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Differential Outcomes by Race and Ethnicity in Patients with Coronary Heart Disease: A Contemporary Review

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Abstract Coronary heart disease (CHD) is a leading cause of death for people of most ethnicities in the USA. However, several racial and ethnic minority groups are disproportionately burdened by CHD and experience higher mortality rates and rehospitalization rates compared with whites. Contemporary CHD research has been dedicated in part to broadening our understanding of the root causes of racial and ethnic disparities in CHD outcomes. Several factors contribute, including socioeconomic and comorbid conditions. These factors may be amenable to change, and targets for initiatives to reduce disparities and improve CHD outcomes. In this article, we review the recently published research related to the distribution and determinants of racial and ethnic differences in CHD outcomes in the USA.

Keywords Race · Ethnicity · Coronary artery disease · Disparities · Outcomes

Introduction

In the USA, race and ethnic minorities are disproportionately impacted by coronary heart disease (CHD). Age-adjusted CHD prevalence is highest among blacks, Hispanics, and American Indian/Alaskan Natives, and lower among whites and Asians or Pacific Islanders [1]. Although substantial reductions in CHD mortality and hospitalization rates have occurred over the past several decades, the declines have not been equal across race and ethnic groups, nor have they eliminated race/ethnic differences in CHD outcomes [2–5]. Though CHD is a leading cause of death for all race/ethnic groups, the CHD mortality rate is substantially higher among non-Hispanic blacks compared with any other racial/ethnic group [2, 3, 6•], and CHD readmission rates are higher among elder Hispanics compared with whites [7]. Several factors have been identified that may contribute to persistent disparities in CHD outcomes, including differences in distribution socioeconomic and clinical resources by race and ethnicity [8, 9]. The purpose of this review is to highlight and to critically evaluate the recently published research to examine factors associated with differential outcomes by race and ethnicity among patients with CHD.

Socioeconomic Status and Access to Care

Socioeconomic position has been identified as a key driver of race and ethnic disparities in CHD outcomes, including mortality and complications following myocardial infarction or revascularization [10].

Age-adjusted case fatality according to neighborhood level household income and by race/ethnicity was recently evaluated among 9116 incident myocardial infarction cases sampled between 1992 and 2002 in the Atherosclerosis Risk in Communities (ARIC) surveillance study [11]. The investigators noted that in the short term (28 days), case fatality did not differ by race [11]. However, over the longer term (1 year), blacks had consistently higher post-MI case fatality rates that whites living in low- and medium-income areas; this race

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difference was not observed in high-income areas [11]. The results from this study suggest that among blacks, the effect of neighborhood income level may play a larger role in longer-term (versus short-term) treatment; for example, it may impact adherence to treatment, access to primary care, and quality of care received [11].

Another major factor currently being studied in conjunction with CHD outcomes is healthcare reform designed to broaden the population that receives healthcare coverage [12]. The impact of healthcare reform on racial and ethnic differences in coronary revascularization rates (coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI)) was recently examined using hospital claims data from adult Massachusetts residents aged 21–64 years [13•]. Participants discharged with a principal diagnosis of ischemic heart disease serviced by the Massachusetts healthcare system before healthcare reform implementation (November 1 2004–July 31, 2006; n=24,216) and after implementation (December 1, 2006–September 30, 2008; n=20,721) were included in the analysis [13•]. Results showed blacks and Hispanics had lower odds of receiving revascularization versus whites in the pre-reform period (odds ratio=0.70; 95 % confidence interval=0.60–0.80, and odds ratio=0.89; 95 % confidence interval=0.78–1.01) [13•]. In the post-reform period, despite expansion of health insurance coverage, blacks and Hispanics continued to have lower odds of revascularization (odds ratio=0.73; 95 % confidence interval=0.63–0.84, and odds ratio=0.84; 95 % confidence interval=0.74–0.97) [13•]. In contrast, Asians had significantly higher odds of revascularization versus whites post-reform (odds ratio=1.29; 95 % CI=1.01–1.65), not observed in the pre-reform period [13•]. These data suggest that in the time immediately following reform, reducing insurance barriers may not eliminate preexisting racial/ethnic disparities of coronary revascularization [13•]; other factors in addition to health insurance coverage may influence racial and ethnic differences revascularization rates among CHD patients.

Quality of Care

The link between race/ethnicity, socioeconomic status, and outcomes after an acute coronary event or revascularization procedure may be associated with differences in quality among admitting hospitals. Historically, the literature has demonstrated that black patients are less likely than whites to be admitted to hospitals with revascularization capabilities and high-quality myocardial infarction outcomes [14].

The current literature continues to yield findings consistent with past results. Medicare data (2007–2010) was recently evaluated to examine racial differences in 30-day surgical readmissions, and the association with hospital site and poverty [15•]. Among CABG patients, blacks and whites who had surgery at minority serving hospitals, and blacks who had surgery at non-minority serving hospitals, had significantly higher (11–17 %) risk adjusted odds of readmission compared with whites at non-minority serving hospitals [15•]. In a separate study, a national Medicare database (2007–2008) was utilized to examine whether hospital quality contributes to racial/ethnic disparities in outcomes after cardiac surgery among CABG patients aged 65 years or more [16•]. The data showed that the hospitals treating the highest number of non-white patients had the highest mortality rates [16•]. Non-white patients had significantly higher risk of mortality after CABG compared to white patients, even after adjustment for patient factors, socioeconomic status, and hospital quality (odds ratio=1.16; 95 % CI=1.05–1.27) [16•]. Taken together, the research suggests that racial disparities in CHD surgical outcomes are in part attributable to differences in hospital quality, but other factors also contribute.

Comorbid Conditions, CHD Risk Factors, and Lifestyle Factors

Differences in distribution of comorbid illnesses, CHD risk factors, and preventive lifestyle behaviors are key factors that are also implicated in contributing to racial and ethnic disparities in CHD outcomes. For example, it is well established that hypertension prevalence is higher among blacks compared with whites, and diabetes mellitus is more common among several race/ethnic minority groups than in whites [2, 10]. A recent analysis of cohort data from two large-scale epidemiologic studies, ARIC (1987–1996) and the REasons for Geographic and Racial Differences in Stroke Study (REGARDS study 2003–2009), documented that a diagnosis of diabetes was associated with a two- to threefold increased risk for CHD mortality, independent of race/ethnic group and other demographic and clinical factors [17]. Another recent analysis from REGARDS among participants 45 years or older without CHD at baseline showed that uncontrolled treatment-resistant hypertension was more common among blacks versus non-blacks and was associated with increased CHD death or non-fatal myocardial infarction (hazard ratio 1.69; 95 % confidence interval 1.27–2.24) [18].

The role that adherence to evidence-based preventive lifestyle behaviors may play in affecting outcomes was recently investigated among 4174 REGARDS study participants with established CHD [19]. Results showed that adherence to physical activity and smoking cessation recommendations were associated with 31–50 % reduced hazard for recurrent CHD and 29–47 % reduced hazard for death compared to non-adherence [19]. There was a strong and graded association between adherence to more preventive lifestyle behaviors (non-smoking, regular physical activity, Mediterranean diet) and reduced risk of CHD and mortality [19]. Blacks in this

study had lower levels of ideal lifestyle behaviors versus whites [19]. Data from this study were corroborated by additional recently published REGARDS results, which documented that among 3167 participants with self-reported coronary artery disease, overall adherence to 7 secondary prevention goals (aspirin use, blood pressure control, lipid management, blood glucose control, non-smoking, healthy body weight, non-smoking status) was lower among blacks versus whites [20].

The impact that race and ethnic differences in CHD risk factor control can have on outcomes was examined among over 65,000 patients undergoing PCI enrolled in the Blue Cross Blue Shield of Michigan Cardiovascular Consortium (PCI January 1, 2010–December 31, 2011) [21]. Compared with white patients, black patients had a greater burden of comorbidities including diabetes, hypertension, and cigarette smoking [21]. After adjustment for comorbidity, black PCI patients had *similar odds* of in-hospital survival post-procedure compared to whites [21]. Race, risk factor control, and outcomes were also recently studied in a setting of comparable access to medical care using data from the Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) trial [22]. Participants (n=1750) all had type 2 diabetes and documented stable ischemic heart disease and received intensive target-based medical treatment for cardiac risk factors [22]. Results showed that race/ethnic minority patients had worse levels for CHD risk factors (hemoglobin A1c, blood pressure, and blood cholesterol levels) at study entry compared to whites. But these factors improved over the study period [22]. Five-year odds of mortality did not differ among white, non-Hispanic black, or Hispanic participants, and improved risk factor control was associated with higher 5-year survival. Taken together, results from these current studies suggest that providing equal access to medical therapy with the goal of uniform risk factor control may reduce racial/ethnic disparities in CHD outcomes.

The link between comorbidity burden and adverse CHD outcomes has also been recently documented in older CHD patients. Analysis of Medicare fee-for-service claims (2007–2009) to identify patterns of 30-day readmission by patient demographic characteristics showed that among 108,992 30-day readmissions after 548,834 acute myocardial infarction hospitalizations, *comorbidity adjusted* hazard ratios for short term (30 days) readmission among black versus white patients were not significant (hazard ratio 0.98; 95 % CI=0.97–1.00) [23].

The differences in short-term and long-term (1-year) outcomes among older (≥65 years) black versus white non-ST segment elevation myocardial infarction (STEMI) patients was also examined among 40,500 patients treated at over 446 hospitals (February 15, 2003–December 31, 2006) participating in CRUSADE (Can Rapid Risk Stratification of Unstable Angina Patients Suppress Adverse Outcomes with Early Implementation of the American College of Cardiology/American Heart Association Guidelines), a voluntary observational data collection and quality improvement initiative [24]. Mortality and readmission rates were examined over a mean follow up of 2.4 years post-myocardial infarction. Compared with whites, blacks were more frequently female, younger, and more likely to have had diabetes, and renal failure, and less likely to have received cardiac catheterization, PCI, or CABG. A 20 % lower risk of mortality was observed among blacks versus whites at 30 days, but at 1 year, a higher mortality was observed among blacks compared with whites. The higher 1-year mortality, however, was no longer significant after risk adjustment. All-cause readmission rates at 30 days and at 1 year did not vary by race after risk adjustment. In a separate study that utilized the CRUSADE database to evaluate outcomes among 37,702 non-STEMI patients ≥65 years old treated at 444 hospitals between 2003 and 2006, it was shown that after risk adjustment, Asian non-STEMI patients had lower mortality (hazard ratio 0.64; 95 % CI=0.50–0.82) and cardiovascular readmissions (hazard ratio=0.79; 95 % CI=0.64–0.98) at 1 year compared with whites [25].

These results suggest that differences in comorbidities and post-discharge factors may impact racial differences in survival and hospital readmissions over the long term among myocardial infarction patients.

Medication Uptake

Observed race and ethnic disparities in CHD risk factor control and outcomes may in part be attributable to differences in evidence-based medication prescription rates or medication adherence [26]. In a retrospective cohort study of 13,354 patients who underwent CABG between 1992 and 2011 at a tertiary referral heart hospital, pre-operative β-blocker use (versus no β-blocker) among black CABG patients was shown to be associated with lower mortality post CABG (adjusted hazard ratio 0.77; 95 % CI=0.67–0.88); among all patients who received pre-operative β-blockers, no statistically significant difference in survival was observed for black patients versus white patients (adjusted hazard ratio=1.1, 95 % CI=0.99–1.2; up to 20 year follow up) [27]. Similarly, results from a study conducted at the same site among 4430 patients who underwent CABG between 2002 and 2011 showed that long-term survival was higher among black patients who were discharged on a β-blocker versus those not discharged on a β-blocker, and the survival advantage was similar with that of white patients (black, adjusted hazard ratio=0.33, 95 % CI= 0.23–0.46; white, adjusted hazard ratio = 0.48, 95 % CI= 0.39–0.58) [28]. Among all patients discharged on a β-blocker, there was no long-term survival advantage for white compared with black patients (hazard ratio=1.2, 95 % CI=

0.95–1.5) [25]. These results are corroborated by additional current research showing lower odds of mortality associated with β-blocker prescription at discharge among cardiac patients, independent of race/ethnic group [29], and suggest that equal access to medications may mitigate disparities in outcomes.

In a large sub-study among participants in the Harmonizing outcomes with Revascularization and Stents in Acute Myocardial Infarction trial (HORIZONS-AMI), the absence of a discharge statin prescription after ST segment elevation myocardial infarction (STEMI) was associated with non-white race, and was an independent predictor of major cardiac events (hazard ratio 1.54; 95 % CI=1.15–2.07) and death (hazard ratio 2.30; 95 % CI=1.41–3.77) at 3 years [30]. Similarly, in a separate study among over 3000 consecutively admitted CHD patients, statin prescription at discharge was associated with a 41 % decreased odds of rehospitalization or death at 30 days; however, discharge statin prescription rate and 30-day rehospitalization rate did not vary by race/ethnic group [31]. At 1 year, race/ethnic minority patients were more likely to be rehospitalized or dead versus white or Asian patients, independent of discharge statin prescription [31]. These results, like those linking socioeconomic factors to outcomes, suggest that issues that come into play after the immediate 30-day post-discharge period (e.g., adherence to the prescription, prescription refill, or other medical follow-up compliance factors) may contribute to racial and ethnic CHD outcome disparities [31, 32].

Complications and Other Factors

Racial or ethnic differences in factors related to patient experiences or complications when receiving cardiac care may also impact CHD outcomes [33]. For example, prior to revascularization, small significant differences in door-to-balloon time among STEMI patients undergoing PCI among African American, and Hispanic versus white male patients have been identified using contemporary national data [34]. Because these differences were observed in men and not in women, they may be attributable to patient factors other than race or ethnicity [34].

There is also a growing body of evidence that other factors may contribute to adverse long-term outcomes *after* revascularization among blacks versus whites, independent of socioeconomic status, comorbidities, or medication adherence. For example, higher rates of stent thrombosis among blacks have been hypothesized as a possible contributing factor [35]. Race/ethnic differences in long-term outcomes after PCI was recently evaluated among TAXUS IV and V and ATLAS trial participants with paxlitaxel-eluting coronary stents [36]. Adjusted 5-year rates of myocardial infarction and stent thrombosis were higher among blacks versus whites and not different between Asians and whites [36]. Mortality and revascularization rates were similar among whites, blacks, and Asians [36]. In a separate single site study among 227 patients documented to have left main coronary artery disease who underwent PCI at an urban academic medical center between March 2000 and December 2008, African American race was associated with an almost fourfold higher odds of death or recurrent myocardial infarction compared with whites and others 1 year after revascularization, after adjustment for age, sex, and comorbid conditions [37]. Finally, in a large cohort study that utilized the nationwide inpatient sample of 1,924,413 patients admitted for myocardial infarction between 2006 and 2008, blacks had a 35 % higher adjusted odds versus whites to have a cerebrovascular accident following an acute myocardial infarction [38].

Race and ethnic differences in post-CABG complications have also been documented. Post-operative atrial fibrillation is a known predictor of increased mortality after CABG, and white patients are at notably at higher risk versus black and other non-Caucasian patients [39]. However, among a cohort of 2907 patients who developed atrial fibrillation following CABG at the East Carolina Heart Institute between 1992 and 2011 (n>13, 000), black patients were 20 % more likely to die than their white counterparts (adjusted hazard ratio 1.2; 95 % CI=1.02–1.4; mean follow-up 8.2 years) [40]. The same research group examined the association between (1) diabetes, (2) chronic obstructive pulmonary disease (COPD), (3) peripheral arterial disease (PAD), and (4) dialysis, with race and long-term outcomes among patients who underwent isolated CABG [40–43]. Long-term survival (median follow-up 8.2 years) after CABG was similar among black and white patients with diabetes [41]. After a median follow-up of 4.4 years, COPD was observed to be an independent predictor of decreased survival independent of race after CABG; black COPD patients did not have different survival experience compared to white COPD patients post CABG [42]. In contrast, after a median follow-up of 8.3 years, risk of death after CABG was significantly higher among black PAD patients compared to white PAD patients [43].

Studies of race/ethnic differences in mortality after CHD revascularization among dialysis patients indicate that whites are at higher risk. Among the 207 hemodialysis patients who underwent first-time isolated CABG procedures between 1992 and 2011, white patients had a significantly higher 5-year mortality risk compared with black patients (adjusted hazard ratio 1.9; 95 % CI=1.2–2.8) [44]. Similarly, in a national study of long-term survival after coronary revascularization in dialysis patients, black versus white race was independently associated with lower risk of mortality after revascularization with drug

eluting stent (hazard ratio=0.87; 95 % CI=0.82–0.91), bare metal stent (hazard ratio=0.86; 95 % CI=0.79–0.94), and CABG (hazard ratio=0.88; 95 % CI=0.81–0.95) up to 6 years after revascularization [45].

The differences in CHD symptom presentation or recognition may also contribute to outcome disparities. For example, black women may present with fewer chest-related and more stomach-related symptoms, regardless of the presence or severity of coronary disease [46]. These racial symptom presentation differences were linked with higher mortality in black versus white women in the NHLBI-Sponsored Women's Ischemia Syndrome (WISE) study of women undergoing coronary angiography for suspected ischemia and without prior history of CHD [46].

Conclusions

Current research indicates that observed disparities in CHD mortality and hospital admissions are associated with (1) patient-level factors such as higher comorbidities, worse risk factor control, sub-optimal preventive lifestyle behaviors, and medication non-adherence, as well as with (2) system-level factors such as low neighborhood socioeconomic status, low access to healthcare, and poor hospital quality. In some studies, there was evidence that disparities persist after controlling for clinical and socioeconomic conditions, suggesting that there are additional factors which may contribute to racial and ethnic differences in CHD outcomes that are not yet identified, or well measured. Cultural competency of healthcare providers and systems, psychosocial stress, prejudice, discrimination, and bias are additional factors that may impact both patient and system-level CHD care and outcomes [47, 48]. Additionally, the majority of new research compares CHD outcomes among blacks versus whites; less information is available from other race or ethnic groups.

Continued research to evaluate strategies to better understand socioeconomic factors and to develop environmental interventions to eliminate racial and ethnic disparities in CHD outcomes is needed.

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Compliance with Ethics Guidelines

Conflict of Interest None.

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