compared to men when it comes to prevention of CVA and other cardiovascular disease (Giralt et al, 2012).

Race and Ethnicity. Racial groups that are defined by the federal government include: white (having origins from Europe, the Middle East, or Northern Africa), black or African American (having origins from Africa), American Indian or Alaskan native (original peoples of North or South America or Central America who have tribal affiliations), Asian (those individuals with origins from the Far East, Southeast Asia, or the Indian Subcontinent), or native Hawaiian or other Pacific Islander. Hispanic/Latino origins are ascertained in national survey data to distinguish those who have roots from Cuba, Mexico, Puerto Rico, and South or Central America of Spanish descent.

The incidence of CVA has been demonstrated to be higher in blacks/African Americans and American Indians/Alaskan Natives have higher incidence of CVA than in white populations. Those of Hispanic or Latino ethnicity also have higher incidence of

CVA than those who are not Hispanic or Latino. In addition, blacks/African Americans have greater impairments following a CVA. (Cruz-Flores et al, 2011)

Compared to whites, blacks/African Americans present with an increased prevalence of risk factors for CVA, including hypertension, diabetes mellitus, heavy alcohol use, physical inactivity, and current cigarette smoking. In multiple studies, both blacks and those of Hispanic or Latino descent demonstrate a presence of personal lifestyle factors that increase their risk of CVA. American Indians/Alaskan Natives also present with more CVA risk factors than whites (Cruz-Flores et al, 2011). Finally, there is evidence that supports an interaction between age and race/ethnicity on risk of CVA (Sealy-Jefferson et al, 2012).

Socioeconomic status (SES). Socioeconomic factors are cited as determinants of access to care and provision of care, but understudied in the area of CVA (Mold, McKevitt, & Wolfe, 2003). In general, lower SES is associated with increased risk and mortality from CVA (Addo et al, 2012). Increased morbidity has also been discovered in lower socioeconomic groups. An inverse relationship appears between SES and risk of CVA - lower SES groups having a higher risk, but study design in this area is too heterogeneous to make definitive conclusions (Cox, McKevitt, Rudd, & Wolfe, 2006). The severity of CVA increases in those with low SES, but this is based on studies with limited samples and studies without the ability to adjust for multiple confounding variables (Cox, McKevitt, Rudd, & Wolfe, 2006). Education, a measure of SES, has also been found to influence incidence of CVA (Löfmark & Hammarström, 2007).

In multiple studies, SES persists as a CVA risk factor, after controlling for age and gender. One study discovered an interaction effect between SES and men that was not found for women. (Steenland, Sherry, & Walker, 2004) In addition, some studies have demonstrated an independent influence of SES on severity of CVA after controlling for ethnicity and gender. On the other hand, additional studies have not replicated these results. (Addo, et al, 2012)

Some studies state that SES might not directly influence CVA risk and severity, but it is the lifestyle patterns of individuals in various socioeconomic groups that place them at risk for CVA and more severe effects from a CVA. For example, studies have uncovered that white men in the lowest poverty-index quartile smoke more, exercise less, and have more co-morbidity. The same pattern exists in women, whereby women in lower SES groups possess patterns of behavior, such as smoking and heavy alcohol consumption, which puts them at an increased risk of CVA, compared to women in higher SES groups (Gillum & Mussolino, 2003).

Personal lifestyle factors. Certain baseline personal lifestyle factors appear to have an impact on chronic disease occurrence and severity of condition. Personal lifestyle factors may include smoking, drinking, and health-seeking behaviors, physical activity, working status, and BMI. Baseline personal lifestyle factors have been studied, but the impact of these behaviors is not well understood, especially regarding the relative influence of personal lifestyle factors on incidence of CVA and severity, when compared to other factors.

*Regularly scheduled medical visits***.** Over time, studies have demonstrated a relationship between better primary care and improved health outcomes (Bower & Girard, 2009; Starfield, Shi, & Macinko, 2005). Although rarely discussed in relationship to CVA incidence and outcomes, it seems worth noting the influence of access to and utilization of primary care by individuals and its impact on disease. For example, during the 1980's, the Spanish government passed legislation to increase the number of primary care physicians in the country, hoping that it would improve the total health care system. Ten years later, studies found that the death rate from CVA improved the most in the areas where primary care pathways were first implemented (Villabli et al, 1999). In US studies, Shi (1992 & 1994) reported improved health outcomes in states where higher ratios of primary care physicians were found, including reduced incidence of CVA and better overall quality of life. This effect persisted even when controlling for demographic characteristics, such as age, gender, race, and SES (Starfield, Shi, & Macinko, 2005).

*Smoking behaviors***.** Smoking has been acknowledged for many years as a modifiable risk factor related to CVA (Wolf, D'Agostino, Kannel, Bonita, & Belanger, 1988). Various studies have demonstrated that non-smokers have lower incidence of CVA. In addition, those who do not smoke appear to have lower mortality from CVA (Towfighi, Markovic, & Ovbiagele, 2012).

Drinking behaviors. The relationship of alcohol consumption to CVA incidence and severity proves to be complex. In particular, there is contradictory evidence on the role of alcohol consumption in CVA risk and severity, depending on gender and type of CVA (Jimenez et al, 2012; Patra et al, 2010). Overall, heavy alcohol consumption is associated with an increased risk of any type of CVA in most studies; however, light to moderate alcohol consumption appears to have some protective effect for ischemic stroke, but these results have been inconsistent. (Calcoya, Rodriguez, Corrales, Cuello,

& Lasheras, 1999; Hart, Smith, Hole, & Hawthorne, 1999; Mazzaglia, Britton, Altmann, & Chennet, 2001; Patra et al, 2010)

Physical activity behaviors. Multiple studies have discovered a protective benefit from moderate physical activity in chronic disease. (Kokkinos, 2008) Evidence suggests that regular physical activity will decrease blood pressure and provide a systemic anti-inflammatory advantage (Abramson & Vaccarino, 2002; Whelton, Chin, Xin, & He, 2002). In a cross-sectional study utilizing the National Health and Nutrition Examination Survey (NHANES), Towfighi, Markovic, and Ovbiagele (2012) discovered that those individuals who participated regularly in physical activity had lower mortality rates from CVA, independent of other factors. While controlling for body weight and other personal lifestyle factors, physical activity level has been discovered as an independent predictor of mortality in some research (Hu et al, 2004).

Body mass index (BMI). BMI has been widely studied, with increases in BMI being a risk factor for incidence of CVA. As weight increases, the risk of CVA increases as well (Strazullo et al, 2010). Some studies have uncovered that lower BMI scores (typically <25) have an inverse relationship to CVA risk, but this has not been extensively studied (Prospective Studies Collaboration, 2009).

Work behaviors. We included work behaviors in the study since baseline-working status might explain those who are healthier at baseline. However, there is limited evidence on how work behaviors might influence CVA risk or severity. Ultimately this was a novel addition to this field of research.

Combination of positive personal lifestyle factors. Evidence is emerging from population-level studies that look at the impact of certain baseline health behaviors on

CVA incident and effects. A study by Myint, Luben, Wareham, Bingham, and Khaw (2009) discovered that in the presence of one additional baseline lifestyle behavior (smoking, physical activity, alcohol consumption, or nutrition) there was a significant decline in CVA risk. In addition, Towfighi, Markovic, & Ovbiagele (2012) observed a cumulative effect of baseline lifestyle factors (nutrition, BMI, smoking, drinking, and physical activity) on mortality following CVA.

As mentioned previously, certain demographic characteristics are found to have an influence on who is likely to engage in both positive and negative personal lifestyle factors, but some studies have demonstrated that personal lifestyle factors persist as a direct influence in incidence and severity of CVA, even after controlling for demographic characteristics. (Johansson & Sundquist, 1999; Khaw et al, 2008; Wray, Alwin, & McCammon, 2005)

Aim 3: Level of Functional Ability Following Incident CVA

Estimates of the recovery of functional abilities following a CVA are difficult to obtain since most individuals with CVA will enter a "handicap situation" that is dynamic in nature; individuals may recover functional independence in the short-term with evolving levels of function dependent on many factors, including (but not limited to) affect and social supports. (Hardy & Gill, 2004) A person who sustains any disabling medical event will have varying levels of demonstrative disability which will be influenced by biological, social, and psychological factors.(Kelly-Hayes, Jette, Wolf, D'Agostino, & Odell, 1992) In addition, attitude, cooperation, and motivation appear to be important factors in recovery. (Desrosiers, et al, 2002; Goljar, et al, 2010)

If the factors that influence functional ability following a CVA are better understood, care pathways can be developed that help individuals preserve functional ability while reducing caregiver burden and the financial costs associated with follow-up care for CVA.

Demographic characteristics. Various demographic characteristics have been studied in relationship to CVA outcomes, some more than others. Most studies focus on the short-term functional status of survivors as opposed to the long-term consequence of CVA.

Age. Younger age has been shown to predict improvement in functional status over time following a CVA, while older individuals consistently have declines in function following a CVA (Alguren, et al, 2009; Clarke, et al, 1999; Cook, et al, 2005; Hardy & Gill, 2004; Kelley & Borazanci, 2009; LeBrasseur, et al, 2006; Bruins Slot, et al, 2007; Sturm, et al, 2002; Woldag, et al, 2006; Tsouna-Hadjis, et al, 2000)

Gender. Women have been found to sustain more serious CVAs than men. Women are also more likely to be discharged to a supported environment (i.e. nursing home) than to home, which may be an indicator of functional ability. However, it has been hypothesized that a woman's discharge disposition might be a function of social support and financial resources, not gender-specific outcomes, since many older women are unmarried and live in poverty. (Gargan & Reeves, 2007) Further complicating the relationship, women are also more likely to report depression following CVA. A more recent study by Mizrahi, Waitzman, Arad, and Adunsky (2012) confirmed that CVA severity, increased age, and presence of cognitive deficits, that are more likely in female survivors of CVA, are more predictive of functional outcome than gender. It has been recognized that most studies to date have not accounted for the various confounding variables that might influence the relationship between stroke outcomes and gender. (Appelros, Stegmayr, & Terént, 2010; Denti, Agosti, & Franceschini, 2008; Lai, Duncan, Dew, & Keighley, 2005)

Socioeconomic status (SES). Studies suggest that individuals with low SES have increased dependency for activities of daily living in the short-term and higher levels of long-term disability. (Cox, McKevitt, Rudd, & Wolfe, 2006) Evidence also suggests that individuals in lower socioeconomic groups are less likely to receive evidence-based intervention, but the findings are not consistent across studies. (Addo, et al, 2012) The mechanism whereby SES might influence functional outcomes is poorly understood.

Race and Ethnicity. Black men have been found to be more likely to be discharged to a more supportive environment (i.e. nursing home) following a CVA than white men. Black women are also more likely than white women to have a more severe initial presentation of CVA. Just as in SES, racial differences are hard to discern because of confounding factors that make inferences difficult. For example, black men have a higher rate of hemorrhagic-type CVA, which influences function independently. Black men also tend to have more co-morbidity at CVA onset. (Onukwugha & Mullins, 2005)

Health conditions.

Presence of co-morbidity. Co-morbidity has a significant impact on functional ability following a CVA, and cardiovascular comorbidities appear to have the most influence. (Turhan, Atalay, Muderrisoglu, 2009) And as co-morbidity increases, the ability to regain functional ability is impaired (Alguren, Lundgren-Nilsson, & Stibrant Sunnerhagen, 2009; Tsouna-Hadjis, et al, 2000)

Severity of CVA. Baseline severity of CVA has a direct impact on both short-term and long-term functional status. Individuals who have more serious CVAs at initial presentation, on average, have worse functional ability over time. (Anderson, et al, 2004; Desrosiers, et al, 2006; Gill, et al, 1997; Hankey, et al, 2002; ; Wolfe, et al, 2011; Wilkinson, et al, 1997)

Type of CVA. Whether a CVA is ischemic or hemorrhagic influences the initial severity of the CVA and the functional outcomes following the stroke. (Bruins Slot, et al, 2007; Sturm et al, 2002) Ischemic CVA incidence is estimated to be 10-times more frequent than hemorrhagic CVA, particularly in Western countries. This makes comparison of outcomes by type of CVA difficult. However many studies report that hemorrhagic CVAs tend to be more severe and have a higher mortality rate. (Anderson, Olsen, Dehlendorff, & Kammersgaard, 2009) Conversely, studies also suggest that those who survive a hemorrhagic CVA will have better functional abilities over time. (Paolucci et al, 2006)

Presence of recurrent CVA. Presence of a recurrent CVA has been cited as one reason for a decline in functional abilities over time in survivors of CVA. (Khan, et al 2012) Studies tend to look at recurrence rate and suggest that a recurrent CVA can have the same impact as the initial incident CVA.

Presence of depressive symptoms. The incidence and prevalence of depression in survivors of CVA have been found to be double that of the general population. (Ayerbe, et al, 2011; Elkind, 2009) Depression has been associated with increased mortality and reduced quality of life in individuals who have sustained a CVA. (House, Knapp, Bamford, & Vail, 2001; LeBrasseur, 2006; Paul et al, 2005; Sturm, et al, 2004) In addition, the presence of depression in survivors has been found to negatively influence level of functional ability. (Herrman, Black, Lawrence, Szekely, & Szalai, 1998; Parikh et al, 1990

Presence of cognitive deficits. Poor cognitive status following stroke influences the level of disability in survivors of CVA. (LeBrasseur, 2006; Pettersen, Dahl, & Wyller, 2002) This area of research typically centers on the immediate cognitive impact of CVA, not how cognitive functioning might decline over time. It is an area of research that requires more in-depth understanding.

Treatment with tPA. Tissue plasminogen activator is a protein that breaks down blood clots. It was introduced in 1996 and has been increasingly used as a primary defense in ischemic stroke management. tPA has successfully led to a decline in mortality following hemorrhagic stroke. It is reasonable to hypothesize that functional outcomes would also be improved, but studies on the long-term impact of tPA are not abundant in the literature. (Duangjit, Muangpaisan, Chotinaiwatterakul, & Dharmasaroja, 2012)

Personal lifestyle factors. The influence of health practices on functional recovery in older adults has been a common topic in research; however more work is needed to determine what baseline factors are most important in the recovery process. Baseline behaviors, including pre-morbid function in activities of daily living and scores on functional mobility measures are associated with functional abilities following a CVA. (Duangjit, Muangpaisan, Chotinaiwatterakul, & Dharmasaroja, 2012) In addition, it has been found that elderly individuals who are nonsmokers, moderate drinkers, have normal BMI, and receive regular medical check-ups were more likely to recover from a disabling event, after controlling for other personal factors (age, socioeconomic status, baseline status, and presence of chronic conditions). (Lee and Kyung-Park, 2006) Other studies have indicated that being older, a woman, and having poor baseline health practices lead to less favorable functional outcomes as well. (Clark, Stump, and Wolinsky, 1998; Perez et al, 2005; Crimmins, 1993; and Atchley and Scala,1998).

Social support. Increased social support has been found to improve functional outcomes in those with a disabling condition. (Fultz, et al, 2003; Tsouna-Hadjis, et al, 2000; Turhan, Atalay, & Muderrisoglu, 2009; Verbrugge, et al, 1994) It is unclear why this relationship exists. It could be that individuals who have increased social support have access to resources that might otherwise be unavailable to those without social support (ie transportation) or that individuals who have decreased social support do not have the encouragement necessary to motivate them to overcome the functional impact of a CVA.

Rehabilitation. Rehabilitation includes occupational therapy (OT), physical therapy (PT), and speech therapy (ST). In general, rehabilitation interventions are noninvasive interventions that present very few adverse side effects and are supported by multiple sources. (Brosseau et al, 2006) The effectiveness of rehabilitation beyond the acute setting but within one year of stroke onset has been the subject of a Cochrane systematic review (Outpatient Service Trialists, 2004). The review showed that those who received therapy after hospital discharge were less likely to deteriorate in activities of daily living (ADL), and had higher ADL scores at follow-up compared to baseline. Other research in clinical settings has documented that individuals who participate in outpatient rehabilitation services following stroke demonstrate an ability to improve motor function, independence, and quality of life regardless of time since the event. (Werner and Kessler, 1996; Ngan-Hing & Streton, 2006; Outpatient Service Trialists, 2004).

Time elapsed since CVA. In general, functional ability improves over the short term for individuals who survive a CVA. Some studies have suggested that although functional abilities improve in the short term, over time, functional ability begins to decline. (Løfgren, Nyber, Mattsson, & Gustafson, 1999; Wilkinson, et al, 1997) It has been argued that the functional decline occurring in the years following a CVA is not due to a natural decline, but the result of increased co-morbidity and/or recurrent stroke. (Pettersen, Dahl, & Wyller, 2002)

Aims 4 & 5: Participation and Utilization of Rehabilitation

Occupational therapy (OT), physical therapy (PT), and speech language pathology (SLP) are rehabilitation professions whose primary focus is to restore function in individuals who have disability and dysfunction in motor and/or cognitive domains. Rehabilitation services are frequently prescribed for individuals following a CVA. Services can be provided while a patient is in a hospital, a skilled nursing facility or acute rehabilitation facility, in the home, or in an outpatient clinic. Various rehabilitation services are covered through both Medicare Part A and Part B, Medicaid, or through private insurers.

Goals in rehabilitation include re-education of clients in normal movement patterns, normalizing tone, facilitating postural adjustments for improved function, facilitating normal function, and preventing secondary complications. (Lennon, 2003) Interventions commonly utilized in rehabilitation attempt to reduce pain and spasticity, as well as to increase range of motion (ROM), muscle force, mobility, walking ability, functional status, physical fitness, and quality of life. In general, rehabilitation interventions are noninvasive. The interventions present very few adverse side effects and the effectiveness of therapeutic interventions is supported by multiple sources. (Brosseau et al, 2006)

Following many advances in prevention and early diagnostics, a new focus in CVA towards functional recovery and the role that rehabilitation might play in improving functional ability among survivors of CVA has been recommended. (Bernhardt & Cramer, 2013) Available data support the effectiveness of rehabilitation with individuals who have sustained a CVA and it has been the subject of a Cochrane systematic review (Outpatient Service Trialists, 2004). The review showed that those who received therapy after hospital discharge were less likely to deteriorate in activities of daily living (ADL), and had higher ADL scores at follow-up compared to baseline. Other research in clinical settings has documented that individuals who participate in outpatient rehabilitation services following CVA demonstrate an ability to improve motor function, independence, and quality of life regardless of time since the event. (Werner and Kessler, 1996; Ngan-Hing & Streton, 2006; Outpatient Service Trialists, 2004).

International guidelines for CVA care support the use of rehabilitation services by both short-term and long-term survivors of CVA. However, it appears that the guidelines have not been widely adopted. (CDC-BRFSS, 2005) Clinical guidelines in the US advocate multidisciplinary involvement to improve the functional recovery of individuals following CVA and support practice to prevent functional decline. (AHRQ National Guideline Clearinghouse, 2011) Not only are survivors of CVA encouraged to have routine follow-up with physicians, but guidelines advocate regular evaluation of post-CVA function by rehabilitation professionals. (UK Department of Health, 2007; Lindsay et al, 2008, Miller et al, 2010).

According to practice guidelines for CVA care in the US and Canada, all patients with CVA should begin rehabilitation therapy as early as possible once medical stability occurs, and survivors should have access to specialized CVA care and rehabilitation services appropriate to their needs post-discharge. People with CVA living in the community should have regular and ongoing follow-up by rehabilitation professionals who can assess recovery, prevent deterioration, and maximize functional outcomes. (Lindsay et al, 2008)

Data from the Center for Disease Control's Behavioral Risk Factor Surveillance System (CDC-BRFSS) (2005) survey on CVA survivors in 21 states and the District of Columbia found that only 30.7% of survivors of CVA received outpatient rehabilitation during the survey year. This calls into question whether clinical practice guidelines recommending periodic PT and OT assessment of those who have sustained a CVA are being followed. It also raises the question as to whether or not providers or insurers are promoting this type of intervention.

Unfortunately, rehabilitation services have "received minimal attention in health services research," so it can be difficult to determine what the underlying issues are regarding lack of utilization of rehabilitation services in those who have survived long-term from CVA. (Freburger and Konrad, 2002) It is also difficult to determine what type of therapy and the intensity of therapy individuals may have received. There have been limited studies to date of utilization of rehabilitation by survivors of CVA.

Factors such as cognition, depression, and level of social support may influence utilization of rehabilitation (Gadidi, Katz-Leurer, Carmeli, & Bornstein, 2011) Utilization patterns may also be influenced by medical providers, since they are the gatekeepers to generating referrals to rehabilitation services. Individuals to whom rehabilitation is recommended may not act on the recommendation. Or, there may be other barriers to utilization of rehabilitation due to payer (e.g., insurance) or other access issues (e.g., transportation).

Understanding utilization of rehabilitation services by survivors of CVA may uncover where efforts to promote rehabilitation services should be targeted. Such efforts will assure that survivors of CVA are receiving appropriate medical care to maintain functional abilities and quality of life. This study aimed to 1) determine what individual level factors that are associated with participation in rehabilitation services among stroke survivors and 2) examine utilization patterns among individuals who have sustained a CVA. It was hypothesized that individuals with more co-morbidity, more severe initial CVA, ischemic CVA, a new CVA, less cognitive deficits, those with a reported physician visit, those who are more physically active at baseline, those who were working at baseline, and those with a strong social support network would be more likely to participate in rehabilitation services. It was also hypothesized that older individuals, those in lower SES, smokers, and heavy drinkers would utilize fewer rehabilitation services. In addition, it was hypothesized that as time elapsed, participation in rehabilitation would decrease.

Conclusion

Unfortunately, in a lot of CVA research, studies have been based largely on samples taken from small geographic areas. Most of these studies have looked narrowly at outcomes, choosing only a few key outcomes that might relate to functional recovery in long-term survivors of CVA. Other studies were cross-sectional and thus failed to use time as a covariate. Given declining mortality from CVA, studies should continue to look at the dynamic nature of recovery from CVA, what predicts recovery and how, since it will have an impact on what services an individual requires. A significant population-level study about the long-term functional outcomes of survivors of CVA has yet to be reported in the literature and this study attempted to fill that void. (Bernhardt & Cramer, 2013)

CHAPTER 3: METHODS

Overview

Since there have been limited population-based studies on both short term and long term survivors of CVA, a population-based survey was utilized to explore the study questions. In addition, since there are a multitude of factors that influence CVA risk, severity, and outcomes the databases utilized for the current study allowed for exploration of many factors, not just a narrow focus of factors which has been common in other studies on CVA survivorship and functional outcome. A longitudinal design was also recommended since the life of individuals following a CVA can become more complex as time elapses following the initial event. Finally, the International Classification of Functioning, Disability, and Health (ICF) (WHO, 2001) inspired the conceptual framework to assure that survivors of CVA were thoroughly described within this population-based sample.

Conceptual Framework

The ICF is the World Health Organization's framework for health and disability (WHO, 2001). The ICF (Figure 1) is a biopsychosocial model, since it looks at the integration of biological, individual, and social perspectives on health. It is a holistic approach, unlike other strictly social or medical models. The ICF combines a set of factors representing an individual within society. The framework allows a researcher to map out the complexity of chronic conditions. (Jette, 2006; Schneider, Hurst, Miller, & Ustun, 2003; Stucki, Ewer, & Cieza, 2003) In order to simplify the use of the ICF with CVA, an expert panel created a set of variables to include in CVA research based on the ICF domains (Cieza al, 2005). This core set was used as a guide for variable selection and analysis in this study. The final, adapted model is shown in Figure 2. Since studies of utilization and outcomes in rehabilitation on a population-level are rare in CVA research, the revised conceptual model based upon the WHO ICF was used for variable selection and analyses.

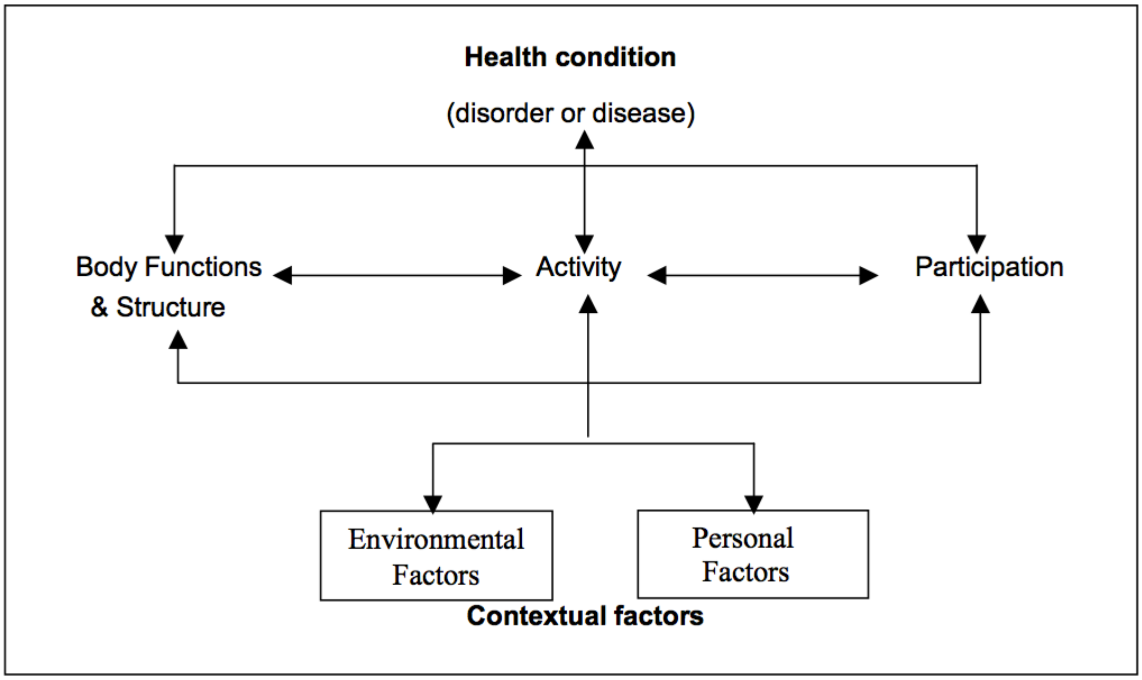

Figure 1. World Health Organization, International Classification of Functioning, Disability, and Health (2004)

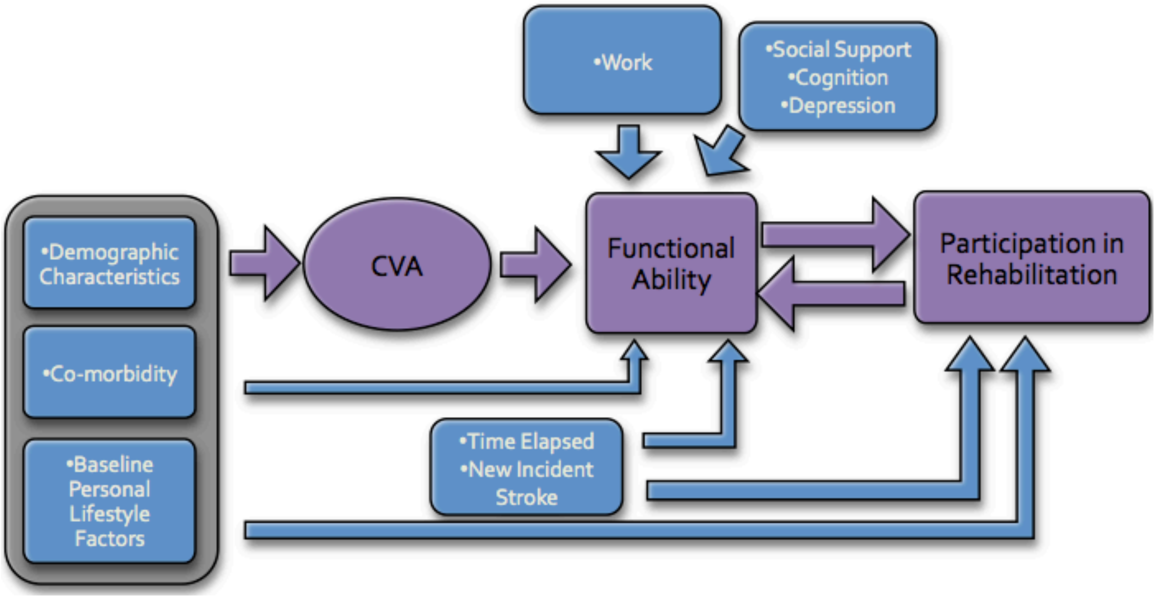

Figure 2. Adapted Conceptual Model

Study Population

The incident study (aim 1) included all individuals 50 years and older who participated in the HRS during the survey years. Individuals who participated in the HRS in the years 2000-2010 were included. After all variables were re-coded and prepared for the incident analysis, the data was transposed from wide to long format. The dataset was structured so that for each survey year an individual responded in the survey, their responses were counted in a new observation. If an individual responded in four survey years during 2000-2010, four individual observations were created for this individual. Baseline data was acquired for each individual observation from the survey year previous.

For severity analyses (aim 2), data from individuals reporting an incident CVA in the HRS were merged with linked Medicare claims data. CVA incidence was taken from the survey years 2000 through 2008 with incident of CVA confirmed during the merge process. The respondents who did not experience a CVA were excluded from the sample, thus only individuals who sustained a CVA and were Medicare fee-for-service beneficiaries were included in the sample. Baseline measures were taken from the survey year prior to occurrence of the incident CVA.

For the analyses for aims 3 -5, data from the HRS were merged with linked Medicare claims data. The individuals in the sample were those who were Medicare fee-for-service recipients and also participated in the HRS. CVA incidence was taken from the survey year's 2000- 2008 and confirmed through the presence of diagnosis codes documented in Medicare claims data. The final sample included individuals who were identified as having had a CVA during the survey years and had Medicare claims data. Incident CVA was defined as an answer of "yes" when individuals were asked whether or not a physician had told them they had had a stroke. Those who reported a CVA previous to starting the survey in 1998 were excluded. Those who required a proxy at baseline (n=5) were also excluded from the study sample. The final sample was n = 515.

Data Sources. In CVA research, a number of prospective cohort studies and registries are in place to assist with our knowledge about CVA, CVA care, and outcomes; examples include the Framingham study and the South London Stroke Register. Large databases can give researchers more detailed information about the impact of CVA on daily functioning, whereas most registries do not. In addition, registries are not usually designed to examine utilization of rehabilitation among those who sustain a CVA. For this study, the linked Health and Retirement Study (HRS) with linked Medicare claims (2013) files were utilized.

Health and Retirement Study. The HRS is a longitudinal study developed at the University of Michigan with support from the National Institute on Aging and the Social

Security Administration. Initiated in 1992, it focuses on the health, economic status, and retirement of older adults in the US. The study sample includes more than 26,000 Americans over the age of 50 who are surveyed biannually, predominantly via telephone. The original housing units included in the sample were generated using a multi-stage, clustered area probability frame. (Health and Retirement Study, 2013)

Linked HRS - Medicare database. A version of the linked HRS and Medicare files from which all sensitive identifiers are removed was used for the severity analyses in this study. It was available by obtaining a Data User Agreement with the University of Michigan and Centers for Medicare and Medicaid Services (CMS). The CMS records carry a unique dummy identifier for each respondent that is linked back to the HRS data through a file supplied by the HRS staff. Case IRB-2012-215 and IRB-2013-55 allowed this researcher to utilize this data.

Variables of Interest

Outcome variables.

Incidence of CVA. Incident CVA was defined as an answer of "yes" when individuals were asked whether or not a physician had told them they had had a stroke. Those who reported a CVA previous to starting the survey in 1998 were excluded. Once respondents reported an incident CVA, they were excluded from subsequent analysis so that only incident CVA was counted. Studies confirm that self-reported CVA can adequately be measured with data from the HRS. (Glymour and Avendano, 2009)

Severity of CVA and Functional ability. The RAND HRS data utilized factors identified by Wallace and Herzog (1996) to create indices of function for use by researchers. The items that were originally included in the HRS for functioning were based upon well-known ADL, IADL, and physical functioning scales. (Fonda & Herzog, 2004) Items had already been embedded into the survey since its inception, but the items for each index were chosen for consistency across waves and their validity for measuring health and functioning. Wallace and Herzog (1996) completed a factor analysis of the Health and Retirement function measures and identified mobility, lower and upper body strength, and completion of ADLs as key areas that adequately assess physical functioning in older adults. Wallace and Herzog (1995), Rodgers and Miller (1997), and Stump, et al (1997) all completed construct validity tests on the physical functioning measures within the HRS. All three studies indicated high construct validity. (Fonda & Herzog, 2004) CVA severity was calculated as the difference between the baseline index score of functional ability and the index score of functional ability after the respondent's incident CVA. This was reported on a continuous scale.

The chosen RAND index score of functional for this study was calculated from 4 subscales within the HRS: strength limitations, upper body mobility limitations, lower body mobility limitations, and activities of daily living. Function was measured on a continuous scale from 0-19. Items measured included: Mobility - climbing one flight of stairs, walking one block; Large muscle - sitting for two hours, getting up from a chair, stooping or kneeling or crouching, and pushing or pulling a large object; Activities of daily living - bathing, eating, dressing, walking across a room, and getting out of bed; Fine motor skills: picking up a dime; and Instrumental Activities of Daily Living - using a telephone, taking medications, handling money, shopping, preparing meals. The index score ranged from independence (0) through dependence (19) in the above areas. An indicator for those who died prior to the next HRS wave following index CVA was utilized in some analyses as a measure of severity.

The primary outcome was change in function from baseline to the function score in the wave following the CVA. For each wave, the function score was re-calculated as a change in function scores from wave to wave so that functional ability could be described over time.

Results were also reported in categories of no, mild, moderate, and severe impairment. No impairment was considered if the index score was zero. Mild impairment was considered for index scores of 1-6, moderate impairment for index scores 7-13, and severe impairment was indicated if index score was 14-19.

In addition, when Medicare data was available, number of days spent in the ICU was another indicator of severity.

*Rehabilitation***.** Within the HRS, respondents were asked whether or not they were participating in rehabilitation services at the time of the survey. A binary yes/no response was recorded for that survey year. From Medicare claims data, it was possible to determine whether or not an individual participated in rehabilitation, when, in what settings, and the level of service utilization. The presence of rehabilitation was recorded at each wave starting at the wave following the CVA. Presence of rehabilitation services in Medicare claims was identified through a search for CPT codes related to OT, PT, and SLP. For confirmation, Healthcare Common Procedure Coding System (HCPCS) and Revenue Center Codes were also searched for any billing of rehabilitation services not counted in CPT codes. If a Revenue Center or HCPCS code was found for a subject who had not been identified through CPT codes, the subject was categorized as having used rehabilitation services. (Table 1) Claims were grouped by day and sorted to remove duplicates by day. The final rehabilitation claims measure was a count of how many days of rehabilitation service were received by an individual, even if multiple claims were found with the same date. For example, if an individual received OT, PT, and SLP in a single day during an inpatient stay, the claim count for that day was 1. Number of claims was reported as a continuous variable in each setting: in-patient, skilled nursing (SNF), home health, and outpatient. For SNF, it was not possible to determine the specific utilization of rehabilitation services but an indicator that rehabilitation was provided was used so that instead of exact rehabilitation utilization, number of days at a SNF was used as the continuous measure for days spent in SNF with rehabilitation services.

Table 4

Rehabilitation Codes Used as Search Criteria in Medicare Claims Files

	CPT Codes		Revenue Center Codes	HCPCS Codes
PT	97001, 97002, 97039	Common codes (PT, OT, or SLP: 90901, 92521, 92522, 92523, 92524, 92605, 92607, 92608, 92609, 92610, 96105, 97110, 97112, 97113, 97116, 97124, 97140, 97150, 97530, 97532, 97533, 97535, 97537, 97542, 97755, 97760	0420, 0421, 0422, 0423, 0424, 0429, 0977	G0151, G0157, G0159
OT	97003, 97004		0430, 0431, 0432, 0433, 0434, 0978	G0152, G0158, G0160
SLP	96105, 96125, 92506, 92507		0440, 0441, 0442, 0443, 0444, 0429, 0979	G0153, G0161

Independent variables.

Demographic characteristics. Demographic characteristics were taken from the HRS-RAND Tracker File, developed by the Rand Corporation in collaboration with the University of Michigan. It contains demographic and other variables, including interview dates and dates of death, were cross-checked by RAND corporation for consistency across waves. RAND Corporation utilized algorithms to adjust for discrepancies in participant responses across waves. All demographic characteristics, except age, were ascertained from the baseline wave and were used as constant factors over the survey years. Age was time-varying. Age was taken from the Tracker File. It was a continuous variable and was calculated from *date of interview* and *date of birth,* rounded to years. As a confidentiality safeguard, individuals over 85 were grouped into one age for this study (85+). Male or female gender was self-reported in the survey. Self-reported race categories included: white, black, or other. Ethnicity was determined by self-identification as having Hispanic or Latino origins. For this study, ethnicity was dichotomized to identify those who were of Hispanic or Latino origin or not. Socioeconomic status (SES) was measured as a percentage of self-reported assets and income as a ratio to the Federal Poverty Level. The ratio of household income to federal poverty level (FPL) was dichotomized (≥200%FPL and <200%FPL). Income was dichotomized to reduce degrees of freedom when number of events was small. Self-reported education was also dichotomized to identify those who had completed high school (HS) from those who had not completed a HS equivalent. All demographic characteristics were self-reported.

Co-morbidity. We used six of the conditions that were self-reported by the respondent or proxy within the HRS: high blood pressure, diabetes, lung disease, heart disease, CVA, and arthritis. Since CVA is the primary focus of this study, the 5 other conditions were treated as co-morbidities. Co-morbidity was an index score calculated from the count of co-morbidities reported by the survey respondent. Co-morbidity was a continuous variable. Co-morbidity was utilized as a constant, baseline co-morbidity measure and also as a time-varying factor, with the number of co-morbidites at each wave.

The presence of a psychiatric diagnosis was requested in the HRS survey as an additional co-morbidity. The author chose not to utilize psychiatric condition as a co-morbid diagnosis for three primary reasons. First, individuals with chronic, disabling psychiatric conditions (e.g. schizophrenia) would likely have personal lifestyle behaviors or proxy status that would already distinguish them in the sample. Secondly, it is likely that many individuals who receive care for more common diagnoses (e.g. depression, anxiety) from their primary care physician would underreport these diagnoses, leading to bias. Finally, depressive symptoms were measured in the HRS and were utilized in this study and, if present with a diagnosis of depression, would likely be correlated with co-morbidity, making the influence of other co-morbidity difficult to distinguish.

Personal lifestyle factors. Personal lifestyle factors included 4 items: report by each respondent whether they have regular contact with a physician, smoking and drinking behaviors, and physical activity levels. These measures were all taken from data at the baseline wave of the HRS and were included as constant factors in analyses. Whether or not someone had a regular physician was determined by whether the respondent reported a visit to physician over the previous twelve months (yes or no). Smoking was binary (currently smoking vs. past smoker or non-smoker) (Wray, Alwin, and McCammon, 2005). Drinking behavior was categorized as non-drinker, mild/moderate drinker (≤ 2 alcoholic drinks/day) or heavy drinker (≥ 3 alcoholic drinks/day). It was then dichotomized to indicate those who were heavy drinkers.

Physical activity was determined by the respondent's self-report of vigorous physical activity. If they reported vigorous physical activity (yes or no) 3 or more days per week, they were considered to have adequate physical activity levels to influence incident of risk and effect from CVA.

Baseline employment status. Working status was assessed at each wave in the HRS. Employment was utilized as a baseline characteristic throughout the analyses. It was categorical and designated individuals who were working full-time or part-time at baseline. In addition, it identified individuals who were retired, partially retired, or disabled. Those who were unemployed and currently looking for work were categorized separately from those who were working or retired. Finally, those who were not employed, retired, disabled, or unemployed and looking for a job were identified as "not in labor force". For some analyses, work status was dichotomized to indicate respondents who were doing any work for pay versus those respondents who were not working for pay at baseline. The decision to dichotomize this variable was based on low cell counts in some categories and the need to reduce the degrees of freedom for analysis based upon number of events within the dataset. The dichotomized factors were based upon results of previous analyses that demonstrated a clear trend between those who were working in some capacity compared to those who were retired, disabled, or not in the labor force.

Body Mass Index (BMI). For descriptive analysis BMI was described as a continuous variable and was utilized as a baseline measure. For multivariate analyses, BMI was a categorical variable divided into those who were underweight ($BMI < 18.5$), normal weight ($18.5 \leq BMI \leq 24.99$), overweight ($25 \leq BMI \geq 29.99$) and obese ($BMI \geq$

30). In analysis, the reference category for BMI was normal weight. It was a constant factor in analyses.

Type of stroke. Type of stroke was identified by Medicare claims data. It was important to distinguish by CVA type since there are different mechanism of CVA, different incidence patterns by type, and different severity hypothesized by type. ICD-9 codes "431: Intracerebral hemorrhage", "434: Occlusion of cerebral arteries" Type of CVA was categorized as 'hemorrhagic', 'ischemic', or 'unspecified' if the CVA was undefined in the claims or there was discrepancy in the coding within the claims data.

Time elapsed since CVA. Elapsed time was calculated as a continuous measure of time since CVA. It was completed by subtracting the *date of interview (at each wave)* from the *date of first reported stroke*. It was re-calculated at each wave.

Presence of new stroke. Presence of new stroke was assessed at each wave and was reassessed every two years. It was identified by yes/no for presence of new CVA within the HRS database. Confirmatory onset of a new CVA was taken from Medicare claims data following a period of 90 days from the initial incident CVA and searching for CVA ICD-9 codes within subsequent claims.

Treatment with tPA. The presence of treatment with tPA was taken from Medicare claims data. It was coded “yes” if ICD-9 code 99.10 was found, and “no” otherwise.

Cognitive deficits. The HRS survey contains a cognitive assessment. It is a 35-point scale that assesses working memory, mental processing speed, knowledge and language, and orientation. (Langa et al, 2008) The score was used as a continuous measure in analyses for those who were self-respondents to the survey after their stroke.

For those who required proxy respondents following the stroke, categories proposed by Langa et al were utilized: Normal cognitive impairment (proxy respondent: excellent); Mild impairment (proxy: very good/good); moderate/severe impairment (proxy: fair/poor). Cognitive status was a time-varying factor - cognition was calculated at each wave.

Presence of depressive symptoms. The HRS utilizes a short-form of the Center for Epidemiologic Studies Depression (CES-D) scale. Respondents are asked about whether they feel depressed, how much effort is involved in daily living, sleep patterns and behavior, feelings of sadness and loneliness, and whether or not the respondent enjoyed life and felt happy most of the time. All items are yes/no binary responses. The scores range from 0 (no depressive symptoms) to 8 (the highest number of depressive symptoms). The scores were utilized as a continuous variable. Those who required a proxy were coded so that they could be identified and distinguished from those who did not require a proxy. This was to make it easier to retain these cases in the final analyses. (Okura, Heisler, & Langa, 2009)

Participation in rehabilitation. Participation in rehabilitation was defined as those who answered, "yes" to the question had they been seen by an occupational or physical therapist in the previous 12 months. This was also confirmed by Medicare. claims data through a search of CPT codes for OT, PT, and SLP services. Rehabilitation was considered 'yes' if a respondent reported participation and it was confirmed by Medicare claims. If the respondent did not reply "yes" in HRS but Medicare claims uncovered billing from rehabilitation providers, then the response was changed to "yes" for future analysis. It was re-assessed at each wave and utilized as a time-varying factor.

Social support. Social support was determined by utilizing the method Muramatsu et al (2007) described for measuring family resources. It was taken from marital status, number of living siblings, child availability, and spouse's self-reported health status. Marital status was binomial and coded as currently married or not. Child availability was categorical (co-residence; children living within 10 miles; child living more than 10 miles away; no living children). Spouse's self-reported health status was binomial (fair/poor vs good/better). The categories were used as an index of social support (0-4). A score of zero indicated lack of any family resources. A score of four indicated that the respondent was married with a spouse in good/better health, children within 10 miles, and had at least one living sibling. Social support was a time-varying factor.

Data Analysis Plan

A pooled cross-sectional analyses was conducted with a large panel database, thus generalized estimating equations were utilized. GEE is a population-averaging method, with the odds ratios referring to the average response over measures within a panel. GEEs adjust for correlation in the individual participant's responses over time. In order to properly utilize GEE, data needed to be transposed from "wide" to "long" format. The original structure of the data was "wide". "Wide" format is identified when the responses for a respondent from each wave of a survey are displayed in one line of data. In the original dataset for this study, each individual had one observation, which included responses from 1998-2010 in one line of data. When the data was converted from "wide" to "long" format, each individual's responses were converted to multiple lines of data; a new observation per year that the individual responded in the survey. For this study, when the data was converted to "long" format, each individual respondent's responses were converted from one line of observation to seven lines of observations.

The use of weights with population-based samples has been a topic of debate. (Hahs-Vaughn, 2005; Kish, 1987) Weights allow a researcher to correct for any "disproportionality" in the sample and account for non-response and underrepresentation in the sampling frame with respect to the target population. (Pfefferman, 1993) For many descriptive statistics with survey panels (e.g. means, medians, and proportions), weightings are suggested. However, when developing regression models with this type of data, there are differing perspectives. Many authors suggest that with regression models, weightings should not be utilized. (Moore, Pedlow, Krishnamurty, & Wolter, 2000) This author decided not to utilize weights in analyses since it was agreed that the analyses chosen would give unbiased regression coefficients with smaller standard errors. (Winship & Radbill, 1994)

Another consideration with such a multitude of factors in a study is testing that the factors do not have multicolinearity. Prior to all analyses, correlation coefficients were produced for all the independent and dependent variables. None of the correlations produced a co-efficient over +/- 0.30. The only two factors that were near the +/- 0.30 correlation co-efficient cut-off were income and years of education with a correlation coefficient of $r = +0.29$, indicating a positive relationship between income and years of education, which would be expected. The results of initial correlations did not produce concern within the chosen factors within any of the study variables.

Analytic Approach.

Aims 1 & 2: Factors influencing CVA incidence and effects. A pooled, cross-sectional approach was utilized with Stata v. 12 for the incident analyses. (StataCorp, 2011) GEE with an independent correlation structure was utilized for two main reasons in the incident analyses: 1.) STATA deletes observations of less than two with autoregressive correlation analyses and 2.) Quasi-likelihood information criterion (QIC) analyses confirmed that independent structure was the best fit for the data. Many authors support the choice of independent correlation structure with this type of data. (Hilbe, 2009) Since the sample size was robust, hypothesized factors were put into the GEE logistic regression model at the same time to determine significance. The outcome was whether or not the respondent reported a CVA between study years. If yes, baseline information about the respondent was taken from the previous wave in which the respondent participated in the study. A respondent was kept in the analysis until they reported a CVA or dropped out of the study.

SAS version 9.3 for UNIX software was utilized on a secure server at Case Western Reserve University for severity analyses (aim 2) and all subsequent analyses (aims 3-5) in compliance with CMS DUA to protect personal identifying information within the Medicare-claims data. (SAS Institute Inc, 2011) For the severity analyses, only data from respondents who reported an incident CVA during the survey years 2000-2008 were merged with Medicare claims data. The initial analyses compared those who died following the CVA and prior to the next survey year with those who did not. Subsequent surveys were completed within 2 years of the incident CVA for all respondents; the analysis was described as short-term (<2 years) to indicate those outcomes that occurred prior to the next survey year and long-term outcomes (>2 years) as those that occurred following the first survey following the CVA. Univariable logistic regression analyses were conducted on mortality. Predictor variables included: age, gender, race, ethnicity, income level, education, employment status, BMI, co-morbidity, type of CVA, and personal baseline characteristics (smoking, drinking, and exercise behaviors and presence of a physician visit within the previous 12 months). The variables significantly related to mortality in these analyses were added to the multivariate model. However, prior to running the final model, multiple imputation was conducted to assess whether imputation of missing values made a significant difference in the outcomes.

Imputation using PROC MI was utilized, where the number of multiple imputations was ten. After multiple imputation was conducted, additional univariable analyses were run with imputed values. No new factors that became significant at that stage. The final regression analysis included age, education, work status, and BMI. The final analysis was conducted using multiple imputation.

For the remaining severity analyses, a similar process was followed but utilizing multivariable linear regression since the outcome variable, index score of function, was continuous. PROC REG was performed with a stepwise selection to identify variables that were significantly related to the index score. Stepwise regression utilized p=0.15 as the cut-off for selection into the final model. After PROC REG with a stepwise selection was completed, an additional multiple imputation procedure was utilized to assess whether missing values had an impact on the results. Imputation did not have an effect on the results, so result of PROC REG procedures are reported without imputation.

Aim 3: Functional ability following incident CVA. The study utilized a pooled, cross-sectional approach to identify the predictors of functional abilities of CVA survivors over time. Functional abilities were identified as the change in functional ability index scores from wave to wave, beginning with the baseline year. A generalized estimation equation (GEE) approach with identity link function was utilized. GEE was chosen because of the nature of the data (panel) and the ability of GEE to adjust for correlation within the data. It is a population-averaging approach that allows a researcher to account for repeated measures within a subject and those factors that were measured over time. An independent working correlation structure was utilized for this analysis after running the model under different working correlation structures and comparing QIC and QICu values (QIC = "quasi-likelihood under independence model criterion") (Pan, 2001). In addition, Anderson, et al (1994) point out that under certain conditions, using a non-independent working correlation structure with GEE with time-varying covariates can lead to bias in the resulting estimate. It was decided therefore to use an independent correlation matrix so that further bias was not introduced into this study's results.

Constant factors in the models included: gender, race, SES, stroke type, initial severity of CVA, a physician visit within previous 12 months of CVA, and baseline measures (employment status, co-morbidity, BMI, smoking, drinking, and physical activity behaviors). Time-varying factors included: age, co- morbidity, cognitive score, depression score, social support, presence of rehabilitation, recurrent CVA, employment status, and BMI. Co-morbidity was utilized as both a static, baseline factor and as a time-varying factor.

Aims 4 & 5: Participation and utilization of rehabilitation. The study utilized a pooled, cross-sectional approach to identify the predictors of functional abilities of CVA survivors over time. Functional abilities were identified as the change in functional ability index scores from wave to wave, beginning with the baseline year. A generalized estimation equation (GEE) logistic regression approach with identity link function was utilized. GEE was chosen because of the nature of the data (panel) and the ability of GEE to adjust for correlation within the data. It is a population-averaging approach that allows a researcher to account for repeated measures within a subject and those factors that were measured over time. An independent working correlation structure was utilized for this analysis after running the model under different working correlation structures and comparing QIC and QICu values (QIC = "quasi-likelihood under independence model criterion") (Pan, 2001). In addition, Anderson, et al (1994) point out that under certain conditions, using a non-independent working correlation structure with GEE with time-varying covariates can lead to bias in the resulting estimate. It was decided therefore to use an independent correlation matrix so that further bias was not introduced into this study's results.

Constant factors in the GEE model included: gender, race, SES, stroke type, initial severity of CVA, a physician visit in the previous 12 months of CVA, and baseline measures (employment status, co-morbidity, BMI, smoking, drinking, and physical activity behaviors). Time-varying factors included: age, co- morbidity, cognitive score, depression score, social support, presence of rehabilitation, recurrent CVA, employment status, and BMI. Co-morbidity was utilized as both a static, baseline factor and as a time-varying factor.

Descriptive analyses of utilization of rehabilitation services were based upon the initial episode of care for CVA. Correlations, t-tests, and ANOVA were conducted, as appropriate, to describe the utilization patterns by each of the individual factors included in the previous analysis (age, gender, race, SES, education, co-morbidity, type of CVA, recurrent CVA, initial severity of CVA, cognition, depression, BMI, social support, time elapsed and baseline personal lifestyle characteristics - smoking, drinking, physical activity, employment status, and presence of a physician visit in the previous 12 months).

CHAPTER 4: RESULTS

Aim 1: Incidence of CVA

Descriptive Analysis. Results of descriptive analyses for the entire sample can be found in Table 5. From the survey years 2000-2010, the final sample (N=23,695) was split into incident CVA (n=1,189) and non-incident CVA cases (n=22,506). Descriptive analyses for the entire sample are based on the data from the first time respondents provided a response for that item during the survey years in which they participated. Chi-square statistics and t-test analyses were performed on categorical and continuous variables, as appropriate to describe the two groups. The group who sustained a CVA was older (age $p \leq 0.001$) and more likely to be black/African American ($p = 0.017$). In addition, the group who sustained a CVA was more likely to have lower SES ($p \leq 0.001$) and less education ($p \leq 0.001$) than those who did not sustain a CVA; those with CVA were also more likely to be retired and less likely to be employed full-time at baseline ($p \leq 0.001$). Health conditions also differed across groups: On average, those who sustained a CVA had higher BMI ($p = 0.0124$) and more co-morbidity ($p \leq 0.001$) than those who did not have a CVA. The groups did not differ significantly by gender ($p=0.903$) or identification with Hispanic/Latino ethnicity ($p=0.075$). Finally, smoking status ($p=0.101$), the presence of heavy drinking ($p=0.576$), and the presence of physical activity ($p=0.822$) did not differ across groups.

Table 5

Characteristics of HRS Survey Sample (2000-2010) (N = 23,695)

	CVA (n = 1,189)	Non-CVA (n = 22,506)	p-value
Gender, n(%)			
Male	522(43.90%)	9,921(44.08%)	0.903
Age, years (mean)	67.93	64.36	<0.001
Race, n(%)			0.017
White	958(80.57%)	18,478(82.10%)	
Black	205(17.24%)	3,287(14.60%)	
Other	26(2.12%)	731(3.25%)	0.075
Ethnicity, n(%)			
Hispanic/Latino	93(7.82%)	2,106(9.36%)	
Not Hispanic/Latino	1,096(92.18%)	20,400(90.64%)	
SES, n(%)			<0.001
<100% FPL	111(9.34%)	1,756(7.80%)	
100-199% FPL	257(21.61%)	3,300(14.66%)	
≥200% FPL	708(59.55%)	13,991(62.17%)	
Education, n(%)			<0.001
< high school (HS)	395(33.22%)	6,248(27.76%)	
GED or HS graduate	406(34.15%)	7,365(32.72%)	
Some college	205(17.24%)	4,447(19.76%)	
College graduate	183(15.39%)	4,412(19.64%)	
Work status, n(%)			<0.001
Full-time	237(19.93%)	7,156(31.80%)	
Part-time	58(4.88%)	1,358(6.03%)	
Unemployed	16(1.35%)	354(1.58%)	
Partially retired	90(7.57%)	1,540(6.84%)	
Retired	616(51.81%)	8,850(39.32%)	
Disabled	54(4.54%)	798(3.55%)	
Not in labor force	118(9.92%)	2,449(10.88%)	
BMI, mean	27.46	27.06	0.0124
Co-morbidity, n(%)			<0.001
0	173(14.55%)	5,443(24.18%)	
1	329(27.67%)	7,266(32.28%)	
2	387(32.55%)	5,209(23.14%)	
3+	300(25.23%)	2,988(13.28%)	
Personal lifestyle factors			
MD visit previous year (yes)	1123(94.45%)	20,666(91.82%)	0.007
Smoking (yes)	195(16.40%)	3,877(17.23%)	0.101
Heavy drinker	69(5.80%)	1221(5.43%)	0.576
Physical activity (yes)	488(41.04%)	9310(41.37%)	0.822

Data taken from first report of measure for both the incident and non-incident cases

Logistic Regression Analysis. Results of GEE logistic regression analyses on incident CVA can be found in Table 6. The total number of observations included in the final GEE analysis was N=160,965.

Demographic characteristics. Gender and age predicted an increased risk of CVA in the sample. More specifically, men had 32% increased odds of having a CVA (p <0.001; CI(1.14-1.54)). Those who were older were also more likely to have sustained a CVA (p = <0.001, OR=1.05, CI 1.04-1.06)). Neither race nor ethnicity was a significant predictor of sustaining a CVA in this study. Neither income nor educational attainment were significant predictors of CVA.

Co-morbidity. As co-morbidity increased, so did risk of CVA. Those who had two (p≤0.001, OR=1.58, CI(1.23-2.03)) or three or more (p≤0.001, OR = 2.60, CI (2.02 - 3.35)) co-morbidities demonstrated an increased risk of CVA compared to those who did not have any co-morbidities.

BMI. Those whose BMI qualified them as obese were at decreased odds of sustaining a CVA compared to those who were normal or over weight (p= 0.031; OR = 0.83,;CI (0.70-0.98). Being underweight was not predictive of CVA (p=0.116).

Personal lifestyle factors. Of the baseline lifestyle factors studied, smoking at baseline had a statistically significant association with sustaining a CVA, with odds of sustaining a CVA 46% higher for smokers than for those who did not smoke (p≤0.001, OR = 1.46, CI(1.22-1.75). None of the other personal lifestyle factors were significant predictors of sustaining a CVA (presence of a regular physician (p=0.823), presence of heavy drinking (p=0.985), or presence of regular physical activity (p=0.084).

Baseline employment status. Individuals who reported being disabled in the survey year prior to their CVA had increased odds of having a CVA (p=0.003,OR = 1.79, CI(1.22 - 2.64)) compared to those who were working full-time at the previous survey. Other working statuses (i.e. part-time, partially retired, retired, unemployed, or not in the labor force) did not demonstrate significance when compared to those who worked full-time.

Table 6

Logistic Regression of Incident CVA on Demographic Characteristics, Health Condition, and Personal Lifestyle Factors (N = 160,975)

	OR	95% CI	p-value
Gender, male	1.32	(1.14 - 1.54)	≤0.001
Age	1.05	(1.04 - 1.06)	≤0.001
Race			
White	Reference	--	--
Black	0.87	(0.55 - 1.37)	0.548
Other	1.07	(0.66 - 1.74)	0.783
Hispanic/Latino	1.08	(0.83 - 1.39)	0.578
Income, % FPL			
<100% FPL	Reference	--	--
100-199% FPL	1.15	(0.89 - 1.49)	0.282
≥200% FPL	0.98	(.77 - 1.26)	0.899
Education			
Less than high school	Reference	--	--
High school graduate	1.07	(0.90 - 1.28)	0.430
Some college	0.99	(0.80 - 1.23)	0.941
College graduate	0.94	(0.73 - 1.19)	0.624

Table 6 (cont'd)			
Logistic Regression of Incident CVA on Demographic Characteristics, Health Condition, and Personal Lifestyle Factors (N = 160,975)			
Work			
Full-time	Reference	--	--
Part-time	0.92	(0.60 - 1.41)	0.701
Unemployed	0.81	(0.35 - 1.85)	0.615
Partially retired	0.80	(0.58 - 1.11)	0.184
Retired	1.05	(0.84 - 1.33)	0.670
Disabled	1.78	(1.21 - 2.63)	0.004
Not in labor force	1.18	(0.87 - 1.61)	0.284
Co-morbidities			
0	Reference	--	--
1	1.17	(0.91 - 1.51)	0.224
2	1.59	(1.23 - 2.04)	≤0.001
≥3	2.63	(2.03 - 3.39)	≤ 0.001
BMI			
Normal weight	Reference	--	--
Underweight	0.46	(0.24 -0.86)	0.016
Overweight	0.92	(0.70 - 0.98)	0.340
Obese	0.79	(0.65-0.96)	0.017
Personal lifestyle factors			
MD visit previous year	0.97	(0.71 - 1.32)	0.823
Smoker	1.45	(1.22 - 1.74)	≤0.001
Heavy drinker	1.00	(0.76 - 1.31)	0.991
Regular physical activity	0.87	(0.75 - 1.02)	0.068

Aim 2: Severity of CVA

Descriptive Analysis. Description of the sample of respondents who sustained an incident CVA whose HRS data were merged with Medicare-claims data can be found in Table 7. The total sample size was 515.

There were more women (56.7%) in the sample than men (43.3%). The average age for the sample was 73.7 years. Race and ethnicity were consistent with the incident sample prior to the merge, with 81.3% White and 16.7% Black individuals and 7.0% self-identified as Hispanic or Latino. The majority (64.6%) of the sample had income over 200% of the FPL. Thirty four point eight percent of the sample did not have a high school (HS) education, while the rest of the sample (65.2%) identified as having at least a HS diploma. The majority of the sample stated that they were retired (67.0%) or partially retired (8.2%). Of those who were working, 8.0% were working full time, 3.1% were working part time, and 0.6% were unemployed but actively looking for work. Those who were disabled included 2.9% of the respondents, whereas those who were not in the labor force with no specified reason included 10.3% of the sample.

The average BMI of the sample was 27.0. Among the sample, 8.2% had zero co-morbidity, 23.1% had one co-morbidity, 30.7% had two co-morbidities, and 38.0% had three or more co-morbidities. Ischemic stroke comprised 63.3% of the sample, with 9.7% identified as hemorrhagic, and 29.5% remaining unspecified.

The range of personal lifestyle factors among the group follows. Most respondents (95.7%) had a visit with a physician during the preceding 12 months. The percent of current smokers in the sample was 12.6% and 4.1%. of the sample were heavy drinkers. Those who identified as participating in regular, physical activity were 29.5%.

Table 7

HRS-Medicare Sample Who Sustained an Incident CVA from 1998 - 2000

	N=515
Gender, n(%) Male	 223 (43.3%)
Age, years; mean (SD)	73.67 (8.4%)
Race, n (%) White Black Ethnicity, n (%) Hispanic/Latino Not Hispanic/Latino	 422 (81.9%) 93 (18.1%) 36 (7.0%) 479 (93.0%)
SES, n(%) <200% FPL ≥200% FPL	 163 (31.7%) 298 (64.6%)
Education, n(%) < High school (HS) ≥ HS	 179 (34.8%) 336 (65.2%)
Work status, n (%) Full-time Part-time Unemployed Partially retired Retired Disabled Not in labor force	 41 (8.0%) 16 (3.1%) 3 (0.6%) 42 (8.2%) 345 (70.0%) 15 (2.9%) 53 (10.3%)
BMI, mean (SD)	27.04 (5.0%)
Type of CVA Ischemic Hemorrhagic Unspecified	 326 (63.3%) 50 (9.7%) 139 (27.0%)
Co-morbidity, n (%) 0 1 2 3+	 40 (8.2%) 113 (23.1%) 150 (30.7%) 186 (38.0%)
Personal lifestyle factors Regular MD (yes) Smoking (yes) Heavy drinker (yes) Physical activity (yes)	 463 (95.7%) 54 (12.6%) 21 (4.1%) 152 (29.5%)

Regression Analysis with Death as Outcome. Table 8 compares those with an incident CVA who died prior to their next scheduled interview (n=65) to those who did not (n=450) on demographic, health and life style characteristics. Chi-square and Fisher's exact tests were conducted along with t-tests as appropriate to compare the two groups. The two groups were significantly different by age (p<0.001) with those who died from CVA (78.21) older, on average, than those who did not die from CVA (73.01). The groups also differed by BMI (p=0.030), with the group who survived having a higher BMI on average (27.22) than those who died (25.78). The samples were not statistically different by gender, race/ethnicity, income, education, work status, type of CVA, co-morbidity, or personal lifestyle factors.

Table 8

HRS-Medicare Sample Who Sustained an Incident CVA from 1998-2008 (N=515)

	Died (n=65)	Survived (n=450)	p-value
Gender, n (%)			
Male	25(38.5%)	252(38.5%)	0.399
Age, years; mean (SD)	78.21(7.9%)	73.01(8.2%)	<0.001
Race, n (%)			
White	51(78.5%)	371(82.4%)	0.339
Black	14(21.5%)	79(17.6%)	
Ethnicity, n (%)			
Hispanic/Latino	60(92.3%)	419(93.1%)	0.812
Not Hispanic/Latino	5(7.7%)	31(6.8%)	
Income, n(%)			
<100% FPL	13(20.0%)	150(33.3%)	0.785
≥200% FPL	26(66.7%)	272(64.5%)	
Education, n (%)			
<high school (HS)	31(47.7%)	148(32.9%)	0.104
≥HS graduate	34(52.3%)	302(67.1%)	
Work status, n (%)			
Full-time	1(1.5%)	40(8.9%)	0.139
Part-time	1(1.5%)	15(3.3%)	
Unemployed	0(0.0%)	3(0.7%)	
Partially retired	2(3.1%)	40(8.9%)	
Retired	53(81.5%)	292(64.9%)	
Disabled	2(3.1%)	13(2.9%)	

Not in labor force	6(9.2%)	47(10.4%)	
BMI, mean (SD)	25.78(5.1%)	27.22(4.9)	0.030
Type of CVA Ischemic Hemorrhagic Unspecified	 35(53.9%) 7(10.8%) 23(35.4%)	 291(64.7%) 43(9.6%) 116(25.8%)	 0.215
Co-morbidity, n (%) 0 1 2 3+	 5(7.7%) 12(18.5%) 21(32.3%) 27(41.5%)	 35(8.3%) 101(23.8%) 129(30.4%) 159(37.5%)	 0.794
Personal lifestyle factors Regular MD (yes) Smoking (yes) Heavy drinker (yes) Physical activity (yes)	 59(96.7%) 3(5.3%) 3(4.6%) 15(23.1%)	 404(95.5%) 51(13.7%) 18(4.0%) 137(30.4%)	 0.664 0.073 0.815 0.224

The final model was fitted based on results of univariable analyses (Table 9), both before and after imputation of missing values. Only those factors that were found significant in the univariable analyses were included in the final model. The variables that were significant in univariable analyses included age (OR: 1.09; p≤0.001), education (OR:0. 54; p=0.021), work status (OR: 0.24; p=0.006), and BMI (underweight: OR: 2.45; p=0.312; overweight: OR:0.43; p=0.009; and obese: OR: 0.70; p=0.292; reference: normal weights). The final model utilized multiple imputation.

Table 9

Univariable Logistic Regression of Death on Demographic Characteristics, Health Conditions, and Personal Lifestyle Factors (N = 515)

	OR	p-value
Gender, female	1.26	0.403
Age	1.09	≤0.001
Race Black/other vs White	 1.29	 0.436
Hispanic/Latino	1.12	0.812
Income, % FPL ≥200%FPL vs <200%FPL	 0.80	 0.483
Education HS grad vs Non-HS grad	 0.54	 0.021
Work Working vs not working	 0.24	 0.006
Work Full-time Part-time Unemployed Partially retired Retired Disabled Not in labor force	 Reference 2.67 <0.01 2.00 7.23 6.15 5.11	 --- 0.498 0.992 0.578 0.053 0.151 0.139
Co-morbidity	1.15	0.134
CVA type Ischemic Hemorrhagic Undefined	 Reference 1.35 1.65	 -- 0.497 0.085
BMI Normal weight Underweight Overweight Obese	 Reference 2.45 0.43 0.70	 -- 0.312 0.009 0.292
Personal lifestyle factors MD visit within year vs no visit Smoker vs non smoker Heavy drinker vs not heavy drinker Physical act vs no physical act	 1.39 0.35 1.16 0.69	 0.666 0.086 0.815 0.226

Table10			
Final Logistic Regression of Death on Age, Education, Employment Status, and BMI From Multiple Imputation (N=515)			
	OR	95% CI	p-value
Age	1.07	(1.03-1.12)	0.001
Education HS grad vs non HS grad	0.56	(0.32-0.96)	0.036
Work Working vs not working	0.43	(0.14-1.27)	0.126
BMI Normal weight Underweight Overweight Obese	 Reference 2.14 0.53 1.05	 -- (0.36-12.52) (0.27-1.03) (0.51-2.13)	 -- 0.400 0.060 0.898

Table 10 displays the final results of multivariable logistic regression analysis of survival on demographic, health and life style characteristics with multiple imputation.

Age. Age was significant in the final model. Those who were older had 7% increase in odds of dying from their CVA (CI(1.03-1.12); p = 0.001).

Education. Education was significant. Those who were HS graduates experienced a decrease in the odds of dying from a CVA (OR: 0.56; CI(0.32-.96; p=0.036).

Work. Employment status was not significant in the final analyses, but those who were working at baseline had a decreased odds of dying following a CVA (OR: 0.43; CI(0.14-1.27); p=0.126).

BMI. BMI as a predictor of death following CVA produced mixed results. Being overweight had statistically significant reduced odds of dying from a CVA compared to those who were normal weight. (CI(0.27-1.03); p=0.024). Those who were underweight (CI (0.36-12.52); p=0.400) or obese (CI(0.51-2.13); p=0.898) had increased odds of dying compared to those who were normal weight, but neither were significant. For those who were underweight, the relationship was not significant and the confidence interval was extremely large.

Regression Analysis on Long-term Survivors of CVA.

Description of the functional status of individuals who survived long-term from a CVA (> 2 years) are reported in Table 11. Index of function was a score 0-19. The functional change score that was used in the severity analysis theoretically ranged from [-19 to +19]. However, the range of scores for functional change in the study sample was [-19 to +9]. A negative functional change score indicated a reduction in functional ability following the CVA, with a -19 indicating that an individual went from being completely independent in function to completely dependent after the CVA. The functional ability measurements reported pre-CVA compared to those reported post-CVA were significant (p<0.001). The average functional change from pre-CVA to post-CVA was -3.64 (SD: 5.14).

Table 11

Functional Status of Long-Term Survivors of Incident CVA in HRS-Medicare Sample (N=450)

	Baseline	Post-CVA	p-value
Severity, mean(SD)¥	3.86 (3.81)	7.51 (5.65)	<0.001
Severity, n (%)			
No impairment	335 (65.2%)	190 (37.0%)	<0.001
Mild impairment	129 (25.1%)	146 (28.5%)	
Moderate impairment	44 (8.6%)	96 (18.7%)	
Severe impairment	6 (1.2%)	81 (15.8%)	
Change in functional status score from baseline to post-CVA, mean (SD)€		-3.64 (5.14)	

¥ Index score 0-19: Score of zero indicates no identified functional impairment.
€ Negative score indicates less independence.

Linear regression analyses results can be found in Table 12. Following stepwise selection, age, co-morbidity, type of CVA, and baseline physical activity were found significant at p = 0.15, thus included in the final model. Age (p=0.026) and type of CVA (hemorrhagic) (p=0.024) remained significantly related to a reduction in functional ability post-CVA. Those with hemorrhagic stroke had worse functional scores compared to those with ischemic CVA or other unspecified CVA (p=0.715; β = 0.094). Presence of vigorous physical activity at baseline predicted slightly better functional status following CVA, but these results were not significant (p=0.106; β=0.084). The overall model effect was small (r^2 =0.04).

Table 12			
Linear regression Using Stepwise Selection of Initial Functional Ability on Demographic Characteristics, Health Conditions, and Personal Lifestyle Factors. (N=450)			
	β	p-value	R^2
Age	-0.116	0.026	0.045
# of Co-morbidities	0.094	0.072	
Type of CVA Hemorrhagic	-0.117	0.024	
Physical activity	0.084	0.106	

Aim 3: Functional ability over time

Descriptive analysis. Descriptive analyses are presented in table 13. The total sample for the descriptive analysis was 450. Eight hundred and fifty nine observations were utilized in the GEE analysis.

There were more women (61.5%) in the sample than men (38.5%). The average age for the sample was 73.0 years. Over eighty percent (82.4%) of the sample was White, 17.6 were Black and 6.9% identified as having Hispanic or Latino roots. The majority (64.5%) of the sample had income over 200% of the FPL. Those without a high school (HS) education comprised 32.9% of the sample, with the rest having at least a HS diploma. Most of the sample (78.2%) was not working for pay at baseline, while the remaining 21.8% reported working for pay at baseline. ,

The majority of the sample (63.8%) sustained an ischemic CVA with 10.4% having a hemorrhagic event and 25.8 coded as unspecified. The average initial severity of the CVA was - 3.0 (SD: 4.7) indicating that the average level of functional ability declined after the CVA. Higher functional ability scores were indicative of less independence, so a change from more independent functioning to more dependence in functional ability was a negative score. The sample had an average of 2.4(SD: 1.4) co-morbidities. Being overweight was the majority of the sample with 23.3%. Of the remaining sample, 34.9% were normal weight 0.9% were underweight and 23.3% were obese. Almost 300 (66.4%) of the individuals in the sample sustained a recurrent CVA over the years of data collection.

Most respondents, 95.5%, had had a visit with a physician during the preceding 12 months. The percent of current smokers was 13.7% and heavy drinkers comprised 4.0% of the sample. Approximately 30% of sample respondent identified as participating in regular, physical activity.

The average depression score in the first survey following CVA was 2.2 (SD: 2.2) and the average baseline depression score for the sample was 1.9. Depression scores ranged from 0-8, with zero indicating no depressive symptoms, and 8 indicating severe depressed symptomatology. The average cognitive score among the sample in the survey year following the CVA was 19.8(SD: 5.4). Cognition scores ranged from 0-35, with a higher score indicating better cognitive abilities.

Eighty-two individuals in the sample were receiving therapy during the first interview following the CVA. Social support varied among the sample with 1.4% of the sample with no indication of social support, those with one level of social support were 17.3% of the sample, those with two levels of social support were 31.4% of the sample, those with three levels of social support were 22.7% of the sample, and those with four levels of social support were 27.2% of the sample.

Table 13

Demographic, Health, and Lifestyle Characteristics of the Combined HRS-Medicare Sample (N=450)

Age, years; mean (SD)	73.0 (8.2)
Gender, Male n (%)	252 (38.5%)
Race, n (%) White Black Ethnicity, n (%) Hispanic/Latino Not Hispanic/Latino	 371 (82.4%) 79 (17.6%) 419 (93.1%) 31 (6.9%)
Income, n (%) <100% FPL ≥200% FPL	 168 (38.2%) 272 (64.5%)
Education, n (%) <high school (HS) ≥HS graduate	 148 (32.9%) 302 (67.1%)
Employment Status (yes)¢	98 (21.8%)
BMI Underweight Normal Overweight Obese	 4 (0.9%) 157 (34.9%) 184 (40.9%) 105 (23.3%)
Co-morbidity; mean (SD)£	2.35 (1.40)
Severity of CVA; mean (SD)¥	-3.0 (4.7)
Type of CVA Ischemic Hemorrhagic Unspecified	 287 (63.8%) 47 (10.4%) 116 (25.8%)
Personal lifestyle factors Physician visit past yr (yes) Smoking (yes) Heavy drinker (yes) Physical activity (yes)	 404 (95.5%) 51 (13.7%) 18 (4.0%) 137 (30.4%)
Second CVA at any time (yes)	299 (66.4%)
Cognition Score; mean (SD)₠	19.9 (5.4)
Depression Score; mean (SD)§	2.2 (2.2)

Table 13 (cont'd)	
Demographic, Health, and Lifestyle Characteristics of the Combined HRS-Medicare Sample. N=450	
Rehabilitation (yes)	82 (18.2%)
Social support⌘	
0	6 (1.4%)
1	74 (17.3%)
2	134 (31.4%)
3	97 (22.7%)
4	116 (27.2%)
¢Employment status: Working for pay at baseline or not (binomial) ;£Co-morbidity: Continuous 0-6; ¥Initial severity of CVA: index score from 0-19. Zero indicates complete independence while 19 indicates complete dependence; ₠Cognition Score: index score from 0-35. Higher score indicates better cognition; §Depression score: Index score from 0-8. Higher score indicates more depression; ⌘Social support index score as a count of the following: married (yes/no) + spouse self-reported health status (good/better heath) + presence of children within 10 miles + presence of one living sibling	

GEE linear regression analysis. Results of GEE linear regression analysis can be found in Table 14. The primary outcome was functional ability, measured at each interview following the CVA on a continuous scale ranging from 0-19. Table 2 displays estimates, standard errors, and significance levels associated with the factors included in the final analysis. A negative regression coefficient indicated that higher values of the predictor were associated with more independence.

Demographic characteristics. Of the demographic characteristics studied, age, gender, and race were factors significantly associated with functional ability. As an individual aged, their functional ability became worse, requiring more assistance from others (p=0.003). Black individuals were more likely to have decreased functional ability over time compared to white individuals (p=0.004). Gender (p=0.076) was also significantly associated with worse functional ability over time, with females experiencing more declines over time. Income ($p=0.790$), and education ($p=0.246$) were not significantly associated with functional ability over time.

Baseline personal lifestyle factors. Employment status was significantly associated with functional ability. Those individuals who were working for pay at baseline demonstrated more functional ability over time compared to those who were not ($p=0.003$). Individuals who reported regular participation in physical activity at baseline also had significantly better functional ability over time compared to those who did not ($p<0.0001$).

Those who reported a physician visit in the previous twelve months, were smokers, or were heavy drinkers did not appear statistically different in their functional ability over time compared to those who did not have these characteristics ($p=0.699$, $p==0.756$, $p=0.982$ respectively). Baseline co-morbidity was not significantly related to functional ability over time ($p=0.967$); however having an increase in co-morbidity over time was significantly associated with less functional ability ($p<0.0001$).

Health condition. Type of CVA did not predict any change in functional ability over time (hemorrhagic: $p=0.689$, unspecified: $p=0.195$, reference group = ischemic), nor did having a second CVA ($p=0.961$). Initial severity of CVA ($p<0.0001$) was a significant predictor of functional ability over time. Individuals who had mild CVAs demonstrated better functional ability over time compared to those who had more severe CVAs, who had worse functional ability over time.

Cognition. Functional ability was significantly better over time as cognitive scores increased. ($p=0.0003$).

Depression. As depression scores increased, functional ability over time decreased significantly (p<0.0001).

Social support. Those who reported at least two or more types of social support at baseline had improved functional ability over time compared to those who did not report any social support. (1 type: p=0.101, 2 types: p=0.032, 3 types: p=0.0.679, 4 types: p=0.036).

Rehabilitation. Those who were participating in rehabilitation services had significantly less functional ability over time (p=0.004).

Table 14

GEE Linear Regression of Functional Ability on Demographic Characteristics, Health Conditions, and Personal Lifestyle Factors (N=450)

	Estimate	S.E.	95% CI	p-value
Age, years	0.09	0.03	(0.15 - 0.15)	0.006
Gender Male	 0.53	 0.37	 (-0.20 - 1.26)	 0.154
Race White Black	 --- 0.92	 --- 0.61	 --- (-0.28 - 2.13)	 0.016
Income <100% FPL ≥200% FPL	 --- -0.02	 --- 0.43	 --- (-0.87 - 0.83)	 0.835
Education <high school (HS) ≥HS graduate	 --- 0.40	 --- 0.45	 --- (-0.47 - 1.28)	 0.337
Employment Status¢	-1.36	0.45	(-2.25 --0.48)	0.003

Note: Negative estimates indicate improved functional abilities

Table 14 (cont'd)

GEE Linear Regression of Functional Ability on Demographic Characteristics, Health Conditions, and Personal Lifestyle Factors (N=450)

	Estimate	S.E.	95% CI	p-value
BMI				
Underweight	0.73	0.75	(-0.73-2.20)	0.339
Normal	---	---	---	---
Overweight	1.29	0.77	(-0.23- 2.80)	0.169
Obese	1.00	0.75	(-0.47 - 2.47)	0.335
Co-morbidity(baseline)£	0.22	0.22	(-0.20 - 0.65)	0.967
Co-morbidity£	0.51	0.22	(0.08 - 0.93)	0.003
Initial severity of CVA¥	-0.50	0.06	(-0.61 - -0.38)	<0.001
Type of CVA				
Ischemic	---	---	---	---
Hemorrhagic	-0.16	0.74	(-1.61 - 1.29)	0.783
Unspecified	0.51	0.42	(-0.32 - 1.34)	0.272
Time elapsed	0.00	0.00	(0.00 - 0.00)	0.003
Personal lifestyle factors				
MD visit past yr (yes)	0.12	1.19	(-2.22 - 2.45)	0.746
Smoking (yes)	0.26	0.57	(-0.87 - 1.38)	0.782
Heavy drinker (yes)	-0.14	0.73	(-1.56 - 1.29)	0.980
Physical activity (yes)	-1.41	0.37	(-2.14 - -0.68)	0.0001
Second CVA€	0.02	0.28	(-0.52 - 0.56)	0.955
Cognition Score₠	-0.15	0.04	(-0.23 - -0.08)	0.001
Depression Score§	0.41	0.07	(0.27 - 0.55)	<0.0001
Rehabilitation (yes)	1.12	0.42	(0.30 - 1.94)	0.007
Social support⌘				
0	---	---	---	---
1	-2.96	0.80	(-4.53 - -1.39)	0.003***
2	-3.17	0.75	(-4.64 - -1.71)	<0.0001***
3	-2.85	0.79	(-4.42 - 1.29)	0.001***
4	-3.01	0.73	(-4.44 - -1.59)	<0.0001***

Note: Negative estimates indicate improved functional abilities
¢Employment status: Working for pay at baseline or not (binomial) ;£Co-morbidity: Continuous 0-6; ¥Initial severity of CVA: index score from 0-19. Zero indicates complete independence while 19 indicates complete dependence; € Presence of a second CVA (yes or no); ₠Cognition Score: index score from 0-35. Higher score indicates better cognition; §Depression score: Index score from 0-8. Higher score indicates more depression; ⌘Social support index score as a count of the following: married (yes/no) + spouse self-reported health status (good/better heath) + presence of children within 10 miles + presence of one living sibling

Aims 4 and 5: Participation and Utilization of Rehabilitation Services

Utilization of rehabilitation. Table 15 summarizes self-reported data on rehabilitation use among individuals who sustained a CVA. The report of rehabilitation was recorded at each survey year following the CVA and was a binary response to whether the respondent was currently participating in rehabilitation at the time of the interview. At the first interview following the CVA, only 21.6% of individuals reported receiving rehabilitation services for a CVA-related impairment (n=515). Of those who survived to the next wave (n=268), 6.8% report utilization of rehabilitation services at the time of the survey. Utilization of rehabilitation services by survivors over the last three survey years increased, with 15.8%, 16.5%, and 18.9% of the survivors reporting rehabilitation in years 6, 8, and 10, respectively.

Table 15

Self-Reported Participation in Rehabilitation by HRS Survey Year (N=515)

	2 years (n=514)	4 years (n=268)	6 years (n=152)	8 years (n=91)	10 years (n=53)
Yes	111(21.6%)	35 (6.8%)	24 (15.8%)	15 (16.5%)	10 (18.9%
No	403(78.6%)	233 (86.94)	128 (84.2%)	76 (83.5%)	43(81.1%)

Note: Data is presented starting at the first survey following the CVA (2 years following CVA). Only individuals who survive to the next survey year are included in the results given for that year.

Table 16 summarizes the level of Medicare claims for rehabilitation services by each individual in the sample following the incident CVA (n=515). Utilization by level of care was calculated only for those individuals who had rehabilitation claims in each level of care. Utilization among the different types of rehabilitation services was 74.5% for OT, 88.4% for PT, and 54.9% for SLP. Of the entire sample, 402 (78.1%) had an inpatient stay with rehabilitation claims; 284 (55.1%) had outpatient rehabilitation claims; 258 (50.1%)had home health (HH) claims; and 235 (45.6%) had skilled nursing claims. Those in in-patient care had an average of 3.6 days (SD: 1.8) of service with a range of 1-10 days. Those in outpatient care had average of 16.8 days of service (SD: 14.1) with a range of 1-45 days. Rehabilitation claim-days among those with HH care averaged 13.7 claim-days (SD: 9.4) with a range of 1 - 44. For those with a SNF stay, average number of rehabilitation claim days was 23.5 (SD: 9.5), with a range of 1-66 days.

Table 16

Medicare Claims for Rehabilitation Services During Initial Care Episode (N=515)

Rehabilitation Services in any setting; n (%)	
OT (yes)	380 (74.5%)
PT (yes)	451 (88.4%)
SLP (yes)	280 (54.9%)
Inpatient rehabilitation claim-days; mean (SD), [range] (n=402)	3.6 (1.8), [1 - 10]
Outpatient rehabilitation claim-days; mean(SD),[range] (n=284)	16.8 (14.1), [1 - 45]
Home health rehabilitation; mean (SD), [range] (n=258)	13.7 (9.4), [1 - 44]
Skilled Nursing Facility days; mean(SD),[range] (n=235)	23.5 (9.5) [1 - 66]

Tables 17a and 17b display associations between each individual factor and the level of utilization in each service setting (inpatient, SNF, HH, and outpatient) during the initial episode of care following the CVA. All factors hypothesized to be related to receipt of rehabilitation were included in these analyses. Individual factors that demonstrated no significant difference in utilization within any setting were gender, race, education, BMI, or having had a physician visit over the 12 months prior to the CVA.

The utilization of rehabilitation services by type of CVA was significantly different or trending to significance within all settings (inpatient: p=<0.001; SNF: p=0.011; HH: p=0.060; outpatient: p=0.021). On average, those with an "unspecified" type CVA had the lowest levels of utilization. Those with ischemic CVA and hemorrhagic CVA had varying levels of utilization across settings. Utilization of services by employment status differed within three of the four settings: inpatient (p=0.005), HH (p=0.004), and outpatient (p=0.013) with those who were employed at baseline having, on average, less service utilization than those who were not working at baseline. Having a second CVA was also associated with different utilization patterns in three settings (inpatient (p<0.001), HH (p,0.001), and outpatient (<0.001)) with those who had a second CVA having, on average, more rehabilitation across service areas. Income influenced utilization of rehabilitation services in SNF (p=0.021) and outpatient settings (p=0.051). Individuals in higher income category, on average, participated in less rehabilitation services. Utilization differed by smoking status in the outpatient setting (p=0.035). Non-smokers, on average, had higher levels of utilization in this setting. Heavy drinkers had statistically different utilization in home health than non-heavy drinkers (p<0.001). Heavy drinkers had, on average, less utilization of rehabilitation in HH settings. Individuals who reported vigorous physical activity also differed statistically from those who did not in utilization of HH services (p=0.001). Those who were physically active at baseline, on average, utilized less HH services.

The relationship between age and utilization of rehabilitation across service settings was significant (inpatient: r=0.17; p<0.001; SNF: r=0.13, p=0.048; r=0.15, p=0.001; outpatient, r=0.16, p=0.001). In general, as individuals aged, their utilization increased. The relationship between co-morbidity and utilization of HH services was significant (r=0.09, p=0.032) but co-morbidity did not have a significant association to service utilization in other settings. In HH, those with more co-morbidity tended to have increased utilization. Severity of CVA and HH service utilization was significant ($r=0.25$, $p<0.001$). Those who had more severe CVA tended to have increased utilization. Cognition had a relationship to utilization of services in the inpatient ($r=-0.06$, $p=0.023$) and outpatient ($r=-0.11$, $p=0.041$) settings while there was no significant relationship in the SNF or HH settings and cognition. In the inpatient and outpatient settings, those with higher cognitive scores tended to have lower utilization of rehabilitation services. The presence of depressive symptoms had a significant relationship to amount of HH services ($r=0.15$, $p=0.002$) but not in the other service settings. In the HH setting, those who demonstrated higher levels of depression had higher utilization patterns. Finally, social support influenced level of utilization of HH services ($r=0.10$, $p=0.026$) but not in inpatient, SNF, or outpatient settings. Those with more social support had lower levels of utilization in the HH setting.

Table 17a

Univariable Analysis: Relationship of Number of Days or Claim-Days by Setting to Categorical Factors (N=515)

	Inpatient (n=402)		SNF (n=235)		Home Health (n=258)		Outpatient (n=284)	
	Claim-days (mean)	Sig.	Days (mean)	Sig.	Claim-days (mean)	Sig.	Claim-days (mean)	Sig.
Gender								
Male	2.8 (2.2)	0.617	22.1 (9.3)	0.153	6.0 (9.6)	0.076	9.3 (13.1)	0.992
Female	2.8 (2.2)		23.1 (10.0)		6.7 (9.6)		9.6 (13.5)	
Race								
White	2.8 (2.2)	0.501	23.3 (10.0)	0.289	6.7 (9.6)	0.791	9.6 (13.5)	0.467
Black/other	2.7 (2.0)		22.9 (8.1)		7.5 (9.5)		7.9 (13.1)	
Income								
<200% FPL	3.0 (2.2)	0.812	24.7 (9.5)	0.021	8.1 (10.1)	0.828	9.6 (14.0)	0.051
≥200% FPL	2.7 (2.2)		21.7 (9.3)		6.3 (9.4)		6.3 (9.4)	
Education								
< High school	2.8 (2.1)	0.814	24.1 (9.5)	0.361	6.9 (8.8)	0.945	9.3 (13.0)	0.996
≥ High school	2.8 (2.2)		22.8 (9.9)		6.8 (10.0)		9.3 (13.7)	
Employment								
Working	2.3 (2.0)	0.005	21.8 (13.1)	0.493	4.3 (7.3)	0.004	6.6 (11.7)	0.013
Not working	2.9 (2.2)		23.5 (9.1)		7.5 (9.9)		9.9 (13.7)	
Type of CVA								
Ischemic	3.0 (2.0)	<0.001	24.5 (9.3)	0.011	7.5 (10.1)	0.060	10.2 (14.0)	0.021
Hemorrhagic	3.0 (2.0)		21.8 (12.1)		6.7 (9.4)		10.7 (14.2)	
Unspecified	1.9 (1.9)		19.9 (8.9)		5.3 (8.0)		6.6 (11.2)	

Table 17a (cont'd)

Univariable Analysis: Relationship of Number of Days or Claim-Days by Setting to Categorical Factors (N=515)

	Inpatient (n=402)		SNF (n=235)		Home Health (n=258)		Outpatient (n=284)	
	Claim-days (mean)	Sig.	Days (mean)	Sig.	Claim-days (mean)	Sig.	Claim-days (means)	Sig.
Recurrent CVA								
Yes	3.1 (2.1)	<0.001	23.8 (9.3)	0.145	8.0 (10.2)	<0.001	11.1 (14.4)	<0.001
No	2.2 (2.2)		21.6 (10.6)		4.7 (7.7)		5.8 (10.6)	
BMI								
Normal	2.8 (1.6)	0.909	20.0 (12. 4)	0.640	11.5 (10.6)	0.347	10.0 (18.2)	0.572
Underweight	2.9 (2.2)		23.5 (9.4)		6.2 (9.5)		8.6 (13.2)	
Overweight	2.7 (2.2)		22.4 (8.9)		6.8 (9.6)		10.3 (13.8)	
Obese	2.8 (2.1)		24.2 (11.3)		7.7 (9.5)		8.5 (12.9)	
Physician visit								
Yes	2.8 (2.1)	0.716	23.3 (9.8)	0.434	7.0 (9.7)	0.124	9.0 (13.2)	0.753
No	2.6 (2.5)		20.8 (9.2)		3.9 (8.5)		10.1 (15.8)	
Smoking status								
Yes	2.7 (2.3)	0.889	22.4 (9.1)	0.566	5.3 (8.7)	0.160	6.1 (10.6)	0.035
No	2.7 (2.0)		23.5 (10.0)		7.1 (9.6)		9.6 (13.7)	
Heavy drinker								
Yes	2.5 (2.6)	0.577	19.0 (12.1)	0.310	1.8 (4.0)	<0.001	7.2 (9.3)	0.319
No	2.8 (2.1)		23.4 (9.6)		7.1 (9.7)		9.4 (13.6)	
Physical act.								
Yes	2.7 (2.1)	0.674	22.1 (9.7)	0.267	5.3 (8.0)	0.001	9.2 (13.7)	0.905
No	2.8 (2.2)		23.7 (9.7)		7.5 (10.1)		9.2 (13.3)	
Recurrent CVA								
Yes	3.1 (2.1)	<0.001	23.8 (9.3)	0.145	8.0 (10.2)	<0.001	11.1 (14.4)	<0.001
No	2.2 (2.2)		21.6 (10.6)		4.7 (7.7)		5.8 (10.6)	

Table 17b

Univariable Analysis: Relationship of Number of Days or Claim-Days by Setting to Continuous Factors (N=515)

	Inpatient (n=402)		SNF (n=235)		Home Health (n=258)		Outpatient (n=284)	
	R	Sig.	R	Sig.	R	Sig.	R	Sig.
Age	0.17	<0.001	0.13	0.048	0.15	0.001	0.16	0.001
Co-morbidity	0.02	0.732	-0.05	0.401	0.09	0.032	-0.06	0.189
Severity (ICU Days)	***	***	0.39	0.549	0.25	<0.001	0.05	0.362
Cognition	-0.06	0.023	-0.05	0.471	-0.09	0.089	-0.11	0.041
Depression	0.08	0.114	0.03	0.675	0.15	0.002	0.02	0.731
Social Support	-0.03	0.470	-0.13	0.054	-0.10	0.026	-0.03	0.454

***Severity measure was number of ICU days. Relationship between inpatient stay and ICU days was not calculated due to multicolinearity.

Logistic Regression on Participation in Rehabilitation over Time

The results of logistic regression analyses are shown in Table 18 and Table 19. The number of observations utilized in GEE analyses was n=995. Table 6 shows for each individual factor analyzed the likelihood that the respondent participated in rehabilitation services over the survey years. A p-value <0.01 was utilized as a cut-off for inclusion in the final logistic regression model to account for multiple comparisons.

Age, employment status, type of CVA, initial severity (number of ICU days), time elapsed since CVA, having a recurrent CVA, cognition score, physician visit over the previous 12 months, and being a smoker all had a statistically significant relationship to an increase in the likelihood that the respondent would receive rehabilitation. Those who were older were more likely to participate (OR: 1.06; p<0.001). Those who were employed at baseline were more likely to participate in rehabilitation as well (OR: 1.86; 0.060). Having an ischemic CVA reduced the odds that someone would participate in rehabilitation (OR: 0.41; p =0.03) while those who had an 'unspecified' CVA (OR: 3.07; p<0.001) had triple the odds of participating in rehabilitation compared to the other types of CVA. Initial severity reduced the chance of participating in rehabilitation over time ((number of days in ICU - OR: 0.92; p=0.020). As functional ability declined, the odds of participating in rehabilitation services increased (OR: 1.12; p<0.001). In addition, having a recurrent CVA almost doubled the odds of participating in rehabilitation services (OR: 1.99; p<0.007). Higher cognitive scores predicted lower odds of participating in rehabilitation services (OR: 0.93; p=0.015). Smokers had increased odds of participating in rehabilitation services compared to those who did not smoke at baseline (OR: 2.74; p=0.009). Finally, the presence of a physician visit over the previous 12 months decreased in the likelihood that an individual would participate in rehabilitation services.

Gender, race, SES, education, BMI, depressive symptoms, social support, drinking behaviors, and physical activity behaviors did not influence participation in rehabilitation services over time.

Table 18

GEE Logistic regression of Utilization of Rehabilitation Services on Demographic Characteristics, Health Conditions, and Personal Lifestyle Factors (N=995)

	OR	p-value
Gender, female	1.06	0.845
Age	1.09	<0.001
Race Black/other vs White	1.15	0.707
Income, % FPL ≥200%FPL vs <200%FPL	1.13	0.800
Education HS grad vs Non-HS grad	1.41	0.292
Employment Working vs not working	1.86	0.060
Co-morbidity	1.15	0.226
CVA type Ischemic Hemorrhagic Unspecified	 0.41 0.58 3.07	 0.003 0.378 <0.001
Initial severity	0.92	0.020
Functional ability	1.12	<0.001

Table 18 (cont'd)

GEE Logistic regression of Utilization of Rehabilitation Services on Demographic Characteristics, Health Conditions, and Personal Lifestyle Factors (N=995)

	OR	p-value
Co-morbidity	1.15	0.226
CVA type		
Ischemic	0.41	0.003
Hemorrhagic	0.58	0.378
Unspecified	3.07	<0.001
Initial severity	0.92	0.020
Functional ability	1.12	<0.001
Second CVA	1.99	0.0007
BMI		
Normal weight	1.06	0.841

Table 19 shows results of the final GEE logistic regression of participation in rehabilitation on only those factors that were significant in the univariable analyses. Of those factors (age, employment, number of days in the ICU, recurrent CVA, type of CVA, function over time, cognition score, MD visit in previous year, and smoking status), only age was significantly predictive of participation in rehabilitation services, with an increased odds of participating in rehabilitation, however the odds of participation in rehabilitation were only 1% higher as individuals aged (p=0.002). No other patterns were uncovered in the utilization of rehabilitation over time, as none of the other factors were significant and most odds ratios were at or near 1.0.

Gender, race, SES, education, BMI, depressive symptoms, social support, drinking behaviors, and physical activity behaviors did not influence participation in rehabilitation services over time.

Table 19			
GEE Logistic Regression of Utilization of Rehabilitation on Age, Employment, Initial Severity, Second CVA, CVA Type, Functional Ability, Cognition, Physician Visit, and Smoking Status (N = 995)			
	OR	95% CI	p-value
Age	1.13	(1.05-1.22)	0.001
Employment at baseline	1.27	(0.50-3.23)	0.612
Initial severity	1.00	(0.89-1.13)	0.122
Second CVA	0.61	(0.33-1.10)	0.098
CVA Type			
Ischemic	Reference	---	---
Hemorrhagic	0.76	(0.10- 5.70)	0.788
Unspecified	2.17	(0.91-5.13)	0.077
Functional ability	1.08	(0.98-1.20)	0.122
Cognition Score	1.00	(0.94-1.06)	0.972
MD visit in previous year	0.53	(0.12-2.29)	0.399
Smoker	2.22	(0.81-6.03)	0.120

It was unclear following the initial mulitvariable analysis why all the significant univariable factors were no longer significant. We decided to utilize another approach to examine the relative contribution of the variables. GEE linear regression with stepwise selection with a cut-off of p<0.15 was implemented. The following factors were included in the final model, which met this cut-off: age, second CVA, CVA type as unspecified, functional ability, and cognition (Table 20). After the final multivariable analyses with those factors included from stepwise selection, age (p<0.001), and having an undefined CVA(0.038) were statistically significant predictors of participation in rehabilitation with statistical significance while having a second CVA trended towards significance (p=0.051). Those who were older were 14% more likely to participate in rehabilitation. Also, those who had a second CVA were 64% more likely to participate, while those with an undefined CVA -were less likely to participate in rehabilitation (OR=0.45). Functional ability (p=0.10) and cognition (p=0.93), while meeting the cutoff to be included in the model, did not demonstrate significance once combined with age, second CVA, and CVA type. Based on the results of the final multivariable analyses with stepwise selection, we believe these results were more plausible for explaining patterns of recovery in CVA and utilization of services. It is unlikely that age would be the only factor in utilization, as was discovered in the initial mulitvariable analyses. CVA type and second CVA were significant in the final model and aligned better with our hypotheses. We used the final analyses results for the following discussion.

Table 20

GEE Logistic Regression With Stepwise Selection of Utilization of Rehabilitation on Age, Second CVA, CVA Type, Functional Ability, and Cognition (N = 995)

	OR	95% CI	p-value
Age	1.14	(1.08-1.22)	<0.001
Second CVA	1.64	(1.00-2.70)	0.051
CVA Type Unspecified	0.45	(0.21-0.95)	0.038
Functional ability	1.07	(0.98-1.18)	0.101
Cognition Score	0.99	(0.94-1.06)	0.932

CHAPTER 5: DISCUSSION AND CONCLUSION

Discussion

Aims 1 &2: Incident and Effects of CVA

This study confirms findings from previous studies that certain demographic characteristics, co-morbidity, and smoking status all influence the risk of CVA. In this study, the odds of sustaining a stroke were higher, in general, in individuals who were older and male. In addition, increased co-morbidity led to higher odds of sustaining a CVA. Finally, smoking contributed significantly to risk of CVA. Other findings from this study were inconsistent with those of previous studies or expand upon what other studies have shown.

The use of employment as a variable within this study was novel, as employment status has received little attention in CVA risk assessment. When broken down into categories of working status (full time work, part time work, retirement, unemployed, or disabled), disability predicted CVA in this sample when compared to the reference group of full time work. Individuals who are working may have been healthier and more physically fit at baseline or working itself might provide a protective benefit against CVA. However, from the results of this study, it is not possible to make any conclusions about causation.

SES is commonly found to influence health care outcomes and utilization. However, in this study, SES was not significantly related to CVA risk. Others have suggested that the lifestyle behaviors of those in lower SES groups may differ from those with higher SES. (Addo et al, 2012; Cox, McKevitt, Rudd, & Wolfe, 2006; Mold, McKevitt, & Wolfe, 2003) This study appears to support the notion that factors related to the lifestyle of individuals in varying SES groups, rather than SES per se may help determine CVA risk.

In this study sample, it was also found that the odds of CVA decrease in those who are underweight and obese compared to individuals who are normal weight. However, the group who sustained a CVA had, on average, a higher BMI. There has been an assumption that the higher someone's BMI, the worse health they should expect. Given other conflicting evidence in the literature in relationship to BMI and medical events in old age, it might be worth re-considering how BMI is defined uniformly in the literature related to health and health outcomes. What might be the cut-point where BMI is protective? Is there a threshold at which an increased BMI may be protective? (Doehner, Schenkel, Anker, Springer, & Audebert, 2013; Olsen, Dehlendorff, Petersen, & Andersen, 2008) One recent study describes the "obesity paradox" in type II Diabetes Mellitus (DM), whereby individuals who have an increased BMI demonstrate improved morbidity and mortality from CVA. In this study, they found risk of CVA similar across BMI categories (Constanzo, et al, 2014). The results are interesting related to BMI and add to a mounting level of evidence that BMI might not have a linear effect on CVA risk or severity. BMI might have some type of protective influence in chronic disease and old age, where individuals who have an increased BMI (but are not obese) have better life expectancy and improved recovery following a significant medical event. The sample in this study demonstrate this effect, in that those who were overweight had reduced odds of death from CVA and that BMI did not have a linear relationship to outcomes. However, again, since this finding has not been widely explored, the results are reported with caution.

Despite previous data that support the role other modifiable personal lifestyle factors (physical activity, having a regular MD, and drinking behaviors) in incidence of CVA and the effects of CVA, this sample surprisingly failed to demonstrate that most of these risk factors are significantly related to odds of experiencing a CVA. Previous studies have found significant relationships between other personal lifestyle factors (BMI, physical activity, and having a regular MD) in both chronic disease and CVA. However, these studies typically looked at each factor in univariable analyses or only one or two of the factors coupled with demographic characteristics. For example, some studies have looked at the impact of physical activity behaviors on CVA risk, while controlling for demographics, but did not include regular medical care and drinking behaviors in the same study. (Calcoya, Rodriguez, Corrales, Cuello, & Lasheras, 1999; Hart, Smith, Hole, & Hawthorne, 1999; Starfield et al, 2005; Towfighi, Markovic, & Ovbiagele, 2012; Wolf, D'Agostino, Kannel, Bonita, & Belanger, 1988)

The failure of this study to document a relationship of most lifestyle factors measured to CVA may be due to biases in the self-report survey data we used. In particular, individuals may not have accurately reported personal lifestyle factors, either over- or under-estimating their responses. For example, studies suggest that heavy drinkers may under-report their alcohol consumption. If this is true for the HRS respondents, it may explain why alcohol consumption had no significant effect on CVA in our analysis. In addition, the operationalization of regular source of medical care might have been inadequate. In this study, regular source of medical care was defined as an appointment with a physician in the previous 12 months. Having a place to go for regular medical care is regarded as an important component of optimal health, with literature supporting the efficacy of primary care centers that provide a coordinated care system aimed at improving health and preventing illness. Having a medical home or regular medical care is defined as having access to a regular primary care physician over time who has connections or referral sources in place to assist with prevention of serious health consequences and maintaining health overall. To measure the impact of regular medical care and whether or not the presence of a medical home has an impact on CVA risk and severity is important. This study was unable to measure this in the way that perhaps it should have been measured.

This study also utilized self-report of physical activity that was defined as vigorous physical activity more than 3 days per week. Those who continued to work into old age might not report this level of physical activity, but they may be more active, in general, at baseline. It is also possible that individuals, who are more consistent in their activity, albeit at lower levels, might demonstrate decreased odds of CVA risk and severity, but this could not be examined in this study. Finally, nutrition, another lifestyle factor was not available in this dataset. Nutrition has been found to be a significant factor in CVA risk, but the HRS data does not collect this information.

This study confirmed within this sample that age and SES have a significant impact on the likelihood that one will die in the short-term (<2 years) following a CVA. It has been discussed in the literature that those individuals in lower socioeconomic groups may have a tendency towards personal lifestyle behaviors that put them at increased risk for more severe effects from a significant medical event. More recently, it has been proposed that the personal lifestyle behaviors of various racial or ethnic groups might be more predictive than race or ethnicity alone. In this study, those who were HS graduates had lower odds of dying from CVA compared to those who were not HS graduates. This may support the theory that individuals who are of certain SES status may have lifestyle patterns that might put them at risk.

On the other hand, it might also point to better access to care for individuals who are more educated. Access to care is a well-studied predictor of receiving timely medical care for serious medical events, with those in lower SES groups tending to have more serious presentation following a significant medical event due to reduced access to appropriate medical care. Access to care might also be related to lower ongoing receipt of healthcare and preventative treatments. So, those in higher SES might have advantage in that their baseline health status may be better, and they have ability to access medical care during a significant medical event.

In this study, the predictors of decreased short-term functional effects of those who survived a CVA were age and having a hemorrhagic CVA. This is consistent with the literature on the effects of CVA. Older individuals tend to fare worse than their younger counterparts following disabling medical events, including CVA. In addition, many smaller studies on the type of CVA and initial severity indicate that individuals who sustain a hemorrhagic CVA will present with worse functional outcomes at earlier stages of recovery.

While physical activity was not significant in the final model, the trend in the findings was that those who reported vigorous physical activity had less severe functional effects from the CVA. This helps support the theory that baseline lifestyle factors may play a role in the initial severity and recovery from serious medical events, such as a CVA.

The type of data available may have biased some of the conclusions that were drawn about severity as well. Because the HRS files were linked to Medicare claims data, the sample was older than the population studied in the incident analysis. In addition, since managed care participants were excluded, the sample size was significantly reduced from the original HRS dataset.

Also, the time from CVA to interview were based, at times, on estimates. CVA date was first gathered from self-report in the HRS. CVA dates were also searched within the Medicare claims data. There was noted inconsistency in the reported dates from the HRS. In addition, it is likely that even some of the Medicare claims dates where CVA was first reported may not have been 100% accurate; the method for looking for CVA on the claims was to look at first incident of ICD-9 codes. Firm conclusions about the acute phase (under 12 months) following the CVA could not be generated because of the way the dates were generated.

Missing data presented an issue once the data were merged. Multiple imputation was utilized to minimize the effect of missing values, however, even after multiple imputation, the results did not significantly change from the original analysis.

Finally, information on personal lifestyle may be biased with survey data. Individuals may not report their behaviors accurately. In addition, in an older population, current lifestyles might not adequately reflect lifelong patterns of behavior for some respondents. For example, those who participated in regular, vigorous physical activity over the lifespan but stopped in later life due to some type of ailment or health condition would not be classified as being physically active in this study.

Aim 3: Functional ability over time following CVA

The significant predictors of functional ability over time in this study included age, race, co-morbidity, initial severity of CVA, time elapsed since CVA, employment status, physical activity behaviors at baseline, cognitive scores, depression scores, participation in rehabilitation, and social support.

Age and race have consistently demonstrated a relationship to declined functional ability in chronic disease and disabling conditions, so their significance in this study was expected.

Baseline co-morbidity, which was included in this study as one indicator of baseline health, was not significantly associated with functional ability. This was an interesting finding since in some of the literature on the influence of race on health outcomes it has been hypothesized that co-morbidity, not race alone, may determine health outcomes. There appears to be a connection between race and co-morbidity patterns, which has been found in other studies. Findings from the current study seem to suggest that race itself may predict decreased functional ability after CVA. Having a second CVA was also not significant. It may be that the individuals who had a second CVA had a more severe type of CVA at initial presentation or had more co-morbidity over time than individuals who did not sustain a second CVA.

When used as a time-varying variable in the model, co-morbidity was predictive of declining functional ability after a CVA in this study. Co-morbidity may be an indicator of other complications associated with a CVA, which might explain its association with reduced functional ability following a CVA. Co-morbidities might be conditions independent of the CVA itself, also explaining why co-morbidity predicts decline in functional ability. This finding suggests that medical care following a CVA should include not only the CVA and CVA related impairments but also co-morbidities that may play in an individual's functional ability.

As hypothesized, baseline lifestyle behaviors appeared to have some influence on the recovery of individuals who sustained a CVA. More specifically, those who were working for pay at baseline fared better over time than those who were not working at baseline. In addition, physical activity behaviors had an influence on outcomes. It may be that individuals who are working into old age and those who report regular physical activity are already healthier than their same-age peers. It may also be that working and/or regular physical activity have some type of protective mechanism in preventing significant functional decline after a CVA. Newer research has uncovered the same relationship. This study supports these findings, however, further research in this area should be considered.

In more recent studies, depression has been linked to a variety of health outcomes. Our findings support this notion, in that those individuals with more symptoms of depression tended to have decreased functional ability over time. This finding highlights the need for more timely mental health interventions in individuals who have CVA, since the risk of depression in CVA is more than double the average population. Early efforts to assist individuals who survive a CVA to adjust to the illness, along with giving them new coping mechanisms following a CVA might not only improve quality of life, but functional ability as well. It may be reasonable to suggest screening for depression at all levels of care for individuals following CVA given the increase in prevalence of depression among CVA survivors and the findings from this study that individuals with depression fared worse functionally.

In this study, rehabilitation services were utilized more as individuals declined in functional ability. Rehabilitation services are commonly prescribed for individuals following significant medical events and/or a significant change in functional abilities. Given this, it was not surprising that those individuals who participated in rehabilitation tended to be worse functionally. What this study was unable to detect was whether or not rehabilitation services improved functional ability following an intervention. Since data on function was collected over two year increments, it would be difficult to discern what was benefit from rehabilitation versus the natural healing process.

Higher cognitive scores also predicted improved functional ability over time. It may be that individuals who have improved cognition are better able to understand the consequences of the CVA. They may be able to understand recommendations and follow-through with medical advice. For example, someone with a new cognitive impairment may have difficulty participating in rehabilitation and/or following through with other medical advice. Since a change in cognition may be a natural consequence of CVA, interventions need to be developed that assist individuals who have cognitive impairments following a CVA. These individuals should be able to participate in their care in order to achieve the best results. Healthcare providers can improve outcomes with individuals who have cognitive impairment by allowing their family and caregivers to participate in their medical appointments. In addition, health care information should be shared in the format that is most understandable to each individual patient, which might include pictures or videos, not just verbalized or written instructions. Healthcare providers should also assess patients for understanding of their condition and the consequences of not following medical advice. Reminder letters or phone calls might also make a difference in patient follow-through in those who have limited cognition.

Time elapsed since CVA was not significantly related to decreased functional ability over time. As hypothesized and supported in the literature, it may be that functional ability improves over time, but in the long term functional ability declines due to other factors within the individual and in the environment, which may be why time elapsed did not become significant in this model. In addition, the other factors studied appear to have more of a role in functional ability over time than time by itself.

Social support was also predictive of improved functional abilities over time in this study. In this study, the impact of one type of social support was predictive of better functional ability over time. New research suggests that a good social support network may be protective against disability into older age. This study suggests that an individual might not need an extensive social network, but having at least two family resources influenced outcomes positively. It is important that health care providers assist their patients in identifying social support networks. If an individual does not identify any level of social support, health care providers may need to support these individuals in different ways. This might include referral to community agencies that can provide transportation and/or "check-in" services that might otherwise be provided by a social support network.

The conceptual model for this study was developed to illustrate the role that multiple factors play in the functional ability of CVA survivors over time. The hypotheses were based upon the work of various researchers, with the addition of some novel factors: namely, social support and employment status at baseline. The hypotheses generated from the conceptual model were that health conditions, recurrent CVA, and depression would all have a negative influence on the functional ability of CVA survivors over time. Other hypotheses generated were that employment status at baseline, personal lifestyle factors, social support, and cognitive status would have a positive influence on the functional ability of survivors over time. In addition, the role of time in functional ability was hypothesized that as time elapsed, the effect of time would change. The results supported the hypotheses that were generated, in that those who were "healthier" at baseline had better functional ability over time among the sample. In addition, the hypotheses related to age, time elapsed, social supports, and health condition were also supported by the results of analyses in this study.

Aims 4 and 5: Participation and utilization of rehabilitation services

Since, to our knowledge, this study was the first of its kind in looking at utilization of rehabilitation patterns among survivors of CVA, it paves the way for additional research into the utilization of rehabilitation by individuals who have sustained a CVA and reasons why individuals might not be receiving these services. Evidence suggests that rehabilitation is effective in improving function in those who have sustained a CVA. International guidelines in CVA care recommend the regular presence of rehabilitation professionals in the on-going medical care of individuals who have sustained a CVA. However, the results of this study indicate that a majority of individuals who have CVAs do not receive routine follow-up with rehabilitation, as suggested by the guidelines.

In this study, type of CVA had a relationship to utilization. Those with "unspecified" type CVA had, on average, lower levels of utilization across settings. It may be that those who are labeled as "unspecified" sustain more mild CVAs. However, this is not consistent with severity by CVA type as completed in preliminary analyses (hemorrhagic mean severity = -4.34; ischemic mean severity = -3.42; unspecified mean severity = -3.90) So, perhaps these individuals may go through fewer imaging procedures, resulting in an "unspecified" designation. More detailed information about imaging patterns and utilization might be useful to study this in future studies. The diagnosis and coding patterns for CVA would be worth additional exploration in analysis of claims data: Are there a disproportionate number of individuals in certain demographic groups identified as "unspecified" compared to those of other demographic groups (e.g. race or gender)? Or, does the diagnosis of CVA change over time across settings? Other studies utilizing Medicare claims and CVA indicate that the consistency of coding and accuracy of coding is variable across settings and regions. Andrade et al (2012) conducted a systematic review of algorithms utilized by researchers to address CVA and CVA type through claims data and their conclusion was that more validation studies needed to be conducted. We would agree.

Employment status also had a relationship to utilization. Those who were employed at baseline received, on average, less rehabilitation service across three settings. This may be related to the health and activity level of those who are employed into old age. It may also suggest that employment has some type of protective effect and/or that baseline behavior influences the course of CVA. Other baseline behaviors, smoking, drinking, and physical activity had influence only among specific service areas.

On average, heavy drinkers and those who were physically active at baseline, had, on average, less utilization of home health services. Heavy drinkers may return to the home environment and begin drinking again, which might influence the likelihood of allowing a health care provider into the home to provide services. Those who are physically active prior to the CVA might also return to a similar type of lifestyle that they had prior to the CVA upon return home from a hospital stay for CVA, which might be the reason for reduced rehabilitation utilization in home health care. These findings reinforce the idea that baseline lifestyle behaviors influence recovery from CVA, however no pathway of causation was studied.

After re-running the logistic regression model of participation in rehabilitation, age, having a second CVA, and CVA type as "unspecified" were the remaining factors that were significant in relationship to an individual's participation of rehabilitation. The final model did not support the hypotheses that other demographic characteristics or personal baseline characteristics (smoking and drinking behaviors, physical activity, BMI, and employment status) have a significant independent influence on participation in rehabilitation. Likewise, depression and cognition did not predict participation in rehabilitation.

Cook, et al (2005) studied rehabilitation patterns among CVA survivors using HRS data. It is one of the only studies in the literature that utilized this dataset with CVA. They also discovered that age had a positive impact on whether or not an individual would participate in rehabilitation services. In addition, they discovered that drinking behaviors influenced participation negatively as was discovered in the univariable analyses in this study. Functional ability, income and having a regular physician visit also predicted increased participation in rehabilitation in their study. Their study was based on a cross-section of HRS data from 1998. By pooling data over waves, we believe that we were able to develop a better picture of individuals who have sustained a CVA and make stronger conclusions about utilization of services. By utilizing Medicare files, it was also possible to confirm self-report of rehabilitation services within the HRS. In this sample, self-report from the HRS indicated that only 10- 20% of respondents were participating in rehabilitation services for their CVA at the time of the survey. However, by utilizing Medicare data, the utilization rate was reported as 45-70% of the respondents. The discrepancies in utilization rates raises questions about how much information can be drawn from HRS data alone when looking at rehabilitation outcomes. The large discrepancy in HRS self-report of services and the actual claims for services suggests that this measure should not be utilized without confirmatory data. Medicare claims data, as were utilized in this study, may be one of the best ways to study utilization of rehabilitation in the elderly.

Rehabilitation services are commonly recommended in light of some functional decline, so it is unclear why initial severity of CVA or functional ability did not predict participation in rehabilitation services in this study. It may suggest the presence of an underlying, untested factor involved in utilization of rehabilitation that was not studied here. This could be positive, in that, it may indicate that there is a factor within the healthcare environment that influences the referral of individuals to rehabilitation. The fact that having a second CVA increased the likelihood that someone participated in rehabilitation in this study, might point to the referral pathways that are present in a healthcare environment. Having a second CVA increases health care encounters and might increase the probability of receiving a referral for rehabilitation services. Another factor in referral might be that patients receive referrals from physicians but do not follow through with the referral and choose not to attend rehabilitation services. Finally, it may be that providers do not realize that rehabilitation services can be utilized in the long-term, hence, do not generate referrals.

It appears that individuals who sustain a CVA mostly receive rehabilitation services upon hospitalization but do not return to rehabilitation services in the long-term, as suggested by the guidelines. The guidelines suggest that individuals should return to rehabilitation to detect minor changes in motor and/or cognitive processes to receive interventions that prevent functional decline; however, our results indicate that this is not the case. Previous analyses suggest that function gradually declines over time. If individuals experiencing a CVA knew that rehabilitation service could be beneficial to them, even after the acute stage of recovery, more individuals might utilize these services.

Unfortunately, data from self-report can be biased. Especially when reporting personal lifestyle factors. Respondents may under report "negative" lifestyle factors such as smoking or drinking behaviors or over report more "positive" lifestyle factors such as physical activity behaviors. Utilization of rehabilitation through self-report is also concerning and can bias results; however, with the addition of Medicare-claims data, it reduced bias in this study. This sample was older than the original HRS sample after the addition of Medicare claims. This is a natural consequence of utilizing Medicare claims data since individuals over the age of 65 are the primary recipients of Medicare benefits. This might be why age became such a strong predictor. It might also explain why some of the baseline lifestyle factors did not maintain significance in the final model. Perhaps that as individual's age, they are less likely to participate in activities even if they were lifelong pursuits. For example, perhaps a respondent was very physically active throughout the lifespan, but recently stopped vigorous physical activity due to arthritis. This study was unable to account for those factors.

As an occupational therapist, this author utilized current literature (which was limited) and clinical experience to create hypotheses related to participation and utilization of rehabilitation services within the conceptual model. The results are somewhat surprising. Younger age was hypothesized to influence participation under the assumption that younger individuals would be more motivated for improvement in function, thus participating in more rehabilitation. However, upon reflection, it may be that older individuals sometimes have rehabilitation services "forced" upon them, especially in SNF settings where a condition of stay is usually some level of participation in rehabilitation. In addition, older individuals may need more time in rehabilitation to get desired results. Older individuals do not recover at the same pace as their younger counterparts. This also leads to the role that social support plays in utilization. If a family is unable (or unwilling) to assist an individual following a CVA, the individual might receive more services to make up for a lack of social support at home.

Other surprising findings in the analyses were related to cognition and depression. Those who were more impaired in cognition were more likely to participate in rehabilitation and those who were more depressed were more likely to participate in rehabilitation. As a therapist, I have seen many patients who have severe cognitive deficits and not able to achieve benefit from rehabilitation because they had difficulty with the demands of rehabilitation or they could not follow rehabilitation professional's directives and were discharged from services. In addition, it always appeared to me, from a clinical standpoint, that individuals who are more depressed received less rehabilitation because they are not motivated to participate.

These results might reflect not to the difference in therapy received but the difference between what type of time is required by a therapist (e.g. billable time) to achieve the desired results. For example, although the individual who is more depressed may receive less "observeable" rehabilitation, they might take more of the therapist's time to get a desired result. For example, motivating a client to participate is part of the "art" of being a therapy professional. Trying to get someone who does not want to participate to actually participate takes trial and error, which means billable units/minutes by the therapist. In addition, those people who are more cognitively impaired may experience the same phenomenon. They might be slower and need more redirection during rehabilitation, so the actual time commitment from a therapist is increased with this type of involvement. On the other hand, people who have better cognition (and less depression) will be more likely to understand what is involved in rehabilitation, carryover with what is taught during therapeutic sessions, and become a better advocate for their care.

In order to understand the factors that are involved in utilization of rehabilitation services, further research along the following lines is suggested. First, a longer-term baseline period for personal lifestyle factors should be used to determine any decline in function leading up to the CVA to analyze if this influences participation. Also, those who did not participate in rehabilitation should be analyzed more thoroughly, perhaps through their utilization of other services following the CVA. For example, were they followed by other services, such as social work or nursing, but not rehabilitation? Finally, other studies that explore physician and other provider attitudes towards rehabilitation or provider referral patterns would be helpful.

Conclusion

The original hypotheses for this study were based on work by multiple authors who studied demographics, health conditions (e.g. type of CVA), and personal baseline behaviors (e.g. smoking, drinking) influence on the risk and severity of CVA. The conceptual model for this study was based on the WHO ICF to describe these factors in relationship to CVA risk and severity, in order to illustrate the complexity of these relationships. The analysis plan was designed to model these relationships. The author chose a rich resource for data, by utilizing the HRS and linked HRS Medicare data. The use of the HRS allowed the author to look at personal lifestyle behaviors that are commonly overlooked in registries and other large databases. In addition, with the linked HRS Medicare dataset, the author confirmed health conditions (e.g. type of CVA). It is unlikely that this type of analyses could be conducted without the addition of linked HRS Medicare data. However, the complexity of studying multiple factors, including personal lifestyle factors, in large populations in relation to CVA risk and severity was highlighted during the analyses. The complexity of the analyses is most likely why many researchers have not done this type of analyses previously.

This study has confirmed previous findings about the impact of initial severity of CVA; the role that increased age and lower SES status has on mortality. The results suggest that more research in the area of BMI, employment status, and physical activity behaviors would be beneficial to understanding the incidence and functional effects of CVA. Higher BMI appeared to be protective in this study, so perhaps there is a possibility that being overweight at an old age may have some medical benefit in surviving from a significant medical event, such as a CVA, and medical providers can tailor their discussion with patients to this information. In addition, more research on the role that physical activity plays in the effects of CVA would strengthen the recommendation of exercise in disability and disease. Finally, the role that employment status has on the incidence may be important for retirement planning.

Since this study looked at such a large number of risk factors, it highlights the complexity of describing stroke risk and severity. It also confirms known factors in CVA risk including age, gender, co-morbidity, and smoking status. The impact of personal lifestyle factors on CVA was not as clear as the authors anticipated. The limitations in the data and these study results should encourage providers to collect more detailed information from their patients regarding personal lifestyle behaviors. Electronic health records are an important avenue for the collection of more detailed information about an individual's lifestyle and their health behaviors. The inclusion of more detailed data on risk factors should be encouraged as electronic medical records become more sophisticated. Once collected, this data can be utilized for future studies. This will improve our understanding of CVA risk and its effects. With more evidence on the role that personal lifestyle factors play in CVA, improved prevention and monitoring efforts can be designed for those at risk.

The number of individuals surviving CVAs is increasing as medical technologies are enabling individuals to survive the initial event. The findings from this study suggest that there are areas where simple interventions might have a large impact on functional ability of survivors of CVA: depression, cognition, and social support networks. Limitations in this study included the inclusion of many factors that were self-reported which may have biased the results. In addition, many of the predictive factors were gathered at two-year intervals, which limits the author's conclusions about the impact these factors might have on functional ability. The time between study years may include many untested, confounding factors that are unable to be studied by this type of research. By utilizing different research methodologies that also focus on the functional ability of individuals who sustain a CVA over time with similar factors may uncover confounders to functional ability and/or strengthen the conclusion made by this study.

It is important to understand the functional recovery of individuals who have sustained a CVA and their utilization of services. CVA is a financial burden to individuals in both direct and indirect costs. Rehabilitation focuses on improving function, and if utilized appropriately may influence indirect costs related to personal care services while improving the quality of life of survivors, and reducing caregiver burden. However, it appears that rehabilitation professionals are not routinely intervening over time with individuals who have sustained a CVA. There does not appear to be a clear trend in who does or does not receive services and in what setting. There may be a systematic reason why individuals who have a CVA are not begin seen by rehabilitation professionals as suggested by the guidelines.

There are influences on the utilization of rehabilitation services that makes it difficult to study. Individual differences in recovery, co-morbidity and other health conditions, referral patterns, and therapist effort are all things that need to be considered when studying patterns of utilization of rehabilitation. Based on the results of this study, the next step in research should focus on increasing awareness of the guidelines for CVA among medical providers to improve their knowledge of the recommendation and their knowledge of the evidence related to rehabilitation services in long-term survivors of CVA. In addition, continued studies on the utilization of rehabilitation among different populations of individuals would be helpful to begin to understand how and why individuals do or do not participate in rehabilitation following a significant medical event.

In future work, the following suggestions are suggested for the risk and severity analyses. First, measuring personal lifestyle factors from multiple waves prior to the CVA would provide a better indicator of lifestyle prior to the period immediate to the CVA, and perhaps, before any signs of declining health status leading up to the CVA. In addition, operationalization of social support measures that is more detailed in relationship to who provides assistance and who is available within the respondents immediate surroundings, as opposed to the family resource measure utilized in this study might provide more insight into what social support is most supportive of functional ability over time. Also, a measure of regular medical care over time (e.g. the two or three waves prior to the CVA) would be a better indictor of regular medical care as opposed to the one time point prior to the CVA which was utilized in this study. Regular medical care could also be ascertained from the linked HRS-Medicare files through a new algorithm - looking at different utilization levels of services in some capacity. In addition, perhaps a comparative study with only HRS data would provide for a larger sample of CVA survivors on the analyses of baseline factors, however it would eliminate the ability to confirm CVA diagnoses, type of CVA, or date. It might be helpful in detecting those non-medical measures that influence functional ability with more clarity. Future research should continue to analyze the impact that positive personal lifestyle factors play in relationship to CVA risk and severity. The influence of SES on personal lifestyle behavior should be investigated more thoroughly hoping that it may answer questions about the role that lifestyle factors may play in chronic disease and CVA. In addition, another lifestyle factor, nutrition that was not obtained in this study should be considered in other studies on the contribution of lifestyle behaviors to chronic disease and serious medical events. More detailed information on employment status should also be utilized in combination with smoking, drinking, and physical activity behaviors. In addition, factors related to regular source of care and the impact of a long-term relationship with a primary care physician, should be continued when studying CVA to uncover relationships to CVA risk and severity.

Future work on functional ability and utilization of rehabilitation could address the following: 1)Re-conducting the analyses with novel operationalization of personal lifestyle factors, including more distinctions between different smoking status, drinking status, physical activity behaviors, and employment status. For example, it would be helpful to use other available measures for employment, including number of years working, what type of employment, and/or how physically demanding was/is the respondent's job; all are available in the HRS dataset. For drinking status, it would be helpful to look at various usage levels and it's impact on CVA risk and severity as opposed to dichotomizing it as heavy drinker or not heavy drinker. The same suggestion would be made for physical activity behaviors - utilize all levels of physical activity as opposed to dichotomizing this factor. It would also be worth exploring the relationship between physical activity behaviors and employment. Finally, it would be helpful to track utilization of physician over time as opposed to using a cross-sectional measure, which might be a better indicator of regular source of care (for example, using the previous 2-3 waves of data, as opposed to only one wave that was utilized in this study). 2) Tracking personal lifestyle factors over time. For example, utilize data from the 2 previous waves to uncover any trajectories in personal baseline behaviors that cannot be detected in one cross-sectional observation. Finally, 3) utilizing the same analyses, but with information on nutrition and diet, as opposed to personal lifestyle behaviors, possibly using the NHANES -Medicare dataset could provide more information to the recovery and functional ability of survivors after CVA.

CVAs are a leading cause of death and disability worldwide. It is just as important to understand the risk of sustaining a CVA, as it is to understand the outcome related to the event. By understanding factors that lead to better functional outcomes following a CVA and intervening through preventative efforts, the consequences of CVA may be minimized, improving quality of life and reducing caregiver burden and financial hardships that are common consequences of CVA.

Not only does CVA cause death and disability, it creates significant financial and social consequence in both the short term and the long term. The functional ability of survivors of CVA is important to understand since individuals who are more functional will likely be less of a burden on their caregivers and on health services over time. Interventions such as screening for depression and management of co-morbidity, along with different modes of communication with individuals who have cognitive deficits following a CVA during a health care encounter may be beneficial in maximizing an individual's functional ability. In addition, knowledge about the utilization of rehabilitation among CVA survivors may lead to improved guidelines in CVA care.

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