AHA/ASA Scientific Statement

Racial-Ethnic Disparities in Stroke Care: The American Experience

A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association

The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists.

Salvador Cruz-Flores, MD, MPH, FAHA, Chair; Alejandro Rabinstein, MD, Vice Chair; Jose Biller, MD, FAAN, FAHA; Mitchell S.V. Elkind, MD, MS, FAAN; Patrick Griffith, MD, FAAN; Philip B. Gorelick, MD, MPH, FAAN, FAHA; George Howard, DrPH, FAHA; Enrique C. Leira, MD, MS, FAHA; Lewis B. Morgenstern, MD, FAHA, FAAN; Bruce Ovbiagele, MD, MS, FAHA; Eric Peterson, MD, MPH, FAHA; Wayne Rosamond, PhD, MS, FAHA; Brian Trimble, MD; Amy L. Valderrama, PhD, RN; on behalf of the American Heart Association Stroke Council, Council on Cardiovascular Nursing, Council on Epidemiology and Prevention, and Council on Quality of Care and Outcomes Research

Purpose—Our goal is to describe the effect of race and ethnicity on stroke epidemiology, personal beliefs, access to care, response to treatment, and participation in clinical research. In addition, we seek to determine the state of knowledge on the main factors that may explain disparities in stroke care, with the goal of identifying gaps in knowledge to guide future research. The intended audience includes physicians, nurses, other healthcare professionals, and policy makers.

Methods—Members of the writing group were appointed by the American Heart Association Stroke Council Scientific Statement Oversight Committee and represent different areas of expertise in relation to racial-ethnic disparities in stroke care. The writing group reviewed the relevant literature, with an emphasis on reports published since 1972. The statement was approved by the writing group; the statement underwent peer review, then was approved by the American Heart Association Science Advisory and Coordinating Committee.

Results—There are limitations in the definitions of racial and ethnic categories currently in use. For the purpose of this statement, we used the racial categories defined by the US federal government: white, black or African American, Asian, American Indian/Alaskan Native, and Native Hawaiian/other Pacific Islander. There are 2 ethnic categories: people of Hispanic/Latino origin or not of Hispanic/Latino origin. There are differences in the distribution of the burden of risk factors, stroke incidence and prevalence, and stroke mortality among different racial and ethnic groups. In addition, there are disparities in stroke care between minority groups compared with whites. These disparities include lack of awareness of stroke symptoms and signs and lack of knowledge about the need for urgent treatment and the causal role of risk factors. There are also differences in attitudes, beliefs, and compliance among minorities compared with whites. Differences in socioeconomic status and insurance coverage, mistrust of the healthcare system, the relatively limited

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

This statement was approved by the American Heart Association Science Advisory and Coordinating Committee on April 6, 2011. A copy of the document is available at http://my.americanheart.org/statements by selecting either the "By Topic" link or the "By Publication Date" link. To purchase additional reprints, call 843-216-2533 or e-mail kelle.ramsay@wolterskluwer.com.

The American Heart Association requests that this document be cited as follows: Cruz-Flores S, Rabinstein A, Biller J, Elkind MSV, Griffith P, Gorelick PB, Howard G, Leira EC, Morgenstern LB, Ovbiagele B, Peterson E, Rosamond W, Trimble B, Valderrama AL; on behalf of the American Heart Association Stroke Council, Council on Cardiovascular Nursing, Council on Epidemiology and Prevention, and Council on Quality of Care and Outcomes Research. Racial-ethnic disparities in stroke care: the American experience: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2011;42:2091–2116.

Expert peer review of AHA Scientific Statements is conducted at the AHA National Center. For more on AHA statements and guidelines development, visit http://my.americanheart.org/statements and select the "Policies and Development" link.

Stroke **is available at http://stroke.ahajournals.org** **DOI: 10.1161/STR.0b013e3182213e24**

number of providers who are members of minority groups, and system limitations may contribute to disparities in access to or quality of care, which in turn might result in different rates of stroke morbidity and mortality. Cultural and language barriers probably also contribute to some of these disparities.

Minorities use emergency medical services systems less, are often delayed in arriving at the emergency department, have longer waiting times in the emergency department, and are less likely to receive thrombolysis for acute ischemic stroke. Although unmeasured factors may play a role in these delays, the presence of bias in the delivery of care cannot be excluded. Minorities have equal access to rehabilitation services, although they experience longer stays and have poorer functional status than whites. Minorities are inadequately treated with both primary and secondary stroke prevention strategies compared with whites. Sparse data exist on racial-ethnic disparities in access to surgical care after intracerebral hemorrhage and subarachnoid hemorrhage.

Participation of minorities in clinical research is limited. Barriers to participation in clinical research include beliefs, lack of trust, and limited awareness. Race is a contentious topic in biomedical research because race is not proven to be a surrogate for genetic constitution.

Conclusions—There are limitations in the current definitions of race and ethnicity. Nevertheless, racial and ethnic disparities in stroke exist and include differences in the biological determinants of disease and disparities throughout the continuum of care, including access to and quality of care. Access to and participation in research is also limited among minority groups. Acknowledging the presence of disparities and understanding the factors that contribute to them are necessary first steps. More research is required to understand these differences and find solutions. **(*Stroke*. 2011;42:2091-2116.)**

Key Words: AHA Scientific Statements ■ race ■ ethnicity ■ access to care ■ epidemiology ■ stroke

The present document is a comprehensive statement on racial and ethnic disparities in stroke care in the United States. This statement was developed by a panel of biostatisticians, epidemiologists, nurses, cardiologists, and vascular neurologists encompassing a broad range of expertise.

The intended audience for this statement includes physicians, nurses, other healthcare professionals, and policy makers. The goal of this statement is to provide an overview of the role of race and ethnicity in stroke care; their impact on the different rates of incidence, prevalence, and morbidity and mortality of stroke among minorities compared with whites; and their effect on personal beliefs, access to care, response to treatment, and participation in clinical research. In addition, we seek to determine gaps in knowledge about disparities in stroke care, propose solutions, and guide future research.

This statement is divided into sections selected by the chair of the writing group. Each section author searched the literature on the topic assigned and considered for inclusion papers based on observational (analytic or descriptive) or experimental studies that addressed racial-ethnic disparities in stroke. Because of the wide scope of the topic, the members of the writing group were responsible for primary reviews of individual sections, and the complete statement was assembled by the writing group chair. The statement underwent peer review and was approved by the American Heart Association Science Advisory and Coordinating Committee.

Background

Racial and ethnic minorities now constitute 28% of the population in the United States, but that number is expected to reach nearly 40% by 2030. The percentage of non-Hispanic whites is now ≈67%. Among minority groups, it is estimated that Hispanic Americans, the fastest-growing group in the United States, now represent 14% to 15% of the US population; blacks or African Americans account for 12%; and Asian Americans and American Indian and Alaska Natives represent ≈7%. The US Census Bureau estimates that the number of Asian Americans will probably reach 10% of the US population by 2050.[1] With the percentage of racial and ethnic minorities in the United States almost doubling by the year 2050, there is an increasing need to reduce racial-ethnic disparities in health care.[1]

With an ever-changing and diverse healthcare environment, healthcare providers must not only become knowledgeable in the rapidly growing field of pharmacogenomics and the reported racial differences of genetic polymorphisms,[3] but they must also possess knowledge about the effects of race and ethnicity on stroke epidemiology and access to care to help create cultural awareness and improve access to and quality of care for minorities. In fact, under the competency of professionalism outlined by the Accreditation Council for Graduate Medical Education, residents are expected to "demonstrate sensitivity and responsiveness to patients' culture, age, gender and disabilities."

Racial and ethnic disparities in health care exist and remain a growing concern.[4] A 2006 study found striking disparities in life spans between different racial-ethnic groups in the United States. The authors characterized their provocative observations as the "Eight Americas," where life expectancy ranged from 86.7 years for Asian American women to 61.7 years for black or African American men.[5] They found that Asian Americans had an average life expectancy of 84.9 years; whites living in the rural northern plains/Dakotas, 79 years; mostly white "middle Americans," 77.9 years; low-income whites in Appalachia and the Mississippi Valley, 75 years; black or African American "middle Americans," 72.9 years; American Indians in the West, 72.7 years; blacks or African Americans in the South, 71.2 years; and high-risk urban-dwelling blacks or African Americans, 71.1 years.

Cardiovascular disease, including stroke, was the largest contributor to these disparities in life expectancy. More importantly, not only is the burden of stroke higher in blacks

or African Americans and Hispanics than in whites,[6] but a population-based study estimating the temporal trends in stroke incidence among different racial groups conducted in the greater Cincinnati (OH)/northern Kentucky area concluded that the incidence of first-ever ischemic strokes declined steadily over the study period (ascertainments were made in 1993–1994, 1999, 2005, and 2010) in whites,[7] even though the incidence remained unchanged among blacks or African Americans, which suggests a worsening of the racial disparity gap in stroke incidence. Although the study may not be generalizable to other regions of the country, other population-based studies have reported similar findings.[8] Therefore, further research and thoughtful debate are needed to understand why minority Americans have worse health outcomes. Some of the important issues to address include, but are not limited to, disparities in morbidity and mortality due to stroke; disparities in environmental, biological, socioeconomic, sociocultural, and dietary determinants of disease; major barriers in access to care; major differences in quality of care; the role of language and culture as barriers to compliance and access; and the potential presence of bias among healthcare providers. Determining the underlying reasons for disparities in stroke care could help find solutions to resolve these disparities.

Definitions

The concepts of race and ethnicity are complex and difficult to define. The definition of race originally denoted physical and biological characteristics; however, this definition has been refined to incorporate social characteristics and their interactions.[9,10] Race encompasses a number of related factors, such as biological and geographic origins, ancestry, culture, economics, politics, and racism.[11] Indeed, racial categories may determine social, economic, and political disadvantages that may impact health status and well-being.

The concept of ethnicity has been proposed as a replacement category for race, because ethnic groups share common ancestry, history, or culture but highlight cultural and social characteristics rather than biological ones.[11] Ethnicity may also imply a common language or religious tradition.[12] Of note, assignment to a racial or ethnic category in census data or clinical studies is usually self-reported information. The number of factors considered in the definition of race is certainly responsible for the limitations in the current racial and ethnic categories found in the literature.

The racial and ethnic categories currently in use relate to those defined by the federal government.[5,13,14] At present, the race categories recognized by the government include white, a person having origins in any of the original peoples of Europe, North Africa, or the Middle East; black or African American, a person having origins in any of the black racial groups of Africa; American Indian or Alaskan Native, a person having origins in any of the original peoples of North and South America, including Central America, who maintains cultural identification through tribal affiliations or community attachment; Asian, a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian Subcontinent, including Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, Philippine Islands, Thailand, and Vietnam; and Native Hawaiian or other Pacific Islander, a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific islands. In addition, 2 ethnic groups are defined: Hispanic/Latino origin, a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race; and not of Hispanic/Latino origin.[14] Despite the limitations associated with the use of these categories, they provide the framework to begin our discussion.

The federally defined categories stand in contrast to the definitions used in stroke studies. White race is usually defined in stroke studies by self-reported data using the federal racial and ethnic classifications.[15] In these classifications, whites are defined as people having origins in Europe, North Africa, or the Middle East.[15] The Northern Manhattan Stroke Study (NOMAS), a prospective study comparing the incidence of stroke among whites, blacks or African Americans, and Hispanics, used self-report methods and defined white race as being white without any Hispanic origin.[16]

Black or African American refers to a person having origins in a black racial group or Africa.[15,17] Yet some investigators have chosen to categorize these patients as individuals of "African descent"[18] or "black."[19] More recently, the REasons for Geographic and Racial Differences in Stroke (REGARDS) investigators defined race by self-report methodology that requested participants to select their race from a list (white, black or African American, Asian, etc).[20]

The racial-ethnic groups American Indian and Alaskan Native are usually combined; however, these 2 groups are distinct in terms of geography, culture, and beliefs.[21] Hundreds of American Indian tribes are spread throughout the United States, many of which are not federally recognized.[21] Alaskan Natives are a diverse group with differences in diet, geographic location, lifestyle, and socioeconomic status (SES).[22] The stroke literature has not thoroughly examined stroke in American Indians and Alaskan Natives. In addition, racial and ethnic misclassification of American Indian and Alaskan Native groups has significantly limited assessment of national rates of cardiovascular disease mortality.[23,24] Few studies have specifically examined groups of American Indians or Alaskan Natives. The Strong Heart Study examined a population of American Indians, but only those in 13 specific tribes in southwestern Oklahoma, central Arizona, and North and South Dakota.[25] The Genetics of Coronary Artery Disease in Alaska Natives (GOCADAN) Study looked at Alaskan Natives, but only those from the Norton Sound region of Alaska.[26] The Alaska Native Stroke Registry, begun in 1995, is a surveillance system for patients within the Alaska Native health system.[27]

There is a paucity of data about Asians, Hawaiians, or Pacific Islanders in the stroke literature. Two studies focused specifically on Chinese immigrants in New York City,[28,29] whereas a few studies used data from the Nationwide Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project to examine stroke in Asians/Pacific Islanders.[30,31] Several studies have used data from the Honolulu Heart Program to examine stroke in Japanese American men.[32–37]

There is no universally applied definition of Hispanic or Latino ethnicity in clinical or epidemiological research studies. Operationally, most studies use the terms Hispanic or

Latino interchangeably and refer to populations who self-identify in this manner. Most published reports involving Hispanic or Latino populations use the former term exclusively. The Hispanic Community Health Study/Study of Latinos, a National Institutes of Health–funded cohort study of cardiopulmonary disease begun in 2007, is recruiting 16 000 people who self-identify as Hispanic or Latino.[38] In this study, Hispanic or Latino ethnicity is defined as people or descendants of people from Cuba, Mexico, Puerto Rico, and other Spanish-speaking countries in the Caribbean (Dominican Republic), Central America (Costa Rica, Guatemala, Honduras, El Salvador, Nicaragua, or Panama), or South America (Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, or Venezuela). People from Spain are not consistently categorized as Hispanic. Similarly, people from Portuguese-speaking countries, such as Brazil, have not been consistently categorized as Hispanic either.

Racial and ethnic health disparities occur around the world, but the conglomerate of different races and ethnic groups and the disparities in health care associated with them has been an especially important issue in the United States. In this statement, we focus on racial-ethnic disparities in the United States. Trimble and Morgenstern[39] divided disparity in terms of avoidable and unavoidable inequalities that lead to stroke. This approach provides a framework to establish priorities in service and research areas.[39] There are many possible explanations for why racial-ethnic disparities exist, including cultural variations in perceptions of health and the healthcare system, environmental exposures, genetic factors,[40] SES,[41] disadvantage in early childhood,[42] fear, mistrust, prejudice,[39] and educational level.[43] The goal of Healthy People 2010 was to eliminate these disparities.[44] Although it might not be possible to change unavoidable inequalities such as certain differences in biological determinants of disease (ie, age, sex, and genetics), we must strive to close the gap with regard to avoidable disparities such as access to care, mistrust, and bias, among others. To achieve that goal, we first need to establish and acknowledge the existence of disparities and to understand their determinants as a prerequisite to finding solutions.

Summary

There are limitations to the operational definitions of racial and ethnic categories in use. For the purpose of this statement, we will use the categories defined by the federal government. Those racial categories are white, black or African American, Asian, American Indian/Alaskan Native, and Native Hawaiian/other Pacific Islander. Hispanic/Latino is considered an ethnic category.

Epidemiology

Differential Burden of Risk Factors

Although the reasons for racial and ethnic differences in stroke incidence and mortality are not entirely clear, the role of the distribution of risk factor burden across racial and ethnic groups must be considered an important contributor. Prevention of mortality, morbidity, and disability due to stroke requires a greater emphasis on the identification of people at high risk for stroke, especially vulnerable groups, and efforts to shift the levels of risk factors in the entire population.[45]

Hypertension is a well-established risk factor for stroke across all racial-ethnic groups. In NOMAS, hypertension was an independent risk factor for stroke in whites, blacks or African Americans, and Hispanics, but was more prevalent and associated with more strokes among blacks or African Americans.[46] Similarly, compared with whites, blacks or African Americans in national and regional survey samples have been shown to have a higher prevalence of other risk factors related to stroke, including diabetes mellitus, hypercholesterolemia, peripheral vascular disease, elevated C-reactive protein, left ventricular hypertrophy, heavy alcohol use, and current cigarette smoking and physical inactivity.[20,47,48] The greater risk factor burden in blacks or African Americans than in whites accounts for a significant proportion of the higher stroke incidence[49,50] and mortality[51] observed among blacks or African Americans.

Less is known about the stroke risk factor burden among Hispanics, American Indians/Alaskan Natives, and Asians. The etiologic fraction (ie, proportion of strokes due to the risk factor) of hypertension has been reported to be greater among Caribbean Hispanics than among whites. Although there are limitations to this estimate, it provides a sense of the impact of a risk factor.[46] In the San Antonio Heart Study, triglycerides, body mass index, and systolic and diastolic blood pressure were higher and high-density lipoprotein cholesterol level was lower in Hispanics (men and women) than in non-Hispanic whites.[52] A recent study found metabolic syndrome to be more common among Hispanics than among whites or blacks or African Americans.[53] Even after adjustment for sociodemographic variables, metabolic syndrome was a better predictor of stroke risk among Hispanics than among whites. In NOMAS, hypertension, diabetes mellitus, hypercholesterolemia, heavy alcohol use, and current cigarette smoking were more prevalent in Hispanics than in whites.[45] Although the San Antonio Heart Study included Hispanics mostly of Mexican origin and NOMAS included Hispanics of Caribbean ancestry, it is remarkable that the results are similar. Data from the Behavior Risk Factor Surveillance System (BRFSS) showed that the prevalence of ≥2 self-reported risk factors (among hypertension, high cholesterol, diabetes mellitus, current smoking, physical inactivity, and obesity) was highest among blacks or African Americans (48.7%) and American Indian/Alaskan Natives (46.7%) and lowest among Asians (25.9%).[47] In addition, data from the National Health and Nutrition Examination Survey (NHANES 1988 to 2006) showed that the prevalence of diabetes mellitus was more than twice as great among blacks or African Americans and Mexican Americans than among whites[54] (Table).

Summary

The burden of risk factors is different among racial and ethnic groups. Blacks or African Americans have a higher prevalence of hypertension, diabetes mellitus, and left ventricular hypertrophy than whites. Hispanics have a higher prevalence of metabolic syndrome and diabetes mellitus than whites and blacks or African Americans. The prevalence of at least 2 risk factors for stroke is also higher in American Indians/Alaskan Natives than in whites.

Table. Racial-Ethnic Disparities in Stroke Risk Factors

Author, Year	Data Source, N	Topic Area	Results
Sacco et al, 2001[46]	Northern Manhattan Stroke Study (n=688 cases and n=1156 controls)	Racial-ethnic disparities in impact of stroke risk factors	Hypertension: independent risk factor for whites, blacks or African Americans, and Hispanics, but greater prevalence and etiologic fraction among blacks or African Americans and Hispanics AF: greater prevalence in whites Coronary artery disease: most important for whites and least important for blacks or African Americans Prevalence of physical inactivity greater in Caribbean Hispanics
Bravata et al, 2005[48]	NHANES III N=11 163 participants	Impact of SES in racial disparities in stroke risk factors	Blacks or African Americans had a higher prevalence of 5 risk factors related to stroke (hypertension, DM, claudication, elevated CRP, inactivity) Whites had a higher prevalence of 3 risk factors related to stroke (older age, MI, decreased HDL) Ethnicity was associated with increased stroke risk (OR 1.32, 95% CI 1.04–1.67) after adjustment for 8 risk factors but not after adjustment for income Income was independently associated with stroke (OR 0.89, 95% CI 0.82–0.95)
Mitchell et al, 1990[52]	San Antonio Heart Study (n=3301 Mexican Americans and n=1877 whites)	Risk factors for CVD mortality in Hispanics and non-Hispanic whites	Triglycerides, BP, BMI, HDL were all lower in Mexican Americans Mexican Americans smoked fewer cigarettes per day on average
Heuschmann et al, 2008[55]	South London Stroke Register (n=2874)	Ethnic disparities in stroke incidence and vascular risk factors	Stroke incidence declined over 10 years for white men, white women, and black or African American women, but not for black or African American men Hypertension, AF, and smoking decreased over time in whites, but there were no changes in blacks or African Americans Total stroke incidence was higher in blacks or African Americans (RR 1.27, 95% CI 1.10–1.46)
Hajat et al, 2001[56]	South London Stroke Register (n=995 whites, n=203 blacks or African Americans, n=52 other)	Ethnic differences in stroke risk factors and subtypes	Age and previous CVD were associated with infarct rather than hemorrhage Blacks or African Americans had less AF and less excessive alcohol intake and were less likely to have ever smoked Blacks or African Americans are more likely to have hypertension and DM
CDC MMWR 2005[47]	2003 BRFSS survey (n=103 191 total, n=79 891 whites, n=10 016 blacks or African Americans, n=6858 Hispanic, n=1070 Asian, n=1914 American Indian/Alaskan Native, n=3440 other)	Racial-ethnic disparities in stroke risk factors	Six risk factors were examined: high BP, high cholesterol, diabetes, current smoking, physical inactivity, and obesity Prevalence of having ≥2 risk factors was highest among blacks or African Americans (48.7%) and American Indian/Alaskan Natives (46.7%) and lowest among Asians (25.9%) Prevalence of having ≥2 risk factors differed by education status (25.9% among college graduates vs 52.5% among those with less than a high school diploma) Prevalence of having ≥2 risk factors differed by income (28.8% for >$50 000/y vs 52.2% for <$10 000/y)
Thomas et al, 2005[51]	N=300 647 whites and n=20 223 blacks or African Americans in MRFIT	Racial-ethnic disparities in CVD risk factors	More than 4 times as many blacks or African Americans as whites had elevated risk factor levels and low income Adjustment for age, income, and risk factor differences explained most of the 35% greater mortality in blacks or African Americans At all risk factor levels (low, medium, high) blacks or African Americans were at increased CVD risk compared with whites (HR 1.37, 95% CI 1.20–1.57 for stroke)
Cushman et al, 2008[20]	REGARDS, n=23 940	Stroke risk by region and race	Higher stroke probability in Stroke Belt (10.7) followed by Stroke Buckle (10.4) and elsewhere (10.1) Blacks or African Americans had higher scores for Framingham Stroke Risk Score components of hypertension, SBP, DM, smoking, and LVH Blacks or African Americans had less history of heart disease, less AF
Giles et al, 1995[49]	NHANES I, n=8203 whites and n=1362 blacks or African Americans	Determinants of black or African American–white risk differences for cerebral infarct	Blacks or African Americans were at increased risk for infarct RR decreased substantially for older blacks or African Americans but only slightly for younger blacks or African Americans after adjustment for age, sex, education, DM, SBP, hypertension therapy, hemoglobin, and heart disease
Howard et al, 2006[57]	REGARDS, n=11 701 participants	Racial differences in hypertension	Blacks or African Americans were more aware of their hypertension than whites Among those treated, hypertension was less likely to be controlled in blacks or African Americans than in whites Trend for better treatment and control of hypertension in Stroke Belt
Ayala et al, 2001[58]	National Vital Statistics records: n=507 256 ischemic, n=97 709 ICH, n=27 334 SAH	Racial differences in stroke-type mortality	Mortality rates for all stroke types higher among blacks or African Americans than whites All minority populations had higher mortality rates from SAH than whites
Albala et al, 2008[53]	Northern Manhattan Stroke Study (n=3298 stroke-free residents)	Metabolic syndrome and stroke risk across racial groups	Metabolic syndrome was more common among Hispanics (50%) than whites (39%) or blacks or African Americans (37%) After adjustment for sociodemographics and risk factors, metabolic syndrome was associated with increased stroke risk (HR 1.5, 95% CI 1.1–2.2) Metabolic syndrome had a greater effect on stroke risk in women and Hispanics
Deleu et al, 2006[59]	N=302 Arab and South Asian stroke patients admitted to Hamad Medical Corp in Qatar	Ethnic variations in risk factor profiles	Stroke recurrence and carotid artery lesions were more common in Arabs than among South Asians Hypertension and DM were much more common in both Arabs and South Asians than in Western populations
Hayes et al, 2006[60]	N=153 466 women in 2003 BRFSS	Racial differences in multiple risk factors for CHD and stroke	Multiple risk factors(≥2 risk factors), including diabetes, current smoking, high BP, high cholesterol, obesity, or physical inactivity Prevalence of multiple risk factors lowest in whites and Asians After adjustment for age and SES variables, OR of having multiple risk factors were greater in blacks or African Americans (OR 1.53, 95% CI 1.42–1.64) and American Indians (OR 1.36, 95% CI 1.11–1.67) and lower in Hispanics (OR 0.83, 95% CI 0.76–0.91) than in whites

(*Continued*)

Table. Continued

Author, Year	Data Source, N	Topic Area	Results
Hozawa et al, 2007[61]	N=14 162 adults in ARIC	Attributable risk of CVD incidence among blacks or African Americans and whites	Proportion of subjects with optimal risk factor levels was lower in blacks or African Americans than in whites Proportion of subjects with at least 1 elevated risk factor was higher in blacks or African Americans (80%) than in whites (60%) Proportion of CVD events explained by elevated risk factors was high in blacks or African Americans (90%) compared with whites (65%)
McGruder et al, 2004[62]	N=96 501 persons from NHIS	Racial and ethnic disparities in CVD risk factors in stroke survivors	Blacks or African Americans were 1.65 times as likely and Hispanics 0.73 times as likely as whites to report hypertension Hispanics and blacks or African Americans were more likely to report DM but less likely to report CHD than whites Overweight and physical inactivity were both higher in blacks or African Americans and Hispanics than in whites Stroke prevalence was highest in blacks or African Americans (2.8%), followed by whites (2.2%) and Hispanics (1.3%)
Mokdad et al, 2003[63]	N=195 005 adults in BRFSS	Obesity and related risk factors across ethnic groups	Blacks or African Americans had higher rates of obesity and diabetes than Hispanics; Hispanics had higher rates than whites Decreasing education was associated with increasing prevalence of both obesity and DM
Winkleby et al, 1998[64]	NHANES III: n=1752 blacks or African Americans, n=1481 Mexican Americans, n=2023 whites	Ethnic/SES differences in CVD risk factors	Most CVD risk factors were higher among minority women than whites After adjustment for education, differences in BP, BMI, physical inactivity, and DM remained for black or African American and Mexican-American women Women of low SES from all ethnic groups had a higher prevalence of smoking and physical inactivity

AF indicates atrial fibrillation; ARIC, Atherosclerosis Risk in Communities; BMI, body mass index; BP, blood pressure; BRFSS, Behavioral Risk Factor Surveillance System; CDC, Centers for Disease Control and Prevention; CHD, coronary heart disease; CI, confidence interval; CRP, C-reactive protein; CVD, cardiovascular disease; DM, diabetes mellitus; HDL, high-density lipoprotein; HR, hazard ratio; ICH, intracerebral hemorrhage; IRR, incidence rate ratio; LVH, left ventricular hypertrophy; MI, myocardial infarction; MMWR, *Morbidity and Mortality Weekly Report;* MRFIT, Multiple Risk Factor Intervention Trial; NHANES, National Health and Nutrition Examination Survey I; NHIS, National Health Interview Survey; OR, odds ratio; REGARDS, REasons for Geographic And Racial Differences in Stroke; RR, relative risk; SAH, subarachnoid hemorrhage; SBP, systolic blood pressure; and SES, socioeconomic status.

Differential Burden of Stroke Morbidity: Prevalence, Incidence, and Recurrence

Whites

Among non-Hispanic whites, the prevalence of stroke is ≈2.3%.[65] The age-adjusted incidence of first ischemic stroke in whites was 88 per 100 000 in NOMAS.[8] Of those who have a first stroke, a recurrent stroke occurs within 5 years in 15% of men and 17% of women 40 to 69 years of age and in 23% of men and 27% of women ≥70 years of age.[8] In comparison, the incidence of ischemic stroke among whites was higher in the greater Cincinnati (OH) region at 130 per 100 000.[66]

Blacks or African Americans

The overall prevalence of stroke is ≈4.0% among non-Hispanic blacks or African Americans,[65] with an age-adjusted incidence of first ischemic stroke of 191 per 100 000 in NOMAS and 194 per 100 000 in the greater Cincinnati region.[8,67] Blacks or African Americans tend to be more likely to report stroke symptoms,[66] to experience transient ischemic attacks,[68] and to be hospitalized for stroke,[69] and they have approximately twice the number of incident strokes as whites.[67] The disparity in stroke incidence is particularly prominent among younger adults.[67] For example, population-based data show that the risk ratio of first-ever stroke in blacks or African Americans compared with whites is 2.05 (95% confidence interval [CI] 1.49 to 2.69) in those <34 years of age, 4.18 (95% CI 3.96 to 4.41) in those 35 to 44 years of age, 2.02 (95% CI 1.90 to 2.15) in those 45 to 54 years of age, 1.74 (95% CI 1.65 to 1.84) in those 55 to 64 years of age, 1.66 (95% CI 1.60 to 1.72) in those 65 to 74 years of age, 1.33 (95% CI 1.28 to 1.38) in those 75 to 84 years of age, and 1.11 (95% CI 1.06 to 1.15) in those >85 years of age.[67]

Compared with the stroke risk of white children, black or African American children have a higher risk of stroke (relative risk [RR] 2.12), with sickle cell disease being the most important cause of ischemic stroke among black or African American children.[70] The increased stroke risk among black or African American children is not fully explained by the presence of sickle cell disease, but it is unclear what other factors may be at play.[70]

With regard to recurrent stroke, in a cohort of 299 patients admitted to a New York hospital, blacks or African Americans had an adjusted RR of recurrent stroke of 2.4 compared with whites.[71] In another study, among those 65 to 74 years of age, blacks or African Americans had a higher rate of readmission for stroke than whites, with an RR of 1.4.[72] Lower adherence to current standards of secondary stroke prevention in black or African American patients might help explain these discrepancies.[73]

With regard to functional outcome, a study showed that after an index stroke, black or African American stroke survivors had greater disability than white stroke survivors. However, from the data presented, it is unclear whether the disability is related to the subtype of stroke.[74] In contrast, in a more recent study, blacks or African Americans and Hispanics were more likely to be discharged home than whites. Although the reason is not entirely clear, it is possible that younger age in minorities with stroke or higher proportion of strokes secondary to small-vessel disease may contribute to explaining the results.[74]

Hispanics

Among Hispanics (of any race), the prevalence of stroke is ≈2.6%.[65] The age-adjusted incidence of first ischemic stroke was 149 per 100 000 among primarily Caribbean Hispanics in NOMAS[8] in contrast to the Brain Attack Surveillance in

Corpus Christi (BASIC) Project, which showed a crude cumulative stroke incidence of 168 per 10 000 in Mexican Americans and 136 per 10 000 in non-Hispanic whites. Although incidence in these 2 studies may not be directly comparable, the BASIC Project showed a high risk ratio of stroke among Mexican Americans compared with whites; the risk ratio among Mexican Americans was similar to that among blacks or African Americans at a younger age (45 to 59 years of age: RR 2.04, 95% CI 1.55 to 2.69; 60 to 74 years of age: RR 1.58, 95% CI 1.31 to 1.91) but not at older ages (≥75 years of age: RR 1.12, 95% CI 0.94 to 1.32).[75] The same group found a higher risk of recurrent stroke among Mexican Americans than among whites, with an RR of 1.57 after adjustment for demographic data, stroke risk factors, and severity of stroke.[76]

Also, Mexican Americans have a higher incidence of transient ischemic attack, intracerebral hemorrhage (ICH), and subarachnoid hemorrhage (SAH) than non-Hispanic whites when adjusted for age.[75] Conversely, compared with the stroke risk of white children, Hispanics have a lower RR of 0.76.[70]

American Indians/Alaskan Natives

The overall prevalence of stroke is ≈6.0% among American Indians/Alaskan Natives.[65] Data from the Strong Heart Study show that the prevalence of stroke in American Indian men 45 to 74 years of age ranges from 0.2% to 1.4%, whereas among women in the same age group, the prevalence is 0.2% to 0.7%.[77] Among those 65 to 74 years of age, the annual rates per 1000 population of new and recurrent strokes were 6.1 for men and 6.6 for women.[77]

Summary

The incidence and prevalence of stroke are higher among blacks or African Americans, Hispanics, and American Indians/Alaskan Natives than among whites. This difference is more marked at a younger age. Recurrent stroke risk is also higher among blacks or African Americans and Hispanics. The highest burden is among blacks or African Americans. In addition, blacks or African Americans have greater impairment after a stroke.

Differential Burden of Stroke Mortality

Between 1950 and 1996, the age-standardized death rate for stroke declined 70% in the general US population.[78] The mean age of stroke decedents is 79.6 years, and 11.9% of strokes occur in people <65 years of age.[79] However, racial and ethnic minorities have excess deaths from stroke and also experience greater years of potential life lost than non-Hispanic whites.[79] The risk ratio for stroke mortality in all racial and ethnic minorities is higher in the 35-to-64-year-old age group and decreases with aging, becoming equivalent to non-Hispanic whites after the age of 64 years in Hispanics and American Indian/Alaskan Natives and after age 85 years in blacks or African Americans.[80]

Although one of the goals of Healthy People 2010 was to eliminate racial disparities in stroke mortality,[44] little progress has been made. Stroke risk factors are more common in racial and ethnic minorities,[39] and poor understanding of socioeconomic factors and social networks also hinders the development of effective interventions to reduce these disparities.[44] Therefore, risk factor control and removal of barriers to early and effective treatment are crucial to reduce disparities in stroke mortality.

Blacks or African Americans

Blacks or African Americans bear the highest burden of mortality attributable to stroke. A study showed that for people between 45 and 64 years of age, the age-specific stroke mortality in blacks or African Americans is approximately 3 times that of non-Hispanic whites,[74] whereas others found higher mortality due to ischemic stroke, ICH, and SAH in all age groups than in non-Hispanic whites[58]; there were 6370 excess deaths in blacks or African American compared with non-Hispanic whites in 1997.[78] Most of the excess burden is attributed to the higher stroke mortality occurring in relatively young (35 to 64 years of age) blacks or African Americans.[80] Stroke mortality is also higher among blacks or African Americans in the southeastern United States, where the incidence of stroke is higher in all racial groups.[82] Although the Southeast has a lower socioeconomic level than nonsoutheastern states, and SES is less favorable for blacks or African Americans, the higher mortality risk remains after adjustment for SES.[83]

With regard to in-hospital mortality and case fatality rates, there do not appear to be differences among different racial groups. In a recent report, in-hospital mortality was lower among black or African American patients than whites (odds ratio [OR] 0.90, 95% CI 0.85 to 0.95) in hospitals participating in the Get With The Guidelines–Stroke program between 2003 and 2008.[73] Population-based studies have shown comparable results, with a similar 30-day case fatality in minorities and in whites.[7,67] Because people with lacunar infarctions have better survival rates,[84] it has been argued that a greater propensity for less-severe strokes of lacunar subtype among blacks or African Americans is one reason for the lower short-term mortality rate. However, this may not be the only explanation, because blacks or African Americans have a higher incidence of all subtypes of ischemic stroke than whites, with a predominance of strokes secondary to intracranial atherosclerosis and lacunar strokes.[8,85] Another potential explanation is a lower rate of withdrawal of life support among black or African American patients.[86]

Hispanics

Hispanics have a lower or similar age-specific mortality from stroke compared with non-Hispanic whites.[79,87] In a population-based study in Corpus Christi, TX, between 2000 and 2002, risk ratios for all-cause mortality after stroke in Hispanics were 0.58 at 28 days and 0.79 at 36 months compared with non-Hispanic whites, despite similar stroke subtypes and severity between the 2 groups. A previous nationwide study found 242 excess deaths due to stroke in Hispanics <65 years of age in 1997.[78] These studies suggest that although all-cause mortality after stroke may be lower in Hispanics, younger Hispanics (25 to 45 years of age) may have disproportionately high rates of stroke mortality. Hispanics tend to have more diabetes mellitus, higher rates of obesity, lower income, lower education, and less physical activity than non-Hispanic whites. The cause of the higher survival beyond 45 years of age is unknown.[88]

American Indians and Alaskan Natives

Compared with blacks or African Americans and Hispanics, American Indians/Alaskan Natives appear to have a lower age-specific mortality due to stroke. Excess death is the difference between the number of deaths observed in a racial-ethnic group and the number of deaths that would have occurred in that group if it had the same death rate as the white population. In 1997, American Indians and Alaskan Natives had 41 excess deaths compared with non-Hispanic whites in the 35-to-64-year-old age group.[78] No excess deaths were observed for American Indians/Alaskan Natives >65 years of age. When Alaskan Natives are considered separately, their stroke mortality patterns are similar to some American Indian tribes. Between 1999 and 2003, there were 47 excess deaths in Alaskan Natives compared with non-Hispanic whites.[89] The greater mortality due to stroke in Alaskan Natives appears to be true for all stroke subtypes for ages 35 to 65 years.[90] The reason for and extent of this stroke mortality disparity are not clear. Problems with misclassification of race in the past have resulted in underestimation of stroke in American Indians.[24,91]

Summary

Racial-ethnic minorities have higher rates of stroke mortality in the United States. The differences are more marked among blacks or African Americans and people <64 years of age. They appear to be related at least in part to variation in distribution of biological risk factors, although the reasons for these disparities in stroke mortality in Hispanics, Alaskan Natives, and American Indians remain under investigation.

Differences in Disease Awareness

Knowledge of stroke warning signs among the general population is poor, with 30% to 60% of the population being unable to recognize a single stroke warning sign[92] and only 20% to 40% capable of recognizing 5 symptoms and indicating that they would call 9-1-1 if they thought someone was having a stroke.[93,94] There are racial-ethnic disparities in awareness and understanding of the nature of stroke, its signs and symptoms, the need for urgency of treatment, and risk factors. Blacks or African Americans and Hispanics from the central Harlem (NY) area were noted to achieve a substantially lower score than whites on a questionnaire about basic stroke knowledge.[95]

In a Centers for Disease Control and Prevention analysis of a survey from the 2005 BRFSS conducted among almost 72 000 people in 13 states and Washington, DC, the proportion of respondents who were able to identify 5 stroke warning signs and recognize the need to call 9-1-1 was 41.3% among whites compared with only 29.5% among blacks or African Americans and 26.8% among Hispanics.[93] These proportions were improved from a similar multistate study in 2001, when the percentages were closer to 19% for whites and 9% for minority groups.[94] In a study conducted in the greater Cincinnati region, blacks or African Americans were 28% less likely to be familiar with stroke warning signs than whites.[96] Surveys among men have found that blacks or African Americans have lower scores on tests of knowledge about stroke and heart disease.[97]

Hispanic women (32%) were more likely to feel uninformed than white women (22%) and expressed greater fatalism about their ability to prevent vascular disease. In data from the BRFSS among women 45 to 54 years of age, Hispanics were more than 4 times as likely and blacks or African Americans 2.5 times as likely as whites to have low scores on scales of stroke knowledge, even after adjustment for education, income, and type of medical insurance.[98] In addition, poor stroke awareness among black or African American women appears to correlate with lower income and lack of insurance.[99] Among Hispanics, non-English speakers have less knowledge about stroke than those who also speak English.[100]

Even among those with a history of prior stroke, the ability to recognize stroke symptoms and the need to activate emergency medical services remains poor, with lower performance among non-Hispanic blacks or African Americans (22.3%) and Hispanic/other group members (16.7%) than among whites (28.9%).[101] Hispanic ethnicity remained an independent predictor of lack of awareness in multivariate models. These data indicate that all groups, but particularly minority populations, fall short of the 83% rate of stroke symptom recognition targeted by Healthy People 2010.[44]

Racial-ethnic disparities in awareness of stroke risk factors also exist. In a 1999 survey in Michigan, blacks or African Americans were 61% more likely than whites to be unable to report any stroke risk factors.[102] Among 3271 participants in the 4-city Coronary Artery Risk Development in Young Adults (CARDIA) Study, blacks or African Americans had lower scores for knowledge of cardiovascular risk factors than whites, even after adjustment for education.[103] Blacks or African Americans may be more aware of hypertension, which perhaps reflects educational efforts about hypertension in black or African Americans communities. Of note, in the REGARDS study, blacks or African Americans were 30% more likely to be aware of their hypertension than whites and 70% more likely to be treated when aware, although they were still less likely to have their hypertension controlled.[57] According to Centers for Disease Control and Prevention data for adults with hypertension, the proportion aware of having hypertension was also higher among non-Hispanic blacks or African Americans (70.3%) than non-Hispanic whites (62.9%), although it was lowest among Mexican Americans (49.8%).[104]

Education appears to be associated with awareness of the benefits of physical exercise. Among urban women, 42% did not meet suggested levels of physical activity, and physical inactivity was associated with lower levels of education.[105] Among Caribbean Hispanic women in New York, level of education was also strongly correlated with physical activity.[106]

The literature on awareness of stroke warning signs and risk factors has methodological limitations. In 1 study, use of closed-ended questions led to higher scores of knowledge than use of open-ended questions.[107] Earlier studies have not consistently shown an effect of race on stroke knowledge, possibly because of low survey response rates,[107] smaller numbers of patients interviewed and inclusion of patients with acute stroke,[108] and limitation to a single community with active public stroke education programs.[109]

Educational efforts improve knowledge about stroke symptoms among minority populations. Some interventions and a

randomized clinical trial using creative educational programs effectively taught school children to recognize stroke symptoms and the need for urgency of treatment.[110–112] In communities in which children live with grandparents, these strategies may have particularly important health implications. In Cincinnati, a group of black or African American beauticians were educated about stroke risk factors and warning symptoms and were instructed to transmit this newly acquired knowledge to their clientele. This education resulted in a significant improvement in knowledge of stroke symptoms.[113] These data also suggest that educational programs conducted in native languages and using culturally appropriate methods may be more successful.

Summary

Lack of awareness of stroke symptoms and signs, the need for urgent treatment, and the role of risk factors is common among minority groups. This lack of awareness persists even after a stroke and is particularly prominent in women. Education improves such knowledge and awareness, but the long-term effects of educational campaigns are unknown. There is a need for further research to establish whether educational efforts with appropriate sociocultural interventions decrease the morbidity and mortality of stroke.

Differences in Attitudes, Beliefs, and Compliance

Minority groups have poorer control of stroke risk factors that is attributable in part but not in full to lower compliance with treatment recommendations. These disparities exist for practically every major stroke risk factor, including hypertension,[114,115] diabetes mellitus,[116,117] smoking,[118,119] identified carotid plaque,[120] and lipid control.[121] Studies show that blacks or African Americans have poorer hypertension control despite having greater awareness of their hypertension and receiving adequate antihypertensive treatment.[57,122–125] Still, some data show that the OR of uncontrolled hypertension among blacks or African Americans decreases from 1.8 (95% CI 1.3 to 2.5) to 1.5 (95% CI 1.0 to 2.1) after adjustment for confounding factors, most notably a higher lack of adherence to taking medical prescriptions in these patients.[114] In another study, blacks or African Americans had an OR of adherence to hypertension medications of less than half that of whites.[115] However, other studies have suggested that adherence has little effect on blood pressure control in blacks or African Americans.[126] In addition, although whites and blacks or African Americans were equally likely to initiate oral therapy for diabetes mellitus, blacks or African Americans were nearly twice as likely to discontinue medication as their white counterparts (hazard ratio 1.8, 95% CI 1.2 to 1.7).[117] Interestingly, a study of low-income people showed that 85% of whites were adherent to self-monitoring of blood glucose levels compared with 79% of blacks or African Americans and only 78% of Hispanics.[116] Finally, among new statin users with dyslipidemia, blacks or African Americans were 36% less likely to achieve low-density lipoprotein goals over time (hazard ratio 0.64, 95% CI 0.61 to 0.68); however, this disparity persisted after adjustment for statin adherence and low-density lipoprotein testing (hazard ratio 0.60, 95% CI 0.57 to 0.63).[121] Other researchers have shown that not only are there racial disparities in receiving treatment, but these disparities also exist in the aggressiveness of treatment delivered. For example, blacks or African Americans were less likely than whites to be switched between lipid-lowering agents (OR 0.68, 95% CI 0.60 to 0.78), to have treatment augmented (OR 0.53, 95% CI 0.43 to 0.66), or to be prescribed upward titration of treatment (OR 0.75, 95% CI 0.67 to 0.84).[127]

It has been argued that there is an association between health literacy and compliance that may arise from those with low literacy having "a complex array of problems, including difficulty with oral as well as written communication, limited problem solving abilities, lack of self empowerment, trouble following instructions and complying with treatments, and distrust of new information."[128] For example, those with lower health literacy have an OR of 1.37 (95% CI 1.08 to 1.74) for low refill adherence, although this association was substantially attenuated by adjustment for covariates, including race and income.[129] Health literacy (and particularly numeracy skills) has an inconsistent association with anticoagulation control. A study showed that variability in international normalized ratio was 32% higher among those with the lowest literacy level than among those at the highest level ($P=0.009$).[130] Others found no association between literacy and the proportion of time with the international normalized ratio in the therapeutic range (OR 1.0, 95% CI 0.7 to 1.4), but no genetic factors influencing response to anticoagulation were included in the analysis.[131]

There is a rich literature on misunderstandings of the causes and treatment of stroke and stroke risk factors. For example, a study showed that there was high attribution of the risk of hypertension to high-fat diet and stress but less awareness of the role of lack of exercise, salt intake, and obesity.[132] The heavy attribution of increased risk mainly to diet and at the exclusion of obesity and exercise was also encountered in another study.[133] In interviews with 12 groups of blacks or African Americans (≈9 people per group) in the Dallas, TX, area, the most frequently reported perceived causes of hypertension were stress (100% of groups interviewed), heredity (83%), consumption of pork (67%), salt intake (67%), excessive use of alcohol (67%), overweight (67%), and evil spirits (42%). The most commonly perceived treatments for hypertension included garlic (92% of groups), herbs/vitamins (92%), physician-prescribed medications (83%), vinegar (75%), and diet or weight loss (67%).[134]

There are also insights from a qualitative research study on the pathways of beliefs and attitudes about compliance among 106 blacks or African Americans who had hypertension.[135] The results indicate that the factors that contribute to this lack of compliance can be classified into the domains of patient-specific barriers, medication-specific barriers, disease-specific barriers, and logistical barriers.

- Patient-specific barriers included (1) forgetfulness; (2) beliefs that medications were associated with impotence or drug dependence/addiction or are not needed when one feels well; and (3) attitudes such as denial or feelings that medications are not needed if there is no family history of

hypertension and that medications are associated with other poor outcomes such as development of kidney disease or diabetes mellitus, as well as being required to take medications for the rest of one's life.
- Medication-specific barriers included side effects such as allergies, hives, dizziness, headaches, and loss of sexual desire.
- Disease-specific barriers included the absence of symptoms, which was interpreted as implying the lack of need for treatment.
- Logistical barriers included the burden of filling prescriptions, obtaining clinic visits, having to use the restroom while away from home, and having to carry extra medications to avoid missing a dose.

In a review of 11 qualitative research studies that examined lay beliefs about hypertension, the authors found that the perceptions described previously are consistently found in the black or African American population, including the perceived causes of hypertension (stress, racism, and poor diet), as well as the symptoms and side effects of treatment (headache, increased heart rate, dizziness, sluggishness, and sweating).[136,137] Likewise, in 60 other interviews, the believed causes of hypertension were further classified into 4 broad categories: inherited, stress related, behavioral, and biologically mediated.[138]

However, there are clearly other nonbelief pathways that are likely contributing to racial differences in compliance. In addition to health literacy, analyses adjusted for potential confounders show that a lack of adherence resulted from an inability to afford medications, which was more likely among blacks or African Americans (OR 1.38, 95% CI 1.08 to 1.78) and Hispanics (OR 1.35, 95% CI 1.02 to 1.78).[139] Among diabetic people with poor glucose control, blacks or African Americans were least likely to cite positive healthcare experiences and were most likely to cite stress, depression/mood, and diet temptations as barriers.[140]

Some authors suggest that perceived racial bias may be playing a substantial role as a barrier to good compliance. One study found that a belief that the healthcare system treats people unfairly based on race is associated with delays in filling prescriptions (OR 2.02, 95% CI 1.11 to 3.17), and perceived discrimination in the community is associated with delays in medical testing (OR 2.42, 95% CI 1.09 to 5.36).[141] Likewise, another study showed an increasing likelihood of failure to adhere to medical care subjects with 1 to 2 discrimination experiences (OR 1.8, 95% CI 1.2 to 2.6) and those with ≥2 discrimination experiences (OR 2.6, 95% CI 1.7 to 4.1) were compared with people with no discrimination experiences.[142]

Summary

There are definite differences in attitudes, beliefs, and compliance among minorities. Denial of disease, concern for potential or experienced side effects of medications, absence of symptoms, hierarchy of need, burden of filling prescriptions, and attending doctor visits influence compliance with treatment. Lower health literacy also plays a significant role. In addition, there is limited evidence to support the idea that appropriate sociocultural interventions can improve communication, education, and awareness among minorities. Finally, the perceived or true presence of racial discrimination during interaction with the healthcare system has a negative impact on compliance.

Disparities in Access to Care

Disparities in Access to Acute Stroke Treatment

Access to care is a complex concept that incorporates availability, accommodation, affordability, and acceptability.[143] Causes of racial disparities in access to emergency care include differences in insurance coverage, potential racial biases by caregivers, and the relative small number of minority physicians available to care for minorities.[144] In addition, undocumented Hispanic immigrants may be more reluctant to use health services.[145] However, specific data on ethnic disparities in access to acute stroke care are incomplete and often present conflicting results.[41]

Disparities in access have been reported at different levels of acute stroke care. There is less stroke symptom recognition by blacks or African Americans.[97] Delay in arrival at the emergency department (ED) decreases the odds of receiving acute stroke treatment.[146] A study in New Jersey showed that blacks or African Americans and Hispanics with acute stroke were less likely to use ambulance services, which was associated with delayed arrival at the ED.[147] Intrahospital disparities in delays of care have also been reported. One study showed that Hispanics had longer waiting times to see a physician after arriving at an ED with stroke symptoms.[147] In contrast, blacks or African Americans, but not Hispanics, had significantly longer waiting times in the ED in a study using data from the National Hospital Ambulatory Medical Care Survey (1997–2000 and 2003–2005).[148] The difference persisted after adjustment for other factors associated with longer waiting time, such as arrival by means other than ambulance, urban location of the hospital, and nonemergency triage. Longer waiting time in the ED leads to treatment delays that include administration of thrombolytic therapy. More research is needed to understand the reasons for this discrepancy in emergency care.

Summary

Minorities are less likely to use emergency medical services. In addition, they have delayed arrival at the ED. Blacks or African Americans and possibly Hispanics have longer waiting times in the ED, which may contribute to their lower likelihood of receiving thrombolysis for acute ischemic stroke. Although some of these disparities are the result of lack of awareness, language barriers, and reluctance to seek attention because of immigration status, the role of unmeasured factors on these differences cannot be excluded, and the evidence suggests the potential existence of bias in the delivery of care.

Disparities in Access to Stroke Rehabilitation

Few studies have examined racial-ethnic disparities in stroke rehabilitation, and the available evidence is unclear and somewhat contradictory. With regard to access, a study of the Veterans Health Administration found no racial-ethnic differ-

ences in referral to or receipt of inpatient rehabilitation services,[149] whereas another study examining acute stroke patients in Maryland revealed that blacks or African Americans living in urban areas were more likely than urban-dwelling whites to be discharged from the hospital to inpatient rehabilitation.[150]

In terms of time between stroke onset and admission to rehabilitation, several studies showed no difference between different racial groups,[151,152] except for 1 study that found blacks or African Americans had a slightly longer time to initiation of rehabilitation than whites (4.4 days versus 3.8 days; $P<0.05$).[149]

The effect of the Functional Independence Measure (FIM) score on admission to rehabilitation is equally contradictory. A retrospective cohort study found no racial-ethnic differences in admission FIM scores,[151] whereas others found significant differences in FIM scores. One study of a large urban county hospital reported that Hispanics had lower admission FIM scores than blacks or African Americans,[152] and another study found that unadjusted FIM scores were highest for whites compared with other racial groups.[153]

A few studies reported no racial-ethnic differences in length of stay for inpatient rehabilitation[151–153]; however, 1 study of Veterans Affairs (VA) and non-VA inpatient rehabilitation facilities reported significantly longer average lengths of stay for blacks or African Americans than for whites.[154] No racial-ethnic differences have been seen in the intensity of inpatient rehabilitation therapies, such as occupational therapy and physical therapy.[151,155] A study using data from the BRFSS found that blacks or African Americans had a higher prevalence of outpatient rehabilitation than whites (adjusted OR 1.49, 95% CI 1.1 to 2.0).[156] Results on the delivery of outpatient occupational therapy and physical therapy services are conflicting. A telephone survey reported that whites were more likely than nonwhites to receive occupational therapy and physical therapy services after stroke,[157] whereas another study examining data from the Health and Retirement Study did not find racial differences in receipt of these services.[158]

Summary

Information on access to rehabilitation services offers conflicting findings. Current evidence shows that minorities have equal access to rehabilitation services and that they have longer stays and poorer functional status than whites.

Disparities in Access to Stroke Prevention Services

Differences in access to and use of stroke prevention resources is poorly documented and understudied. The few well-done studies available point to the need for further research. In a study of 5840 stroke survivors as part of the National Health Interview Survey, researchers found that women, blacks or African Americans, and the poor were significantly less likely to fill prescriptions because of cost.[159] One report suggests that blacks or African Americans are less likely to have thorough diagnostic evaluations after a first stroke and are less likely to receive guideline-concordant stroke preventive medication.[160] In another study, which used the 2005 BRFSS in 11 862 stroke survivors, little difference was found among blacks or African Americans and non-Hispanic whites with respect to secondary prevention measures. The study found that secondary prevention resources were underused by both racial groups.[161] In a community-based study examining Mexican Americans and non-Hispanic whites, no difference in preventive therapies was found for patients having their first or second stroke.[75] In this same community, it was found that access-to-care variables were strongly associated with first stroke in both Mexican Americans and non-Hispanic whites, which suggests the need to remedy these barriers for all populations.[88]

The possibility of behavioral intervention programs to improve stroke prevention efforts appears promising. One study showed that 84% of subjects demonstrated a willingness to participate in a church-based primary stroke prevention project focused on diet and exercise.[162] Similarly, another study of a practice-based stroke prevention project reported greater improvement in stroke prevention behaviors among black or African American participants than among non-Hispanic white participants.[163]

Summary

Although secondary prevention treatments are underused by all races and ethnic groups, minorities are less likely to receive medications for secondary prevention. Some of these differences may be confounded by SES, education, and insurance coverage. Behavioral modification programs may be effective in minority populations.

Potential Contributing and Confounding Factors

Several factors could influence racial-ethnic disparities in access to care for those with or at risk for stroke, thereby complicating study design, interpretation of results, and ability to compare results across studies. These factors include SES, public awareness, perception of resource availability, literacy, mistrust of the healthcare system, language barriers, religious and cultural beliefs, cultural isolation, access to transportation, immigration status, and healthcare provider issues. More importantly, these factors may also be mediators for or barriers to intervention.

Income

Low SES is associated with an average lifespan that is 10 years less than that of people with high SES.[164] In particular, evidence from observational studies using large administrative data sets indicates that being poor is associated with greater prevalence of stroke risk factors, higher stroke incidence, lower quality of life after stroke, and higher mortality after stroke.[165,166] Lack of access to medical care is likely one mediator of the relationship between poverty and undesirable stroke outcomes. In the United States, blacks or African Americans have lower average SES than whites. For instance, 9.1% of white families lived below the poverty level in 1999, compared with 24.9% of black or African American families.[39] Indeed, many studies have compared racial-ethnic differences in stroke occurrence or stroke mortality and observed that SES accounted for a proportion of the observed racial-ethnic differences. Within a large biracial population of blacks or African Americans and whites in greater Cincinnati/northern Kentucky, it was observed that 39% of the racial disparity in stroke incidence for blacks or African Americans

was associated with lower SES as defined by the proportion of subjects below the poverty line.[167] Furthermore, in a sample of community-dwelling stroke survivors, lower income appeared to explain the higher association of black or African American race with stroke prevalence after adjustment for clinical risk factors.[48]

Lower level of education, a variable often related to lower SES, may contribute to exacerbating the difference in stroke incidence between blacks or African Americans and whites. Data from the Atherosclerosis Risk in Communities study showed that the black or African Americans–versus-white age-adjusted rate ratio for ischemic stroke was 2.41 (95% CI 1.85 to 3.15) but was attenuated to 1.38 (95% CI 1.01 to 1.89) after additional adjustment for baseline hypertension, diabetes mellitus, smoking status, coronary artery disease, and, notably, education level.[50]

Insurance

Because cerebrovascular disease is a chronic, often progressive condition that reflects long-term exposures to vascular risk factors, lack of health insurance may compound the effects of low income or education on health risk behaviors by limiting access to primary and secondary prevention. Individuals without health insurance tend to be more likely to forgo routine physical examinations; to be unaware of a personal diagnosis of hypertension, diabetes mellitus, or hyperlipidemia; and to have higher levels of neurological impairment, a longer average length of hospital stay, higher rates of stroke, and a higher risk of death.[168,169] A cohort study of stroke survivors noted that being of black or African American race was associated with less ability to afford medication.[159] Moreover, NOMAS showed that those with no insurance or Medicaid are more likely than those with Medicare or private insurance to experience declines in function and quality of life after stroke, starting ≈3 years after the stroke.[170,171] Conversely, there are also substantial racial disparities among veterans with equal access to health care through the VA systems. For example, blacks or African Americans and Hispanics were less likely to use inpatient therapy services after a stroke than their white counterparts.[172]

Mistrust

For black or African American and Hispanic patients, racial beliefs and preferences may affect the quality of interaction with their healthcare provider and may be a contributor to racial disparities.[173] One study found an association between patients' beliefs about discrimination in health care and specific preferences for the race or ethnicity of their physician.[174] Patients with racial preferences for their physician appear to be more likely to rate their regular physician highly if they are in a race-concordant relationship, with approximately one quarter of blacks or African Americans and one third of Hispanics preferring that their personal physician be of similar race or ethnicity.[173] In fact, racially concordant visits appear to be longer and have more favorable communication characteristics.[175] Importantly, the number of minority physicians is limited, which makes it difficult for minority patients to reach minority physicians all the time. However, there is a paucity of data that specifically examined mistrust of care providers among minority patients with or at risk for stroke. This issue certainly deserves further exploration.

Providers

It was shown that most of the care for black or African American patients is provided by relatively few primary care providers compared with care for white patients. In addition, physicians caring for blacks or African Americans are more likely to report having great difficulty accessing subspecialty support for their patients and feel that they are unable to provide high-quality care for their patients.[176] Furthermore, it has been suggested that in many cases, physicians treating black or African American patients may be less well trained clinically, less likely to be board certified in their primary specialty, less knowledgeable about preventive-care practices, less surgically competent, and less likely to have access to important clinical resources than physicians treating whites.[176–179] However, relatively little else is known about the effect of knowledge, training, and qualifications of healthcare providers on racial disparities in access to appropriate stroke care.

Healthcare System

The healthcare system may lend itself to care disparities. Stroke registry studies evaluating routine clinical practice have indicated that being of black or African American race is associated with significant delays from 911 call to arrival in the ED[180] and time to a computed tomography scan of the head after hospital arrival.[181,182] Blacks or African Americans also appear less likely than their white counterparts to receive intravenous thrombolytic treatment[183] and to undergo cardiac monitoring, noninvasive cerebrovascular testing,[184] dysphagia screening, or smoking cessation counseling.[181] Recent data from the American Heart Association–sponsored Get With The Guidelines–Stroke program, which included 397 257 patients at 1181 hospitals, provided evidence that blacks or African Americans with stroke received fewer evidence-based care processes than Hispanic or white patients. Quality of care improved substantially over time for all 3 racial/ethnic groups, perhaps because of participation in quality-improvement measures.[73] However, not all studies that investigated this issue have shown racial disparities among routinely treated stroke patients. A study of patients with stroke at VA hospitals noted that a patient's race was not associated with having invasive carotid imaging or carotid endarterectomy (CEA), echocardiography, or noninvasive cerebrovascular testing.[185] Notably, the VA healthcare system is an open-access program. Further studies are required to better delineate the reasons behind these management disparities, where they occur, and how to resolve them.

Awareness

Lack of stroke knowledge is a barrier to appropriate care and likely contributes to racial disparities in access to care. For instance, Mexican Americans in Texas were less likely than non-Hispanic whites to know that therapy for acute stroke existed, to recognize a time window for treatment, to indicate that they would call 911 for stroke symptoms, and to recall stroke symptoms.[186] Language impediments may exacerbate this issue. In fact, lack of English proficiency is strongly

associated with lack of stroke knowledge among Hispanics and highlights the need for educational interventions about stroke emergencies and preventive care targeted to Spanish-speaking communities.[100] Although these findings were limited to Texas, it does highlight the importance of language and communication as a barrier for awareness. Further studies are needed to confirm these findings.

Summary

Several factors may contribute to racial and ethnic disparities in access to stroke care. They include SES, insurance coverage, mistrust of the healthcare system, a relatively limited number of providers belonging to minority groups, system limitations, and poor awareness. Large proportions of minorities have lower SES, no health insurance, and lower education levels than non-Hispanic whites. In addition, language barriers may limit stroke awareness and understanding of the options available for prevention and treatment of cerebrovascular disease.

Disparities in Quality of Stroke Care

Differences in Testing

Information on disparities in testing is scant. Carotid angiography has been reported to be performed more commonly in white patients than in blacks or African Americans in the VA healthcare system,[187] although this difference could be related to higher rates of carotid atherosclerosis in whites. Similarly, noninvasive cerebrovascular testing and comprehensive evaluations for the cause of a first stroke occur less often in black or African American patients.[130,158] In contrast, a recent study of the North Carolina Stroke Care Collaborative found no significant association between receiving a computed tomography scan within 25 minutes of hospital arrival and race.[188]

Summary

There is limited evidence showing that minorities are less likely to receive evaluation or testing for cardiovascular disease and stroke than whites. However, more research on this topic is clearly necessary.

Differential Referral to Neurologists

Apart from differences in use of diagnostic tests or application of treatments, discrepancies in stroke care can occur because the proportion of minorities evaluated by specialists is different as compared with whites. Neurological consultations could improve the accuracy of acute diagnosis in selected cases and increase the effectiveness of secondary prevention treatments by allowing a more accurate determination of the mechanism of brain ischemia. Patients treated by neurologists have lower rates of early mortality.[8] Unfortunately, there is a paucity of research assessing the frequency of neurological consultations in multiethnic stroke populations.

A study from the BASIC Project reported that Mexican Americans were less likely to have a neurology consultation in the ED than non-Hispanic whites (OR 0.58, 95% CI 0.35 to 0.98)[189]; however, the clinical significance of this finding is unknown. The absolute difference between neurological consultations in the ED for Mexican Americans and non-Hispanic whites, although statistically significant, was very modest, because most patients in both groups did not have a neurological consultation. In addition, well-trained emergency physicians can accurately identify patients with stroke,[190] and the study did not assess whether there was any persistent discrepancy between the 2 groups in the rate of neurological consultations after admission to the hospital.

In a study of acute stroke patients treated across 137 community hospitals, patients treated by attending physicians who were neurologists were 3.7 times more likely to receive intravenous thrombolysis. This finding was consistent among black or African American and white patients, but only 10.6% of black or African American patients had a neurologist as their attending physician compared with 20.3% of white patients.[152] Thus, this study indicates a discrepancy in delivery of care with possible direct consequences on treatment and patient outcome.

Summary

Minority patients with stroke are less likely to be evaluated by a neurologist. The causes for this disparity are not clear, and further research is needed to better understand the differences and to identify practical solutions.

Disparities in Treatment With Thrombolytic Therapy

Data on disparities in treatment with thrombolytic therapy in patients with acute ischemic stroke are limited. Understanding the elements required in the various steps to achieve successful administration of thrombolytic therapy to patients with acute ischemic stroke provides a means to understanding the barriers and sources of disparities. The links in the stroke Chain of Survival[190a] are rapid recognition of stroke warning signs and activation of the emergency response system (call 911); rapid emergency medical services dispatch, transport, and prehospital notification; triage to a stroke center; and rapid diagnosis, treatment, and disposition in the hospital.

With regard to the administration of thrombolysis, 1 study analyzed the NIS database for 1999 to 2004, which showed that thrombolysis was used in 1.12% of patients hospitalized for ischemic stroke. Higher use of thrombolysis was noted among whites and patients with private, self-pay health insurance, which suggests a discrepancy; however, these associations were not controlled for SES and are limited in that they cannot discern whether other patient characteristics (particularly the presence of contraindications) or patient preferences could have accounted for the differences noted.[191] In a prospective study of the use of recombinant tissue plasminogen activator in acute ischemic stroke in a sample of US academic centers, investigators found that recombinant tissue plasminogen activator was used fewer times in blacks or African Americans even after controlling for delays to presentation.[183] Although the reason for that finding was unclear, physician biases, cultural barriers, and patient mistrust are possibilities that should be considered for additional study. No data are available in relation to access to endovascular acute stroke interventions. More recently, the Get With The Guidelines–Stroke program showed that blacks or African Americans with stroke were less likely to receive

thrombolysis than Hispanic or white patients (OR 0.84, 95% CI 0.77 to 0.91).[73]

Summary

There are disparities in access to and treatment with thrombolysis among minorities compared with whites. The discrepancies appear to exist at several levels of acute stroke care as outlined in the stroke Chain of Survival. Research has not sufficiently analyzed the effects of SES and coverage by health insurance, which could represent sources of systematic biases in healthcare delivery.

Disparities in Prevention

There are several possible reasons for disparities in risk factor control among minority groups, including access to care, physician inertia, adherence and compliance with treatment, and severity of disease. After a stroke and in situations in which barriers to access are reduced, such as in the VA and Medicare systems, disparities might be lessened.

In primary prevention, disparities in blood pressure control are significant. Among men >60 years of age, Hispanics and non-Hispanic blacks or African Americans have worse rates of blood pressure control, even among those treated for hypertension, compared with whites.[192] Middle-aged Hispanic women have the lowest rates of blood pressure control among those treated. In an early analysis from the nationwide REGARDS study, blacks or African Americans were less likely than whites to have their blood pressure controlled (OR 0.73, 95% CI 0.64 to 0.83), despite greater awareness of their hypertension and greater likelihood of receiving treatment if aware of their diagnosis (OR 1.69, 95% CI 1.40 to 2.05).[57] Interestingly, there is no difference between the Stroke Belt and other regions with regard to awareness of hypertension (OR 0.95, 95% CI 0.79 to 1.14), and in fact, there is a trend for better treatment (OR 1.15, 95% CI 0.97 to 1.37) and control (OR 1.11, 95% CI 0.98 to 1.30) in the Stroke Belt region.[193]

Prophylactic use of aspirin is higher among whites than blacks or African Americans. In REGARDS, among 16 908 participants ≥45 years of age, 34.7% of whites used prophylactic aspirin compared with only 27.2% of blacks or African Americans ($P<0.0001$).[194] Aspirin use was also higher among men and higher socioeconomic groups.

Analyses of temporal trends from 1999 to 2006 using repeated NHANES questionnaires indicate that there has been overall progress in improving the rates of control of blood pressure and diabetes mellitus, but there are persistent disparities between whites and minorities.[195] For example, over the period of the study, differences in blood pressure control and glucose control between whites and blacks or African Americans have remained, and those between whites and Hispanics in glucose control have increased slightly. Although overall from 1999 to 2006, the proportion of patients with blood pressure controlled to a target <140/90 mm Hg increased from 45.7% to 56.0%, the pooled 8-year control rates were 52.8% among whites, 44.4% among blacks or African Americans, and 42.5% among US-born Hispanics. For diabetes mellitus control, pooled rates were 58.1% for whites, 41.6% for blacks or African Americans, and only 37.8% for US-born Hispanics. Of note, disparities were less marked among patients >65 years of age, perhaps because of their access to Medicare coverage. For instance, blood pressure differences between blacks or African Americans and whites decreased from 7.0 (95% CI 5.4 to 8.6) mm Hg before age 65 years to 2.8 (95% CI −0.1 to 5.7) mm Hg after age 65 years.

Previous data suggest that there were also differences among racial-ethnic groups in the use of secondary stroke prevention treatments. In an analysis among 19 051 nursing home residents with recent ischemic stroke, Asian Americans and Pacific Islanders were less likely to receive an antithrombotic agent than non-Hispanic whites, whereas American Indians/Alaskan Natives were more likely to receive treatment.[196] Asian Americans and Pacific Islanders, blacks or African Americans, and Hispanics were less likely to receive warfarin when indicated than non-Hispanic whites.[196] In REGARDS, investigators found that blacks or African Americans were less likely than whites to be aware they had atrial fibrillation or to be treated with warfarin.[161]

Recent cross-sectional evidence from nationwide health surveys suggests that once patients have a stroke, the use of most risk-reduction strategies does not differ markedly by race, although most prevention strategies are underused by all groups.[161] For example, data from the 2005 BRFSS show that black or African American stroke survivors are less likely to engage in regular exercise than whites but that they are no less likely to be prescribed aspirin and antihypertensive agents, to have cholesterol and glycosylated hemoglobin measurements when appropriate, and to be counseled to stop smoking and consume a low-fat or low-salt diet. Still, the proportion of those who participated in regular exercise was low among both blacks or African Americans (48%) and whites (58%). In an analysis of 1045 patients from the VA, rates of intervention for smoking cessation and use of aspirin were similar for blacks or African Americans and whites, although both interventions were underused; only 56% of both groups received interventions to quit smoking, and ≈74% received aspirin.[197] In data from the National Health Interview Survey, Hispanic stroke survivors and blacks or African Americans were more likely to be physically inactive and overweight than whites.[62] Screening for hypertension and hyperlipidemia among patients during outpatient office visits does not appear to differ by race.[198] A recent analysis of 4864 stroke survivors ≥45 years of age who responded to the National Health Interview Survey in 2000 to 2006 revealed that Mexican Americans and blacks or African Americans ≥65 years of age had reduced access to primary care providers and were less able to afford medications when compared with whites.[199] There was no difference in access to primary care providers or medications among those <65 years of age. However, Mexican Americans and blacks or African Americans in any age group had worse access to evaluation by specialists.

Yet racial disparities may exist, at least in the early phase of secondary stroke prevention. In hospitals participating in the Get With the Guidelines–Stroke program between 2003 and 2008, adherence to evidence-based performance mea-

sures aimed at reducing the risk of secondary strokes was significantly lower in blacks or African Americans than in whites and Hispanics.[73] These differences were noted in smoking cessation counseling, prescription of antithrombotic medications on discharge, prescription of anticoagulant medications for atrial fibrillation, and prescription of lipid therapy for atherosclerosis-related strokes. Although the differences were generally modest, they showed a consistent pattern and remained significant—or became even more prominent—after controlling for patient-related and hospital-related confounding variables. Such discrepancies could lead to increased risk of recurrent strokes in black or African American patients. The good news is that adherence to these guideline-recommended quality measures improved over the study period among patients of all racial groups in participating hospitals.[73]

Summary

Minorities are inadequately treated with both primary and secondary stroke prevention strategies. Disparities are reduced when people have health insurance and ready access to care. Physical activity rates are particularly low among minority groups. Community healthcare workers and other lay providers may help diminish disparities by providing basic preventive care and education to people with otherwise limited access to health care.[200,201]

Disparities in the Use and Outcomes of CEA

Randomized trials demonstrated that CEA can reduce the risk of stroke in patients with symptomatic carotid artery disease. As a result, screening for carotid disease, as well as subsequent CEA among appropriate patients, is recommended as an effective means of secondary stroke prevention.[202,203] Studies, however, have consistently demonstrated that blacks or African Americans are less likely to receive CEA than whites.[187,204–210] The magnitude of these differences varies slightly among study populations, but on average, results show that blacks or African Americans are 2 to 4 times less likely than whites to have CEA even after risk adjustment. Blacks or African Americans were also at higher risk of stroke after endarterectomy (OR 1.7, $P=0.013$). Potential reasons for these racial differences in the use of CEA include less carotid artery screening among blacks or African Americans than whites[187,211]; racial differences in the distribution of carotid disease and appropriateness for CEA[212–214]; clinical characteristics[206,212]; differential risks for carotid surgery[215–219]; differential patient preferences for surgery[220]; and racial disparities in care.[221] Interestingly, among patients admitted to VA hospitals in the 1990s, there was no significant difference in use of CEA (1.5% among whites versus 0.8% among nonwhites, $P=0.38$).[185]

Summary

There is a differential use of CEA among blacks or African Americans relative to whites; however, these studies have several limitations. They lack the clinical detail necessary for risk adjustment and are relatively dated (pre-2000), focused on specific patient populations, and do not sufficiently consider potential confounders of CEA use. Future studies should be undertaken to determine whether racial disparities in use of CEA continue to exist, to delineate the underlying causes of such differences, and to identify effective interventions designed to reduce these disparities in care.

Differences in Access to Surgery in ICH or SAH

Epidemiological data on racial-ethnic disparities in the surgical treatment of patients with ICH or SAH are surprisingly limited, especially when one considers the often devastating consequences of these forms of cerebrovascular disease,[222,223] their higher incidence among ethnic minorities,[224–227] and the comparative abundance of studies evaluating ethnic disparities in procedures for other disease entities, including cardiovascular disease,[179] and studies on access to surgical management of ischemic cerebrovascular disease, including CEA.[185,187] The impact of advanced directives about restricting aggressive care on access to or performance of surgical procedures for these acute conditions is not well established. This is important because there is evidence indicating that blacks or African Americans are less likely to have withdrawal of life support measures as compared with whites.[86]

Relatively little information was found in a comprehensive review of the literature about racial-ethnic disparities in the United States in terms of surgical treatment and outcome of various cerebrovascular disease entities, including intracranial aneurysms and cerebral arteriovenous malformations, from 1966 through 2005.[228] The available data, which were generally retrospective and greatly confounded, showed no information on ethnic disparities in access to actual surgical treatment of these conditions.[228] A study of adult patients with SAH in the greater Cincinnati area prospectively identified from 1997 through 2005 did not find race to be associated with rates of time to treatment or case fatality.[229] To date, there is no information on racial-ethnic disparities in the care of patients with ICH.

Summary

There is a marked paucity of data on racial-ethnic disparities in accessing surgical care after ICH and SAH. Future research should focus on looking at broad measures of processes of care, the impact of these care processes on clinical outcomes, and the potential contributors and confounders to any differential access to surgical care by race or ethnicity.

Differences in Access to Research

Rates of Participation of Minorities in Clinical Research

Minorities have usually been underrepresented in most major medical trials in general and stroke trials in particular.[230–234] According to figures from the National Institutes of Health, the percentage of minorities who took part in clinical trials funded by the federal government steadily fell from 41.3% to 29.5% between 1997 and 2001. Although the figure rose the following 2 years, reaching 35.8% by 2003, enticing the participation of patients belonging to racial-ethnic minorities remains challenging.

Personal beliefs and preconceived attitudes such as mistrust of medical research appear to be crucial to defining participation in clinical studies.[235] Mistrust of the medical care system may present a barrier to enrollment of minority

patients in research studies.[236] Yet the degree of mistrust among blacks or African Americans, Hispanics, and whites appears to vary depending on sociodemographic characteristics (sex, educational attainment, insurance status, and city of residence).[237] Moreover, a comprehensive literature review appears to contradict assumptions that minority subjects are more reluctant to consent to participate in clinical research by showing only very small differences in the willingness of minorities (mostly blacks or African Americans and Hispanics in the United States) to participate in health research compared with non-Hispanic whites.[238] Because racial and ethnic composition of the patient population may impact clinical trial results and their wide applicability by skewing the proportion of patients enrolled with different stroke subtypes, this issue is of major importance to stroke researchers.

Barriers to Participation of Minorities in Clinical Research

Although ethnic minorities are interested in improving their health and, when given appropriate information, appear willing to participate in clinical research, data indicate that evaluation, study compliance, retention (remaining in the study), and follow-up of ethnic minorities is a challenging process that requires culturally relevant strategies to ensure optimal efficacy.[239] Racial disparities in access to clinical research have been observed in clinical trials, which constitute the major experimental approach to develop safe and effective state-of-the-art treatments, as well as population-based studies. Indeed, it has been suggested that there might be a "recruitment triangle" that is essential to the enrollment and retention of subjects in clinical research, especially clinical trials.[240] This triangle is composed of the subject, vital family members and friends, and the primary medical personnel involved in treatment and care of the subject.[241] The triangle is bound by social support, education about the nature of the research, and trust in study personnel.[241]

Potential barriers to maximal participation of ethnic minorities in clinical research can be divided into 2 main categories: cultural characteristics and structural factors.

Cultural Characteristics (Attitudes, Beliefs, Perceptions, and Awareness)

Regardless of race or ethnicity, the most frequently reported barriers to minority patients' acceptance of clinical trials tends to be mistrust of medical research and the medical system.[239] Mistrust of physicians and the healthcare system among minorities has been supported by studies in recent history in which an effective treatment was withheld as part of the study, as well as documented deficiencies in the delivery of health care to minorities, including unfavorable disparities in the use of diagnostic testing and treatment procedures by physicians.[239] In fact, enrollees in a double-blind, randomized clinical trial of black or African American stroke patients who subsequently withdrew or refused to participate consistently stated that they were worried about being used as "guinea pigs" and that these feelings were reinforced by their family and friends.[240]

Other pervasive notions among ethnic minorities that may impede their full involvement in clinical research are a fatalistic attitude about their chances of recovery from a disease, specific research questions that may be perceived by minority subjects as irrelevant, negative personal experience with a local hospital/medical personnel, or an injury caused by the application of a treatment perhaps taken incorrectly.[241]

Structural Factors (Health and Research Systems and Economic Issues)

Although several studies have highlighted barriers to minority patients' increased participation in clinical research, healthcare professional barriers have received relatively less attention, even though care provider perceptions and attitudes play an important role in study enrollment of underrepresented populations.[242] In fact, care providers, especially physicians, tend to act as gatekeepers and provide the majority of patient education and coordination regarding clinical trials.[243,244]

Evaluations of medical researchers' opinions about low minority recruitment have identified a perception of lower interest in clinical trials among minority patients (due to mistrust of researchers and lack of awareness/information and resources), a lack of investigator confidence in explaining clinical trials in culturally appropriate terms as probable barriers, and the paucity of collegial relationships between university-based physicians and many community physicians caring for minority patients.[245] Other data indicate that a large proportion of study principal investigators do not set a priori recruitment goals for racial-ethnic minorities, even though the number of minority participants needed for hypothesis testing may differ substantially from the numbers needed for more exploratory analyses aimed at generating new hypotheses.[244] The limitations in care among minority populations and the relative lack of resources in these communities leads these populations[236] to seek care in different settings from clinics to EDs or to never have access to medical care, making recruitment of minorities into stroke population-based studies difficult to achieve.[241]

Some investigators have created challenges for themselves by blindly using approaches to recruit subjects that may have been effective among nonminority groups, such as the use of mailed surveys, individual appeals, and reliance on individuals' basic trust in healthcare providers.[241] For instance, telephone reminder interventions in minority-rich urban populations are often unsuccessful, largely because up to 20% of the samples cannot be reached by telephone. Failure to network with local organizations, to pilot test to ensure that questions are culturally sensitive, to use bilingual recruiters (for subjects who speak only Spanish), or to provide ancillary services (eg, hiring social workers to help obtain other health and social services to show genuine interest in community welfare) could adversely affect the most well-meaning attempts to enroll and retain minority subjects in experimental studies.[239]

The race/ethnicity of a physician may also affect participation of minority patients in clinical research. Hispanic/Latino physicians tend to be significantly less likely than their non-Hispanic white counterparts to find clinical trials to be of scientific value, which probably determines whether they recommend them to their patients.[243]

There is relatively limited information in the literature on the enrollment and retention of minority women in clinical

trials. However, available data indicate that the factors that greatly influence the participation of women in clinical research are SES and educational level.[247]

External Validity of Current Evidence

In the United States, there has been a long history of underrepresentation of racial and ethnic minorities in biomedical research.[11,39,248–251] Minorities were underrepresented in many types of clinical research, including stroke and other cardiovascular diseases.[11,231,251,252] In response to these observations, the US Congress mandated that the National Institutes of Health enroll more women and minorities in clinical trials.[253] Furthermore, the US Food and Drug Administration made specific recommendations that included standardized race and ethnicity categorization in studies to create a level of consistency in the evaluation of drug differences according to these demographic parameters.[254] These recommendations raised practical study design challenges. In the case of enhancement of enrollment of minorities in randomized controlled trials, the absolute number of minority enrollees usually was not sufficient to draw substantial conclusions about drug efficacy and safety.[255] Post hoc subgroup analyses of such data served to promote formulation of a hypothesis but were not adequate for direct testing of the hypothesis, because there might be uncontrolled or uncontrollable confounding.[256]

The latter potential shortcoming led to the recommendation that large targeted trials be funded to yield meaningful and usable data in relation to women and racial-ethnic minorities. In stroke research to date, there have been few such exclusive randomized controlled trials in racial-ethnic minorities. Thus far, the African-American Antiplatelet Stroke Prevention Study (AAASPS) and the Stroke Prevention Trial in Sickle Cell Anemia (STOP I and II trials) have been the prime examples of this type of study.[11,257,258] These trials are landmark studies and have shown that minority patients are interested in biomedical research and can be successfully recruited and retained for such trials.

Assessment of the external validity of the current evidence is very important. Results of clinical trials may not be generalizable to racial-ethnic minorities not represented in the clinical trial because of the potentially different response to treatment related to different prevalence and severity of disease and different genomic or metabolic profiles in specific racial-ethnic subgroups. For instance, there has been recent interest in the cytochrome P-450 superfamily of enzymes responsible for drug metabolism.[259,260] Specifically, within this superfamily of enzymes, there has been recent study of the CYP2C19 variant that is involved in the conversion of clopidogrel from its prodrug to its active metabolite.[261,262] It is estimated that this genetic variant, which prevents adequate conversion of clopidogrel to its active form, is common and may occur in 40% of people of African ancestry, 50% of people of East Asian ancestry, and 30% of people of European ancestry.[262] Similarly, variant alleles in the genes CYP2C9 and VKORC1 that affect warfarin metabolism may have a higher frequency of occurrence in some racial-ethnic minorities.

These findings, although not specific to 1 race or ethnic minority group, are important to patients who are being treated and their healthcare providers because the results may predict the success or failure of therapy. Without focused study of racial-ethnic minorities, it will be difficult to predict excess risk among these people.[263] Overall, such information may provide the opportunity to reduce disparities in health care and health outcomes and help us to better understand disease-response variations among racial-ethnic groups.[4,264]

Summary

There is limited participation of minorities in clinical research. Adequate participation of all racial-ethnic groups is necessary to comply with the ethical principles of justice (ie, fair distribution of risk and benefits related to research), fair subject selection, societal value, and scientific validity.[265] There are barriers to participation in clinical research. These barriers include cultural aspects, such as beliefs, trust, and awareness, as well as healthcare system and economic issues. Moreover, race is a contentious topic in biomedical research.[266] Although race has not been shown to act as a surrogate for genetic constitution in medicine or public health or to necessarily provide a definitive categorization of genetic information about the response to drugs, diagnosis, or cause of disease,[266] information about a patient's race and ethnic background is important for the identification, tracking, and investigation of the rationale for differences in the prevalence and severity of disease and responses to treatment. This is especially important when genetic factors may be involved, because race is associated with social and environmental factors that affect disease prevalence and severity, as well as response to treatment.[264] Thus, it is crucial that we enhance our understanding of the reasons that deter minorities from participating in research studies.

Future Directions

Further efforts are needed to clarify the complex relationship between race-ethnicity, stroke burden, and stroke outcomes. Although available evidence is often limited and not always consistent, it does suggest the existence of disparities and the possibility of a bias in the care provided to minorities with stroke. Strategies aimed at reducing racial-ethnic disparities in stroke care require a better understanding of responsible factors and must start by acknowledging that discrepancies exist and need to be addressed. Support for programs such as the Racial and Ethnic Approaches to Community Health (REACH) program created by the Centers for Disease Control and Prevention should continue and expand.[267] Funds for research in this field should be made available to enhance our knowledge by making possible the design of solid scientific studies. We present our specific recommendations at the end of this statement.

In addition, a universal nomenclature is needed to account for the common characteristics of each group. Although each ethnic group is unique, blanket terms such as "Hispanic" may not be helpful in explaining the disparities in health and

health care among different communities given the existence of many subgroups and heterogeneity within blanket terms. An alternative definition, such as Americans who identify themselves with a Spanish-speaking community or ancestry, should be considered.

Conclusions

Biological determinants may explain differences in the prevalence and incidence of stroke and stroke risk factors and in the morbidity and mortality due to stroke among racial and ethnic minorities compared with whites. However, racial-ethnic disparities in stroke care exist. The disparities appear more marked among people <65 years of age, which suggests that Medicare ameliorates the problem by providing equal access to care. SES and low education are barriers to delivering effective health care. Current literature focuses on the influence of sociocultural factors in access to care by minority populations. However, little attention has been paid to the deficiencies in the healthcare system, which may also limit effective treatment to reach minorities.

Closing the gap generated by these disparities in stroke care will require system changes to facilitate education and access to available resources. Appropriate culturally adjusted programs should be designed to allow prompt identification and modification of vascular risk factors, consistent recognition of stroke symptoms, and ready access to immediate treatment among minorities. If Medicare indeed diminishes the disparities in stroke care among different racial and ethnic populations, it would be reasonable to expect that healthcare reform could contribute to closing the gap in stroke care among minorities of all ages.

Further research is needed to understand the current deficiencies in the healthcare system that allow the occurrence of racial-ethnic disparities and to monitor the effects of healthcare reform as it takes effect. Based on our interpretation of the available information summarized in this document, our recommendations are a general call for future research and public health policy development that should include the following:

- Establish standardized definitions for racial and ethnic groups that reflect common features that may include, but are not limited to, biological, cultural, and social determinants.
- Implement educational programs to promote lifestyle modifications and increase stroke awareness in racial and ethnic minority populations.[268–270] These programs must incorporate the following educational objectives:
  - — Recognition of vascular risk factors, their true causes, their impact on chances of having a stroke, and treatments available to control them
  - — Identification of symptoms of stroke and understanding that stroke is a treatable emergency that should prompt calling 9-1-1 for immediate evaluation
  - — Emphasis on physical activity as a means to reduce stroke risk
- Involve community resources outside of the medical system, such as churches, schools, and community centers, in the implementation of educational programs.
- Target educational programs toward young members of minority populations, because disparities in stroke rates and stroke burden are more prominent in young blacks or African Americans and Hispanics than in young whites.
- Establish programs for provider education to address cultural competence training.
- Prioritize the design of stroke prevention programs for the Hispanic population, because Hispanics are the fastest-growing minority group in the United States and presently constitute a relatively young population. Thus, it can be expected that the burden of stroke in this population will rise substantially in the near future.
- Increase access to health care by broadening the access to insurance coverage in minority populations.
- Expand national strategies for hospital-based implementation of quality improvement in acute stroke care.
- Promote more research to better define factors that contribute to the occurrence of racial-ethnic disparities in stroke care and to assess interventions designed to eliminate these disparities.
- Conduct clinical trials to find interventions to reduce existing disparities.
- Incorporate measures in large stroke trials to ensure adequate representation of all major racial-ethnic groups.
- Expand federal support for trials targeted to minority populations.
- Conduct more research on minority groups other than black or African American and Hispanics, such as American Indians, Asian Americans, and Pacific Islanders.

Disclosures

Writing Group Disclosures

Writing Group Member	Employment	Research Grant	Other Research Support	Speakers' Bureau/Honoraria	Expert Witness	Ownership Interest	Consultant/ Advisory Board	Other
Salvador Cruz-Flores	Saint Louis University	Coaxia Inc*; IMA Rx Therapeutics, Inc*; Neurobiological Technologies, Inc*; Photothera*	None	None	None	None	Axio*; Biotronics*; Eli Lilly*; Roche*	None
Alejandro Rabinstein	Mayo Clinic, Rochester	None	None	None	None	None	None	None
Jose Biller	Loyola University	None	None	None	None	None	None	Editor of *Journal of Stroke and Cerebrovascular Diseases* and *Frontiers in Neurology*
Mitchell Elkind	Columbia University	Bristol-Myers Squibb–Sanofi Partnership†; dia Dexus, Inc†	None	Boehringer Ingelheim†; Bristol-Myers Squibb–Sanofi Partnership*	GlaxoSmithKline*; Merck*; Novartis†; Pfizer*	None	Boehringer Ingelheim*; Daiichi Sankyo*; Tethys Biosciences*	
Patrick Griffith	Morehouse School of Medicine, Neuroscience Institute	None	None	None	None	None	None	None
Philip Gorelick	University of Illinois at Chicago	None	None	None	None	None	None	None
George Howard	University of Alabama at Birmingham	NINDS†	None	None	None	None	Bayer†	None
Enrique Leira	University of Iowa	None	None	None	None	None	None	None
Lewis Morgenstern	University of Michigan	NIH†	None	None	None	None	Genentech*	None
Bruce Ovbiagele	University of California at Los Angeles	None	None	Boehringer Ingelheim†; Bristol-Myers Squibb*	None	None	Boehringer Ingelheim*	None
Eric Peterson	Duke University	Bristol-Myers Squibb–Sanofi†; Merck/Schering†; Schering-Plough†	ACC†; AHA†; STS†	None	None	None	None	None
Wayne Rosamond	University of North Carolina	None	None	None	None	None	None	None
Brian Trimble	Alaska Native Medical Center	NINDS*	None	None	None	None	None	None
Amy Valderrama	CDC	None	None	None	None	None	None	None

This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (1) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (2) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

Reviewer Disclosures

Reviewer	Employment	Research Grant	Other Research Support	Speakers' Bureau/ Honoraria	Expert Witness	Ownership Interest	Consultant/Advisory Board	Other
Gregory L. Burke	Wake Forest University	None	None	None	None	None	None	None
Karen Furie	Massachusetts General Hospital	NINDS†	American Heart Association†	None	None	None	None	None
Carlos S. Kase	Boston University	None	None	None	None	None	None	None
Dawn Kleindorfer	University of Cincinnati	National Institutes of Health, NINDS division, R01 level funding†	None	None	None	None	None	None
James F. Meschia	Mayo Clinic	National Institute of Neurological Disorders and Stroke*	None	None	None	None	None	None
Carlos Rodriguez	Columbia University	None	None	None	None	None	None	None
Eileen M. Stuart-Shor	University of Massachusetts Boston	None	None	None	None	None	None	None

This table represents the relationships of reviewers that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all reviewers are required to complete and submit. A relationship is considered to be "significant" if (1) the person receives $10 000 or more during any 12-month period, or 5% or more of the person's gross income; or (2) the person owns 5% or more of the voting stock or share of the entity, or owns $10 000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Modest.

†Significant.

References

1. Day JC. *Population Projections of the United States by Age, Sex, Race and Hispanic Origin: 1995 to 2050.* Washington, DC: US Government Printing Office; 1996. US Bureau of the Census, Current Population Reports, P25-1130.
2. Deleted in proof.
3. Takahashi H, Wilkinson GR, Caraco Y, Muszkat M, Kim RB, Kashima T, Kimura S, Echizen H. Population differences in S-warfarin metabolism between CYP2C9 genotype-matched Caucasian and Japanese patients. *Clin Pharmacol Ther*. 2003;73:253–263.
4. Smedley BD, Stith AY, Nelson AR, eds. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care.* Washington, DC: National Academies Press; 2003.
5. Murray CJ, Kulkarni SC, Michaud C, Tomijima N, Bulzacchelli MT, Iandiorio TJ, Ezzati M. Eight Americas: investigating mortality disparities across races, counties, and race-counties in the United States [published correction appears in *PLoS Med*. 2006;3:e545]. *PLoS Med*. 2006;3:e260.
6. Lloyd-Jones D, Adams R, Carnethon M, De Simone G, Ferguson TB, Flegal K, Ford E, Furie K, Go A, Greenlund K, Haase N, Hailpern S, Ho M, Howard V, Kissela B, Kittner S, Lackland D, Lisabeth L, Marelli A, McDermott M, Meigs J, Mozaffarian D, Nichol G, O'Donnell C, Roger V, Rosamond W, Sacco R, Sorlie P, Stafford R, Steinberger J, Thom T, Wasserthiel-Smoller S, Wong N, Wylie-Rosett J, Hong Y. Heart disease and stroke statistics: 2009 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee [published correction appears in *Circulation*. 2009;119:e182]. *Circulation*. 2009;119:480–486.
7. Kleindorfer DO, Khoury J, Moomaw CJ, Alwell K, Woo D, Flaherty ML, Khatri P, Adeoye O, Ferioli S, Broderick JP, Kissela BM. Stroke incidence is decreasing in whites but not in blacks: a population-based estimate of temporal trends in stroke incidence from the Greater Cincinnati/Northern Kentucky Stroke Study. *Stroke*. 2010;41:1326–1331.
8. White H, Boden-Albala B, Wang C, Elkind MS, Rundek T, Wright CB, Sacco RL. Ischemic stroke subtype incidence among whites, blacks, and Hispanics: the Northern Manhattan Study. *Circulation*. 2005;111:1327–1331.
9. Williams DR. Race and health: basic questions, emerging directions. *Ann Epidemiol*. 1997;7:322–333.
10. Jones CP. Levels of racism: a theoretic framework and a gardener's tale. *Am J Public Health*. 2000;90:1212–1215.
11. Gorelick PB. Cerebrovascular disease in African Americans. *Stroke*. 1998;29:2656–2664.
12. Senior PA, Bhopal R. Ethnicity as a variable in epidemiological research. *BMJ*. 1994;309:327–330.
13. National Forum on Education Statistics, Race/Ethnicity Data Implementation Task Force. *Managing an Identity Crisis: Forum Guide to Implementing New Federal Race and Ethnicity Categories.* Washington, DC: National Center for Education Statistics, Institute of Education Sciences, US Department of Education; 2008. Publication No. NFES 2008-802.
14. Office of Management and Budget. Standards for the classification of federal data on race and ethnicity. http://www.whitehouse.gov/omb/fedreg_race-ethnicity. Accessed May 16, 2011.
15. Office of Management and Budget. Provisional guidance on the implementation of the 1997 standards for federal data on race and ethnicity. *Fed Regist.* 2001;66:3829–3831.
16. Sacco RL, Boden-Albala B, Gan R, Chen X, Kargman DE, Shea S, Paik MC, Hauser WA. Stroke incidence among white, black, and Hispanic residents of an urban community: the Northern Manhattan Stroke Study. *Am J Epidemiol*. 1998;147:259–268.
17. Office of Management and Budget. Revisions to the standards for the classification of federal data on race and ethnicity. *Fed Regist.* 1997;62:58781–58790. http://www.whitehouse.gov/omb/fedreg_1997 standards. Accessed May 16, 2011.
18. Gillum RF, Gorelick PB, Cooper ES, eds. *Stroke in Blacks: A Guide to Management and Prevention.* Basel, Switzerland: Karger; 1999.
19. Kissela B, Schneider A, Kleindorfer D, Khoury J, Miller R, Alwell K, Woo D, Szaflarski J, Gebel J, Moomaw C, Pancioli A, Jauch E, Shukla R, Broderick J. Stroke in a biracial population: the excess burden of stroke among blacks. *Stroke*. 2004;35:426–431.
20. Cushman M, Cantrell RA, McClure LA, Howard G, Prineas RJ, Moy CS, Temple EM, Howard VJ. Estimated 10-year stroke risk by region and race in the United States: geographic and racial differences in stroke risk. *Ann Neurol*. 2008;64:507–513.
21. Galloway JM. Cardiovascular health among American Indians and Alaska Natives: successes, challenges, and potentials. *Am J Prev Med*. 2005;29(suppl 1):11–17.
22. Schumacher C, Davidson M, Ehrsam G. Cardiovascular disease among Alaska Natives: a review of the literature. *Int J Circumpolar Health*. 2003;62:343–362.
23. Graber JM, Corkum BE, Sonnenfeld N, Kuehnert PL. Underestimation of cardiovascular disease mortality among Maine American Indians: the role of procedural and data errors. *Am J Public Health*. 2005;95:827–830.
24. Rhoades DA. Racial misclassification and disparities in cardiovascular disease among American Indians and Alaska Natives. *Circulation*. 2005;111:1250–1256.
25. Lee ET, Welty TK, Fabsitz R, Cowan LD, Le NA, Oopik AJ, Cucchiara AJ, Savage PJ, Howard BV. The Strong Heart Study: a study of cardiovascular disease in American Indians: design and methods. *Am J Epidemiol*. 1990;132:1141–1155.
26. Howard BV, Devereux RB, Cole SA, Davidson M, Dyke B, Ebbesson SO, Epstein SE, Robinson DR, Jarvis B, Kaufman DJ, Laston S, MacCluer JW, Okin PM, Roman MJ, Romenesko T, Ruotolo G, Swenson M, Wenger CR, Williams-Blangero S, Zhu J, Saccheus C, Fabsitz RR, Robbins DC. A genetic and epidemiologic study of cardiovascular disease in Alaska natives (GOCADAN): design and methods. *Int J Circumpolar Health*. 2005;64:206–221.
27. Trimble B, Hamel R, Gorelick P, Horner R, Longstreth W. Alaska native stroke registry. *Int J Stroke*. 2007;2:60–61.
28. Fang J, Foo SH, Jeng JS, Yip PK, Alderman MH. Clinical characteristics of stroke among Chinese in New York City. *Ethn Dis*. 2004;14:378–383.
29. Fang J, Foo SH, Fung C, Wylie-Rosett J, Alderman MH. Stroke risk among Chinese immigrants in New York City. *J Immigr Minor Health*. 2006;8:387–393.
30. Nguyen-Huynh MN, Johnston SC. Regional variation in hospitalization for stroke among Asians/Pacific Islanders in the United States: a nationwide retrospective cohort study. *BMC Neurol*. 2005;5:21.
31. Shen JJ, Washington EL, Aponte-Soto L. Racial disparities in the pathogenesis and outcomes for patients with ischemic stroke. *Manag Care Interface*. 2004;17:28–34.
32. Rodriguez BL, D'Agostino R, Abbott RD, Kagan A, Burchfiel CM, Yano K, Ross GW, Silbershatz H, Higgins MW, Popper J, Wolf PA, Curb JD. Risk of hospitalized stroke in men enrolled in the Honolulu Heart Program and the Framingham Study: A comparison of incidence and risk factor effects. *Stroke*. 2002;33:230–236.
33. Madison JR, Spies C, Schatz IJ, Masaki K, Chen R, Yano K, Curb JD. Proteinuria and risk for stroke and coronary heart disease during 27 years of follow-up: the Honolulu Heart Program. *Arch Intern Med*. 2006;166:884–889.
34. Curb JD, Abbott RD, Rodriguez BL, Masaki KH, Chen R, Popper JS, Petrovitch H, Ross GW, Schatz IJ, Belleau GC, Yano K. High density lipoprotein cholesterol and the risk of stroke in elderly men: the Honolulu heart program. *Am J Epidemiol*. 2004;160:150–157.
35. Abbott RD, Rodriguez BL, Petrovitch H, Yano K, Schatz IJ, Popper JS, Masaki KH, Ross GW, Curb JD. Ankle-brachial blood pressure in elderly men and the risk of stroke: the Honolulu Heart Program. *J Clin Epidemiol*. 2001;54:973–978.
36. Abbott RD, Curb JD, Rodriguez BL, Masaki KH, Popper JS, Ross GW, Petrovitch H. Age-related changes in risk factor effects on the incidence of thromboembolic and hemorrhagic stroke. *J Clin Epidemiol*. 2003;56:479–486.
37. Brey RL, Abbott RD, Curb JD, Sharp DS, Ross GW, Stallworth CL, Kittner SJ. Beta(2)-Glycoprotein 1-dependent anticardiolipin antibodies and risk of ischemic stroke and myocardial infarction: the Honolulu Heart Program. *Stroke*. 2001;32:1701–1706.
38. Sorlie PD, Avilés-Santa LM, Wassertheil-Smoller S, Kaplan RC, Daviglus ML, Giachello AL, Schneiderman N, Raij L, Talavera G, Allison M, Lavange L, Chambless LE, Heiss G. Design and implementation of the Hispanic Community Health Study/Study of Latinos. *Ann Epidemiol*. 2010;20:629–641.
39. Trimble B, Morgenstern LB. Stroke in minorities. *Neurol Clin*. 2008;26:1177–1190.
40. Kleindorfer D. Sociodemographic groups at risk: race/ethnicity. *Stroke*. 2009;40(suppl):S75–S78.
41. Stansbury JP, Jia H, Williams LS, Vogel WB, Duncan PW. Ethnic disparities in stroke: epidemiology, acute care, and postacute outcomes. *Stroke*. 2005;36:374–386.

42. Glymour MM, Avendaño M, Haas S, Berkman LF. Lifecourse social conditions and racial disparities in incidence of first stroke. *Ann Epidemiol*. 2008;18:904–912.
43. Corbie-Smith G, Henderson G, Blumenthal C, Dorrance J, Estroff S. Conceptualizing race in research. *J Natl Med Assoc*. 2008;100: 1235–1243.
44. US Department of Health and Human Services. *Healthy People 2010 Executive Summary: Midcourse Review*. Washington, DC: US Department of Health and Human Services; 2006. http://www.healthypeople.gov/2010/Document/html/uih/uih_2.htm#goals. Accessed May 16, 2011.
45. Wolf PA, Kannel WB. Preventing stroke: does race/ethnicity matter? *Circulation*. 2007;116:2099–2100.
46. Sacco RL, Boden-Albala B, Abel G, Lin IF, Elkind M, Hauser WA, Paik MC, Shea S. Race-ethnic disparities in the impact of stroke risk factors: the northern Manhattan stroke study. *Stroke*. 2001;32:1725–1731.
47. Centers for Disease Control and Prevention (CDC). Racial/ethnic and socioeconomic disparities in multiple risk factors for heart disease and stroke: United States, 2003. *MMWR Morb Mortal Wkly Rep.* 2005;54: 113–117.
48. Bravata DM, Wells CK, Gulanski B, Kernan WN, Brass LM, Long J, Concato J. Racial disparities in stroke risk factors: the impact of socioeconomic status. *Stroke*. 2005;36:1507–1511.
49. Giles WH, Kittner SJ, Hebel JR, Losonczy KG, Sherwin RW. Determinants of black-white differences in the risk of cerebral infarction: the National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Arch Intern Med*. 1995;155:1319–1324.
50. Rosamond WD, Folsom AR, Chambless LE, Wang CH, McGovern PG, Howard G, Copper LS, Shahar E. Stroke incidence and survival among middle-aged adults: 9-year follow-up of the Atherosclerosis Risk in Communities (ARIC) cohort. *Stroke*. 1999;30:736–743.
51. Thomas AJ, Eberly LE, Davey Smith G, Neaton JD, Stamler J. Race/ethnicity, income, major risk factors, and cardiovascular disease mortality. *Am J Public Health*. 2005;95:1417–1423.
52. Mitchell BD, Stern MP, Haffner SM, Hazuda HP, Patterson JK. Risk factors for cardiovascular mortality in Mexican Americans and non-Hispanic whites: San Antonio Heart Study. *Am J Epidemiol*. 1990;131: 423–433.
53. Boden-Albala B, Sacco RL, Lee HS, Grahame-Clarke C, Rundek T, Elkind MV, Wright C, Giardina EG, DiTullio MR, Homma S, Paik MC. Metabolic syndrome and ischemic stroke risk: Northern Manhattan Study. *Stroke*. 2008;39:30–35.
54. Cowie CC, Rust KF, Byrd-Holt DD, Gregg EW, Ford ES, Geiss LS, Bainbridge KE, Fradkin JE. Prevalence of diabetes and high risk for diabetes using A1C criteria in the U.S. population in 1988–2006. *Diabetes Care*. 2010;33:562–568.
55. Heuschmann PU, Grieve AP, Toschke AM, Rudd AG, Wolfe CD. Ethnic group disparities in 10-year trends in stroke incidence and vascular risk factors: the South London Stroke Register (SLSR). *Stroke*. 2008;39:2204–2210.
56. Hajat C, Dundas R, Stewart JA, Lawrence E, Rudd AG, Howard R, Wolfe CD. Cerebrovascular risk factors and stroke subtypes: differences between ethnic groups. *Stroke*. 2001;32:37–42.
57. Howard G, Prineas R, Moy C, Cushman M, Kellum M, Temple E, Graham A, Howard V. Racial and geographic differences in awareness, treatment, and control of hypertension: the REasons for Geographic And Racial Differences in Stroke study. *Stroke*. 2006;37:1171–1178.
58. Ayala C, Greenlund KJ, Croft JB, Keenan NL, Donehoo RS, Giles WH, Kittner SJ, Marks JS. Racial/ethnic disparities in mortality by stroke subtype in the United States, 1995–1998. *Am J Epidemiol*. 2001;154: 1057–1063.
59. Deleu D, Hamad AA, Kamram S, El Siddig A, Al Hail H, Hamdy SM. Ethnic variations in risk factor profile, pattern and recurrence of non-cardioembolic ischemic stroke. *Arch Med Res*. 2006;37:655–662.
60. Hayes DK, Denny CH, Keenan NL, Croft JB, Sundaram AA, Greenlund KJ. Racial/ethnic and socioeconomic differences in multiple risk factors for heart disease and stroke in women: behavioral risk factor surveillance system, 2003. *J Womens Health*. 2006;15:1000–1008.
61. Hozawa A, Folsom AR, Sharrett AR, Chambless LE. Absolute and attributable risks of cardiovascular disease incidence in relation to optimal and borderline risk factors: comparison of African American with white subjects: Atherosclerosis Risk in Communities Study. *Arch Intern Med*. 2007 26;167:573–579.
62. McGruder HF, Malarcher AM, Antoine TL, Greenlund KJ, Croft JB. Racial and ethnic disparities in cardiovascular risk factors among stroke survivors: United States 1999 to 2001. *Stroke*. 2004;35:1557–1561.
63. Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, Marks JS. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA*. 2003;289:76–79.
64. Winkleby MA, Kraemer HC, Ahn DK, Varady AN. Ethnic and socioeconomic differences in cardiovascular disease risk factors: findings for women from the Third National Health and Nutrition Examination Survey, 1988–1994. *JAMA*. 1998;280:356–362.
65. Centers for Disease Control and Prevention (CDC). Prevalence of stroke: United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56: 469–474.
66. Howard VJ, McClure LA, Meschia JF, Pulley L, Orr SC, Friday GH. High prevalence of stroke symptoms among people without a diagnosis of stroke or transient ischemic attack in a general population: the REasons for Geographic And Racial Differences in Stroke (REGARDS) study. *Arch Intern Med*. 2006;166:1952–1958.
67. Kleindorfer D, Broderick J, Khoury J, Flaherty M, Woo D, Alwell K, Moomaw CJ, Schneider A, Miller R, Shukla R, Kissela B. The unchanging incidence and case-fatality of stroke in the 1990s: a population-based study. *Stroke*. 2006;37:2473–2478.
68. Kleindorfer D, Panagos P, Pancioli A, Khoury J, Kissela B, Woo D, Schneider A, Alwell K, Jauch E, Miller R, Moomaw C, Shukla R, Broderick JP. Incidence and short-term prognosis of transient ischemic attack in a population-based study. *Stroke*. 2005;36:720–723.
69. Casper ML, Nwaise IA, Croft JB, Nilasena DS. *Atlas of Stroke Hospitalizations Among Medicare Beneficiaries.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2008.
70. Fullerton HJ, Wu YW, Zhao S, Johnston SC. Risk of stroke in children: ethnic and gender disparities. *Neurology*. 2003;61:189–194.
71. Sheinart KF, Tuhrim S, Horowitz DR, Weinberger J, Goldman M, Godbold JH. Stroke recurrence is more frequent in Blacks and Hispanics. *Neuroepidemiology*. 1998;17:188–198.
72. Kennedy BS. Does race predict stroke readmission? An analysis using the truncated negative binomial model. *J Natl Med Assoc*. 2005;97: 699–713.
73. Schwamm LH, Reeves MJ, Pan W, Smith EE, Frankel MR, Olson D, Zhao X, Peterson E, Fonarow GC. Race/ethnicity, quality of care, and outcomes in ischemic stroke. *Circulation*. 2010;121:1492–1501.
74. Centers for Disease Control and Prevention (CDC). Differences in disability among black and white stroke survivors: United States, 2000–2001. *MMWR Morb Mortal Wkly Rep.* 2005;54:3–6.
75. Morgenstern LB, Smith MA, Lisabeth LD, Risser JM, Uchino K, Garcia N, Longwell PJ, McFarling DA, Akuwumi O, Al-Wabil A, Al-Senani F, Brown DL, Moyé LA. Excess stroke in Mexican Americans compared with non-Hispanic Whites: the Brain Attack Surveillance in Corpus Christi Project. *Am J Epidemiol*. 2004;160:376–383.
76. Lisabeth LD, Smith MA, Brown DL, Moyé LA, Risser JM, Morgenstern LB. Ethnic differences in stroke recurrence. *Ann Neurol*. 2006;60: 469–475.
77. Tauqeer, Ali T, Jarvis B, O'Leary M. Strong Heart Study Data Book: A Report to American Indian Communities. Rockville, Md: National Institutes of Health, National Heart, Lung, and Blood Institute; 2001. NIH publication No. 01-3285.
78. Centers for Disease Control and Prevention (CDC). Age-specific excess deaths associated with stroke among racial/ethnic minority populations: United States, 1997. *MMWR Morb Mortal Wkly Rep.* 2000;49:94–97.
79. Harris C, Ayala C, Dai S, Croft J. Disparities in deaths from stroke among people aged <75 years: United States, 2002. *MMWR Morb Mortal Wkly Rep.* 2005;54:477–481.
80. Howard G, Howard VJ; REasons for Geographic And Racial Differences in Stroke (REGARDS) Investigators. Ethnic disparities in stroke: the scope of the problem. *Ethn Dis*. 2001;11:761–768.
81. Deleted in proof.
82. Lackland DT, Egan BM, Jones PJ. Impact of nativity and race on "Stroke Belt" mortality. *Hypertension*. 1999;34:57–62.
83. Richardson A, Liao Y, Tucker P. Regional and racial differences in prevalence of stroke: 23 states and District of Columbia, 2003. *MMWR Morb Mortal Wkly Rep*. 2005;54:481–484.
84. Sacco RL, Shi T, Zamanillo MC, Kargman DE. Predictors of mortality and recurrence after hospitalized cerebral infarction in an urban community: the Northern Manhattan Stroke Study. *Neurology*. 1994;44: 626–634.
85. Schneider AT, Kissela B, Woo D, Kleindorfer D, Alwell K, Miller R, Szaflarski J, Gebel J, Khoury J, Shukla R, Moomaw C, Pancioli A, Jauch E, Broderick J. Ischemic stroke subtypes: a population-based

study of incidence rates among blacks and whites. *Stroke*. 2004;35:1552–1556.
86. Mayer SA, Kossoff SB. Withdrawal of life support in the neurological intensive care unit. *Neurology*. 1999;52:1602–1609.
87. Lisabeth LD, Risser JM, Brown DL, Al-Senani F, Uchino K, Smith MA, Garcia N, Longwell PJ, McFarling DA, Al-Wabil A, Akuwumi O, Moyé LA, Morgenstern LB. Stroke burden in Mexican Americans: the impact of mortality following stroke. *Ann Epidemiol*. 2006;16:33–40.
88. Smith MA, Risser JMH, Lisabeth LD, Moyé LA, Morgenstern LB. Access to care, acculturation, and risk factors for stroke in Mexican Americans: the Brain Attack Surveillance in Corpus Christi (BASIC) project. *Stroke*. 2003;34:2671–2675.
89. Day G, Provost EM, Lanier AP. Alaska Native Mortality Update: 1999–2003. Anchorage, AK: Alaska Native Epidemiology Center; 2006.
90. Horner RD, Day GM, Lanier AP, Provost EM, Hamel RD, Trimble BA. Stroke mortality among Alaska Native people [published correction appears in *Am J Public Health*. 2010;100:199]. *Am J Public Health.* 2009;99:1996–2000.
91. Casper ML, Denny CH, Coolidge JN, Williams GI Jr, Crowell A, Galloway JM, Cobb N. *Atlas of Heart Disease and Stroke Among American Indians and Alaska Natives.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, and Indian Health Service; 2005.
92. Nicol MB, Thrift AG. Knowledge of risk factors and warning signs of stroke. *Vasc Health Risk Manag*. 2005;1:137–147.
93. Centers for Disease Control and Prevention. Awareness of stroke warning symptoms: 13 states and the District of Columbia, 2005. *MMWR Morb Mortal Wkly Rep.* 2008;57:481–485.
94. Greenlund KJ, Neff LJ, Zheng ZJ, Keenan NL, Giles WH, Ayala CA, Croft JB, Mensah GA. Low public recognition of major stroke symptoms. *Am J Prev Med*. 2003;25:315–319.
95. Willey JZ, Williams O, Boden-Albala B. Stroke literacy in Central Harlem: a high-risk stroke population. *Neurology*. 2009;73:1950–1956.
96. Schneider AT, Pancioli AM, Khoury JC, Rademacher E, Tuchfarber A, Miller R, Woo D, Kissela B, Broderick JP. Trends in community knowledge of the warning signs and risk factors for stroke. *JAMA*. 2003;289:343–346.
97. Lutfiyya MN, Lipsky MS, Bales RW, Cha I, McGrath C. Disparities in knowledge of heart attack and stroke symptoms among adult men: an analysis of Behavioral Risk Factor Surveillance Survey data. *J Natl Med Assoc*. 2008;100:1116–1124.
98. Lutfiyya MN, Ng L, Asner N, Lipsky MS. Disparities in stroke symptomology knowledge among US midlife women: an analysis of population survey data. *J Stroke Cerebrovasc Dis*. 2009;18:150–157.
99. Lutfiyya MN, Cumba MT, McCullough JE, Barlow EL, Lipsky MS. Disparities in adult African American women's knowledge of heart attack and stroke symptomatology: an analysis of 2003–2005 Behavioral Risk Factor Surveillance Survey data. *J Womens Health (Larchmt)*. 2008;17:805–813.
100. DuBard CA, Garrett J, Gizlice Z. Effect of language on heart attack and stroke awareness among U.S. Hispanics. *Am J Prev Med*. 2006;30:189–196.
101. Ellis C, Egede LE. Ethnic disparities in stroke recognition in individuals with prior stroke. *Public Health Rep*. 2008;123:514–522.
102. Reeves MJ, Hogan JG, Rafferty AP. Knowledge of stroke risk factors and warning signs among Michigan adults. *Neurology*. 2002;59:1547–1552.
103. Lynch EB, Liu K, Kiefe CI, Greenland P. Cardiovascular disease risk factor knowledge in young adults and 10-year change in risk factors: the Coronary Artery Risk Development in Young Adults (CARDIA) Study. *Am J Epidemiol*. 2006;164:1171–1179.
104. Centers for Disease Control and Prevention (CDC). Racial/ethnic disparities in prevalence, treatment, and control of hypertension: United States, 1999–2002. *MMWR Morb Mortal Wkly Rep.* 2005;54:7–9.
105. Cassetta JA, Boden-Albala B, Sciacca RR, Giardina EG. Association of education and race/ethnicity with physical activity in insured urban women. *J Womens Health (Larchmt)*. 2007;16:902–908.
106. Giardina EG, Laudano M, Hurstak E, Saroff A, Fleck E, Sciacca R, Boden-Albala B, Cassetta J. Physical activity participation among Caribbean Hispanic women living in New York: relation to education, income, and age. *J Womens Health (Larchmt).* 2009;18:187–193.
107. Rowe AK, Frankel MR, Sanders KA. Stroke awareness among Georgia adults: epidemiology and considerations regarding measurement. *South Med J*. 2001;94:613–618.
108. Kothari R, Sauerbeck L, Jauch E, Broderick J, Brott T, Khoury J, Liu T. Patients' awareness of stroke signs, symptoms, and risk factors. *Stroke*. 1997;28:1871–1875.
109. Pancioli AM, Broderick J, Kothari R, Brott T, Tuchfarber A, Miller R, Khoury J, Jauch E. Public perception of stroke warning signs and knowledge of potential risk factors. *JAMA*. 1998;279:1288–1292.
110. Miller ET, King KA, Miller R, Kleindorfer D. FAST Stroke Prevention Educational Program for Middle School Students: pilot study results. *J Neurosci Nurs*. 2007;39:236–242.
111. Morgenstern LB, Gonzales NR, Maddox KE, Brown DL, Karim AP, Espinosa N, Moyé LA, Pary JK, Grotta JC, Lisabeth LD, Conley KM. A randomized, controlled trial to teach middle school children to recognize stroke and call 911: the Kids Identifying and Defeating Stroke project. *Stroke*. 2007;38:2972–2978.
112. Williams O, Noble JM. "Hip-hop" stroke: a stroke educational program for elementary school children living in a high-risk community. *Stroke*. 2008;39:2809–2816.
113. Kleindorfer D, Miller R, Sailor-Smith S, Moomaw CJ, Khoury J, Frankel M. The challenges of community-based research: the beauty shop stroke education project. *Stroke*. 2008;39:2331–2335.
114. Bosworth HB, Dudley T, Olsen MK, Voils CI, Powers B, Goldstein MK, Oddone EZ. Racial differences in blood pressure control: potential explanatory factors. *Am J Med.* 2006;119:70.e79–15.
115. Shaya FT, Du D, Gbarayor CM, Frech-Tamas F, Lau H, Weir MR. Predictors of compliance with antihypertensive therapy in a high-risk Medicaid population. *J Natl Med Assoc*. 2009;101:34–39.
116. Levine DA, Allison JJ, Cherrington A, Richman J, Scarinci IC, Houston TK. Disparities in self-monitoring of blood glucose among low-income ethnic minority populations with diabetes, United States. *Ethn Dis*. 2009;19:97–103.
117. Trinacty CM, Adams AS, Soumerai SB, Zhang F, Meigs JB, Piette JD, Ross-Degnan D. Racial differences in long-term adherence to oral antidiabetic drug therapy: a longitudinal cohort study. *BMC Health Serv Res*. 2009;9:24.
118. Kopunek SP, Michael KM, Shaughnessy M, Resnick B, Nahm ES, Whitall J, Goldberg A, Macko RF. Cardiovascular risk in survivors of stroke. *Am J Prev Med*. 2007;32:408–412.
119. Roelands J, Jamison MG, Lyerly AD, James AH. Consequences of smoking during pregnancy on maternal health. *J Womens Health (Larchmt)*. 2009;18:867–872.
120. Rundek T, Arif H, Boden-Albala B, Elkind MS, Paik MC, Sacco RL. Carotid plaque, a subclinical precursor of vascular events: the Northern Manhattan Study. *Neurology*. 2008;70:1200–1207.
121. Yood MU, McCarthy BD, Kempf J, Kucera GP, Wells K, Oliveria S, Stang P. Racial differences in reaching target low-density lipoprotein goal among individuals treated with prescription statin therapy. *Am Heart J*. 2006;152:777–784.
122. Hertz RP, Unger AN, Cornell JA, Saunders E. Racial disparities in hypertension prevalence, awareness, and management. *Arch Intern Med*. 2005;165:2098–2104.
123. Hall WD, Ferrario CM, Moore MA, Hall JE, Flack JM, Cooper W, Simmons JD, Egan BM, Lackland DT, Perry M Jr, Roccella EJ. Hypertension-related morbidity and mortality in the southeastern United States. *Am J Med Sci*. 1997;313:195–209.
124. Jones D, Basile J, Cushman W, Egan B, Ferrario C, Hill M, Lackland D, Mensah G, Moore M, Ofili E, Roccella EJ, Smith R, Taylor H. Managing hypertension in the southeastern United States: applying the guidelines from the Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI). *Am J Med Sci*. 1999;318:357–364.
125. Hajjar I, Kotchen TA. Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988–2000. *JAMA*. 2003;290:199–206.
126. Safford MM, Halanych JH, Lewis CE, Levine D, Houser S, Howard G. Understanding racial disparities in hypertension control: intensity of hypertension medication treatment in the REGARDS study. *Ethn Dis*. 2007;17:421–426.
127. Mark TL, Axelsen KJ, Mucha L, Sadkova Y. Racial differences in switching, augmentation, and titration of lipid-lowering agents by Medicare/Medicaid dual-eligible patients. *Am J Manag Care*. 2007;13(suppl 3):S72–S79.
128. Ad Hoc Committee on Health Literacy for the Council on Scientific Affairs, American Medical Association. Health literacy: report of the Council on Scientific Affairs. *JAMA*. 1999;281:552–557.

129. Gazmararian JA, Kripalani S, Miller MJ, Echt KV, Ren J, Rask K. Factors associated with medication refill adherence in cardiovascular-related diseases: a focus on health literacy. *J Gen Intern Med*. 2006;21:1215–1221.
130. Estrada CA, Martin-Hryniewicz M, Peek BT, Collins C, Byrd JC. Literacy and numeracy skills and anticoagulation control. *Am J Med Sci*. 2004;328:88–93.
131. Fang MC, Machtinger EL, Wang F, Schillinger D. Health literacy and anticoagulation-related outcomes among patients taking warfarin. *J Gen Intern Med*. 2006;21:841–846.
132. Savoca MR, Quandt SA, Evans CD, Flint TL, Bradfield AG, Morton TB, Harshfield GA, Ludwig DA. Views of hypertension among young African Americans who vary in their risk of developing hypertension. *Ethn Dis*. 2009;19:28–34.
133. Peters RM, Aroian KJ, Flack JM. African American culture and hypertension prevention. *West J Nurs Res*. 2006;28:831–854.
134. Wilson RP, Freeman A, Kazda MJ, Andrews TC, Berry L, Vaeth PA, Victor RG. Lay beliefs about high blood pressure in a low- to middle-income urban African-American community: an opportunity for improving hypertension control. *Am J Med*. 2002;112:26–30.
135. Ogedegbe G, Harrison M, Robbins L, Mancuso CA, Allegrante JP. Barriers and facilitators of medication adherence in hypertensive African Americans: a qualitative study. *Ethn Dis*. 2004;14:3–12.
136. Schlomann P, Schmitke J. Lay beliefs about hypertension: an interpretive synthesis of the qualitative research. *J Am Acad Nurse Pract*. 2007;19:358–367.
137. Lukoschek P. African Americans' beliefs and attitudes regarding hypertension and its treatment: a qualitative study. *J Health Care Poor Underserved*. 2003;14:566–587.
138. Boutin-Foster C, Ogedegbe G, Ravenell JE, Robbins L, Charlson ME. Ascribing meaning to hypertension: a qualitative study among African Americans with uncontrolled hypertension. *Ethn Dis*. 2007;17:29–34.
139. Gellad WF, Haas JS, Safran DG. Race/ethnicity and nonadherence to prescription medications among seniors: results of a national study. *J Gen Intern Med*. 2007;22:1572–1578.
140. Shacter HE, Shea JA, Akhabue E, Sablani N, Long JA. A qualitative evaluation of racial disparities in glucose control. *Ethn Dis*. 2009;19:121–127.
141. Van Houtven CH, Voils CI, Oddone EZ, Weinfurt KP, Friedman JY, Schulman KA, Bosworth HB. Perceived discrimination and reported delay of pharmacy prescriptions and medical tests. *J Gen Intern Med*. 2005;20:578–583.
142. Casagrande SS, Gary TL, LaVeist TA, Gaskin DJ, Cooper LA. Perceived discrimination and adherence to medical care in a racially integrated community. *J Gen Intern Med*. 2007;22:389–395.
143. Penchansky R, Thomas JW. The concept of access: definition and relationship to consumer satisfaction. *Med Care*. 1981;19:127–140.
144. Blanchard JC, Haywood YC, Scott C. Racial and ethnic disparities in health: an emergency medicine perspective. *Acad Emerg Med*. 2003;10:1289–1293.
145. Nandi A, Galea S, Lopez G, Nandi V, Strongarone S, Ompad DC. Access to and use of health services among undocumented Mexican immigrants in a US urban area. *Am J Public Health*. 2008;98:2011–2020.
146. Barber PA, Zhang J, Demchuk AM, Hill MD, Buchan AM. Why are stroke patients excluded from TPA therapy? An analysis of patient eligibility. *Neurology*. 2001;56:1015–1020.
147. Lacy CR, Suh DC, Bueno M, Kostis JB. Delay in presentation and evaluation for acute stroke: Stroke Time Registry for Outcomes Knowledge and Epidemiology (S.T.R.O.K.E.). *Stroke*. 2001;32:63–69.
148. Karve SJ, Balkrishnan R, Mohammad YM, Levine DA. Racial/ethnic disparities in emergency department waiting time for stroke patients in the United States. *J Stroke Cerebrovasc Dis*. 2011;20:30–40.
149. Horner RD, Swanson JW, Bosworth HB, Matchar DB; VA Acute Stroke (VAST) Study Team. Effects of race and poverty on the process and outcome of inpatient rehabilitation services among stroke patients. *Stroke*. 2003;34:1027–1031.
150. Gregory PC, Han E, Morozova O, Kuhlemeier KV. Do racial disparities exist in access to inpatient stroke rehabilitation in the state of Maryland? *Am J Phys Med Rehabil*. 2006;85:814–819.
151. Bhandari VK, Kushel M, Price L, Schillinger D. Racial disparities in outcomes of inpatient stroke rehabilitation. *Arch Phys Med Rehabil*. 2005;86:2081–2086.
152. Chiou-Tan FY, Keng MJ Jr, Graves DE, Chan KT, Rintala DH. Racial/ethnic differences in FIM scores and length of stay for underinsured patients undergoing stroke inpatient rehabilitation. *Am J Phys Med Rehabil*. 2006;85:415–423.
153. Ottenbacher KJ, Campbell J, Kuo YF, Deutsch A, Ostir GV, Granger CV. Racial and ethnic differences in postacute rehabilitation outcomes after stroke in the United States. *Stroke*. 2008;39:1514–1519.
154. Stineman MG, Ross RN, Hamilton BB, Maislin G, Bates B, Granger CV, Asch DA. Inpatient rehabilitation after stroke: a comparison of lengths of stay and outcomes in the Veterans Affairs and non-Veterans Affairs health care system. *Med Care*. 2001;39:123–137.
155. Horner RD, Hoenig H, Sloane R, Rubenstein LV, Kahn KL. Racial differences in the utilization of inpatient rehabilitation services among elderly stroke patients. *Stroke*. 1997;28:19–25.
156. Centers for Disease Control and Prevention (CDC). Outpatient rehabilitation among stroke survivors: 21 states and the District of Columbia, 2005. *MMWR Morb Mortal Wkly Rep*. 2007;56:504–507.
157. Mayer-Oakes SA, Hoenig H, Atchison KA, Lubben JE, De Jong F, Schweitzer SO. Patient-related predictors of rehabilitation use for community-dwelling older Americans. *J Am Geriatr Soc*. 1992;40:336–342.
158. Cook C, Stickley L, Ramey K, Knotts VJ. A variables associated with occupational and physical therapy stroke rehabilitation utilization and outcomes. *J Allied Health*. 2005;34:3–10.
159. Levine DA, Kiefe CI, Howard G, Howard VJ, Williams OD, Allison JJ. Reduced medication access: a marker for vulnerability in US stroke survivors. *Stroke*. 2007;38:1557–1564.
160. Tuhrim S, Cooperman A, Rojas M, Brust JC, Koppel B, Martin K, Chassin M. The association of race and sex with the underuse of stroke prevention measures. *J Stroke Cerebrovasc Dis*. 2008;17:226–234.
161. Ross JS, Halm EA, Bravata DM. Use of stroke secondary prevention services: are there disparities in care? *Stroke*. 2009;40:1811–1819.
162. Zahuranec DB, Morgenstern LB, Garcia NM, Conley KM, Lisabeth LD, Rank GS, Smith MA, Meurer WJ, Resnicow K, Brown DL. Stroke Health And Risk Education (SHARE) pilot project: feasibility and need for church-based stroke health promotion in a bi-ethnic community. *Stroke*. 2008;39:1583–1585.
163. Nietert PJ, Ornstein SM, Jenkins RG, Roylance LF, Dickerson LM, Feifer C. The effect of ethnicity on outcomes in a practice-based trial to improve cardiovascular disease prevention. *Int J Equity Health*. 2004;3:12.
164. Wilkinson RG. Mortality and distribution of income: low relative income affects mortality. *BMJ*. 1998;316:1611–1612.
165. Kapral MK, Wang H, Mamdani M, Tu JV. Effect of socioeconomic status on treatment and mortality after stroke. *Stroke*. 2002;33:268–273.
166. Howard G, Anderson RT, Russell G, Howard VJ, Burke GL. Race, socioeconomic status, and cause-specific mortality. *Ann Epidemiol*. 2000;10:214–223.
167. Kleindorfer DO, Lindsell C, Broderick JP, Flaherty ML, Woo D, Alwell K, Moomaw CJ, Schneider A, Kissela BM. Impact of socioeconomic status on stroke incidence: a population-based study. *Ann Neurol*. 2006;60:480–484.
168. Shen JJ, Washington EL. Disparities in outcomes among patients with stroke associated with insurance status. *Stroke*. 2007;38:1010–1016.
169. Fowler-Brown A, Corbie-Smith G, Garrett J, Lurie N. Risk of cardiovascular events and death: does insurance matter? *J Gen Intern Med*. 2007;22:502–507.
170. Dhamoon M, Moon YP, Paik MC, Boden-Albala B, Rundek T, Sacco RL, Elkind MS. Quality of life declines after first ischemic stroke independently of recurrent vascular events: The Northern Manhattan Study. *Neurology*. 2010;75:328–334.
171. Dhamoon MS, Moon YP, Paik MC, Boden-Albala B, Rundek T, Sacco RL, Elkind MS. Long-term functional recovery after first ischemic stroke: the Northern Manhattan Study. *Stroke*. 2009;40:2805–2811.
172. Hinojosa MS, Rittman M, Hinojosa R. Informal caregivers and racial/ethnic variation in health service use of stroke survivors. *J Rehabil Res Dev*. 2009;46:233–241.
173. Chen FM, Fryer GE Jr, Phillips RL Jr, Wilson E, Pathman DE. Patients' beliefs about racism, preferences for physician race, and satisfaction with care. *Ann Fam Med*. 2005;3:138–143.
174. Doescher MP, Saver BG, Franks P, Fiscella K. Racial and ethnic disparities in perceptions of physician style and trust. *Arch Fam Med*. 2000;9:1156–1163.
175. Cooper LA, Roter DL, Johnson RL, Ford DE, Steinwachs DM, Powe NR. Patient-centered communication, ratings of care, and concordance of patient and physician race. *Ann Intern Med*. 2003;139:907–915.

176. Bach PB, Pham HH, Schrag D, Tate RC, Hargraves JL. Primary care physicians who treat blacks and whites. *N Engl J Med*. 2004;351:575–584.
177. Gemson DH, Elinson J, Messeri P. Differences in physician prevention practice patterns for white and minority patients. *J Community Health*. 1988;13:53–64.
178. Schneider EC, Zaslavsky AM, Epstein AM. Racial disparities in the quality of care for enrollees in Medicare managed care. *JAMA*. 2002;287:1288–1294.
179. Mukamel DB, Murthy AS, Weimer DL. Racial differences in access to high-quality cardiac surgeons. *Am J Public Health*. 2000;90:1774–1777.
180. Kleindorfer DO, Lindsell CJ, Broderick JP, Flaherty ML, Woo D, Ewing I, Schmit P, Moomaw C, Alwell K, Pancioli A, Jauch E, Khoury J, Miller R, Schneider A, Kissela BM. Community socioeconomic status and prehospital times in acute stroke and transient ischemic attack: do poorer patients have longer delays from 911 call to the emergency department? *Stroke*. 2006;37:1508–1513.
181. Jacobs BS, Birbeck G, Mullard AJ, Hickenbottom S, Kothari R, Roberts S, Reeves MJ. Quality of hospital care in African American and white patients with ischemic stroke and TIA. *Neurology*. 2006;66:809–814.
182. Morris DL, Rosamond W, Madden K, Schultz C, Hamilton S. Prehospital and emergency department delays after acute stroke: the Genentech Stroke Presentation Survey. *Stroke*. 2000;31:2585–2590.
183. Johnston SC, Fung LH, Gillum LA, Smith WS, Brass LM, Lichtman JH, Brown AN. Utilization of intravenous tissue-type plasminogen activator for ischemic stroke at academic medical centers: the influence of ethnicity. *Stroke*. 2001;32:1061–1068.
184. Mitchell JB, Ballard DJ, Matchar DB, Whisnant JP, Samsa GP. Racial variation in treatment for transient ischemic attacks: impact of participation by neurologists. *Health Serv Res*. 2000;34:1413–1428.
185. Goldstein LB, Matchar DB, Hoff-Lindquist J, Samsa GP, Horner RD. Veterans Administration Acute Stroke (VASt) Study: lack of race/ethnic-based differences in utilization of stroke-related procedures or services. *Stroke*. 2003;34:999–1004.
186. Morgenstern LB, Steffen-Batey L, Smith MA, Moyé LA. Barriers to acute stroke therapy and stroke prevention in Mexican Americans. *Stroke*. 2001;32:1360–1364.
187. Oddone EZ, Horner RD, Monger ME, Matchar DB. Racial variations in the rates of carotid angiography and endarterectomy in patients with stroke and transient ischemic attack. *Arch Intern Med*. 1993;153:2781–2786.
188. Rose KM, Rosamond WD, Huston SL, Murphy CV, Tegeler CH. Predictors of time from hospital arrival to initial brain-imaging among suspected stroke patients: the North Carolina Collaborative Stroke Registry. *Stroke*. 2008;39:3262–3267.
189. Brown DL, Lisabeth LD, Garcia NM, Smith MA, Morgenstern LB. Emergency department evaluation of ischemic stroke and TIA: the BASIC Project. *Neurology*. 2004;63:2250–2254.
190. Kothari RU, Brott T, Broderick JP, Hamilton CA. Emergency physicians: accuracy in the diagnosis of stroke. *Stroke*. 1995;26:2238–2241.
190a. Jauch EC, Cucchiara B, Adeoye O, Meurer W, Brice J, Chan Y-F, Gentile N, Hazinski MF. Part 11: adult stroke: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010;122(suppl 3):S818–S828.
191. Schumacher HC, Bateman BT, Boden-Albala B, Berman MF, Mohr JP, Sacco RL, Pile-Spellman J. Use of thrombolysis in acute ischemic stroke: analysis of the Nationwide Inpatient Sample 1999 to 2004. *Ann Emerg Med*. 2007;50:99–107.
192. Ong KL, Cheung BM, Man YB, Lau CP, Lam KS. Prevalence, awareness, treatment, and control of hypertension among United States adults 1999–2004. *Hypertension*. 2007;49:69–75.
193. Fiscella K, Holt K. Racial disparity in hypertension control: tallying the death toll. *Ann Fam Med*. 2008;6:497–502.
194. Glasser SP, Cushman M, Prineas R, Kleindorfer D, Prince V, You Z, Howard VJ, Howard G. Does differential prophylactic aspirin use contribute to racial and geographic disparities in stroke and coronary heart disease (CHD)? *Prev Med*. 2008;47:161–166.
195. McWilliams JM, Meara E, Zaslavsky AM, Ayanian JZ. Differences in control of cardiovascular disease and diabetes by race, ethnicity, and education: U.S. trends from 1999 to 2006 and effects of Medicare coverage. *Ann Intern Med*. 2009;150:505–515.
196. Christian JB, Lapane KL, Toppa RS. Racial disparities in receipt of secondary stroke prevention agents among US nursing home residents. *Stroke*. 2003;34:2693–2697.
197. Ambriz EH, Woodard LD, Kressin NR, Petersen LA. Use of smoking cessation interventions and aspirin for secondary prevention: are there racial disparities? *Am J Med Qual*. 2004;19:166–171.
198. Holmes JS, Arispe IE, Moy E. Heart disease and prevention: race and age differences in heart disease prevention, treatment, and mortality. *Med Care*. 2005;43(suppl):I33–I41.
199. Levine DA, Neidecker MV, Kiefe CI, Karve S, Williams LS, Allison JJ. Racial/ethnic disparities in access to physician care and medications among US stroke survivors. *Neurology*. 2011;76:53–61.
200. Brownstein JN, Bone LR, Dennison CR, Hill MN, Kim MT, Levine DM. Community health workers as interventionists in the prevention and control of heart disease and stroke. *Am J Prev Med*. 2005;29(suppl 1):128–133.
201. Kuhajda MC, Cornell CE, Brownstein JN, Littleton MA, Stalker VG, Bittner VA, Lewis CE, Raczynski JM. Training community health workers to reduce health disparities in Alabama's Black Belt: the Pine Apple Heart Disease and Stroke Project. *Fam Community Health*. 2006;29:89–102.
202. North American Symptomatic Carotid Endarterectomy Trial Collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. *N Engl J Med.* 1991;325:445–453.
203. Biller J, Feinberg WM, Castaldo JE, Whittemore AD, Harbaugh RE, Dempsey RJ, Caplan LR, Kresowik TF, Matchar DB, Toole JF, Easton JD, Adams HP Jr, Brass LM, Hobson RW 2nd, Brott TG, Sternau L. Guidelines for carotid endarterectomy: a statement for healthcare professionals from a Special Writing Group of the Stroke Council, American Heart Association. *Circulation*. 1998;97:501–509.
204. Gillum RF. Carotid endarterectomy in older women and men in the United States: trends in ethnic disparities. *J Natl Med Assoc*. 2005;97:957–962.
205. Hsia DC, Krushat WM, Moscoe LM. Epidemiology of carotid endarterectomies among Medicare beneficiaries. *J Vasc Surg*. 1992;16:201–208.
206. Kennedy BS, Fortmann SP, Stafford RS. Elective and isolated carotid endarterectomy: health disparities in utilization and outcomes, but not readmission. *J Natl Med Assoc*. 2007;99:480–488.
207. Kresowik TF, Bratzler D, Karp HR, Hemann RA, Hendel ME, Grund SL, Brenton M, Ellerbeck EF, Nilasena DS. Multistate utilization, processes, and outcomes of carotid endarterectomy. *J Vasc Surg*. 2001;33:227–234.
208. Maxwell JG, Rutherford EJ, Covington D, Clancy TV, Tackett AD, Robinson N, Johnson G Jr. Infrequency of blacks among patients having carotid endarterectomy. *Stroke*. 1989;20:22–26.
209. Oddone EZ, Horner RD, Johnston DC, Stechuchak K, McIntyre L, Ward A, Alley LG, Whittle J, Kroupa L, Taylor J. Carotid endarterectomy and race: do clinical indications and patient preferences account for differences? *Stroke*. 2002;33:2936–2943.
210. Saleh SS, Hannan EL. Carotid endarterectomy utilization and mortality in 10 states. *Am J Surg*. 2004;187:14–19.
211. Escarce JJ, Epstein KR, Colby DC, Schwartz JS. Racial differences in the elderly's use of medical procedures and diagnostic tests. *Am J Public Health*. 1993;83:948–954.
212. Oddone EZ, Horner RD, Sloane R, McIntyre L, Ward A, Whittle J, Passman LJ, Kroupa L, Heaney R, Diem S, Matchar D. Race, presenting signs and symptoms, use of carotid artery imaging, and appropriateness of carotid endarterectomy. *Stroke*. 1999;30:1350–1356.
213. Ryu JE, Murros K, Espeland MA, Rubens J, McKinney WM, Toole JF, Crouse JR. Extracranial carotid atherosclerosis in black and white patients with transient ischemic attacks. *Stroke*. 1989;20:1133–1137.
214. Wityk RJ, Lehman D, Klag M, Coresh J, Ahn H, Litt B. Race and sex differences in the distribution of cerebral atherosclerosis. *Stroke*. 1996;27:1974–1980.
215. Conrad MF, Shepard AD, Pandurangi K, Parikshak M, Nypaver TJ, Reddy DJ, Cho JS. Outcome of carotid endarterectomy in African Americans: is race a factor? *J Vasc Surg*. 2003;38:129–137.
216. Dardik A, Bowman HM, Gordon TA, Hsieh G, Perler BA. Impact of race on the outcome of carotid endarterectomy: a population-based analysis of 9,842 recent elective procedures. *Ann Surg*. 2000;232:704–709.
217. Horner RD, Oddone EZ, Stechuchak KM, Grambow SC, Gray J, Khuri SF, Henderson WG, Daley J. Racial variations in postoperative outcomes of carotid endarterectomy: evidence from the Veterans Affairs National Surgical Quality Improvement Program. *Med Care*. 2002;40(suppl):I35–I43.

218. Kennedy BS. Does race predict short-term mortality after carotid surgery? The results of a meta-analysis. *J Natl Med Assoc*. 2002;94: 25–30.
219. Rigdon EE. Racial and gender differences in outcome after carotid endarterectomy. *Am Surg*. 1998;64:527–530.
220. Oddone EZ, Horner RD, Diers T, Lipscomb J, McIntyre L, Cauffman C, Whittle J, Passman LJ, Kroupa L, Heaney R, Matchar D. Understanding racial variation in the use of carotid endarterectomy: the role of aversion to surgery. *J Natl Med Assoc*. 1998;90:25–33.
221. Horner RD, Oddone EZ, Matchar DB. Theories explaining racial differences in the utilization of diagnostic and therapeutic procedures for cerebrovascular disease. *Milbank Q*. 1995;73:443–462.
222. Cahill J, Zhang JH. Subarachnoid hemorrhage: is it time for a new direction? *Stroke*. 2009;20(suppl):S86–S87.
223. Hanley DF. Intraventricular hemorrhage: severity factor and treatment target in spontaneous intracerebral hemorrhage. *Stroke*. 2009;40: 1533–1538.
224. Broderick J, Brott T, Tomsick T, Huster G, Miller R. The risk of subarachnoid and intracerebral hemorrhages in blacks as compared with whites. *N Engl J Med*. 1992;326:733–736.
225. Eden SV, Meurer WJ, Sánchez BN, Lisabeth LD, Smith MA, Brown DL, Morgenstern LB. Gender and ethnic differences in subarachnoid hemorrhage. *Neurology*. 2008;71:731–735.
226. Zahuranec DB, Brown DL, Lisabeth LD, Gonzales NR, Longwell PJ, Eden SV, Smith MA, Garcia NM, Morgenstern LB. Differences in intracerebral hemorrhage between Mexican Americans and non-Hispanic whites. *Neurology*. 2006;66:30–34.
227. Labovitz DL, Halim AX, Brent B, Boden-Albala B, Hauser WA, Sacco RL. Subarachnoid hemorrhage incidence among Whites, Blacks and Caribbean Hispanics: the Northern Manhattan Study. *Neuroepidemiology*. 2006;26:147–150.
228. Eden SV, Heisler M, Green C, Morgenstern LB. Racial and ethnic disparities in the treatment of cerebrovascular diseases: importance to the practicing neurosurgeon. *Neurocrit Care*. 2008;9:55–73.
229. Eden SV, Morgenstern LB, Sekar P, Moomaw CJ, Haverbusch M, Flaherty ML, Broderick JP, Woo D. The role of race in time to treatment after subarachnoid hemorrhage. *Neurosurgery*. 2007;60:837–843.
230. Braunstein JB, Sherber NS, Schulman SP, Ding EL, Powe NR. Race, medical researcher distrust, perceived harm, and willingness to participate in cardiovascular prevention trials. *Medicine (Baltimore)*. 2008; 87:1–9.
231. Gifford AL, Cunningham WE, Heslin KC, Andersen RM, Nakazono T, Lieu DK, Shapiro MF, Bozzette SA; HIV Cost and Services Utilization Study Consortium. Participation in research and access to experimental treatments by HIV-infected patients. *N Engl J Med*. 2002;346: 1373–1382.
232. Hussain-Gambles M, Atkin K, Leese B. Why ethnic minority groups are under-represented in clinical trials: a review of the literature. *Health Soc Care Community*. 2004;12:382–388.
233. Kressin NR, Meterko M, Wilson NJ. Racial disparities in participation in biomedical research. *J Natl Med Assoc*. 2000;92:62–69.
234. Park IU, Taylor AL. Race and ethnicity in trials of antihypertensive therapy to prevent cardiovascular outcomes: a systematic review. *Ann Fam Med*. 2007;5:444–452.
235. Kasner SE, Del Giudice A, Rosenberg S, Sheen M, Luciano JM, Cucchiara BL, Messé SR, Sansing LH, Baren JM. Who will participate in acute stroke trials? *Neurology*. 2009;72:1682–1688.
236. Rajakumar K, Thomas SB, Musa D, Almario D, Garza MA. Racial differences in parents' distrust of medicine and research. *Arch Pediatr Adolesc Med*. 2009;163:108–114.
237. Armstrong K, Ravenell KL, McMurphy S, Putt M. Racial/ethnic differences in physician distrust in the United States. *Am J Public Health*. 2007;97:1283–1289.
238. Wendler D, Kington R, Madans J, Van Wye G, Christ-Schmidt H, Pratt LA, Brawley OW, Gross CP, Emanuel E. Are racial and ethnic minorities less willing to participate in health research? *PLoS Med*. 2006;3:e19.
239. Garber M, Arnold RM. Promoting the participation of minorities in research. *Am J Bioeth*. 2006;6:W14–W20.
240. Gorelick PB, Harris Y, Burnett B, Bonecutter FJ. The recruitment triangle: reasons why African Americans enroll, refuse to enroll, or voluntarily withdraw from a clinical trial: an interim report from the African-American Antiplatelet Stroke Prevention Study (AAASPS). *J Natl Med Assoc*. 1998;90:141–145.
241. Bonner GJ, Miles TP. Participation of African Americans in clinical research. *Neuroepidemiology*. 1997;16:281–284.
242. Lynch GF, Gorelick PB, Raman R, Leurgans S. A pilot survey of African-American physician perceptions about clinical trials. *J Natl Med Assoc.* 2001;93(suppl):8S–13S.
243. Ramirez AG, Wildes K, Talavera G, Nápoles-Springer A, Gallion K, Pérez-Stable EJ. Clinical trials attitudes and practices of Latino physicians. *Contemp Clin Trials*. 2008;29:482–492.
244. Durant RW, Davis RB, St George DM, Williams IC, Blumenthal C, Corbie-Smith GM. Participation in research studies: factors associated with failing to meet minority recruitment goals. *Ann Epidemiol*. 2007; 17:634–642.
245. Pinto HA, McCaskill-Stevens W, Wolfe P, Marcus AC. Physician perspectives on increasing minorities in cancer clinical trials: an Eastern Cooperative Oncology Group (ECOG) Initiative. *Ann Epidemiol*. 2000; 10(suppl):S78–S84.
246. Smith MA, Risser JM, Moyé LA, Garcia N, Akiwumi O, Uchino K, Morgenstern LB. Designing multi-ethnic stroke studies: the Brain Attack Surveillance in Corpus Christi (BASIC) project. *Ethn Dis*. 2004; 14:520–526.
247. Johnson RE, Williams RD, Nagy MC, Fouad MN. Retention of underserved women in clinical trials: a focus group study. *Ethn Dis*. 2003; 13:268–278.
248. Gorelick PB, Richardson D, Hudson E, Perry C, Robinson D, Brown N, Harris Y. Establishing a community network for recruitment of African Americans into a clinical trial. The African-American Antiplatelet Stroke Prevention Study (AAASPS) experience. *J Natl Med Assoc*. 1996;88:701–704.
249. Gorelick PB, Richardson D, Kelly M, Ruland S, Hung E, Harris Y, Kittner S, Leurgans S; African-American Antiplatelet Stroke Prevention Study Investigators. Aspirin and ticlopidine for prevention of recurrent stroke in black patients: a randomized trial. *JAMA*. 2003;289: 2947–2957.
250. Harris Y, Gorelick PB, Samuels P, Bempong I. Why African Americans may not be participating in clinical trials. *J Natl Med Assoc*. 1996;88: 630–634.
251. King TE Jr. Racial disparities in clinical trials. *N Engl J Med*. 2002; 346:1400–1402.
252. Murthy VH, Krumholz HM, Gross CP. Participation in cancer clinical trials: race-, sex-, and age-based disparities. *JAMA*. 2004;291: 2720–2726.
253. Vastag B. Researchers say changes needed in recruitment policies for NIH trials. *JAMA*. 2003;289:536–537.
254. Guidance for industry: collection of race and ethnicity data in clinical trials. http://www.fda.gov/downloads/RegulatoryInformation/Guidances/ucm126396.pdf. Accessed January 25, 2011.
255. Gorelick PB. Mega trials versus small trials in stroke: are more subjects better in a randomized controlled trial? In: Fisher M, Bogousslavsky J, eds. *Current Review of Cerebrovascular Disease.* 3rd ed. Boston, MA: Butterworth Heinemann; 1999:220–221.
256. Gorelick P, Sechenova O, Hennekens CH. Evolving perspectives on clopidogrel in the treatment of ischemic stroke. *J Cardiovasc Pharmacol Ther*. 2006;11:245–248.
257. Adams RJ, Brambilla D; Optimizing Primary Stroke Prevention in Sickle Cell Anemia (STOP 2) Trial Investigators. Discontinuing prophylactic transfusions used to prevent stroke in sickle cell disease. *N Engl J Med*. 2005;353:2769–2778.
258. Adams RJ, McKie VC, Hsu L, Files B, Vichinsky E, Pegelow C, Abboud M, Gallagher D, Kutlar A, Nichols FT, Bonds DR, Brambilla D. Prevention of a first stroke by transfusions in children with sickle cell anemia and abnormal results on transcranial Doppler ultrasonography. *N Engl J Med*. 1998;339:5–11.
259. Caraco Y. Genes and the response to drugs. *N Engl J Med*. 2004;351: 2867–2869.
260. Nebert DW, Russell DW. Clinical importance of the cytochromes P450. *Lancet*. 2002;360:1155–1162.
261. Collet JP, Hulot JS, Pena A, Villard E, Esteve JB, Silvain J, Payot L, Brugier D, Cayla G, Beygui F, Bensimon G, Funck-Brentano C, Montalescot G. Cytochrome P450 2C19 polymorphism in young patients treated with clopidogrel after myocardial infarction: a cohort study. *Lancet*. 2009;373:309–317.

262. Mega JL, Close SL, Wiviott SD, Shen L, Hockett RD, Brandt JT, Walker JR, Antman EM, Macias W, Braunwald E, Sabatine MS. Cytochrome p-450 polymorphisms and response to clopidogrel. *N Engl J Med*. 2009;360:354–362.
263. Burroughs VJ, Maxey RW, Levy RA. Racial and ethnic differences in response to medicines: towards individualized pharmaceutical treatment. *J Natl Med Assoc*. 2002;94(suppl):1–26.
264. Burchard EG, Ziv E, Coyle N, Gomez SL, Tang H, Karter AJ, Mountain JL, Pérez-Stable EJ, Sheppard D, Risch N. The importance of race and ethnic background in biomedical research and clinical practice. *N Engl J Med*. 2003;348:1170–1175.
265. Emanuel EJ, Wendler D, Grady C. What makes clinical research ethical? *JAMA*. 2000;283:2701–2711.
266. Cooper RS, Kaufman JS, Ward R. Race and genomics. *N Engl J Med*. 2003;348:1166–1170.
267. Department of Health and Human Services, Centers for Disease Control and Prevention. Racial and ethnic approaches to community health: about REACH 2010 (1999–2007). http://www.cdc.gov/reach/reach_2010/index.htm. Accessed January 24, 2011.
268. Artinian NT, Fletcher GF, Mozaffarian D, Kris-Etherton P, Van Horn L, Lichtenstein AH, Kumanyika S, Kraus WE, Fleg JL, Redeker NS, Meininger JC, Banks J, Stuart-Shor EM, Fletcher BJ, Miller TD, Hughes S, Braun LT, Kopin LA, Berra K, Hayman LL, Ewing LJ, Ades PA, Durstine JL, Houston-Miller N, Burke LE. Interventions to promote physical activity and dietary lifestyle changes for cardiovascular risk factor reduction in adults: a scientific statement from the American Heart Association. *Circulation*. 2010;122:406–441.
269. Chin MH, Walters AE, Cook SC, Huang ES. Interventions to reduce racial and ethnic disparities in health care. *Med Care Res Rev*. 2007;64(suppl):7S–28S.
270. Davis AM, Vinci LM, Okwuosa TM, Chase AR, Huang ES. Cardiovascular health disparities: a systematic review of health care interventions. *Med Care Res Rev*. 2007;64(suppl):29S–100S.

Racial-Ethnic Disparities in Stroke Care: The American Experience: A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association

Salvador Cruz-Flores, Alejandro Rabinstein, Jose Biller, Mitchell S.V. Elkind, Patrick Griffith, Philip B. Gorelick, George Howard, Enrique C. Leira, Lewis B. Morgenstern, Bruce Ovbiagele, Eric Peterson, Wayne Rosamond, Brian Trimble and Amy L. Valderrama

Stroke. 2011;42:2091-2116; originally published online May 26, 2011;
doi: 10.1161/STR.0b013e3182213e24
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0039-2499. Online ISSN: 1524-4628